5th International Conference on Building Resilience

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ACKNOWLEDGEMENTS

As Chairs of the International Conference on Building Resilience 2015 we are delighted to have the opportunity to hold this conference.

The Local Organising Committee met regularly and together we made an array of, hopefully better, key decisions! All involved have provided a willing source of on-going support and guidance that is very much appreciated. Our thanks go to the International Scientific Committee members who made extensive efforts in reviewing papers to tight time scales in ensuring the high quality of the conference. We also thank the keynote speakers for their willingness to stimulate invaluable discussions and debate around the conference theme. We also thank session chairs for agreeing to ensure the conference is as challenging, exciting and rewarding as possible.

We have received exceptional help and support from a number of people, organisations and bodies in the work for this conference. We must firstly acknowledge the invaluable support from Professor Dilanthi Amaratunga and Professor Richard Haigh of the Global Disaster Resilience Centre of the University of Huddersfield UK. Dilanthi and Richard have traditionally conducted this conference series but they were very kind and generous for providing our institution with the opportunity to conduct the conference in 2015. A special thanks must go to Professor Srinath Perera Chair of Construction Economics, Department of Architecture and Built Environment at Northumbria University, UK. Professor Perera has been a driving force behind the Doctoral Workshop.

We would particularly like to acknowledge the support of Professor Kevin Hall, Deputy Vice Chancellor (Research and Innovation) of the University of Newcastle, and Professor SueAnne Ware, Head of the School of Architecture and Built Environment, Faculty of Engineering and Built Environment at the University of Newcastle. In addition to funding by means of a sponsorship, the School of Architecture and Built Environment at the University of Newcastle provided unwavering backing and encouragement.

Organisations that have acted as conference partners are especially thanked. The efforts involved with a conference of this scale are significant and it would not have been possible to organise this conference without their assistance. We particularly thank: University of Newcastle and its School of Architecture and Built Environment; The Faculty of Engineering and Built Environment.

The International Conference on Building Resilience 2015 is being held in conjunction with ANDROID (Academic Network for Disaster Resilience to Optimise Educational Development), which aims to promote co-operation and innovation among European higher education institutions to increase society's resilience to disasters of human and natural origin – such as earthquakes or the damage caused by on-going wars. ANDROID is an EU funded research project which aims to modernise higher education institutions through governance reforms. The Hiddersfield University of in the United Kingdom leads this project in partnership with 64 European higher education institutions and three institutions from Australia, Canada and Sri-Lanka.

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Most of all, we want to thank our colleagues who worked very hard for the professional undertaking of the work involved in the tasks that are so often unseen and unrewarded for a conference of this scale. We thank Dr Kaushal Keraminiyage for all his efforts on the development and management of the conference database, Associate Professor Thayaparan Gajendran for his work in organizing the Doctoral workshop. We also thank our Students from the Master of Disaster Preparedness and Reconstruction for their excellent support with leading up to during the conference.

Finally, we would not have been able to make this event happen without the support of specific professional staff in the School of Architecture and Built Environment who deserve special thanks from us for the professional way in which they have managed the complex arrangements for delegates, all internal transport, printing assignments, and coordination of our suppliers they are SallyAnne Herron, Carrol Wood, Joanne Connor and Christopher May.

PREFACE

This book contains the abstracts of keynotes and papers submitted to, double blind peer reviewed, and accepted for the 5th International Building Resilience Conference 2015, 15th – 17th July at Newcastle City Hall, Newcastle, Australia.

The Conference is organised by: the School of Architecture and Built Environment, Faculty of Engineering and Built Environment at the University of Newcastle; the Global Centre for Disaster Resilience, Huddersfield University, UK. The Conference is organised in support of the UNISDR 'Making Cities Resilient' campaign and in association with our partners: the ANDROID Disaster Resilience Network; the United Nations International Strategy for Disaster Risk Reduction (UNISDR); the Asian Disaster Preparedness Center (ADPC); the Royal Institution of Chartered Surveyors (RICS) UK, Disaster Management Commission; and the International Journal of Disaster Resilience in the Built Environment, Emerald Publishing.

Communities around the world are faced with the threat of disasters on a daily basis. National governments, local government associations, international, regional and civil society organisations, donors, the private sector, academia and professional associations as well as every citizen needs to be engaged in reducing their risk to disasters. All these stakeholders must play their part in contributing to building disaster resilient communities. The 2015 International Conference on Building Resilience encourages debate on individual, institutional and societal coping strategies to address the challenges associated with disaster risk.

Key themes include:

1. **Resilience**
    1. Conceptual understanding of resilience
    2. Overall systems resilience
    3. Measurement of resilience
2. **Built environment**
    1. Structural mitigation
    2. Infrastructure
    3. Sustainable development
    4. Shelter and housing
3. **Communication**
    1. Community engagement and participation
    2. Inter-disciplinary working and partnerships
    3. Digital media
    4. Knowledge management
4. **Disaster risk**
    1. Multi-hazard scenarios
    2. Risk assessment, monitoring and evacuation
5. **Slow-onset disaster**
    1. Conceptual understanding of slow-onset disasters
    2. Climate change impacts and slow-onset disasters
    3. Risk assessment and monitoring of slow-onset disasters
    4. Social impacts of slow-onset disasters
6. **Healthcare facilities, infrastructure and system resilience planning**
    1. Emergency planning and disaster response
    2. Community resilience planning for emergency preparedness
    3. Social determinants of health
    4. Health and wellbeing of disadvantaged and socio-economically excluded populations
    5. Health system resiliency planning
7. **Social resilience**
    1. Livelihoods
    2. Social protection and vulnerability
    3. Social support processes
    4. People, displacement and security
8. **Governance**
    1. Local government and disaster risk reduction
    2. National planning
    3. Role of NGOs
    4. Evidence based policy making
9. **Education**
    1. Capacity building
    2. Lifelong learning

This event builds upon the successful 2008, 2011, 2013 and 2014 International Conferences on Building Resilience, which was held in Sri Lanka and the United Kingdom. The 2011 Conference was held in association with the launch of The Making Cities Resilient: 'My City is getting ready!' campaign, which addresses issues of local governance and urban risk. The 2013 Conference further supports the campaign focus areas up to 2015, including city-to-city learning and capacity building, and an emphasis on partnerships.

The Conference organisers are also delighted to welcome three keynote addresses by leading academics and practitioners: Professor Kevin Hall, Deputy Vice Chancellor (Research and Innovation), University of Newcastle, Australia; Dr. Louise Brooke-Smith immediate past Global President of the RICS; Professor Makarand (Mark) Hastak, Professor and Head of Construction Engineering and Management Purdue University USA. These keynote addresses provide a local and global perspective and vision for disaster resilience research.

Further contributions to the Conference are made by members of the research community and practice that address disaster risk and the need to develop resilience from diverse perspectives, as demonstrated by the range of subjects tackled by authors. The abstracts are a brief summary of the full research articles that can be found in the USB Drive that accompany this book. All abstracts and full papers were reviewed in their entirety, prior to publication, by the International Scientific Committee comprising independent, qualified experts. The Editors would like to extend their sincere gratitude to all the authors of the published contributions for their excellent work and participation at the International Conference on Building Resilience 2015.

The conference is being held in Newcastle, a metropolitan area is the second most populated area in the Australian state of New South Wales and includes most of the Newcastle and Lake Macquarie local government areas. It is the hub of the Greater Newcastle area which includes most parts of the local government areas of City of Newcastle, City of Lake Macquarie, City of Cessnock, City of Maitland and Port Stephens Council. 162 kilometres NNE of Sydney, at the mouth of the Hunter River, it is the predominant city within the Hunter Region. Famous for its coal, Newcastle is the largest coal exporting harbour in the world, exporting over 97 Mt of coal in 2009–10 with plans to expand annual capacity to 180 Mt by 2013. Beyond the city, the Hunter Region possesses large coal deposits. Geologically, the area is located in the central-eastern part of the Sydney basin.

Recenlty Newcastle has had a number of devastating significant events that have resulted in severe damage. The most recent was in April 2015 the result of a large east-coast low (similar to a tropical cyclone) that left the city devastated and closed for a number of days. It is our hope that Newcastle will benefit greatly from the research and activities associated with the Conference, and that the city provides an appropriate backdrop for tackling challenging questions about how to develop disaster resilient communities.

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Does the post-disaster resilient city really exist? A critical analysis of the heterogeneous transformative capacities of housing reconstruction 'resilience cells'

Angeliki Paidakaki
KU Leuven
Frank Moulaert
KU Leuven

Abstract

Coined by ecological sciences, the concept of resilience has been widely used in disaster scholarship as a tool to conceptualize and enhance capacities of organizations and communities in the face of natural risks. While radical in relation to its stress on systems renewal and transformation, the concept still needs further socio-political reconstruction to become useful to lead responsiveness to urban realities on the ground. The nexus and interactions of various parameters that define and guide future 'resilience' trajectories – such as physical infrastructure, social and spatial inequalities, path dependencies and complex governance systems, power relationships and competing discourses, human agency and political mobilization – need to be better disentangled. By focusing on the chronology of post-disaster housing reconstruction processes and examining the tensions therein between the various discourses that steer housing production, we aim to put a spotlight on the heterogeneity in the transformative capacity of the various actors, institutions and visions of housing systems that preexist or emerge in the post-disaster city. This heterogeneity of 'resilience cells', such as growth coalitions, neighborhood associations and housing cooperatives, will consequently lead the discussion towards the investigation of 'new' roles of the state in negotiating and formulating relevant disaster governance models and housing (re)construction systems.

Keywords: resilience, urban political ecology, housing reconstruction, discourse, power, path dependency, social innovation, governance, redundancy, resilience cells

1. Introduction

Disaster scholarship is a dynamic interdisciplinary research arena which has been preoccupying itself with natural hazards for at least six decades. Some of the questions it strives to answer are: How is risk perceived? What is the risk natural hazards pose to (urban) communities/human settlements? Who will be responsible for dealing with this risk? with what means and towards what ends? The concept that currently dominates the disaster discourse is that of resilience. Initially theorized in the 1970s by Holling as an ecological concept, resilience was later reformulated as a potentially useful tool to build, develop or reinforce capacities in organizations, local communities and entire systems to withstand future unexpected natural episodes (Kuhlicke, 2013). While first used to refer to the ability of an ecosystem to resist shock, today the concept has evolved and encompasses a more thoughtful understanding of what resilience implies, taking into account the multi-dimensionality of urban, peri-urban and rural systems, including their physical infrastructure, social and spatial inequalities, path dependencies and complex governance systems, power relationships and competing discourses, human agency and political mobilization. However, this understanding is still at an embryonic level. So far, few studies have unpacked the contentious nexus between pro-justice and pro-growth rhetoric, resilience planning and disaster governance. Some of the questions that urgently need to be answered are the following: Resilience of what, to what and for whom? Who is benefiting from mobilizing and imposing a biased understanding of resilience and to what end? Whose interests are best promoted and accommodated by a post-disaster 'dynamic transformation'? Who is in the decision-making room for post-disaster rehabilitation, which socio-spatial-unit focus is chosen, whose knowledge and whose recovery is prioritized? (Kuhlicke, 2013; Wilkinson in Davoudi et al., 2012)

In this article, we argue that there are various 'resilience cells' within cities, namely social groups of various kinds who have their own language and defend their discourses based on their own common values, needs and aspirations and sometimes ideological foundations. Some 'resilience cells' are more powerful compared to others, in terms of recognition, access to resources, facilitation of their needs through policy orientations, legislative amendments and spatial planning. However, we assume that what makes a system resilient is a just redistribution in terms of resources and cultivation of empowerment of the various 'resilience cells' that preexist or emerge after a natural crisis and struggle for their right to resilience equity. We further assume that this redistribution can only be facilitated by the state, as a mediating body with legislative and executive powers which interacts with the 'resilience cells' and provides the best possible conditions for all to peacefully co-exist, survive, and evolve. Our assumptions will be backed up with theoretical insights..

The theoretical insights feeding the argumentation of this paper derive from urban political ecology (Swyngedouw 2005; 2006; 2009; 2010), housing studies (Turner 1972; 1974; 1978; 1980), and socially innovative governance (Moulaert 2005; 2007; 2010). In order to unpack the heterogeneous transformative potential of urban systems, according to which we will later reconceptialize the notion of resilience, we will narrow down the focus of the analysis on the post-disaster housing reconstruction period but with a historical retrospect when this is contextually relevant. This will provide disaster analysts with an analytically significant long-term chronological platform on which they can test how resilience is variously imagined and re-imagined, shaped and reshaped in terms of discourses, policy orientations, values and actions. The (a)symmetry of power relations among the agents who hold different understandings of resilience, we argue, further guides the implementation of a 'city's resilience' with a particular set of actions and initiatives while alternative ones in terms of means, goals and aspirations are either wasted away or highly contained. The reason why we take a housing construction perspective is two-fold: first because it is a micro-urban system with its own discourses, governance, and resources that reflects the wider urban socio-physical complexities; and second because we believe that because of its multi-dimensionality housing plays a key role in avoiding and overcoming disasters not only through replacing damaged or destroyed materiophysical assets, but also because of its potential to enhance democratic redevelopment with an eye towards socioeconomic changes and the betterment of the life of communities.

The exploratory journey of this paper will take the following steps. In section 1, we will embark on the investigation and critical analysis of the evolution of the disaster resilience concept. After presenting the state of the art in the disaster resilience scientific discourse and identify some of the current knowledge gaps in the disaster resilience problematic, we will be in a better position to suggest future research trajectories and perspectives that can fill the emerged lacuna in the literature. In section 2.1, this lacuna will become the fuel to take off and examine disasters from a zoomed-out, urban political ecology perspective. After viewing the whole urban picture, in sections 2.2 and 2.3 we will visit the micro-system of housing production, which to a great extent reflects the wider urban socio-physical complexities. By digging out different dynamics in the housing system (i.e. pro-growth regimes, social innovation, path dependencies, governance structures and the role of the state etc.), as well as revealing the different political opportunities offered by housing production within the context of post-disaster reconstruction, we will be analytically more empowered in section 3. to return to the notion of resilience and consider it with a fresh critical look. The section 4. seeks room for some conclusive remarks regarding the importance of governing post-disaster 'resilience cells'.

2. Resilience: an overview of the scientific discourse and the state of the art

In the 1970s, the disaster scholarship took the concept of resilience up in response to the inherent uncertainties embedded in the pre-existing technocratic approach of 'absolute protection' (Berkes 2007; Klein et al. 2003; Allenby and Fink 2005; de Bruijn 2004; Kuhlicke and Kruse 2009; Merz et al. 2010 in Kuhlicke, 2013). Since then, the concept has developed different 'facial' features; starting from strong ecological ones, that later developed into more complex socio-physical and which recently evolved into more socio-critical and political.

The ecological face of the disaster resilience concept was introduced by Holling in the 1970s. Trained as an ecologist, Holling understood resilience as a ‘‘measure of the persistence of systems and of their ability to absorb change and disturbance in a timely manner and still maintain its ongoing functions and controls as well as the same relationships between populations’’(Holling, 1996: 31 cited in Davoudi et al., 2012). The characteristics he attributed to resilience were those of 'efficiency, constancy and predictability', all of which are desirable qualities for a 'fail-safe' engineering design. The time dimension was another strong given characteristic, to test systems resilience by how fast they reestablish their pre-disaster status of normality (Davoudi et al., 2012).

However, these characteristics could not perfectly adjust into the context of an urban environment. From an urban sociology perspective, the detachment of nature from society is fundamentally misleading. It leads to the social construction of hazards as disorders and hence the resilience focus is mainly on the urban spatial dimensions (disaster-prone regions) and not on the social dimensions (and primarily disaster vulnerable groups and individuals) (Oliver-Smith, 2004; Few 2003). The assumption of a return to the former state of equilibrium and the 'resistance to change' perspective are also misjudgments that underestimate social complexity, the adaptive evolution and the ability for transformation of urban human systems (Lorenz, 2013). At the same time, this 'bounce back' quality is socially and politically undesirable when taking into consideration the perils of returning to pre-disaster structures and institutions that had given birth to vulnerability and the conditions that instigated the disaster in the first place (Manyena 2009 in the Editorial of Local Environment, 2011). While the ecological characteristics of resilience make better sense when applied in robust engineering structures able to withstand natural shocks in the short-term, they are inadequate in tackling the underlying chronic social determinants of vulnerability as well as in reflecting the long-term social learning, institutional adaptation and social transformation triggered by the disaster and maintained across time guiding future disaster planning trajectories.

To address this limitation, the disaster resilience discourse surpassed a nature-society dualism and placed its focus on adaptation, in the sense of 'bouncing forward' and envisioning new imaginations of a safer city (Manyena 2009 in the Editorial of Local Environment, 2011). This focus on the adaptive capacity underpins the undiscovered evolutionary dimension of resilience, molding new, social features onto the face of resilience. Resilience in this perspective is understood not only as a fixed asset (in terms of engineering and ecological robustness), but also as a continually changing, socially transformative process (Davoudi, in Davoudi et al., 2012). This approach underscores the importance of developing a capacity to track down “the opportunities that always arise during a crisis to emerge stronger and better than before” (Seville, 2009: 10 cited in Davoudi et al., 2012). Strength and betterment are interpreted here mainly in social justice terms, manifested in a more just redistribution of social bads and goods that will allow the levels of vulnerability of the various social subpopulations embedded into spatially defined systems (cities, neighborhoods) to be less polarized (Cutter et al., 2008; Vale and Campanella, 2005 cited in Duval-Diop et al., 2010).

The 'bounce forward' ability conceptualization of resilience has implications for disaster research and scholarship because it helps us to re-think about the underlying philosophical arguments, particularly those around social engineering, structure and agency (Editorial of Local Environment, 2011). Various social groups and institutions will reorganize themselves in order to increase their capabilities to influence change, most of the times in a contentious way. While on the one hand, the 'bouncing forward' represents a more radical agenda and an attractive and plausible proposition (Shaw cited in Davoudi et al., 2012), on the other hand, the burning question is bouncing forward to what and for whom? (Porter and Davoudi in Davoudi et al., 2012) Whose knowledge and whose recovery are prioritized? (Kuhlicke, 2013; Editorial of Local Environment, 2011). In a nutshell, whose transformative ability will be enhanced and whose will be undermined? In order to respond to these critical questions, the resilience face has recently developed political features. The aim is to better theorize and operationalize the political moment in which disaster resilience can be institutionalized into urban planning (see also Swyngedouw, 2009a).

By placing emphasis on the unbalanced power relations embedded in human systems, commentators argue that the most powerful stakeholders sanction alternative opinions and actions by consolidating a position of superiority with reference to their own hegemonic social construction of 'resilience' (also see Davoudi, 2012; Cannon and Müller-Mahn 2010, in Davoudi et al., 2012; Kuhlicke, 2013). From this perspective, resilience is clearly acknowledged to be a fundamentally debated and politically fraught discourse “enwrapped with power relations and enabling some effects while closing down others” (Leach, 2008: 13 cited in Davoudi et al., 2012). Like that, we argue, protection measures should not only be focusing on how the cities relate to a natural hazard, but also how different social systems form an environment for each other, posing risks to one another, in terms of unjust oppression of alternative meanings and capacities of resilience (see also Teigão dos Santos and Partidário, 2011). Through these lenses, the discursive call for resilience can never be a-political or power-blind. However, there are notably few publications, if any, that address the socio-political contention over the meanings of resilience which then steers and gives shape to the pursued security actions in practice (see also Wilkinson in Davoudi et al., 2012). The interactions between discursive hegemony (or antagonism), power relations, social innovation and recognition that ultimately drive governance models and steer resource trajectories need to be unpacked and investigated urgently. For that purpose, we will mobilize insights stemming from urban political ecology, and especially the concept of metabolic circulations, in order to take a zoomed out perspective of how all the afore-mentioned parameters interplay with each other, sketching the complex socio-physical and political profile of a city. We will then zoom in and dig into the mechanisms of the urban subsystem of housing production and allocation in order to dig out a heterogeneous transformative potential of post-disaster building processes which ultimately define and operationalize resilience in a variety of ways.

3. Resilience revisited; a housing perspective

3.1 The urban political ecology of housing reconstruction

An urban political ecology approach can be used as a theoretical tool for analyzing how decision-makers arbitrate the distribution of resources and in doing so, develop into leading agents in the governance and control of the populations of whom they are accountable (Smith and Ruiters, 2006). Cities are conceived as vehicles constituted in and through metabolic circulatory socio-ecological flows (Cook and Swyngedouw, 2012). The heterogeneous assemblages that emerge are central to a historical-geographical materialist ontology (Swyngedouw, 2006). To understand the meaning of it, we need to treat urban ecology not so much as a question of values, morals, or ethics, but rather as a mode of "understanding the evolving material interrelations between human beings and nature" (Foster, 2000: 10–11 cited in Swyngedouw, 2006). Swyngedouw and Heynen (2003: 905) explain that "under capitalist social relations, the metabolic production of use-values operates in and through specific social relations of control, ownership and appropriation and in the context of the mobilisation of both nature and labor produce commodities (as forms of metabolized socionatures) with an eye towards the realization of the embodied exchange value". Metabolic circulations such as real estate trends and land speculation, changing economic and political landscape, changing population trends, changing housing demand, trends in private philanthropic, competing rebuilding interests within city boundaries, multi-state advocacy efforts, ongoing rebuilding efforts (Duval-Diop et al., 2010) are instilled by different levels of power and generate positions of empowerment and dis-empowerment (Cook and Swyngedouw, 2012), recognition and misrecognition.

This ultimately results in the establishment of such conditions under which particular trajectories of socio-environmental change weaken the socio-economic stability of some social groups or geographic spaces, while the sustainability of social groups and places elsewhere might be reinforced (Swyngedouw and Heynen, 2003). When digging deeper into the politics of socio-ecological transformations, we are in a better position to tease out a) who (or what discourse) gains from and who pays for, b) who (or what discourse) benefits from and who suffers (and in what material and non-material ways) from particular processes of metabolic circulatory change, and c) what or who needs to be protected and sustained and how this can be supported and accomplished (hegemonic vs. non hegemonic narratives and actions) (Swyngedouw, 2010).

At the same time, urban trajectories are never stagnant. They are in a continuous, mostly slow flux. What tends to be witnessed in moments of crises is an accelerated renewal of the urban system. The mechanisms of crisis and recovery may both provoke and accelerate social innovation, in terms of satisfaction of specific needs (usually material like housing, but also socio-cultural, or political in terms of empowerment and cultivation of citizenship) and changes in social relations including governance relations by virtue of collective initiative (Moulaert, 2010; 2013). For example, associations, co-operatives and solidarity networks come into being amid conditions of deprivation of human needs and fill the gaps in institutional forms to carry forward alternatives (co-operative organization of the social firm, redistribution mechanisms, legal status of third-sector initiatives) (Moulaert et al., 2005). This emergence and re-emergence of social innovation is the response to the alienation and non-satisfaction of a variety of needs by the traditional sectors (private and public) in times of socioeconomic and natural crisis (Moulaert and Ailenei, 2005). Dynamic, new trajectories have the potential to startlingly change the pre-crisis, urban metabolic profile.

To better illustrate the afore-mentioned intricate politico-urban dynamics and how they interact with socially innovative practices and processes, we focus on housing systems. In this paper, we make the assumption that a post-disaster housing reconstruction period can be a relevant political moment in which we can start theorizing and operationalizing resilience into urban planning. We argue that housing, beyond its apparent socio-economic importance, and its exosceleton protective value for the human body (Erguden, 2001; Bullard and Wrigth, 2005, cited in Masozera et al., 2007; Gandy, 2005: 28 cited in Cook and Swyngedouw, 2012), is also an instrument for action by people, a potential paradigm for change depending on contextual factors, such as, the relations between public authorities, civil organizations and developers; the amounts and sources of reconstruction funding; and the ability of people and communities to voice their needs and demands in the aim to rebuild damaged living conditions (Turner, 1978). On the one hand, housing reconstruction presents an opportunity for progress in the functioning of the community, starting from discussing housing alternatives to bringing up the questions of human rights and changes in socio-political relationships (Boano and Hunter, 2012; Johnson, 2011;

Sattherthwaite, 2011), while on the other hand, it provides an opportunity for re-triggering processes of wealth accumulation. We argue that the ultimate design of reconstruction policies and the allocation of rights in the reconstruction 'experiment' will depend on the how the state best accommodates the various housing discourses advocated by various groups who envision development and mobilize actions in radically different ways.

To be more explicit, the housing system landscape could be characterized by the following provisional bipolar division: one the one hand, we witness the powerful pro-growth urban coalitions, consisting of powerful local actors and institutions (i.e. developers, realtors, bankers, utility companies) working together to generate and extract *exchange values* through ongoing land-use intensification (including hazard-prone areas, usually on the coast) (Bull-Kumanga et al., 2003). These agents define housing problems by material standards and housing values are determined by the material quantity of related products, such as profit or equity (Turner, 1980). Houses are, hence, treated as commodities subdivided into lots, ready to become the object of a profitable transaction in the free market (Pais and Elliot, 2008). On the other hand, we observe the, generally less powerful, pro-equity coalition, individual homeowners and their associations, neighborhood associations and civic groups who advocate primarily for *use values* and who are interested in preserving and improving the local quality of life (Pais and Eliott, 2008). It is also these groups who advocate in favor of a qualitatively richer housing market or a more just distribution of economic resources (Davoudi et al., 2012).

In between these two groups we further observe a variety of organizations who are engaged in co-materializing initiatives; namely placing emphasis on housing production as a collective activity, and not as an end product. Either connected to ideological connotations or triggered by traditional housing market exclusion due to financial insolvency, these groups undertake responsibility for their own social reproduction and housing reconstruction. Their mode of organization usually manifests itself through disaster affected homeless people's cooperatives, community land trusts, and grassroots rebuilding initiatives collectively erecting houses in 'solidarity' style (Biel, 2012; Satterthwaite, 2011)

What we contend is that all these three broadly-grouped-housing agents have their own transformation capacities. Their differentiation – across and among them – lies in the ways by which they understand and materialize transformation, and the answers they give to questions like: For whom are we rebuilding? How do we provide for the needs of all the people who were displaced by a natural disaster? Who should be sitting in the decision-making room? Who should rebuild? What civic principles and moral values are on the table that frame and push reconstruction processes forward? (Gutmann, 2006)

The symmetries or asymmetries in power relations among the social agents occupying different positions in the housing system(s) will respectively empower or dis-empower voices echoing alternative developmental values attached to housing (and the consequent manifestation in housing actions and programs), which will ultimately define the orientation of urban planning processes and future socio-environmental metabolic ontologies, and hence the trajectories of the disaster resilience scientific discourse.

3.2 The heterogeneous developmental potential of housing reconstruction

The discussion on transformation inevitably leads us to ask an urgent question: a transformative process with an eye towards resilience steered by who and heading in which direction? An interesting way to unpack the transformative heterogeneity within housing systems is by embarking on John Turner's (1972; 1974; 1980) influential idea of treating housing either as a verb or as a noun. This idea lies on the following distinction: "When (housing) is used as a noun, (it) describes a commodity. When used as a verb, it describes the process of housing. If housing is treated as a noun, then different kinds of agencies will plan for and provide for people's housing needs with the result that homeless people become consumers or passive beneficiaries. If housing is treated as a verb, decision-making power is equally distributed and homeless people may participate in directing the construction of their own houses or may even become involved in building them". Both treatments share transformative potential. One the one hand, when housing is treated a noun, and hence as a commodity, the growth logic is celebrated, and the real estate use values are transformed into exchange values in order to cater for wealth accumulation. On the other hand, when housing is treated a verb, the material aspect of the housing need is only met through the simultaneous activation of sociopolitical processes aiming for a more inclusive and democratic housing governance system (Boano and Hunter, 2012; Gonzalez et al., 2010).

3.2.1. Housing as a noun: recommodifying housing

When housing is seen in a materialistic manner, constructed as top-down, profit-generating product (see also Boano and Hunter, 2012; Johnson, 2011), a 'growth ethic' is promoted. The 'bouncing back' reconstruction rhetoric in the aftermath of natural disasters is translated as a return to normal housing markets. Consequently, Davoudi et al. (2012: 332) argue, "the possibilities of transformation will conveniently suit the neoliberal urban growth, regeneration and renewal agendas that have persistently dominated planning discourses for the past 30 years". The 'reconstruction project or experiment' provides a new set of opportunities for accumulation of capital in formerly public sectors of the disaster-affected region's political economy. Thus, disasters create a momentous occasion and basin of resources for the region's pro-growth coalition to accelerate and even expand long-established plans for transforming real estate use values into exchange values for private development (BondGraham, 2011). By voicing the need to return to 'normality', the priority is not to meet the housing needs of the majority of the disaster-affected (neo)homeless citizens, but, rather, to invest in profit-generating sectors (Adams et al., 2009), resetting the 'ground rules' for appropriate behavior in cities, generally defined by middle-class norms and with minimalist supply-side interventions (Peck, 2006).

But what exactly does 'normality' entail in housing systems? Davoudi et al. (2012) arguably criticize the depolitcized and normalized understanding of the housing-markets’ normality, when evidently over-inflated housing markets, predatory lending practices, and gross wealth disparities are socially and spatially dysfunctional in a profound way. However, this post-disaster planning discourse remains hegemonic by promising growth that is good for everyone on the basis that it brings new jobs, taxes and stature to the area and reconstitutes citizens’ pride and the collective psyche (Pais and Elliot, 2008). In this way, the post-disaster landscape provides the opportunity for capitalistic modes of housing production to renew themselves by entering new cycles of wealth accumulation (Biel, 2011). This local growth is also state-driven, as governments at different scales hold legal authority over zoning and land-use decisions, while at the same time are well positioned to leverage capital investments. This serves the 'inherent' elite practices of producing space and built forms well (Pais and Elliot, 2008). Therefore, privatization goes hand in hand with state intervention in the form of rules, laws, policy tools and programs to stimulate private investment and benefit and empower private contractors (Gotham, 2012, 2014). At the same time, Seidman (2013) rightly reminds us that post-disaster neighborhood rebuilding is also about re-population; about bringing people back to reclaim a neighborhood as their home. As a reaction to unjust post-housing trajectories – which usually mirror the pre-disaster ones – we also observe examples of individuals and organizations rediscovering the values of solidarity and reciprocity, who organize themselves in various ways in order to cater for their housing needs (or fight for their housing rights), as well as groups imagining new modes of collective housing ownership or housing (re)building in a socially collective way.

2.2.2. Housing as a verb

When housing is treated as a verb, people (re)claim their right to determine and act upon their own specific housing needs and priorities (Turner, 1980). In social innovation terms, it is about meeting a material housing need through activating the capacity building and governance dynamics of social movements and initiatives (Martinelli, 2010). In this case, buildings contain political essence due to their physical relation with specific social processes regarding empowerment, recognition of previously silent or housing excluded social groups, changes in the existing social – and power– relations towards a more inclusive and democratic housing governance system (Boano and Hunter, 2012; Gonzalez et al., 2010).

What is important to note is that post-disaster emerging and pre-disaster existing social mobilization regarding housing issues varies in terms of ideology, interest and agendas, modes of action, level of professionalism, cooperation with or against the state, and/or in favor or against the socio-political status quo (Swyngedouw, 2009b; Johnson, 2011; Gonzalez et al., 2010).

Within this landscape of social movements, power imbalances are also to found. According to Swyngedouw (2009b: 74), this ultimately determines “the rise and prominence of new social actors, the consolidation of the presence of others, the exclusion or diminished power position of groups that were present in earlier forms of government and the continuing exclusion of other social actors who have never been included”. The important question we would like here to pose is: wouldn't it be socially just as well as democratically correct if all the various actions were equally given a facilitating room (in terms of policies, regulatory frameworks, resources) to unfold their tranformative capacity? If we assume that all initiatives (the market-oriented, the welfare-based, the socially innovative, the radical) arise out of the need to meet specific housing needs (i.e. profitable assets, quality of life, social and spatial inclusion, alternative lifestyle etc.) for specific groups of people (developers, banks, homeowners, neighborhood associations, affordable housing providers, community land trusts, housing cooperatives, activists etc.), shouldn’t we then try to investigate new governance models that would respond to and cater for this pluralism? If a path-dependent narrow range of housing allocation models does not fit the needs (material, sociopolitical, citizenship etc.) of various groups and neighborhoods on the ground, wouldn't it be more resilient to open up this range and examine what works and what does not work in practice?

There are enormous pressures to figure out ways of controlling and imposing the narrative about what will and should happen. Different groups feel that they are allowed or not allowed to tell their story as the potentially dominant one. To a great extent, the sheer power of past dominant narratives together with the loss of memory of heroic struggles have steered and guided existing trajectories that work as constraints on innovation or radical rethinking of places and yield a much less transformative result than might be desirable (Vale, 2006). Due to the existence of power imbalances and contentious relationships between the various housing agents fighting for their lion's share in construction and reconstruction processes, we argue that it is the role of the state, as a mediating force and as an agent with legislative and executive powers over housing production and allocation, to: a) ensure that all voices are taken into account and that narratives are not misinterpreted or manipulated in various ways; b) pursue social justice in terms of power distribution across the various agents; and c) reorganize governance structures and institutions accordingly to make them more responsive and relevant to all the socio-spatial and economic realities and needs on the ground.

3.3 Imagining new housing governance models – the role of the state

Reconstruction governance is the long-term post-disaster response domain where society's housing priorities are defined and redefined by a diversity of actors concerned (Hilhorst, 2003). Natural disasters therefore bring an implicit breach of a social contract where the state is expected to facilitate the return of the disaster displaced and provide them with all the relevant means with which they can meet their ends in terms of housing. The aftermath of disaster, thus, affects state-society relations (Teigão dos Santos and Pertidario, 2011) and how individuals and organizations institutionally relate with each other in their responses to environmental, safety and developmental issues. In this dialectical process, the state – in its double role of target and mediator of contention – is a central actor also in the post-disaster context, since opportunities and threats, as well as outcomes for future, socially optimal, urban risk-reduction trajectories, are conditioned by the permissive or repressive stance of local, regional and national authorities (Tilly, 1978 cited in Martinelli, 2010). The housing safety fractures caused by pre-disaster social-spatial segregation and disintegration, hence, cannot possibly be overcome without the transformation of institutions and practices of reconstruction governance through a redefinition of state–civil society relations (Garcia, 2006; LeGales, 2002 cited in Moulaert, 2010). Garcia (2006: 762) explains that "since social welfare builds on a conception of social justice and this is relative to social meaning, the extent to which the state performs as an enabling institution beyond its regulatory function depends on the sense of justice forged by institutional design and supported by citizens". The state's promptitude to support a sense of justice may not be strong in the absence of citizens' commitments to defend equality and democracy (ibid) and/or in hectic conditions inevitably provided by a post-disaster context.

What we argue is that governance structures are relational, conflictual and dynamic. Even the state itself can never be a neutral terrain among social forces and political projects; but any bias is always tendential and can be undermined or reinforced by appropriate strategies deriving from civil society actors (including the market) (Jessop, 1990). At the same time, the state is not a monolithic institution whose socially accepted function is to define and enforce collectively binding decisions on the members of a society in the name of their common interest or general will. This means that the state is comprised of various inter-scalar administrative bodies, institutions and organizations, which are affected in a different way by the various post-disaster reconstruction narratives and the articulation and aggregation of differential interests, opinions and values (ibid). This provides plenty of room for manoeuvre to influence priorities, also for the less vocal groups who have been traditionally absent from political and administrative systems on a local and other institutional/spatial scale (Moulaert et al., 2005).

The post-disaster reconstruction discussion would then move towards the symbiosis of two necessarily opposing but complementary societal images: that of the ‘planned society’ and that of the ‘good society’, in John Friedmann’s terms’ (Turner, 1978). However, the governance framework emerging from this symbiosis can only make sense if civil society initiatives are 1) not ‘captured’ by the state, thus weakening their innovative dynamics when they fall prey to the public-managerial logic in the bureaucratic apparatuses (the case of authoritarian planning and NPM policy implementation procedures), and 2) not 'cherry-picked' to conveniently correspond to the state's conventional view of governance and delivery management (Swyngedouw and Moulaert, 2010; also Garcia, 2006). City authorities have been encouraging local consensus politics and co-operation and at the same time have discouraged contestation. This type of governance may be falling short of democratic governance especially if the numbers of excluded citizens, namely poor citizens and denizens in cities, are increasing (Garcia, 2006). This brings the post-Fordist, market-inspired models of governance into the spotlight. Few examples of these technologies are reflexive risk-calculation, accountancy rules and accountancy-based disciplining, quantitative evaluations of performance and a superior accountability (Dean, 1999; Burchell 1993 cited in Swyngedouw, 2005; Lévesque, 2013), which call for audit activity as a central disciplining and controlling technology (Power 1997 cited in Swyngedouw, 2005). In this way, democratic values, identities, and social relations along with public spaces, the common good, and the obligations of civic responsibility are ultimately undermined (Giroux, 2006).

The search for socially innovative governance initiatives should therefore place the magnifying lenses closer to the capacity for experimentation and reflective learning (Gonzalez and Healey, 2005). Today we cannot think of civil society as a homogeneous unity. Gerometta et al. (2007: 2018) aptly observed that “within fragmented cities with heterogeneous social groups as well as within distressed neighborhoods where often socially and ethnically diverse groups live together involuntarily, values and orientations are likely to be heterogeneous and conflicting”. The outcomes of actions can be assessed in different ways. For example, for some groups, a housing intervention can be considered successful because it fostered a public space for deliberation and achieved advances in the diffusion of true citizenship and the delivery of social and political rights to all, but for others it could be considered a failure because it was not sufficiently radical when, for example, democratization of the state housing system was not systematically used as a step towards deepening social change (Novy and Leubolt, 2005). In disaster terms, this means that resilience is seen differently from different perspectives.

What we call for is for the state to become both a planner and a mediator between different civil society and market forces. The state is not only ideologically legitimized as the political expression of civil society, but it also has to sanction the private ownership of the means of production and guarantee the appropriation of surplus value in ways that support accumulation. Hence, the current challenge for the state that pursues a ‘developmentalist’ agenda is not only to find a balance between market-organized economic growth and all other possible political objectives, but also to seek for more socially just methods in dealing with competition and tensions concerning the conditions of accumulation and the mechanisms of appropriation and distribution of surplus value (Swyngedouw 2009b).

From a normative perspective, we argue that it shall remain under the state's mandate to guard against risk by fostering and maintaining diversity and conciliation. This mandate is translated into the provision by the state of an enabling institutional, regulatory and legal framework that will disallow hegemonic discourses to dominate the reconstruction process, and instead invest in experimenting with a variety of possible 'resilience cells'. For example, in the post-disaster housing domain, in order to be able to cater for the urgent housing needs of disaster victims, a more pluralistic tenure system needs to be explored. A system that widens the array of possibilities to secure tenure by offering alternatives to individual, private property (Barnes and Riverstone, 2010), but which also has the potential to initiate a social process of learning and a rediscovery of political involvement. This necessitates a middle ground development pathway, building on current path dependencies, while exploring and materializing new paths as well. It is not about anathematizing neo-liberal policies all together, but rather allowing other types of actions and alternatively institutionalized markets (i.e. housing cooperatives, community land trusts, incremental housing development by multiple developers) to be allocated a fair portion of resources to test their resilience. However, we argue that in order for the state to formulate a relevant enabling framework for a multiplicity of initiatives, it needs to implement transactive planning (Friedmann, 1987); meaning the planners should be in interpersonal and collective dialogue with grassroots movements, gain an improved understanding of the 'practice field' of new political actions and movements on housing production and then facilitate innovative ideas validated through action.

4. Resilience re-conceptualized

When the concept of resilience is analytically tested from a post-disaster housing reconstruction perspective, a series of critical parameters emerge, which point towards an urgent need to re-clarify the concept in order to make it more pertinent to the realities on the ground. These parameters revolve around power relations in development narratives that ultimately result in some housing tools being more accommodated compared to others.

The problem with hegemonic resilience rhetoric lies in the fact that it may appeal on the grand level, but often makes less sense – at least in a comprehensive way – when applied in 'real communities' in regions, cities and neighborhoods. When we take on board the socio-spatial dimension of resilience, and focus on urban agents and metabolic trajectories, the realities are more complex and sensitive to path dependency and specific contexts as well as discourses – whether in terms of resistance to hegemonic restructuring or in terms of construction of counter-hegemonic discourses and practices (Moulaert et al., 2007). An uncritical, definition of resilience as the capacity of rapid recovery back to normality in a safe and better way, thus, can sanction alternative issue frames aspired and mobilized by less powerful groups, institutions and even individuals who have different needs, pursue different goals and consequently are not given equal attention in time, resources, and values (Roundtable Review, 2006; Pyles and Harding, 2012).

The contemporary rehousing system is designed to respond financially when disasters destroy property, not when they destroy homes and communities. This force for growth – material and symbolic – downplays pre-hurricane forces of opposition to pro-growth development, blurs the differentiation between use and exchange values, thus carrying forward the interests of pro-growth coalitions (Pais and Elliot, 2008). This results in a political reconstruction battle between the various housing building stakeholders who compete over both the main *fantasy* (narrative) imposed on the reconstruction planning (pro-growth, pro-justice, pro-comaterializing) and the level entitlements for the right to reconstruction "experimentation".

In this battle, we argue that the role of the state as 'peacemaker' is of crucial importance. The promotion of dynamic governance models of reconstruction that promote socially-just allocated redundancy – both in narratives and modes of actions – is the key to incubating resilience. This assumption can only be tested in specific contexts because natural hazards affect places that have their own historical development trajectories and specific institutional settings. It can also only be tested in a long period of time, during which: 1) the power dynamics between discourses potentially change depending on the sustainability and stamina of their promoters, and 2) new undiscovered 'resilience cells' are developed responding to the different needs based on different everyday experiences ('la diversité du quotidien') (Moulaert, 2010).

From an urban political ecology perspective, we read resilience as a continuous struggle to alter the trajectories of metabolic circulations through a constant recombination of narratives, resources and institutional structures for the sake of imagining and materializing urban environments that respond to the various development aspirations of the citizens' majority. Therefore, we finally argue that the resilient city cannot exist per se, but rather 'resilience cells' within the city struggling for their own right to experimentation, unfolding their own transformative capacities and upscaling successful experiments and experiences.

The following last section makes a preliminary effort to start theorizing the governance of these post-disaster 'resilience cells,' with insights stemming from the asset-based community development (ABCD) approach to social transformation.

5. Conclusive remarks

In the post-disaster city, the initial stress produced by the natural event is often extended due to long-term unmet housing needs. The repercussions of this prolonged stress is a loss of social progress partly due to the reiterated oppression or non-recognition of alternative housing production propositions. One can argue that the core of the housing reconstruction deficit lies with the way in which traditional community development policies and practices stress deficiencies and problems instead of the potentials within the communities themselves. The asset-based community development (ABCD) approach can provide an antidote to the vicious cycles of social stress and open up diverse housing provision options (Kunnen et al., 2013). This can be achieved by giving an equal share to the virtuous cycle of solidarity, experimentation and reflexive learning, triggered by the crisis conditions and expressed through the (re)production of 'resilience cells'.

The ABCD approach is pertinent for the governance of 'resilience cells' because it mobilizes research leading to alternative, counter- hegemonic discourses that speak the multiple 'truths from below'. In this way, various narratives are unfolded, the available assets (informal gathering spaces, partnerships and collaborative networks, associations, groups and organizations, culture/history/heritage) are revealed and comprehensively recorded and understood (Kunnen et al., 2013).

This model of governance premised on the asset-based approach shies away from traditional prescriptive ways of urban renewal strategies and underscores the process of effectuation (Moyersoen and Swyngedouw, 2013). This means that the post-disaster urban revitalization process does not predetermine the reconstruction destiny according to pre-set ideas and tools but mobilizes the plurality of assets available on the ground and lets the various bottom-up dynamics sketch the final socially desirable reconstruction outcome(s) *(*see also Sarasvathy 2001 cited in Moyersoen and Swyngedouw, 2013*)*.

The challenge that lies in the ABCD approach is that assets within spatially-bounded communities are heterogeneous and actions tend to be fragmentary and diverse. Due to the existence and overlapping of 'multiple communities' of interest with potentially conflicting loyalties and orientations (Kunnen et al., 2013), we argue in this paper, that the state should play the role of the tertius in the governance of 'resilience cells'. This translates into the need of the state in gaining a deep understanding of the various conflictual forces played out in the city and exercise social justice in the allocation of rights to experimentation for all. The reconstruction project is thus treated as the long-term democratic provision of a complex good (Moyersoen and Swyngedouw, 2013) that is produced, co-produced and hetero-produced according to the divergent demands and qualities of the 'resilience cells' as monitored and negotiated by the State. In this respect, the paper shifts the debate away from a social justice approach in the allocation of housing. The new focus is moved towards building a narrative of a just redistribution in terms of resources and cultivation of empowerment of the various housing providers who struggle for their right to the reconstruction experiment, and hence, to a resilience equity.

Future research on the long-term reconstruction governance processes in post-disaster cities around the globe will bring more light on the dynamics of 'resilience cells'; which this paper made a first effort to theoretically investigate.

6. References

Adams, V., T. Van Hattum and D. English (2009) Chronic disaster syndrome: Displacement, disaster capitalism, and the eviction of the poor from New Orleans, *American Ethnologist* 36.4, 615–36.

Aldrich, P. D. (2012) *Building Resilience; Social Capital in Post-Disaster Recovery*, The University of Chicago Press, Chicago

Archer, D. and S. Boonyabancga (2011) Seeing a disaster as an opportunity-harnessing the energy of disaster survivors for change, *Environment and Urbanization* 23, 351-64.

Barnes, G. and J. Riverstone (2010) Exploring vulnerability and resilience in land tenure systems after Hurricanes Mitch and Ivan, [WWW document]. URL http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCQQFjAA&url=http%3A%2F%2Fsiteresources.worldbank.org%2FINTIE%2FResources%2FPaper_Barnes_Riverstone.pdf&ei=niTZU8HGNc77oATwzoDIAg&usg=AFQjCNFVh4opRafl2-cFyZJPQAqcZkljvw&bvm=bv.72185853,d.cGU (accessed 22 April 2014).

Biel, R. (2011) *The Entropy of Capitalism*, Brill, Leiden.

Birch, L.E. and M.S. Wachter (2006), Introduction: Rebuilding Urban Places After Disaster. In E.L. Birch and S.M. Wachter (eds.), *Rebuilding Urban Places After Disaster: Lessons from Hurricane Katrina*, University of Pennsylvania Press, Philadelphia.

Boano, C. and W. Hunter (2012) Architecture at Risk (?): The Ambivalent Nature of Post-disaster Practice. *Architectoni.ca* 1.1, 1-13.

BondGraham, D. (2011) Building the New New Orleans: Foundation and NGO Power. *The Review of Black Political Economy* 38, 279–309.

Bull-Kamanga, L., K. Diagne, A. Lavell, E. Leon, F. Lerise, H. MacGregor, A. Maskrey, M. Meshack, M. Pelling, H. Reid, D. Satterthwaite, J. Songsore, K. Westgate and A. Yitambe (2003) From everyday hazards to disasters: the accumulation of risk in urban areas. *Environment and Urbanization* 15, 193-204.

Cutter, L.S., L. Barnes, M. Berry, C. Burton, E. Evans, E. Tate and J. Webb (2008) A place-based model for understanding community resilience to natural disasters. *Global Environmental Change* 18, 598–606.

Cook, R.I.and E. Swyngedouw (2012) Cities, Social Cohesion and the Environment: Towards a Future Research Agenda. *Urban Studies* 49, 1959-79.

Davoudi, S., K. Shaw, L.J. Haider, E.A. Quinlan, D.G. Peterson, C. Wilkinson, H. Fünfgeld, D. McEvoy, L. Porter and S. Davoudi (2012) Resilience: A Bridging Concept or a Dead End? "Reframing" Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planning Practice? Resilience as a Useful Concept for Climate Change Adaptation? The Politics of Resilience for Planning: A Cautionary Note. *Planning Theory & Practice* 13.2, 299-333.

Duval-Diop, D., A. Curtis and A. Clark (2010) Enhancing equity with public participatory GIS in hurricane rebuilding: faith based organizations, community mapping, and policy advocacy. *Community Development* 41.1, 32-49.

Editorial of Local Environment (2011) Disaster resilience: a bounce back or bounce forward ability?. *Local Environment* 16.5, 417-24.

Eizaguirre, S., M. Pradel, A. Terrones, X. Martinez-Cellorio and M. Garcia (2012) Multilevel Governance and Social Cohesion: Bringing Back Conflict in Citizenship Practices Santiago. *Urban Studies* 49.9, 1999–2016.

Few, R. (2003) Flooding, vulnerability and coping strategies: local responses to a global threat, *Progress in Development Studies* 3.1, 43–58.

Friedmann, J. (1987) *Planning in the public domain.* Princeton University Press, West Sussex.

Garcia, M. (2006) Citizenship Practices and Urban Governance in European Cities. *Urban Studies* 43.4, 745-65.

Gerometta, J., H. Haussermann and G. Longo (2007) Social Innovation and Civil Society in Urban Governance: Strategies for an Inclusive City. *Urban Studies* 42.11, 2007–21.

Giroux, A. H. (2006) Reading Hurricane Katrina: Race, Class and The Politics of Disposability. *College Literature* 33.3, 171-96.

Gonzalez, S., F. Moulaert and F. Martinelli (2010) ALMOLIN: How to analyse social innovation at the local level?. In F. Moulaert, F. Martinelli, E. Swyngedouw and S. Gonzalez (eds.), *Can Neighbourhoods Save the City?: Community Development and Social Innovation,* Routledge, New York.

Gonzalez, S. and P. Healey (2005), A Sociological Institutionalist Approach to the Study of Innovation in Governance Capacity. *Urban Studies* 42.11, 2055–69.

Gotham, K.F. (2014) Racialization and Rescaling: Post-Katrina Rebuilding and the Louisiana Road Home Program. *International Journal of Urban and Regional Research* 38.3, 773-90.

Gotham, K.F. (2012) Disaster, Inc.: Privatization and Post-Katrina Rebuilding in New Orleans. *Perspectives on Politics* 10.3, 633-46.

Gotham K.F. and M. Greenberg (2008) From 9/11 to 8/29: Post-Disaster Recovery and Rebuilding in New York and New Orleans. *Social Forces* 87.2, 1039-62.

Gutmann, A. (2006) Preface: “The Wound”. In E.L. Birch and S.M. Wachter (eds.), *Rebuilding Urban Places After Disaster: Lessons from Hurricane Katrina*, University of Pennsylvania Press, Philadelphia.

Hilhorst, D. (2003) Unlocking disaster paradigms: An actor-oriented focus on disaster response. Dorothea Hilhorst, Abstract submitted for session 3 of the Disaster Research and Social Crisis Network panels of the 6th European Sociological Conference, 23-26 September, Murcia, Spain [WWW document]. URL http://ipcc-wg2.gov/njlite_download.php?id=6263 (accessed 4 April 2011).

Jessop, B. (1990) *State Theory; Putting Capitalist States in Their Place*, Polity Press, Cambridge.

Johnson, C. (2011) Kernels of change: civil society challenges to state-led strategies for recovery and risk reduction in Turkey. *Environment and Urbanization* 23, 415-30.

Ingram, J.C., G. Franco, C. Rumbaitis-del-Rio and B. Khazai (2006) Post- disaster recovery dilemmas: challenges in balancing short-term and long-term needs for vulnerability reduction. *Environmental Science and Policy* 9, 607-13.

Katz, C. (2008) Bad elements: Katrina and the scoured landscape of social reproduction. *Gender, Place & Culture: A Journal of Feminist Geography* 15.1, 15-29.

Kuhlicke, C. (2013) Resilience: a capacity and a myth: findings from an in-depth case study in disaster management research. *Natural Hazards* 67.1, 61-7.

Kunnen, N., D. MacCallum and S. Young (2013) 21. Research strategies for assets and strengths based community development. In F. Moulaert, D. MacCallum, A. Mehmood, A. Hamdouch, E. Swyngedouw and S. Gonzalez (eds.), *The International Handbook on Social Innovation: Collective Action, Social Learning and Transdisciplinary Research*, Edward Elgar Publishing Limited, UK.

Lévesque, B. (2013) 2. Social innovation in governance and public management systems: toward a new paradigm? In F. Moulaert, D. MacCallum, A. Mehmood, A. Hamdouch, E. Swyngedouw and S. Gonzalez (eds.), *The International Handbook on Social Innovation: Collective Action, Social Learning and Transdisciplinary Research*, Edward Elgar Publishing Limited, UK.

Lorenz, F.D. (2013) The diversity of resilience: contributions from a social science perspective. *Natural Hazards* 67.1, 7-24.

Martinelli, F. (2010) Historical roots of social change Philosophies and movements. In F. Moulaert, F. Martinelli, E. Swyngedouw and S. Gonzalez (eds.), *Can Neighbourhoods Save the City?: Community Development and Social Innovation*, Routledge, New York.

Masozera, M., M. Bailey and C. Kerchner (2007) Distribution of Impacts of Natural Disasters across Income Groups: A Case Study of New Orleans. *Ecological Economics* 63, 299-306.

Moulaert, F. (2010) Social innovation and community development Concepts, theories and challenges. In F. Moulaert, F. Martinelli, E. Swyngedouw and S. Gonzalez (eds.), *Can Neighbourhoods Save the City?: Community Development and Social Innovation*, Routledge, New York.

Moulaert, F., F. Martinelli, S. Gonzalez and E. Swyngedouw (2007) Introduction: Social Innovation and Governance in European Cities: Urban Development Between Path Dependency and Radical Innovation. *European Urban and Regional Studies* 14.3, 195-209.

Moulaert, F, and O. Ailenei (2005) Social Economy, Third Sector and Solidarity Relations: A Conceptual Synthesis from History to Present. *Urban Studies* 42.11, 2037– 53.

Moulaert, F., F. Martinelli, E. Swyngedouw and S. Gonzalez (2005) Towards Alternative Model(s) of Local Innovation. *Urban Studies* 42.11, 1969–90.

Moyersoen J and E. Swyngedouw (2013) LimiteLimite: Cracks in the City, Brokering Scales and Pioneering a New Urbanity. In J. Beaumont, W. Nicholls and B. Miller (eds.), *Spaces of Contention: Spatialities and Social movements,* Ashgate Publishing, Farnham

Novy, A. and B. Leubolt (2005) Participatory Budgeting in Porto Alegre: Social Innovation and the Dialectical Relationship of State and Civil Society. *Urban Studie*s 42.11, 2023–36.

Oliver-Smith, A. (2004) Theorizing Vulnerability in a Globalized World: A Political Ecological Perspective. In G. Bankoff, G. Frerks and D. Hilhorst (eds.), *Mapping Vulnerability: Disasters, Development and People*, Earthscane, UK.

Pais, F. J., and R.J. Elliot (2008) Places as Recovery Machines: Vulnerability and Neighborhood Change After Major Hurricanes. *Social Forces* 86.4, 1415- 53.

Peck, J. (2006) Liberating the City: Between New York and New Orleans. *Urban Geography* 27.8, 681–713.

Pyles, L. (2011) Neoliberalism, INGO practices and sustainable disaster recovery: a post-Katrina case study. *Community Development Journal* 46.2, 168–180.

Pyles, L., and S. Harding (2012) Discourses of post-Katrina reconstruction: a frame analysis. *Community Development Journal* 47.3, 335–352.

Review Roundtable (2006) Is New Orleans a Resilient City?. *Journal of the American Planning Associatio*n 72.2, 245-57.

Satterthwaite, D. (2011) Editorial: Why is community action needed for disaster risk reduction and climate change adaptation?. *Environment and Urbanization* 23, 339-49.

Seidman, K. F. (2013) *Coming Home to New Orleans; Neighborhood Rebuilding After Katrina.* Oxford University Press, New York.

Smith, L. and G. Ruiters (2006) The public/private conundrum of urban water: a view from South Africa, Chapter 12. In N. Heynen, M. Kaika and E. Swyngedouw (eds.), *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism*, Routledge, New York

Swyngedouw, E. (2010) Impossible Sustainability and the Post-political Condition, Chapter 11. In M. Cerreta, C. Grazia and V. Monno (eds), *Making Strategies in Spatial Planning, Urban and Landscape Perspectives*, Springer, Netherlands.

Swyngedouw, E. and F. Moualert (2010) Socially innovative projects, governance dynamics and urban change Between state and self-organisation. In F. Moulaert, F. Martinelli, E. Swyngedouw and S. Gonzalez (eds.), *Can Neighbourhoods Save the City?: Community Development and Social Innovation*, Routledge, New York.

Swyngedouw, E. (2009a) The Antinomies of the Postpolitical City: In Search of a Democratic Politics of Environmental Production. *International Journal of Urban and Regional Research* 33.3, 601-20.

Swyngedouw, E. (2009b) Civil Society, Governmentality and the Contradictions of Governance-beyond-the-State: The Janus-face of Social Innovation, Chapter 4. In D. MacCallum, F. Moulart, J. Hillier and S. Vicari (eds.), *Social Innovation and Territorial Development*, Ashgate, Surrey.

Swyngedouw, E. (2006) Circulations and Metabolisms: (Hybrid) Natures and (Cyborg) Cities. *Science as Culture* 15.2,105-21.

Swyngedouw, E. (2005) Governance Innovation and the Citizen: The Janus Face of Governance-beyondthe-State. *Urban Studies* 42.11, 1991–2006.

Swyngedouw, E. and C.N. Heynen (2003) Urban Political Ecology, Justice and the Politics of Scale. *Antipode* 35.5, 898-918.

Teigão dos Santos, F and M.R. Partidário (2011) SPARK: Strategic Planning Approach for Resilience Keeping. *European Planning Studies* 19.8, 1517-36.

Turner, J. (1980) What to do about Housing – its part in Another Development. *Habitat International* 5.1/2, 203-211.

Turner, J. (1978) Housing in Three Dimensions: Terms of Reference for the Housing Question Redefined. *World Development* 6.9/10, 1135-45.

Turner, J. (1974) The John Turner Archive: The fits and misfits of people’s housing, Freedom to Build, *RIBA Journal* 2.

Turner, J. (1972) The John Turner Archive: Housing As A Verb Chapter 7. In J.Turner and R. Fichter (eds.), F*reedom to Build, dweller control of the housing process*, Collier Macmillan, New York.

Vale, J. L. (2006) Restoring Urban Viability. In E.L. Birch, S.M. Wachter (eds), *Rebuilding Urban Places After Disaster: Lessons from Hurricane Katrina*, University of Pennsylvania Press, Philadelphia.

A practitioner's model of community resilience

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Abstract

In developing its "Whole Community" approach to community resilience, the Community and Regional Resilience Institute (CARRI) needed a method for assessing community resilience. This would enable community practitioners to determine their current state of resilience, and to evaluate the impact of actions intended to enhance their resilience in future. In practice, this meant that a model of community resilience was needed.

We thus evaluated several existing models for this purpose. The results were somewhat disappointing because none of the models considered was well-suited for our purpose. Some of the models explain a community's evolution during and after a disaster quite well, but require so much data that they are not practical for general use. Many excellent models have been developed for one aspect of community life (e.g., social resilience, infrastructural resilience) but are not easily integrated with other models representing other aspects of community life. There are also models that are theoretically justified but have not yet been tested against actual experience.

Thus, we developed a simple "Whole Community" model based on a generalized loss-recovery curve that also reflected our experience as practitioners. For the model, the community is divided into service areas - community systems that each provide an essential service. For each community system, the model explicitly looks at how the level of service evolves when the community experiences a significant change or disruption. Community systems include systems providing environmental (built and natural), social, economic and financial services to the community.

The model has the following useful features:

- It enables practitioners to consider how resilient a community would be to each of the threats it faces.
- The model reflects each of the types of strategies a community might adopt to become more resilient.

- The model explicitly considers the "Whole Community" in a systematic and consistent manner.
- The model can be applied to any community and to all of the threats they may face.
- The model explicitly considers social capital's impact on community resilience and naturally balances it with other forms of community capital.

Keywords: Community resilience; resilience; Whole Community; model; resilience strategies

1. Introduction

The Community and Regional Resilience Institute (CARRI) has developed a unique "Whole Community" approach aimed at improving community resilience (Plodinec, et al., 2014). CARRI defines a community to be a group of individuals and organizations bound together by geography and perceived self-interest to efficiently carry out common functions. Community resilience is thus simply the ability of the community to positively adapt to change, i.e., to continue to carry out community functions efficiently in the face of turbulent change. As described by Plodinec et al. (2014), this approach has been successfully applied to both civil communities and institutions of higher education (IHEs) – "communities of scholars."

CARRI's approach is embodied in a simple four-step process: organizing the community's leadership; assessing the resilience of each part of the community; formulating plans to improve any weaknesses identified in the assessment; and then implementation of the plans and monitoring of their effectiveness. For each type of community, CARRI has identified a set of systems each of which provides one or more essential services to the community (either civil or IHE). Each of these systems has its own resilience, i.e., some of these systems will recover more rapidly or more completely than others from a severe disruptive event.

In the assessment step of the CARRI approach, the resilience of each of these systems is evaluated. This constituted a major challenge during development and implementation of CARRI's approach. The purpose of the assessment module is to identify the strengths and weaknesses of each of these community systems, and to provide actionable guidance to community leaders on ways to improve the resilience of each system toward the types of disruption potentially confronting the community. This module has to be accurate and consistent with what is known about resilience to each type of disruptive event. The assess must also provide a systematic method for looking at each community system, and be readily understood by community leaders. In practice, this meant that a model of community resilience was needed to overcome this challenge. The requirements for the assessment module thus became requirements for the underlying model itself.

In developing the model we recognized that it could provide a common “language” for communities to use as they looked at themselves and at ways to improve their resilience. The model could help communities to

- Understand their structure, and their connectedness in terms of flows of information and goods and services, both within the community and with other communities;
- Understand and manage the public’s expectations for recovery;
- Improve community plans for limiting the impacts of, responding to, and recovering from disruptions; and
- Prioritize actions, especially investments of money or human capital needed to limit impacts or to recover from disruptions.

2. Criteria for the Model

CARRI used the following criteria in seeking an appropriate model to serve as a basis for its assessment module.

- Practical. The model must be simple enough so that a community’s leadership can both grasp its essentials and apply its results.
- Complete. The model must be usable within (or at least adaptable to) a Whole Community approach. This implies the model ought to reflect the resilience of each part of the community, and reflect the importance of social capital while balancing it with other forms of community capital.
- Useful. The model must be able to provide useful guidance to practitioners: identifying strengths, weaknesses and opportunities for improvement. This also implies that the guidance provided through the assessment module ought to encompass all of the potential strategies a community might use to improve its resilience.
- Scalable. The model must be applicable to any community, regardless of type.
- Comprehensive. The model must be applicable to any type of disruptive event facing a community.

Defensible. The model must be consistent with real-world observations and experience. In this regard, the model must be consistent with the work of Aldrich (2012) and of Weil, et al. (2012), both of which point out the importance of both financial and social capital in the recovery process.

3. Models considered

A variety of models were considered; unfortunately none of the models met all of the criteria. This is not to imply that there is anything "wrong" with the models, only that they were not appropriate for our intended use.

Some of the models failed to meet the criteria because they were neither complete nor comprehensive (for example, Cutter, et al., 2008; Norris, et al., 2008). Both of these are focused on social aspects of resilience and are not readily expanded to a Whole Community concept. Further, Cutter's model focuses heavily on a community's weaknesses and little on its strengths. Others failed to meet the criteria because their scope was limited to a single type of community. For example, Kirmayer, et al. (2009) was focused on indigenous communities; Smith, et al., (2012) limited themselves to poor rural communities in Appalachia. Mayunga's (2007) model met many of the criteria but was incomplete and not readily expanded. However, his approach has valuable features that informed the approach later adopted by CARRI.

Many of the potentially most useful models were not adopted because they were too data-intensive (Chang, Miles, 2011; Cimellaro, 2010; Paton, 2006, and subsequent work; Rose, 2003, and subsequent work). In general, these models were expressions of the approach originally developed by Bruneau, et al. (2003), refined in different ways (Though not considered for this effort, the model recently developed by Scott Miles (2015) also falls into this category.). These models can be valuable tools for explaining what happened during and after a disruptive event, but the amount of data required to generate useful results is daunting. It is unlikely that a community leader could be convinced to undertake the intensive effort to collect the requisite data prior to a disaster to try to predict the community's ability to recover from crisis before one occurs. However, it is important to note that each of these models has had significant success in explaining specific instances of recovery from a disaster. Rose and Krausmann, in particular, have used a macroeconomic model based on Bruneau's approach to develop general resilience guidelines for businesses (Rose and Krausmann, 2013).

Bruneau's approach has several positive aspects that made it a suitable starting point for CARRI's development effort:

- It potentially can be applied to each part of the community.
- It potentially can be applied to every type of disruption that a community may face.
- It is based on the concept of a loss-recovery curve, which adequately reflects what is known about the primary impacts of a disaster.

4. Model Development

As discussed previously (Plodinec, 2014), CARRI had chosen to consider communities and community resilience in terms of the systems that provide essential services. These span the environmental, economic and social arenas. Each system differs in its elements and assets so it cannot be assumed that the evolution of any community system after a disruptive event will be the same as that of any other community system (Plodinec, 2012). Thus, each of these community systems is assumed to have its own resilience model. Because of the interconnectedness of community systems, the model also has to reflect interdependencies among the systems.

Bruneau, et al. (2003) represent the state of a community system during disruption and recovery as a function, *Q(t)*, varying between 0% (total loss of service) and 100% (full service), reflecting the degree of service that the system is providing. The resilience of the system, *R*, then is calculated as

$$R = \int_{t_0}^{t_1} (100 - Q(t))\, dt$$

where the disruption occurs at t0 and recovery has occurred by time t1. The models based on Bruneau's approach start with this simple equation and then develop various calculational schemas.

In CARRI's model this simple equation is generalized in several ways. First, the implicit assumption in Bruneau's work that the system will attain the same level of service is discarded. The loss-recovery curve is deconvoluted into three parts – the level of service an instant before disruption occurs, a function representing the loss of service due to a disruption external to the system, and a function representing the recovery of service through the efforts of those who are a part of the community system, i.e.,

Level of service = initial level of service + externally-forced change(s) in service + internally-induced change(s) in service

It must be recognized that disruptions faced by a community may have both positive and negative consequences. For example, a decision by a major business to relocate to a community may be a very positive disruption to local government because of an increase in tax revenue. However, that same disruption due to a decision made outside the community may lead to severe stresses on the community's educational system (because of a large number of new students) that will require investment in the educational system before service can be fully restored.

The level of service – whether disrupted or not – also depends on expenditure of resources by those who are a part of the system. Thus, if a community's transportation department does not spend enough on maintenance, service eventually will be eroded. As represented in the model, resources may be financial (e.g., currency or credit), temporal (e.g., manpower, people's time), or physical (e.g., construction materials, energy) as appropriate to the specific system.

This leads to a general equation reflecting the impacts of a change or disruption on the performance of each community system:

$$F_{ij}(t+dt) = F_{ij}(t) + \int_{t}^{t+dt} C_j(t) \cdot \frac{\partial F_{ij}}{\partial C_j} dt + \int_{t}^{t+dt} R_{ij}(t) \cdot \frac{\partial F_{ij}}{\partial R_{ij}} dt$$

where $F_{ij}(t)$ is the level of service for community system "i" after disruption "j;" $C_j(t)$ is the disruption

j" that arises outside the system; $\partial F_{ij}/\partial C_j$ is the change in the level of service induced by the change; $R_{ij}(t)$ are the resources available to the stakeholders of community system; and $\partial F_{ij}/\partial R_{ij}$ is the change in the level of service due to the recovery effort. It should be noted that each of the terms on the right side of the equation are functions of time, i.e., the change may not be instantaneous or even linear, resources will certainly change over time, as will the differentials.

The equation can be thought of as a sort of state function for each community system. For CARRI's purposes, the change "j" has usually been seen as an "Act of God" affecting all of the community's systems. However, since the stakeholders in the system may also use their resources to make changes to the system that could significantly impact the rest of the community, it must be recognized that while the change "j" is external to a particular community system, it may not be external to the community (As an example, consider an electric utility investing in the burial of power lines.). In this manner, the model can be used to consider interdependencies among community systems.

The differential $\partial F_{ij}/\partial R_{ij}$ is a sort of efficiency function, reflecting how well the community system's stakeholders actually transform resources into improvements in the level of service. It generally improves with time immediately after a disruption as the system's stakeholders learn how to better utilize the resources available to them. As resources dwindle, or the stakeholders' attention is diverted to other matters, this factor may actually begin to fall off. It depends on the experience and expertise of the system's stakeholders in dealing with change; the connectedness of those stakeholders (reflecting the well-known fact that exchanges of business cards after a disaster are indicative of a slow recovery); and the degree of planning for recovery that has been done.

It should be clear that the equation makes no assumption about whether the level of service returns to pre-disruption levels, or never reaches that level, or eventually reaches a higher level of service. All of these have been observed in real communities. Compared to Bruneau's formulation, CARRI's does not try to determine a unique resilience of a community system – or even of the community – per se. The model's purpose is help a community to become more resilient by helping it to identify actions that will reduce risk or speed recovery.

The model in the form presented above may be satisfying to engineers but certainly would not be to most community leaders. For purposes of explanation to others, and focusing only on situations in which a change causes a reduction in service, the model can be reduced to a simpler formulation. For a given community system, and a given disruption, the level of service of the system, *F(t)*, is given by

$$F(t) = F(0) - L(t) + w(t) \cdot R(t)$$

in which the second term reflects the impacts of the disruption, and the third term the recovery effort. "*w(t)*" is the "efficiency" as discussed above, and *R(t)* the resources available to the system. This gives rise to the graph of a community system's response and recovery from a disruption presented below.

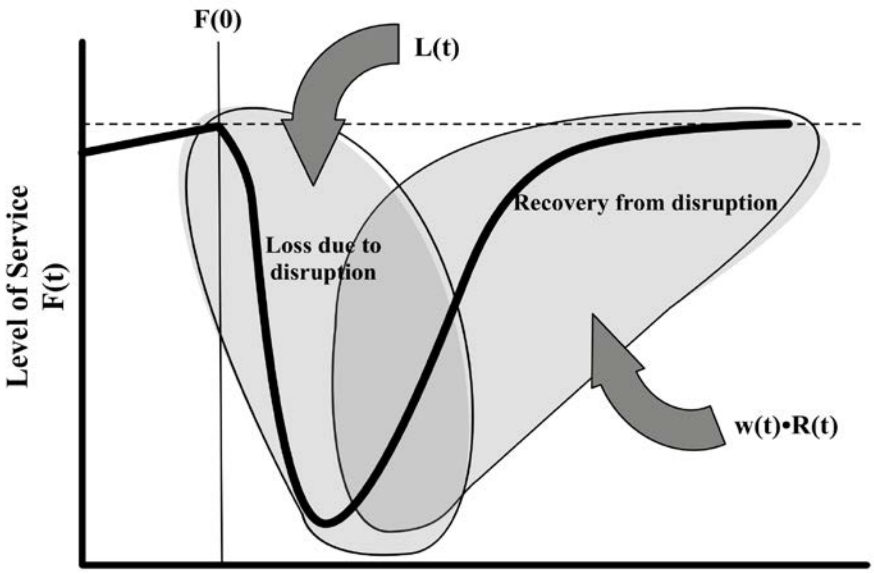

Figure. Notional representation of the model.

5. Relationship between successful strategies and the model

In order for the model to meet the “Useful” criterion, it must be consistent with strategies that have ben successfully used by communities to limit the impacts of and rapidly recover from disruptions. The types of strategies that have been used by communities to improve their ability to deal with disruptions can be encapsulated into four archetypes: increasing the capability of community systems to provide service; limiting loss of service, either through mitigation or through redundant assets; increasing the resource base the community system’s stakeholders can call on, both internally and externally; and improving the ability of the community system’s stakeholders to more effectively and efficiently use all of the resources available. These archetypical strategies are each aligned with one of the parameters in the simpler form of the model – capacity with F(0), limiting loss with L(t), increasing resources with R(t), and effective and efficient use of resources with w(t).

Alesch (2009) has identified factors that impact the resilience of communities. These are discussed below, and the relevant factors in the model are indicated.

- Communities are more successful in recovery if there are few pre-existing problems (e.g., inadequate infrastructure, poverty, crime). In essence, dealing with these problems can be considered as increasing the ability of the relevant community systems to handle disruption (F(0)).
- Similarly, communities are more successful in recovery if they have a robust economy. Growing a community’s economy not only implies an increase in resources, but also increases the social connectedness among community members. This is especially true if major employers are locally based (F(0)).
- Communities recover more effectively if they anticipate the systemic impacts of a crisis, and mitigate them. Charleston, SC, has recognized that in the event of an earthquake, they will lose about 90% of their hospital beds.
- Further, several areas in the tri-county regional community will be effectively isolated because of damage to transportation systems. As a result, the tri-county region has placed 19 medical stations in potentially isolated to provide both medical and communications ability and thus limit the loss of life (L(t)).

- Communities recover more rapidly if there are fewer systemic impacts, particularly if damage is limited so that it does not exceed the resources available to any community system (L(t)).
- Communities will recover more rapidly if they have access to external resources. An obvious external resource is insurance. The New York-New Jersey Port Authority has issued "catastrophe" bonds. In the US, electric utilities from around the country will generally shift resources to help a local utility overwhelmed by disaster. This is embodied in the Emergency Management Assistance Compacts system (R(t)). Exercises of recovery plans can also point out situations in which there is insufficient human capital to carry out necessary functions. For example, after a disaster that has caused widespread damage to a community's housing stock, the staff of local government departments (e.g., those responsible for issuing building permits) may be overwhelmed by the increased demand for service.

Communities are more likely to recover if they have a sound recovery plan, particularly if there is good agreement within the community about what should be done. This points to the importance of experienced and effective leadership in each community system. Exercises that test the plan are an important way to achieve this, as well as ensuring that stakeholders in community systems are connected. Exercises also improve the proficiency of a community system's stakeholders in dealing with disruption (w(t)).

6. Prediction of community resilience

Ideally, a community would use the model to predict its resilience – how well it would recover – to each type of disruption it faces. Although the model is simple, it can, in many cases, provide estimates accurate enough to determine what actions might be taken and to prioritize them. For community services relating to infrastructure, economic or environmental services, the system's stakeholders can reasonably estimate its non-disrupted level of service, F(0), directly. For a given type of disruption (e.g., natural disaster, economic, pandemic), the system's stakeholders can also estimate the total reduction in service these community systems might experience due to a given disruption, L(t), although they likely would not have enough information to say anything about its time dependence. The system's stakeholders should also be able to identify what resources are available for that system, R(t).

Unfortunately, it is much more difficult to make these types of estimates for some of the social community systems, for example, the one CARRI designates as "Individuals and Families." In this case, stakeholders in the community system (including neighborhood associations and faith-based and other organizations and associations, for example) may not have information available to make direct estimates of any of the model parameters. For these systems indirect measures are suggested, which might include:

- Identification of neighborhoods likely to be affected by natural disasters or economic disasters.
- The availability of health care for each neighborhood in the community (poor availability implying greater impact from pandemics, for example).
- Identification of the characteristics of those neighborhoods (e.g., demographics, employment, income, crime).
- The connectedness of neighborhoods and other groups within the community. As Weil, et al. (2012) have shown, this was a key determinant of the resilience of various community groups in New Orleans after Katrina. Aldrich (2012) has seen the same in his investigations of the recovery from the earthquake and tsunami that struck Japan in 2011.
- Identification of the level of resources available to individuals and families (e.g., insurance).

For all of the community systems, the most difficult parameter to estimate is the ability of the system's stakeholders to use whatever resources are available, w(t). Thus, w(t) reflects the "connectedness" of each community system, its degree of planning, and its experience in carrying out those plans (based on either actual response and recovery from a disruption or testing through exercises). Each of these components of w(t) is treated as a fuzzy scalar quantity; these are then combined to provide an estimate of the efficiency and effectiveness of the community system's stakeholders to use whatever resources are available.

Combining these parameters leads to a simple metric that reflects the ability of the community system to recover from disruption, w•R/L, in which the time dependence of each is ignored and the total expected loss and all of the resources available to the system (both external and internal) are used. If the ratio is much greater than one, it is likely that the community system will prove resilient to the disruption; if much less than one, the community system is unlikely to recover.

7. From model to assessment

CARRI's purpose in developing the model was to provide a framework for assessment of community systems. In practice, CARRI has found that while few communities are interested in making the investments required to model each community system, many want to assess themselves. It is beyond the scope of this paper to go into detail about this translation of model to assessment module for each community system, but generically the same path was followed. For each community, community leaders came together to identify potential disruptions facing the community, as part of the "organizing phase" of CARRI's approach. For each community system, CARRI assembled "system maps" identifying the important system stakeholders. Subject matter experts (SMEs) from these stakeholders were then brought together and, through a facilitated process, identified the level of service currently being provided – both strengths and weaknesses, and how service might suffer in the event of each disruption identified by the community leaders (considering both the service itself and key assets). The SMEs then identified both the types of resources needed and the amount that appeared to be readily available. Finally, the SMEs considered each of the factors that relate to w(t), using the system maps as aids in determining connectedness.

Thus, the SMEs considered each of the parameters F(0), L, R, and w. Rather than trying to combine these results into some sort of resilience score, CARRI provided a list of potential actions that the system's stakeholders could take to improve system resilience. The system stakeholders and community leaders then considered these actions (and any others identified by system SMEs) and developed a prioritized plan.

8. Conclusion

CARRI's approach to modeling community resilience has proven to be useful – community leaders and other practitioners can grasp what the model and its outputs mean (Plodinec, et al., 2014). The approach is clearly scalable – it has been applied to both civil communities and institutions of higher education of various sizes and types (Plodinec, et al., 2014). It explicitly considers all of the potential disruptions a community may face. Because it models each community system, it is inherently a "Whole Community" approach; and because it models each community system in the same way, each is treated in a consistent and systematic manner. As discussed above, it can be used to predict the resilience of each community system, but it is probably more practical for use as the basis for a structured assessment, as CARRI has done.

Finally, it balances the social capital inherent in each community system with other types of relevant capital. These are reflected in both the resource term (e.g., considering the manpower needed for system and community recovery) and in the determination of how effectively and efficiently resources may be used. The efficiency term reflects the bonding capital in each community system; the resource term reflects the bridging capital – the ability to access resources external to the system. Thus, these system models have proven to be practical, complete, useful, scalable, comprehensive and defensible in practice.

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9. References

Aldrich, D. P., 2012. *Building resilience: Social capital in post-disaster recovery*. University of Chicago Press, Chicago, IL.

Alesch, D. J., Arendt, L. A., Holly, J. N., 2009. *Managing for long-term community recovery in the aftermath of disaster*. Public Entity Risk Institute, Washington, DC.

Bruneau, M., Chang, S.E., Eguchi, R.T., Lee, G.C., O'Rourke, T.D., Reinhorn, A.M., Shinozuka, M., Tierney, K., Wallace, W.A., and Von Winterfeldt, D., 2003. A framework to quantitatively assess and enhance the seismic resilience of communities. Earthquake spectra, 19 (4), 733-752.

Cimellaro, G. P., Reinhorn, A. M., and Bruneau, M., 2010. Framework for analytical quantification of disaster resilience. Engineering Structures 32 (11), 3639-3649.

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008. A place-based model for understanding community resilience to natural disasters. Global Environmental Change, 18 (4), 598-606.

Kirmayer, L. J., Sehdev, M., Whitley, R., Dandeneau, S. F., Isaac, C., 2009. Community Resilience: Models, Metaphors and Measures. International Journal of Indigenous Health, 5 (1), 62-117.

Mayunga, J. S., 2007. Understanding and applying the concept of community disaster resilience: a capital-based approach. Summer academy for social vulnerability and resilience building, 1-16.

Miles, S. B., Chang, S. E., 2011. ResilUS: a community based disaster resilience model. Cartography and Geographic Information Science, 38 (1), 36-51.

Miles, S. B, 2015. Foundations of community disaster resilience: well-being, identity, services, and capitals. Environmental Hazards, DOI: 10.1080/17477891.2014.999018.

Paton, D., & Johnston, D. M. (Eds.), 2006. *Disaster resilience: an integrated approach*. Charles C Thomas, Springfield, IL.

Plodinec, M. J., 2012. Bases for a Community Resilience System. In n Proceedings of the First International Symposium on Societal Resilience, Homeland Security Studies and Analysis Institute, Washington, DC, 201-26.

Plodinec, M. J., Edwards, W., and White, R., 2014. Applications of a "Whole Community" Framework for Enhancing Community or Campus Resilience. Procedia Economics and Finance, 18, 9-16.

Rose, A., 2004. Defining and measuring economic resilience to disasters. Disaster Prevention and Management: An International Journal, 13 (4), 307-314.

Rose, A., Krausmann, E., 2013. An economic framework for the development of a resilience index for business recovery. International Journal of Disaster Risk Reduction, 5, 73-83.

Smith, J. W., Moore, R. L., Anderson, D. H., Siderelis, C., 2012. Community resilience in Southern Appalachia: A theoretical framework and three case studies. Human Ecology, 40 (3), 341-353.

Weil, F., Lee, M. R., Shihadeh, E. S., 2012. The burdens of social capital: How socially-involved people dealt with stress after Hurricane Katrina. Social science research, 41(1), 110-119.

The Inclusive and Integrated Disaster Networked Governance framework: a conceptual model for analysing the cooperative outcomes of resilience building[1]

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Abstract

The integration of disaster risk reduction, climate change adaptation and development is becoming a priority internationally. Resilience building needs to be considered holistically and this can be achieved through the development of cooperation strategies at different scales of governance. This paper presents the Inclusive and Integrated Disaster Networked Governance framework, which is a method to determine the impacts of government and non-government networks on resilience building. This framework was adapted from the Earth System Governance Project and Social Network Analysis concept, and developed in the field (Vanuatu). Four main research pillars were found to be critical in assessing the success of cooperation outcomes: government/non-government networking, cross-sectoral networking, networked leadership and networked learning.

Keywords: networked governance; resilience building; disaster; climate change; government/non-government cooperation; cross-sectoral networking; leadership; learning

1. Introduction

2015 represents a decisive year for decision-making on resilience building with the adoption of the Sendai Framework for Disaster Risk Reduction (2015-2030) and the development of the United Nations Sustainable Development Goals. Government and non-government actors must cooperate in order to develop effective disaster risk reduction frameworks and build more resilient communities [1]. Fragmentation (of programs, projects, funds, goals and actor configuration) is a critical factor undermining national and local capacities to build resilience. Full integration, however, might hinder the development of expertise, and affect smaller stakeholders. Academic research is further needed to help policy-makers and practitioners have a better and more holistic understanding of disaster resilience building, and to assist implementation at the community level. This paper presents the Inclusive and Integrated Disaster Networked Governance (2IDNG)

[1] This framework was developed for the purposes of the author's PhD research on networked governance of disasters and climate change in Vanuatu

framework as a conceptual model determining the impacts of networked governance on resilience building, and analysing mechanisms to achieve an optimal balance between fragmentation and integration. This research framework was developed in the context of a larger research project on the reciprocal impact between networked governance and disasters in the context of a Small Island Developing State (SIDS).

Although the integration of climate change and development in the disaster risk management sector is a stated priority in the international debate for disaster risk, it has not yet been achieved in most countries [1]. The Pacific SIDS, however, have demonstrated initiatives towards integration, both at the policy and operational levels [2]. The 2IDNG was partly developed based on, and tested during fieldwork on the South Pacific archipelago of Vanuatu. As in the case of many SIDS, Vanuatu is characterised by the co-existence of strong local contexts, centralisation of decision-making in the main island, relative dependency on regional plans and funds, and strong involvement of international aid. For several years, the archipelago has been listed as the most at-risk country based on exposure and vulnerability to disaster risks [3] [4] [5] [6]; the recent cyclone Pam, one of the strongest cyclones seen in the South Pacific, supported this dataset. Based on the knowledge of this exposure and vulnerability, resilience building became a priority in the country and is the goal of many projects led by national agencies, international and local non-governmental organizations (NGOs), donors and researchers.

The archipelago benefits from active disaster and climate networks that bring together numerous and diverse government and non-government initiatives for integration and networking. Three main cooperative bodies have been recently established in the country: the government *National Advisory Board for disaster risk and climate change adaptation* (NAB), and the non-government *Vanuatu Climate Action Network* (VCAN) and *Vanuatu Humanitarian Team* (VHT). Additionally, this research identified a significant amount of small institutionalised networks (specific to certain sectors, such as emergency management, agriculture or gender protection) and cooperative committees at all levels of governance; with a total of approximately 50 cooperative bodies, called sectoral networks in this paper, that are active in the whole networked system of disaster resilience building in the country. This whole networked system is characterized by a complex set of formal and informal linkages between sectoral networks and between individual members, informal relations being particularly critical in traditional and oral societies (such as Vanuatu) for achieving resilience building. Yet, Vanuatu's networked structure for disaster resilience is very recent; forcing the intervention of significant international aid, Cyclone Pam revealed the system's strength, limitations and needs for improvement. For the purposes of the larger research project, Vanuatu is used as a case study to test the developed networked governance framework for disaster risk and climate change in SIDS.

2. Background of the 2IDNG framework

2.1 Combination of the Earth System Governance project and Social Network Analysis

This research was developed in the context of the Political Ecology approach, examining the interconnection between the social, economic, environmental and political spheres, as well as the interrelation between policies, vulnerabilities and private efforts to build resilience [7]. Consistent with the Political Ecology approach, this research was designed based on the principles of the Earth System Governance (ESG) Project, field observations and early findings from Social Network Analyses (SNA) in order to develop a holistic view of formal and informal network interconnections evolving within the interdependency of society and nature.

ESG is a conceptual framework that Biermann et al. [8 p.4] defined as the "interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating and adapting to global and local environmental change, in particular, earth system transformation, within the normative context of sustainable development." The ESG Project aims to address the difficulties related to the "*uncertainty*", "*intergenerational dependencies*", "*functional interdependence*", "*spatial interdependence*", and "*extraordinary degree of harm*" that characterize the transformations of the earth system ([9] p.4-6). The ESG framework was designed around interconnected governance principles: "*credibility*" of the Governments' commitment; "*stability*" of the ESG structures; "*adaptiveness*" of the governance components to adjust to environmental, social and political changes; and "*inclusiveness*" of all type of stakeholders [8] [9]. Early findings for this paper identified and recommended *capitalization* of resources as a fifth connected, yet distinct, governance principle essential to assess impacts of a governance system on resilience building. In this paper, capitalization is defined as one's capability to build sustainable human capital (expertise, capacities, learning and network) from one's and others' experience, information, knowledge, skills and connections, and to have an optimal use of this existing capital. Many scholars have used the ESG framework to bring a new perspective to major disaster management and post-2015 strategies, both globally and in the Pacific, such as [10] [11] [12]. More understanding is needed, however, of the interdependency between formal and informal networking, and the impact of the interaction between government and non-government networks related to resilience building.

Exploring formal and informal relations, capacities and resources available to actors, social capital is a subtle and complex concept to apply in practical research. SNA is a mathematical tool developed by sociologists to study structures of such relations, and capital exchanges between members of a network [13] [14]. Using SNA software, such as UCINET 6 [15] and NetDraw ([16], social network analysts can visually map descriptive information on the configuration of a network, and help build in-depth understanding of connection mechanisms, resources sharing incentives, and coordination drivers and restraints [13] [14] [17]. SNA became more frequent in the disaster sector in the 2000's; however, such studies focused on the organizational level and on disaster management. Due to the increasing need for networked governance for disasters, climate change and sustainable development, more research is needed on inter-organizational networking in resilience building bringing together emergency management, disaster risk reduction, climate change adaptation and development-related sectors.

2.2 Designing the 2IDNG framework

The 2IDNG framework was designed to support this need through more comprehensive research on the impacts of government and non-government, formal and informal, cross-sectoral cooperation in the process of disaster resilience building. In the case of Vanuatu, the 50 networks, committees and cooperative bodies, active in emergency management, disaster risk reduction, climate change adaptation and sustainable development, are of significantly different size, influence, functioning mechanisms and leadership systems, and yet compose a whole disaster resilience-building network.

A network, whether it is mandated or the recognition of informal relations, is constructed with structural and functional elements that will determine its potential outcomes: such as the configuration of its members, the sectoral fitting, leadership or available tools for sustainability. Given the flexible and changing nature of networks, the structure, configuration, goals and needs evolve over time impacting on the initial structural and functional elements of the network. Distribution of network members, sectoral dominance and isolation, evolution in leadership and development of learning capacities are main cooperation outcomes, which influence the beneficial development of other outcomes for effective resilience building, such as capacity building, resource optimization, policy implementation or trust building.

Therefore, within the 2IDNG framework were developed four interconnected pillars of research to overcome the difficulties encountered in determining the impacts of networks on policy making and practice:

<u>Government/non-government networking</u>: Governments are traditionally the governing entity for humanitarian affairs in their own country, but non-government stakeholders are increasingly empowered to take part in resilience building because of the dependency on international aid in developing countries and the need for more flexible governing structures facing the earth system complexity. The 2IDNG framework analyses the new form of networked governance for disaster and climate change by determining the respective roles and positions of government and non-government stakeholders, as well as the pathways for government/government, non-government/non-government, and government/non-government cooperation.

<u>Cross-sectoral networking</u>: Cross-sectoral relations are important to assess because disaster resilience building requires a holistic approach as all sectors related to disasters, climate change and sustainable development (such as emergency management, agriculture, education or health) have simultaneously more or less direct and significant impact on the final outcomes.

<u>Networked leadership</u>: Leadership is an on-going and major debate in resilience building (such as community leadership, women leadership or shared leadership). Stakeholder configuration, goals,

needs and potential outcomes of sectors related to disasters and climate change continuously evolve and are increasingly complex. This situation raises the need for a more flexible, adaptive and inclusive (fragmented and integrated) leadership within government and non-government networks.

Networked learning: Resilience building relies on the capacity of network members to learn from success and failures of existing strategies and mechanisms, as well as developing capitalization tools and anticipation capacities.

Figure 1 illustrates the dynamics of the 2IDNG framework consisting in the analysis of formal and informal networks, institutions, policies and norms at all levels:

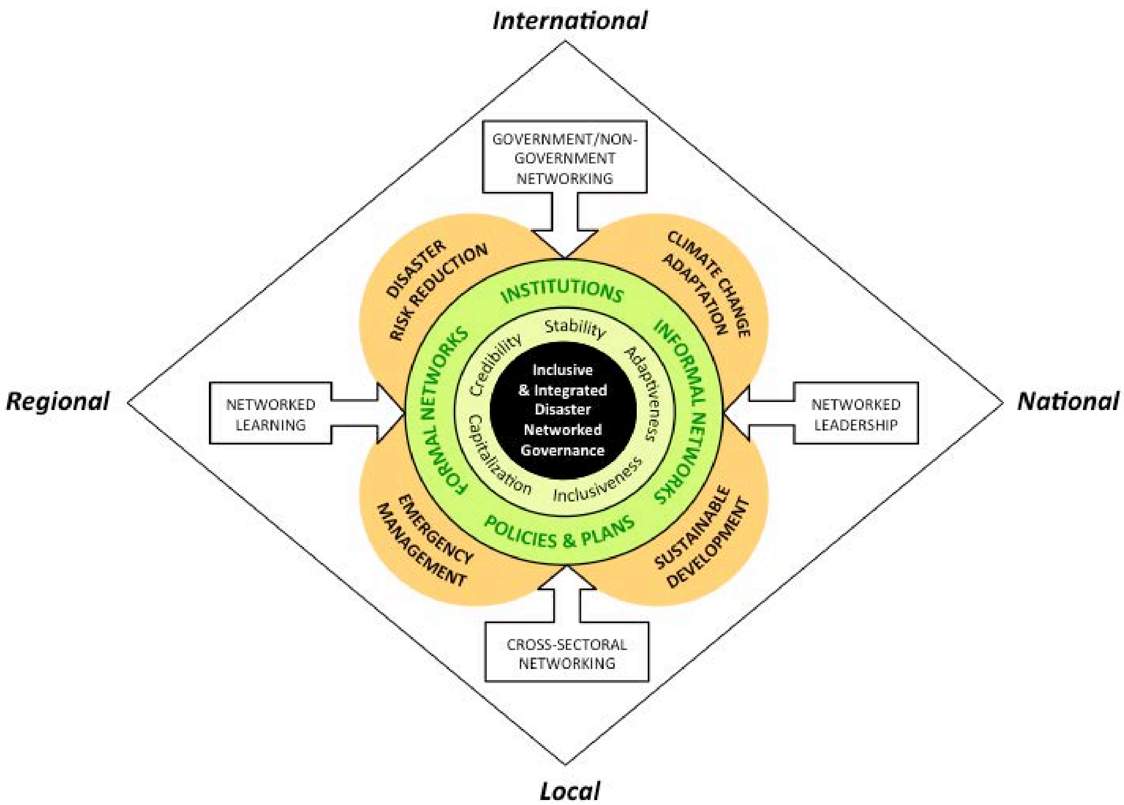

Figure 1: The 2IDNG framework

3. Understanding the 2IDNG framework

3.1 The combined pillars of government/non-government and cross-sectoral networking

Structural analysis of the whole networked system for resilience building identifies opportunities and drivers for, as well as obstacles to government/non-government cooperation for the integrated sectors individually and as a whole system. The 2IDNG framework is designed to address the following questions: What is the configuration of the whole networked system? What are the linkages and cooperation mechanisms that exist between the different forms of systems evolving simultaneously, for example between mandated networks and unanticipated institutionalized networks; or between networks of different leadership forms? What are the mechanisms to support individual, organizational and networked performance? What form of whole-of-network setting supports the integration of diverse sectoral networks, while not undermining sectoral expertise building? Are there complex subgroup linkages?

Structural mapping addresses critical questions divided into three categories. First, the configuration of the network gives information on the potential of the network determining the availability of human and financial resources for each network member, each sector and the whole networked system:

- What is the size of the whole networked system?
- What are the characteristics of the members (type, size, sector, influence etc.)?
- What are the mechanisms to meet and share resources (where, how often, who is leading them, what are the incentives to participate)?

Second, the nature of the linkages between stakeholders determines the quality and potential of the relationships between network members:

- Who is connected with whom?
- Are the relationships formal or informal? Is there an informal dimension in formal relationships? Are there informal relationships that should be institutionalized to be optimized?
- What is the sphere of connections (Bonding - within same group, bridging - between different but similar groups part of the same system, and linking - between different systems [18])?
- Are there dominant and isolated sectors/stakeholders?
- Are links reciprocal? How does the direction of linkages influence the quality of the relationships?

Third, the identification and analysis of the sectoral networks and subgroups within the whole system establish the risks and opportunities inherent in heterogeneous networks:

- What are the characteristics, influence and connections of the sectoral networks?
- What are the government and non-government distribution and interaction within and between sectoral networks?
- What are the characteristics, influence and connections of subgroups within the whole networked system and within the sectoral networks?
- Are there dominant and isolated sectoral networks?
- Are there valuable linkages between sectoral networks and subgroups that are missing?

3.2 The pillars of networked leadership and networked learning

3.2.1 The pillar of networked leadership

Leadership is defined in this paper as the ability to motivate, empower and facilitate a group of people to make decisions and lead operations, achieving a shared goal while supporting individual development. Analysing leadership within a whole networked system is critical to assess the potential outcomes for resilience building, as leadership will have significant impacts on efficiency and efficacy of the system (elements such as information and resources sharing, trust, consensus, dominant goals, dominant understanding of the concept, dominant languages etc.). Provan and Kenis [19] identify three forms of leadership within networked governance systems. The first and most common form, the "participant-governed", is led by all the network members themselves as a group. The second form is a "lead organization-governed" system, where a network member was identified as the best equipped to lead the collaboration. Finally, the "network administrative organization" form is a system in which an ad-hoc administrative entity was created to lead the collaboration between network members. The size of the network, the level of trust among members, the shared and individual goals, as well as the nature of operations expected within the network are determinants for the choice of the form of networked leadership.

A whole and holistic resilience-building networked system ideally brings together many formal and informal sectoral networks with diverse forms and characteristics. The 2IDNG framework aims to identify and understand what type of leadership mechanisms are in place to manage such a networked system, while not undermining the leadership of each sectoral network. Simultaneously, the 2IDNG framework analyses leadership by comparing the prescribed leadership functions of the network members based on their professional position with the perceived influence of members by other members. Disaster and climate change resilience building is a complex process where non-hierarchical, informal and sometimes non-visible organizations play a significant role. SNA mathematically measures several patterns of connectivity and influence that determine leading functions of the network members: these are described as the "in-degree centrality", "betweeness centrality" and "eigenvector centrality" [13] [14] [17]. These three indicators measure the influence of the stakeholders based on their own connections within the whole networked system. The 2IDNG puts in perspective these three centrality measures with the professional functions that determine the leading role of members, and with the members' perception of which stakeholders have significant influence on decision-making within the whole networked system. Each type of leadership has a different impact on cooperation process and outcomes. Table 1 describes the research question for assessment and signification of each leadership indicator:

Table 1: Leadership indicators

Indicators	Assessment	Signification

Professional position	What are the professional position and functions of the stakeholder?	Leading functions due to the stakeholder's position in his/her organization
Perceived leading influence	How many times did other network members name the stakeholder as main decision-maker within the network?	Other members perceive the stakeholder as main decision-maker within the network
In-degree centrality	How many times did other network members name the stakeholder as main collaborator?	Stakeholder's predominance through extensive and numerous connections, and recognition of his/her input by the other network members
Betweeness centrality	How many times is the stakeholder positioned between two other network members?	Stakeholder's power on communication and information dissemination within the network
Eigenvector centrality	How central are the network members connected to the stakeholder?	Stakeholder's influence on decision-making through strategic connection and cooperation with central and influent actors within the network

SNA mapping may identify a certain reliability of the whole networked system on sectoral networks or individual members; the disappearance of sectoral networks or members will probably have a significant impact on the configuration and linkage mechanisms of the whole system. Identifying these sectoral networks and members gives critical information to:

- Better understand what makes certain sectors and members more connected;
- Better strategize the whole networked system and organizational levels:
  - If the whole networked system is content with these specific networks/members' predominance, empowering them will support sustainability of the network and decision-making can be more cost-effective.
  - If the whole networked system does not want to rely as much on these specific networks/ members, dependent sectors/members need to be empowered to consolidate their links with the rest of the network or others outside of the network.
  - Dependent sectoral networks or members can decide themselves to diminish their dependency by consolidating other links.
  - Predominant sectoral networks and members can become more cognisant of their impacts, and thus responsibilities, within the whole networked network.

By studying networked leadership, the 2IDNG framework builds better understanding as much of the impact of networked governance on leadership as of the outcomes of leadership on networking.

3.2.2 The pillar of networked learning

The pillar of leadership influences, and is influenced by, the final 2IDNG pillar: learning. Adapted from Taylor's [20] definition of learning organizations, this paper defines learning networks as networks where members build and improve practice for resilience building by consciously and continually learning from their own and other network members' experience. Taylor [20] identifies several principles to learning. To start with, learning is an on-going process but often unconscious, therefore network members need to consciously identify and develop existing learning sources and mechanisms. Furthermore, learning through better use of information, knowledge and analysis capacities needs to have a positive impact on practice. Additionally, learning must be an iterative process, which constantly progresses depending on the evolution of the network structure, goal, outcomes and needs. Lastly, experience within the network is a critical source of learning, whether it is experience of individuals, organizations or inter-organizational cooperation.

Transparent learning about successes, failures and existing mechanisms in disaster risk management and climate change adaptation is essential to identify pathways for cost effective and sustainable resilience building. Learning in a multi-stakeholder environment, such as a 2IDNG system, and a complex context, such as a SIDS, is a requirement for actors to be fully aware of the power distribution and external influences on their own work. Learning is also a means to improve accountability and legitimacy within the network. Learning must take place on different levels to optimize invested resources through the capitalization of existing outcomes in resilience building. It also contributes in developing a more comprehensive vision of the whole networked system to anticipate the obstacles and opportunities for resilience building.

To be appreciated as a learning network, networked learning must consist in interlinkages between all learning levels: individual, organizational, inter-organizational and whole-networked. Table 2 identifies examples of learning areas in which each level needs to invest, in order to lead cost-effective resilience building. The different learning levels are interdependent; an investment failure or success on one level will have an impact on the achievement of learning efforts on another level.

Table 2: Examples of areas for positive outcomes at each learning levels

Learning	**Examples of learning areas for positive outcomes**

levels	
Individual	Formal and informal capacities and resources (technical and functional); formal and informal linkages with other individuals inside and outside the organization; identification of own and others' failures and successes
Organizational	Human and financial resources; formal and informal linkages with other organizations; capacity building mechanisms; problem-solving mechanisms; identification of own and others' failures and successes
Inter-organizational	Co-funded projects linkages; resources sharing mechanisms; cooperative decision-making mechanisms; communication pathways; identification of failures and successes in cooperation
Whole-networked	Communication tools and platforms; diversity of members; resources invested in cooperative projects; evolution trends of the network structure, goal and outcomes; identification of failures and successes within the network; identification of existing and potential external forces affecting the network; network credibility and influence in the outside

The 2IDNG framework addresses the analysis of learning areas in different steps. Initially, existing mechanisms to continually and consciously identify and capitalize information, knowledge and reflection capacities are analysed at all levels. Furthermore, the existing and potential impacts of these resources on practice are analysed. Finally, evaluation and capitalization mechanisms are developed to improve learning, based on the anticipated evolution of the structure, goals and needs of the whole networked system.

4. Conclusion

Based on the four pillars of government/non-government networking, cross-sectoral networking, networked leadership and networked learning, the 2IDNG framework was developed in the specific context of disaster and climate change networked governance in the SIDS of Vanuatu, and its use to other contexts might be less applicable. This framework, however, highlights a number of critical questions that need to be addressed when any networked governance system is analysed. The application of the 2IDNG framework to study cyclone Pam response and recovery will highlight the strengths and weaknesses of the networked governance system for disaster resilience building in place before the event. This will also help build theory on the management of international humanitarian aid in a SIDS.

The overriding purpose of the larger research is to discuss the reciprocal impact between politics and disasters; and the development of the 2IDNG framework is a key step towards it. The new priorities set in the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals will advocate for new political forms; it is then important to evaluate the successes and failures of current and recent governance systems, that have not yet achieved their full potential, such as the recent development of Vanuatu's whole networked system for disaster resilience building.

5. References

[1] UNISDR (2015) Making Development Sustainable: The Future of Disaster Risk Management. Global Assessment Report on Disaster Risk Reduction. Geneva, Switzerland: United Nations Office for Disaster Risk Reduction (UNISDR).

[2] UNDESA (2014) Partnerships Briefs for Small Island Developing States. Climate Change and Disaster Risk Management. UN Conference on Small Island Developing States. United Nations Department of Economic and Social Affairs (UNDESA) Division for Sutainable Development.

[3] Birkmann, J., Welle, T., Krause, D., Wolfertz, J., Suarez, D-C, Setiadi, N.J. (2011) WorldRiskIndex: Concept and results. World risk report 2011, pp 11-26.

[4] Welle, T., Birkmann, J., Rhyner, J., Witting, M., Wolfertz, J., (2013) WorldRiskIndex 2013. World risk report 2013, pp 45-56.

[5] Welle, T., Birkmann, J., Rhyner, J., Witting, M., Wolfertz, J. (2012) WorldRiskIndex 2012: Concept, updating and results. World risk report 2012, pp 11-26.

[6] Welle, T., Birkmann, J., Rhyner, J. (2014) WorldRiskIndex 2014. World risk report 2014, pp 39-52.

[7] Aboagye, D. (2012) The political ecology of environmental hazards in Accra, Ghana. Journal of Environment and Earth Science, Vol. 2, No. 10, pp 157-172.

[8] Biermann, F., Betsille, M.M., Gupta, J., Kanie, N., Lebel, L., Liverman, D., Schroeder, H., Siebenhüner, B. (2009) Earth System Governance: People, Places and the Planet. Science and Implementation Plan of the Earth System Governance Project. With contributions from Conca, K., da Costa Ferreira, L., Desai, B., Tay, S. and Zondervan, R. Earth System Governance Report 1, IHDP Report 20. Bonn, IHDP: The Earth System Governance Project.

[9] Biermann, F. (2007) Earth System Governance as a crosscutting theme of global change research. Global Environmental Change, Vol. 17, pp 326-337.

[10] Pratono, A. (2007) Promoting Participatory Earth System Governance on Emergency Program: Case of Earth Disaster in Indonesia. 2007 Amsterdam Conference on the Human Dimensions of Global Environmental Change. Vrije Universiteit Amsterdam, 24-26 May 2007.

[11] Gero, A., Meheux, K., Dominey-Howes, D. (2010) Disaster risk reduction and climate change adaptation in the Pacific: the challenge of integration. ATRC-NHRL Miscellaneous Report 4.

[12] Djalante R. (2013) Identifying Drivers, Barriers and Opportunities for Integrating Disaster Risk Reduction and Climate Change Adaptation in Indonesia: An Analysis Based on the Earth System Governance Framework. In: Leal Filho W (Ed.). Climate Change and Disaster Risk Managements. Springer Berlin Heidelberg, Berlin, pp 131-147.

[13] Chung, K.K., Hossain, L., David, J. (2005) Exploring sociocentric and egocentric approaches for social network analysis. Proceedings of the 2nd international conference on knowledge management in Asia Pacific, pp 1-8.

[14] Hossain, L., Kuti, M. (2010) Disaster response preparedness coordination through social networks. Disasters, Vol. 34, No. 3, pp 755-786.

[15] Borgatti, S.P., Everett, M.G., Freeman, L.C. (2002) Ucinet 6 for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

[16] Borgatti, S.P. (2002) Netdraw Network Visualization. Analytic Technologies: Harvard, MA.

[17] Borgatti, S.P. (2005) Centrality and network flow. Social Networks, Vol. 27, pp 55-71.

[18] Aldrich, D.P. (2012) Building Resilience: social capital in post-disaster recovery. Chicago, the University of Chicago, Press.

[19] Provan, K. G., Kenis, P. (2007) Modes of Network Governance: Structure, Management, and Effectiveness. Journal of Public Administration Research and Theory, Vol.18, No. 2, pp 229-252.

[20] Taylor, J. (2002) On the Road to Becoming a Learning Organization. In: Michael, E., Fowler, A. (Eds.). The Earthscan reader on NGO management. London: Earthscan, pp 347-352.

Building resilience to disasters through workshops for services providers using national monitoring and evaluation framework

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Abstract

There is global, national, state and local level recognition of the importance of being prepared for disasters and building resilience against the impacts that they have on individuals and communities. Programs in this area have commonly focused on working with individuals or households. Increasingly there has been a recognition that there are groups within our community who are particularly vulnerable to the impacts of disasters and are hard to reach using traditional approaches; these may include people with a disability, coming from culturally and linguistically diverse (CALD) backgrounds or having an age related vulnerability (very young or very old) just to name a few.

Red Cross has run a series of workshops for service providers who have this specific and invaluable knowledge of the needs of these vulnerable groups. These workshops were a collaboration between local government, combat agencies (flood and fire services) and other relevant experts. Baseline data was collected during the registration process, feedback collected after the workshops and a follow up feedback collected from a random selection of participants 6 months after the workshops. Of the participants that were not doing preparedness work prior to participation in the project 67% were doing something to increase the preparedness of their organisation or clients at the time of follow up. A total of 54 (44%) participants received follow up phone calls, as a part of this they were asked to indicate the number of clients benefiting from the increase preparedness work. The total number of beneficiaries was 1817.

We have continued to add to the collected baseline data with following workshops and have a consistent approach to our data collection. This is providing Red Cross with a critical evidence base to support future research and funding. This monitoring process draws upon the Red Cross Emergency Preparedness Monitoring and Evaluation Framework

The Building Resilience Workshops project won the Resilient Australia Award (not for profit category) at both the state and national level.

Keywords: resilience, monitoring, engagement, collaboration, evaluation

1. Introduction

Disasters, both natural and man-made, are an inevitable part of life in Australia, and as such a wide range of services are involved in disaster management. Historically, the work of government, emergency services and non-government, not-for-profit, and voluntary organisations (collectively referred to as NGOs) in disaster management has focused predominantly on the response to and immediate recovery from these events. As the frequency and severity of disasters increases, there is correspondingly increased recognition of the need to prepare for them.

For one hundred years Australian Red Cross Emergency Services have provided assistance to individuals, families and communities during and after disasters, recognising that the impacts of disasters extend beyond survival to being able to cope with the disruption that an emergency can cause to a person’s existence (Australian Red Cross., 2014). In recent years their work has expanded into disaster preparedness programs aimed at increasing individuals and community’s resilience and ability to cope with disaster. An intended outcome of these programs is that the impact of disasters is lessened at both a psychosocial and practical level (Australian Red Cross., 2014).

The impacts of a disaster can be severe, with affected people experiencing a range of potential disruptions to their lives, including loss of a loved one, a sense of security, hope, faith and trust in others, dignity, social networks and institutions, access to services, property, material goods, pets, prospects of a livelihood and places and landscapes (Australian Red Cross., 2014). Disasters impact everyone, but they do not impact everyone equally. Often those most vulnerable to the impacts of disasters are also those who experience the greatest disruption (Council of Australian Governments., 2011). For this reason, targeting the disaster resilience of vulnerable groups will produce the greatest outcome.

Resilience to disaster is a long-term outcome; it requires a commitment and sustained behaviour change by individuals, organisations and communities as a whole. Planning for disasters builds the resilience of communities over time, particularly if government and other organisations take the building of resilience into account when they develop services, products and policies (Council of Australian Governments., 2011).

In 2013 Red Cross received funding to design and deliver six workshops with the intent of promoting behaviour change amongst community service organisations to work with their clients in order to increase their clients’ preparedness for and resilience to disasters. The workshops were held in the Hunter and Central Coast regions of New South Wales (NSW) and in the Australian Capital Territory (ACT).

Influencing positive behaviour change amongst community services providers, that would in turn result in increase disaster preparedness of groups considered particularly vulnerable to the impacts of disasters, was central to the project. Community Service providers were identified as the ideal conduit to reach the target groups, because they are often difficult to access via standard communication methods such as internet, Community Presentations and print. In addition, Community Service providers are often trusted by their clients and therefore are ideally placed to facilitate disaster preparedness with their client group. The workshop presentations and activities aimed to increase the preparedness knowledge of community service providers and encourage them to integrate preparedness behaviour into their service delivery.

2. Evaluating Behaviour Change

Change in individual behaviour leads to change in communities. Yet the ways to influence behavior are as varied and nuanced as the individuals whose behaviour is being changed. Red Cross has approached behaviour change with regards to disaster preparedness in a number of ways; producing books that guide the development of emergency plans, presentations by volunteers to community groups, and workshops for community members, community services organisations and combat agencies. To this point there has not been a consistent measure to establish the effectiveness of these interventions and allow for comparison.

To evaluate the behaviour change exhibited through the building resilience workshops, Red Cross applied Icek Azjens Theory of Planned Behaviour. The theory posits that the best predictor of behaviour change is intention; the stronger the intention, the more likely change will result. Intention is shaped by a person's attitude towards the behaviour and its outcome, subjective norms and normative beliefs, and the perceived control over completing the behaviour (Azjen, 1991).

Behavioural belief relates to the attitude toward the action. For the desired behaviour to be acted out, the behavioural belief and outcome need to be viewed favourably. In addition, subjective norms (such as societal expectations) along with normative beliefs (particularly those of people whose opinions are highly valued) shape an individuals intention to engage in and complete promoted behaviours (Azjen. 1991, 2011). Community narratives also play a significant role in shaping the narratives of individuals (Chamlee-Wright and Storr, 2011).

Social norms and expectations shape individual choices. Positive individual choices are more likely in an environment with strong social capital. The creation of social capital relies on sociability and a capacity to form relationships and develop cooperation. Trust and the extent of networks within communities are guided by how individuals act towards one another and engage with community institutions (Cavaye, 2004, Onyx and Bullen, 2000, Putnam, 2000). Social capital comprises of networks of interlocking relationships between individuals and groups that encourage communities to work together towards a common goal. These networks of shared norms and values create an environment of reciprocity and attention to others welfare (Putnam, 2000, Fahey, 2003, Onyx and Bullen, 2000, Mayunga, 2007).

While the above factors indicate intention, actual and perceived control is the lynch pin to achieving action. The performance of some activities may be blocked by a lack of resources such as skills, money, training and cooperation from others. Perceived control relates to the ease with which the desired behaviour can be completed and this is influenced by confidence, accessibility of required resources and the action being realistic (Azjen. 1991, 2011).

3. Building Resilience workshops

The workshops were designed to reflect Australia's National Strategy for Disaster Resilience, which focuses on 'priority areas to build resilient communities across Australia'. The Strategy supports preparedness through 'a long-term, evolving process to deliver sustained behavioural change and enduring partnerships' (Council of Australian Governments, 2011). The expected increase in the frequency and severity of disasters will increase demand for government resources and expertise. As such, the PPRR (prevention, preparedness, response and recovery) cycle should be seen not only as the responsibility of experts and agencies, but also the responsibility of business, communities and individuals. By being aware of the potential risks, actively planning and preparing for disasters and being engaged in their community, individuals can increase their community's disaster resilience (Council of Australian Governments., 2011, Fahey, 2003).

Red Cross worked with community service organisations rather than directly with community members. This approach assumed preparedness messages would be more far-reaching if provided to key community service providers with an existing relationship of trust with their clients. Through their client interactions, participants could develop and share emergency preparedness strategies to increase the individuals' disaster preparedness and resilience.The workshops also provided a fertile space for organisational engagement, including collaboration between Red Cross, emergency services agencies and local government to increase shared messaging and engagement in emergency preparedness. Community service providers were also encouraged to share their strategies with one another and identify possibilities for future funding opportunities.

Each workshop focused on a specific sector, culturally and linguistically diverse (CALD) communities, older people and people with a disability, and was tailored to their unique needs. Red Cross community engagement prioritises communities particularly vulnerable to the impacts of disasters, acknowledging that these factors are diverse, and may include location, population density and mobility, demographic profile and socio-economic status (Council of Australian Governments., 2011)

All sectors of society from government to nongovernment to business and individuals have a role to play in increasing the resilience of their community to disasters. The collective impact of this will be greater and more effective if organisations and individuals work together rather than independently (Council of Australian Governments., 2011).

Working together requires community members to volunteer their time and effort. Working together also requires government and not-for-profit organisations to employ community engagement strategies so that communities are empowered to play a central role in planning and are involved in making decisions that effect them (Fahey, 2003, Council of Australian Governments., 2011, Graham, 2011). What follows below is a description of the workshop strategy, designed to reflect these principles.

At registration, Red Cross surveyed attendees to help establish baseline data. Information gathered included their organisation's role and size, the number of clients they supported and the type of emergency preparedness work they had carried out with their clients. Twenty-nine percent indicated they were currently doing some form of preparedness activities, the majority including creating emergency plans, talking about emergency kits and emergency drills.

In total 130 attendees representing 65 different organisations of various sizes. Feedback was received from 103 participants.

A Participant Handbook was provided to each attendee, containing the project background, key definitions, a workshop program and helpful resources and references. At the beginning of the workshops, the Red Cross facilitator emphasised that emergency preparedness is a shared responsibility and the workshop would enable community service providers to assist their clients to take ownership of their own preparedness, taking into account pre-existing vulnerabilities.

The morning session comprised of presentations from two universities and a counselling provider (Lifeline). A panel of emergency services agencies including Red Cross, Rural Fire Services, Fire & Rescue, State Emergency Services and police from respective locations in which the workshops were held. Local government and the Department of Health also participated in the Hunter and Central Coast workshops. In the ACT the ambulance services also participated in the panel. Presentation messages included influencing behaviour change, responding to the social impacts of heatwaves; emergency service agencies' roles, experiences and knowledge, the psychological impacts of disasters and in the ACT, workforce sustainability during a disaster. In the last ACT workshop, the Red Cross facilitator provided the psychological impacts of disaster information on behalf of Lifeline and also included a brief talk about psychological preparedness for disasters.

In the afternoon, attendees were divided into small groups (5-7 people) to discuss preparedness strategies for their organisations and clients, and then share these with the larger group. Each group was asked to create disaster scenarios, either for individuals or an organisation, based on their combined knowledge and experience of vulnerable community members or circumstances specific to their work. These scenarios were then analysed to create a list of potential vulnerabilities and capacities for their organisations or clients during an emergency or disaster. The group then developed strategies to reduce the impact of such an emergency or disaster. Many of the challenges from each scenario were common to all three target groups, for example, the event (fire, flood, extreme heat and power failure), lack of direct aid from an emergency services agency and lack of an emergency plan. Participant's perception of the relevance of the presentations varied between workshops, with people finding the emergency services agencies and the Macquarie University research on the social impacts of heatwaves most useful.

4. Developing a consistent evaluation mechanism to measure behaviour change and impact

Previous evaluations have been intervention specific, they have provided valuable insight into each intervention, but have not been comparable to each other. As the majority of our programs and projects aim to effect bahviour change in participants the use of a behavior change model seemed most appropriate. Red Cross aimed to identify a behaviour change model that could be applied to their disaster preparedness programs to measure their effectiveness in promoting behaviour change. Whilst there are a number of behavior change models Icek Azjens Theory of Planned Behaviour was chosen as it is widely accepted and has been successfully used to demonstrate behavior change. The theory was retrospectively applied to the workshop evaluation both to measure the utility of the model when applied in this context, and to assess whether meaningful change was undertaken as a result of the workshop.

The purpose of the evaluation was to measure how valuable the workshops were to the attendees and to determine to what extent they increased their efforts to induce a positive behaviour change in their vulnerable clients towards preparedness for disasters. Commencing in June 2013, baseline data was collected from Community Service providers at the time of registration on Eventbrite to measure to what extent attendees and their organisations provided emergency preparedness activities or education to their clients. At the completion of each workshop, attendees were asked to complete an evaluation form to measure the workshop experience. Attendees were asked to indicate the usefulness of each presentation and session to their work.

In applying the Theory of Planned Behaviour the behavior change is defined as activities implemented by the staff of Community Services provider that increase the knowledge and capacity of clients to react appropriately during a disaster and prepare them to recover from these events. Activities that were considered to reflect the expected behavior change are emergency plans, grab and go kits or general education about the disasters that may impact on them. Due to the post-application of this theory this definition has been developed after the program has been completed.

4.1 Participant belief of expected behaviour and their role in its implementation

Attendees were asked a series of questions at the time of registration to identify what they hoped to achieve as a result of participating in the workshop and if they were already doing work to prepare their clients for disasters. Analysis of what participants expected to gain from participating in the workshops suggests that many participants were aware of the client group's vulnerability to disasters, but were unaware of how to address this. Some participants indicated multiple gains that they wanted to achieve from participating in the workshops. Fifty participants indicated that they hoped to gain knowledge from attending this workshop. For some it was just knowledge, for others it was knowledge regarding the disasters they are vulnerable to, on disaster preparedness, and knowledge to assist with action in a range of areas. An additional nine commented on developing skills to assist them in their work. Eight indicated that networking with other organisations was something that they hoped to achieve by participating in the workshop. Forty-four were hoping to gain skills and develop strategies to prepare clients for disasters, 16 participants wanted to know how to assist their clients during a disaster and 15 wanted to gain information regarding the development of policies and procedures for their organisation both before and during disasters. One person wanted to gain knowledge on how to build resilience in communities post disaster.

Participants were asked at the time of registration to indicate what, if any, disaster preparedness activities they were already doing. A total of 27% (34) of participants were already doing some sort of preparedness work with their clients. Participants were able to indicate more than one response. The majority of organisations (19) had evacuations plans, fourteen respondents indicated that they had emergency kits, 6 had run fire drills, 9 had conducted some form of education for their clients including conversations and information sessions with them, 2 had done risk assessments and two had business continuity plans.

While a majority (73%) said no to having already done preparedness work, the answers regarding what participants hoped to get out of the training indicated that most had considered what they could do to take care of their clients during a disaster.

At the end of the workshop participants were asked to indicate how likely they were to implement strategies with their clients. A total of 89% indicated that they were either likely or highly likely to implement strategies. Many participants, even if they were unsure if they would implement preparedness strategies with their clients, answered the next question regarding what strategies they were most likely to implement. Some respondents indicated more than one strategy. A total of 37 respondents indicated that they would provide kits for their clients; help them set up emergency kits or provide them information regarding the content that should go into one. A total of 36 respondents highlighted some form of education as a strategy they were likely to implement. The intended objectives being increased awareness amongst their clients as to the risks and how to prepare, to having presentations and sessions from external agencies and running workshops with their clients or staff. Seven indicated some sort of educational strategy related to their policies and procedures.

A follow up survey was carried out with 54 (44%) of participants six months after the completion of the workshops. The participants were randomly selected. Those selected were asked to indicate if participating in the training had changed their understanding of what it was to be prepared for disasters. A total of 72% indicated that the workshops had changed their understanding of what it was to be prepared for a disaster, with 19% indicating a neutral position and 9% (5 participants) indicated that the workshop had not changed their understanding of what it was to be prepared. Of this last group, 4 of the 5 indicated they were already doing preparedness work with their clients before they participated in the workshop. While the remaining organisation that had not been doing so before, was afterwards.

Of those that said they were doing preparedness activities (inclusive of organisations doing preparedness work before the workshop) 25 participants surveyed said that they had provided education of some sort to clients, staff and the community. Seven had provided their clients with kits or provided information on putting them together to their clients, 3 had distributed plans to their clients. Thirteen indicated changes in policy and procedures such as protocols for what to do during an emergency, developing a centralised register of clients and / or scaling of clients with a need for assistance during an emergency.

4.2 Societal expectation of participant’s role in implementing behaviour change with clients

The fact that so many of the participants indicated a desire to prepare their clients for disasters could be seen as a personal expectation, rather than a societal expectation that they care for their clients during disasters. Sixty respondents to the pre-workshop survey indicated that they wanted to be able to assist their clients by either preparing beforehand, or during a disaster. While 4 of those interested in increasing their knowledge mentioned that it was in order to educate or support their clients better.

The questions asked of the participants did not ask them to reflect on why they felt a need to assist with the disaster preparedness of their clients. This gap in evaluation will be addressed in future iterations of the pre- post- and follow up surveys of participants.

4.3 Perceived vs real control of participants to implementation of behaviour change

As Azjen (1991) indicates intention is the best indicator of behaviour change. A core factor in the transfer from intention to action is control, both perceived and actual. The percentage of workshop participants that had implemented preparedness activities with their clients demonstrates a sense of control over the behaviour change. For those that had not implemented any preparedness activities with their clients their response to why they had not reflects whether the barrier was real or perceived.

In the survey participants completed at the end of the workshop, 49% indicated they were highly likely to implement some sort of preparedness strategy with their clients after the workshop, with 40% likely and 10% unsure.

When followed up 6 months after the workshops only 14 (26%) stated that they had not implemented any strategies with their clients. Half of these respondents still intended to implement strategies, but had not been able to yet. While 74% of participants indicated that they had (some of these respondents already indicated that they were doing preparedness work). Of the follow up sample that had not been doing preparedness work before participating in the workshop, 67% now were.

For those who were not implementing strategies with their clients and had no intention to, their reasons included time (not having enough of it), no direct contact with clients, the clients are reliant on the organisation to be prepared, or they already had strategies in place (provide a grab and go bag to clients). Finally 3 respondents indicated that it was not within the scope of their job.

The other 7 that expressed an intention to implement preparedness strategies with their clients indicated that the delay had been due to a lack of capacity or that it was in progress but there were competing priorities and issues with funding.

Once those that still intended to implement preparedness strategies were excluded, only 13% of participants had not and had no intention to implement disaster prep strategies with their clients.

5. Conclusions

The program evaluation demonstrates that the perception and understanding of the behaviour in question changed as a result of the program. The number of participants who indicated that the workshop changed their understanding of what it was to be prepared supports this conclusion. It is also reflected in the preparedness activities documented at the different stages of data collection, with the majority of respondents indicating that their existing preparedness strategies related to evacuation plans, while a significant number of workshop participants were planning to implement educational strategies or provide or assist clients in putting together emergency kits and finally to the majority of preparedness strategies implemented being educative followed closely by strategies to change policy and procedure.

The application of the Theory of Planned Behaviour has highlighted a number of weaknesses in the evaluation of this program. It would be ideal to pre-apply the theory during the development of the program and evaluation questions. By pre-applying the theory we would be able to develop pre-, post, and follow up evaluation questions that would clearly reflect aspects of the theory of planned behaviour allowing for a stronger analysis of the impact of these workshops in facilitating behaviour change and therefore increase not only the occurrence of organisations preparing their clients for disasters and an understanding of what that is.

Funding has been secured for a similar project. The Theory of Planned Behaviour proved an effective model to measure the effectiveness of disaster preparedness strategies. However, in order to be able to confidently establish a pattern of behaviour change, the expected behaviour change and associated baseline data needs to be clearly defined at the start of the project in the future. The team are currently in the process of pre-applying the Theory of Planned Behaviour to the project design and evaluation.

References

[1] Dynes, R. (2003) Finding Order in Disorder: Continuities in the 9-11 Response. International Journal of Mass Emergencies and Disasters, Research Committee on Disasters, International Sociological Association, Vol. 21, No. 3, pp 9-23.

[2] Australian Red Cross. (2014) Submission to the Productivity Commission Review of Natural Disaster Funding Arrangements. Melbourne: Australian Red Cross. URL: http://www.pc.gov.au/__data/assets/pdf_file/0006/137463/sub056-disaster-funding.pdf [Accessed on 18/03/2015]

[3] Azjen, I. (1991) The Theory of Planned Behaviour. Organisational Behaviour and Human Decision Processes, 50, 179 – 211.

[4] Azjen, I. (2011) The Theory of planned behaviour: Reactions and reflections, Psychology & Health, 26:9, 1113 – 1127.

[5] Cavaye, J. (2004) Social Capital: a Commentary on Issues, Understanding and Measurement. Observatory PASCAL - Place Management, Social Capital and Learning Regions.

[6] Chamlee-Wright, E. & Storr, V. H. (2011) Social capital as collective narratives and post-disaster community recovery. The Sociological Review, 59, 266 - 282.

[7] Council of Australian Governments. (2011) National Strategy for Disaster Resilience. In: Council of Australian Governments. (ed.). Canberra: Commonwealth of Australia.

[8] Fahey, C. (2003) 'Working with communities' to 'build social capital' – Reflecting on old and new thinking about volunteers. The Australian Journal of Emergency Management, 18, 12 -17.

[9] Graham, W. (2011) Effectiveness of disaster assistance programs in promoting individual resilience in recovery from disasters. Canberra: The Winston Churchill Memorial Trust.

[10] Mayunga, J. S. (2007) Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. Summer Academy for Social Vulnerability and Resilience Building. Munich, Germany.

[11] Onyx, J. & Bullen, P. (2000) Measuring Social Capital in Five Communities. The Journal of Applied Behavioural Science, 36, 23-42.

[12] Putnam, R. D. (2000) Bowling Alone: The Collapse and Revival of American Community, New York, Simon & Schuster.

Analysing community needs and skills for enhancing disaster resilience in the built environment

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Abstract

A better cooperation among all the stakeholders working towards enhancing the disaster resilience of societies can only be achieved if the expectations or the needs of each stakeholder are understood. In the light of this, this research attempts to outline the needs of communities affected by disasters for the purpose of aligning the needs and skill requirements with the abilities of built environment professionals serving these communities. Skills for professional practice are mainly imparted on individuals by Higher Education Institutions while communities are basically the receiver of all what other stakeholders in disaster resilience have to offer. The two groups are therefore among the main stakeholder groups relevant to the achievement of disaster resilience of societies. The 'community' is one of the stakeholders groups identified for a broader study; others are local and national government, NGOs and international agencies, academia and research organisations, and the private sector. However, this paper focuses only of the needs and skills of the 'community'. Therefore the aim of the paper is to identify and describe community needs and skill requirements for enhancing disaster resilience; this will subsequently be aligned with built environment professional's areas of capabilities and findings will be recommended for attention and further use. The paper presents the analysis of a series of semi-structured interviews conducted with key members of some communities affected by disasters as well as some of the professionals that participated in the restoration/reconstruction of those communities. Appropriate qualitative data analysis method was used and the eventual outcomes were current and emerging needs and skills of communities related to built environment professionals towards enhancing social, economic, technological, environmental and institutional dimensions of disaster resilience of societies. Responses were structured to the different stages of the property cycle i.e. Preparation, design, construction and use stages of a property development. The importance of collaborative working and effective use and empowerment of community groups and individuals among others were emphasized by the result of the study. Twenty nine classifications of skill and needs were derived after matching specific needs and skills like-for-like. Since it is important for professionals to update and upgrade their knowledge towards enhancing their capabilities and meeting the expectations of stakeholders, this study is a valuable contribution to both theory and practice.

Keywords: building resilience, built environment, communities, competencies, disaster resilience

1 Introduction

The need for all stakeholders' contribution towards building disaster resilience was clearly emphasized by the Hyogo framework for action 2005 – 2015 (UNISDR, 2005) as well as many other authors. The community is one of the important stakeholders under the theme of disaster resilience; other stakeholders are local and national government, NGOs and international agencies, academia and research organisations, and the private sector. It should be noted that in all activities that require the participation of several parties, expectations and desires of each party usually vary but needs to be converged. Bosher et al. (2007b) attempted to align Disaster Risk Management (DRM) activities with design-construction-operation process (DCOP) and the expected inputs from key stakeholders for each stage of the DRM and the DCOP. The study provided a visual representation of the link between stakeholders, DRM activities and DCOP. It therefore helps one to visualize how DRM activities can be built into the construction process as well as how the design, construction, operation process can be used to enhance the political, economic, social, technological, environmental and institutional resilience of a community. Similarly, a number of authors have identified the need for professionals involved in the development of the built environment to adopt and actively engage in the implementation of all strategies relating to disaster risk reduction (DRR) for resilience (Benson and Twigg, 2007, Bosher et al., 2007a).

Having established the fact that a number of stakeholders are relevant to the disaster resilience theme, this study focuses on the community group alone. Issues relating to other stakeholder groups will be reported in other publications. According to Twigg (2009), 'in conventional emergency management, communities are viewed in spatial terms: groups of people living in the same area or close to the same risks'. The habitants of any community execute their day to day activities by simply interacting with each other and both the natural and the built environment. The natural and the built environment should therefore be prepared to satisfactorily manage stressors. At times, communities lead the development process of the built environment at the pre-or post-disaster, this is called community driven development. Community-driven development (CDD) as it is referred to are programs that emphasize the engagement of beneficiaries in the design and management of development projects, this is done by giving communities direct control over major project decisions (Fearon et al., 2008). Even when the community is not leading the development process, it still has a direct link with the development process (i.e. the property cycle) via the identification of property needs of the community, planning, provision of full or part funding, and provision of technical and non-technical expertise during preparation, design, construction, use, and reconstruction among others. A number of authors have described what should be in communities to make it resilient (Twigg, 2009); some others have described probable indicators of resilience of communities, researches and definite submissions on how to achieve these indicators are limited, none has actually observed things through the eyes of respective stakeholder groups and with adequate focus on a specific area of practice – built environment.

This study intends to fill the identified gap by identifying the specific expectations of the community stakeholder group that should be aligned and embedded with the activities and services of built environment professionals. The understanding of these needs and its entrenchment in the capabilities of construction professionals will enhance professionals' performance while serving communities in disaster situations. This will increase the satisfaction of members of disaster affected communities and as well assist in enhancing disaster resilience. This study will also help in reducing the impact of future disasters on communities if some of the needs relevant to new constructions are met.

2 Literature review

2.1 Disaster resilience

Resilience has been described as an overloaded concept by many authors; this is because its meaning depends to an extent on the discipline in which it is being considered. Holling (1973) used the word resilience to describe a ‘‘measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables”. Resilience was defined as ‘‘the capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back’’ by Wildavsky (1991). Several authors have presented series of definitions and descriptions afterwards, the existence of varieties of definitions prompted the position of Twigg (2009), the study decided to settle for broad definitions and easily understood characteristics after describing the existence of large number of definitions as confusing. Manyena (2009) described disaster resilience as the ability to ‘bounce forward’ on following a disaster, but the definition left another ambiguity as the real meaning of bouncing forward needs to be explained further, it is currently being perceived by different stakeholders to mean different things. The confusing nature of the several definitions was also mentioned by Sapountzaki (2007). Alexander (2013) acknowledged the multidisciplinary nature of the term resilience and this has been supported by a number of researchers. The multidisciplinary nature of the term definitely has a role to play in the seeming confusion in its definition. However, UNISDR (2009) defined disaster resilience as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. The UNISDR (2009) definition is being adopted in this study because it is perhaps among the most popular and most acceptable definitions.

2.2 Community as a stakeholder group

According to Twigg (2009), ‘in conventional emergency management, communities are viewed in spatial terms: groups of people living in the same area or close to the same risks’. Although, this definition is silent on other probable dimensions of ‘community’ i.e. values, common interests, activities, structures, social, occupational, religious, or other characteristics, it is indeed very appropriate for the disaster resilience theme. Disaster resilience is significantly increased by active planning and preparation for protecting human and properties. People living in the same area or close to the same risks should therefore know and be involved in local community disaster management arrangements as it is all about them. The community should simply lend her ‘voices and choices’ to the development of human, organizational and management capacity to solve disaster related issues as they arise (Sastry, 2001, p. 2 cited in(Hossain, 2013). With respect to the property cycle, the need for the involvement of the community cannot be overemphasized, but the modes of involvement and the expectations of the community in this regard should be known.

2.3 Built Environment professionals and property cycle

Built environment professionals have different responsibilities at different stages of property development. Several issues and duties are also associated with different stages in the development process. Careful consideration of requirements for each stage is definitely required to achieve a satisfactory delivery. With respect to disaster resilience and disaster management, Bosher et al.

(2007b) attempted to align contributions from professionals and stakeholder groups at the design-construction-operation process (DCOP) with the phases of disaster management. Similarly, Thurairajah et al. (2011) mapped main built environment professionals' role in disaster management. It is obvious that the built environment professionals have a significant role to play in achieving disaster resilience and since respective professionals' duties are with respect to stage of the construction process, efforts at enhancing their performance are better viewed with respect to the phases of construction process. In this study, five-stage cycle was adopted; the stages are preparation, design, pre-construction, construction, and use stages.

2.4 Dimensions of disaster resilience

The term 'Resilience' like a number of other principles and concepts can be described by some different characteristics. As a result, Authors have established the existence of several dimensions to resilience and some went ahead to establish indicators or probable measures with for the different dimensions. Burton (2012) attempted to develop a set of indicators for community resilience, as a result, some domains or dimensions of resilience were identified, these set of domains called variable are social, economic, institutional, infrastructure, community capital, and environmental resilience. Similarly, Cutter et al. (2008) in a study that aimed to develop a place based disaster resilience model identified six dimensions of resilience under which the study developed candidate variables (indicators), the dimensions used by Cutter et al. (2008) ecological, social, economic, institutional, infrastructure, and community competence. In a similar manner, Seneviratne et al. (2010) while discussing knowledge factors grouped the knowledge factors under technological, social, environmental, legal, economic, functional, institutional, political factors. Some other authors have other classifications. It is evident from the work of the authors above among others that a theme of issues exists within the context of disaster resilience. A careful consideration of the decisions of the above mentioned author among others with respect to dimensions of resilience resulted in the adoption of five dimensions or domains of resilience in this study, the dimensions used are economic, environmental, institutional, social, technological dimensions. The choice dimensions practically cover all the issues covered by the chosen dimensions of all other authors.

3 Research method

A total of fifteen Semi-structured interviews were conducted with respondents from the "community" stakeholder group across different countries and continents. The respondents identified and interviewed were individuals that have either experienced disaster events as a member of an affected community or individuals that were deeply involved in the reconstruction and recovery of disaster affected communities. This is because issues relating to disasters are better discussed with people with relevant experience. This is consistent with ``judgement sampling" (Sekaran, 1992). The focus of the interview was on the needs of communities, and the skills required from construction industry professionals serving these communities. Accordingly, the interviews were more of a discourse structured around the stages of disaster management cycle. It is believed that it will be easier for respondents, especially the ones from the community stakeholder group, to describe their disaster experience and associated issues for interviewers to sieve the relevant parts. The semi-structured questions provided a good check and guide for the discussion. The data gathered from respective interviews were subsequently analysed using thematic coding (Flick, 1998). The themes that emerged from the interviews conducted were collated. Similar themes were merged after combining all related themes. The themes were presented under two main headings i.e. Needs and Skills. The items identified as “needs” are desires and expectations of respondents, some of the needs were said to be made available to their communities during their disaster experience. Some of the needs are also part of what the communities were expecting but were not provided for them. All the needs were categorized into five dimensions of resilience (Social, Economic, Institutional, Environmental, Technological) and each of the dimensions of resilience is sub-headed with the five stages of property lifecycle i.e. Preparation, Design, Pre-construction, Construction and Use stage. See Figure 1 for the summary of the process.

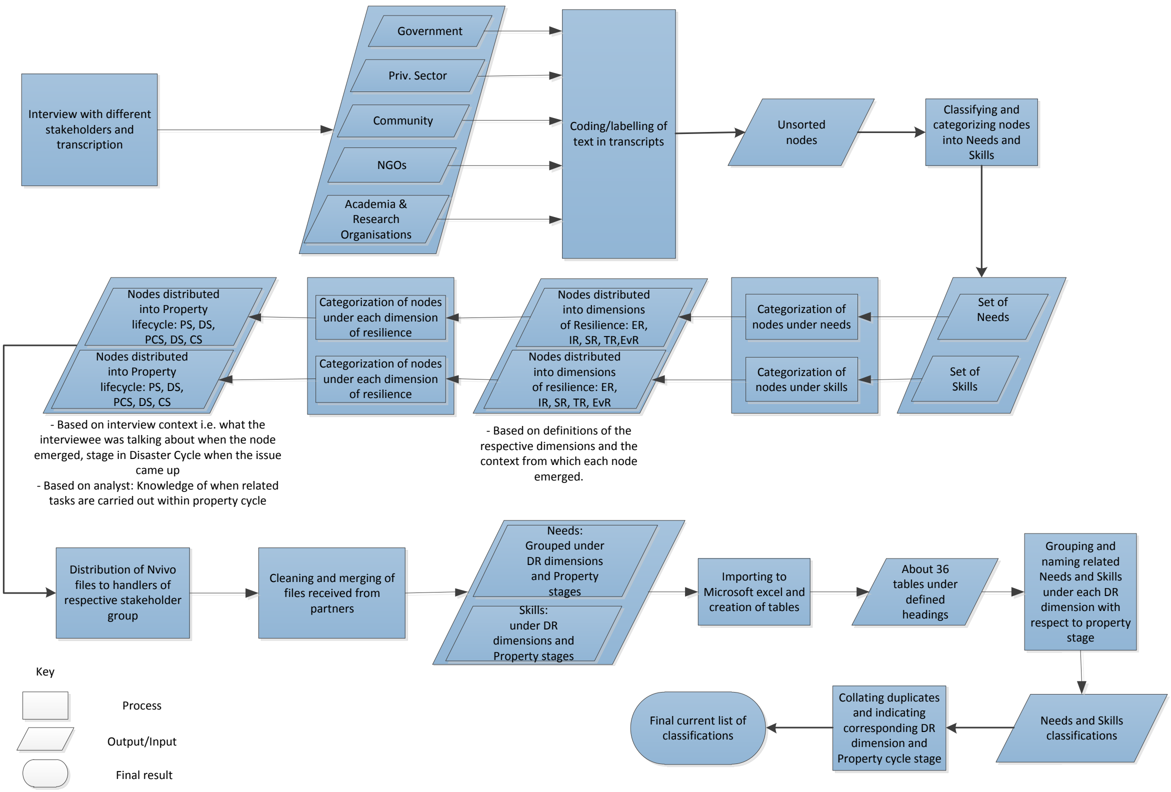

Figure 1 Summary of data collection and analysis process

4 Data Analysis and Results

The interview generated a long list of needs and skills with respect to the property lifecycle stages under the respective dimensions of resilience. Reported in this paper is the summary of the set of needs and skills.

4.1 Analysis results for market needs and skills

The resulting list of “market skills and needs” is discussed in separate sections below under dimensions of resilience with the highlight of related property lifecycle stages indicated in accompanying tables. Since there were stages in the entire process of this study, labels (needs and skills) derived from interview transcripts were directly classified under property lifecycle and dimensions of resilience; all related needs and skills were then classified into broader groups in a defined order. In this section, the respondents' submissions with respect to market needs and skills were explored and the classifications derived after merging needs and skills like-for-like are presented in tables. The stages of property lifecycle are represented in the tables as indicated thus: Preparation Stage – PS, Design Stage – DS, Pre-Construction Stage – PCS, Construction Stage – CS, Use Stage – US.

4.1.1 Market needs and skills for enhancing economic resilience

All related needs and skills derived as requirements for enhancing economic resilience were merged as described in an earlier section of this paper. This resulted in eighteen classifications presented in Table 1. Each of the classifications listed have sub items. For instance, budgeting and financial planning is a name given to the combination of the demand for financing (flood) adaptation strategies, fund sourcing and financial management skills, financial help, budgeting and financial planning, funding or financing to address disaster resilience, as extracted from the interview transcripts. Also, item 9, business planning is the name given to a combination of labels that emerged from the interview transcripts, the labels are business continuity strategies, business protection, and business plans. Also, Asset/Resource management that appears in the table is a result of the combination of labels like damage assessment, damage assessment and claim management, use of local skills and resources, needs assessment and prioritisation of resources, resource management, needs assessment and prioritisation of resources among others. It should be noted that each of the classifications have similar list of sub-items which were all seen by interviewees as requirements for enhancing economic resilience at different stages of property lifecycle as indicated in the table. It is appropriate to mention that the procedure that led to the identification of the stage of property lifecycle to which a classification heading suits most has been explained in Figure 1. The 'x' in the table indicates the property stage to which the skill and needs that made up the classification are mostly relevant. Appearance of 'x' in more than one of the stages of the property cycle for a single classification implies that the skill needs are important to more than one stage in the property lifecycle. The non-assignment of a classification to some property stages does not imply outright irrelevance of that classification (needs and skills) at that stage but not as important as the other stages to which it has been assigned, refer to Figure 1 for details of data analysis process. The needs and skills identified as well as the eventual classifications are to be viewed from the context of disasters, disaster resilience and disaster management.

Table 1 Classification of needs and skills for enhancing economic resilience

No.	**Classifications**	**Resilience Dimension**	**Property lifecycle stages**				
		Economic Resilience (ER)	*PS*	*DS*	*PCS*	*CS*	*US*
1	Budgeting & financial planning	x	x	x	x	x	x
2	Quantification & costing of construction works	x	x	x	x	x	
3	Supply chain management	x	x	x	x	x	
4	Consultancy services	x	x	x	x	x	x
5	Procurement & contract administration/practice	x			x		
6	Health & safety	x					x
7	Work progress & quality	x	x	x		x	x

	management						
8	Team working	x	x		x	x	x
9	Business planning	x	x	x	x	x	x
10	Environmental assessment	x	x	x			x
11	Management of the built environment	x	x	x		x	
12	Insurance	x	x	x	x	x	x
13	Communication & negotiation/Information systems	x	x				
14	Project audit & reporting	x	x		x	x	
15	Project management	x	x	x	x	x	x
16	Asset/Resource management	x	x	x	x	x	x
17	Disaster management	x		x			
18	Risk management	x		x			x

4.1.2 Market needs and skills for enhancing environmental resilience

Nine classifications were derived from the interview as needs and skills required for enhancing environmental resilience, see Table 2. It should be noted that the classifications are not arranged in order of importance. Similar to earlier discussions, building regulation & planning is a combination of similar themes that emerged from the interviews, among these themes are: knowledge on land-use planning, resilience planning, designing and construction. The classification Environmental assessment is a combination of themes: awareness of potential disaster threats, knowledge of potential hazards, risk and exposure, knowledge on weather and environmental changes, local topography, dealing with listed and old properties, weather changes monitoring, knowledge and experience of environmental or environment management among others. Continuing professional development as a classification emerged from the combination of education and training, education on disaster resilience, sustainability and disaster resilience modules in schools. Other classifications emerged from specific themes also but the focus of this paper is currently limited to main classifications with respective dimensions of resilience and the property lifecycle stages to which they are related.

Table 3 Classification of needs and skills for enhancing environmental resilience

No.	Classifications	Resilience Dimension Environmental Resilience (EvR)	Property lifecycle stages				
			PS	*DS*	*PCS*	*CS*	*US*
1	Building regulation & planning	x	x	x		x	
2	Health & safety	x	x				x
3	Work progress & quality management	x	x	x	x	x	x
4	Governance	x	x	x	x	x	x
5	Environmental assessment	x	x	x	x	x	x
6	Management of the built environment	x	x	x		x	x
7	Disaster management	x	x				
8	Continuing professional development	x	x	x	x	x	x
9	Quality leadership and people management	x		x			

4.1.3 Market needs and skills for enhancing institutional resilience

Classifications under each dimension of resilience were well refined to prevent the allocation of different names to the same set of themes. Institutional resilience refers to timely return of institutions to satisfactory functionality in terms of the delivery of institution based services to citizens after a catastrophe. It covers issues relating to administration, legal, political and professional services. Interviewees made submissions based on real experience of disaster situations as well as technical experiences with illustrations on some occasions. Eventually, the themes that emerged from the interview resulted in twenty five (25) classifications presented in Table 4. Consultancy services as a classification resulted from the request of respondents for access to independent professionals, construction professional help, need for someone to oversee reconstruction. Respondents decried the inability of many residents to have access to professionals that can give valid and non-profit based advice at the different stages of construction and reconstruction. Stakeholder management as a classification resulted from the combination of themes from interviews such as clarity on roles and responsibilities of different parties, multi-stakeholder engagement among others while management of dispute resolution as a classification emerged from the combination of knowledge of dispute resolution i.e. grievance management procedures and similar themes. Legal/Regulatory compliance is a combination of policy and legal framework addressing built environment resilience, knowledge of prevailing laws, need for them, implementation and enforcement of relevant laws, need for the flexibility of laws and policies among others. It is clear that some of the classifications listed in this category also appeared under previous dimensions of resilience, this implies that the skills and needs have influence across the other dimensions of resilience and across the society as a whole although they have more significance in specific contexts.

Table 4 Classification of needs and skills for enhancing institutional resilience

No.	**Classifications**	**Resilience Dimension Institutional Resilience (IR)**	**Property lifecycle stages**				
			PS	*DS*	*PCS*	*CS*	*US*
1	Supply chain management	x			x		
2	Consultancy services	x	x	x	x	x	x
3	Procurement & contract administration/practice	x			x		
4	Building regulation & planning	x	x	x	x	x	x
5	Legal/Regulatory compliance	x	x	x	x	x	x
6	Health & safety	x	x				
7	Work progress & quality management	x	x	x		x	x
8	Quality leadership & people management	x	x	x	x	x	x
9	Team working	x	x	x	x	x	x
10	Governance	x	x	x	x	x	x
11	Stakeholder management	x	x	x	x	x	x
12	Business planning	x	x	x		x	x
13	Environmental assessment	x	x	x		x	x
14	Management of the built environment	x	x	x		x	x
15	Insurance	x	x		x		x
16	Time management	x	x	x	x	x	

17	Communication & negotiation/Information systems	x	x	x	x	x	x
18	Project audit & reporting	x	x				
19	Management & dispute resolution procedures	x	x	x	x	x	x
20	Cross cultural awareness in global resilience	x	x	x	x	x	x
21	Project management	x	x	x	x	x	x
22	Asset/Resource management	x				x	x
23	Risk management	x					x
24	Continuing professional development	x					x
25	Emergency management	x		x			

4.1.4 Market needs and skills for enhancing social resilience

The interview analysis resulted in a long list as earlier mentioned; this resulted in twenty five (25) classifications as needs and skills requirement for enhancing social resilience, see Table 5 below. Social resilience refers to the ability to start, nurture and maintain positive relationships even in the face of threats or unpleasant eventualities or mishaps (Cacioppo et al., 2011). Team working is a product of the combination of themes such as effective involvement of community groups, relationship with other agencies and communities, maintaining or re-establishing community relationships, team working, social cohesion, working with the community, community participation and mobilisation, collaborative working, empowering community among others while cross cultural awareness resulted from the merging of themes such as use of local skills and local knowledge, language (familiarity with local language) and communication skills, understanding of differences in cultures, attitudes, motivation among others. Communication & negotiation/Information systems as a classification resulted from the merging of communication effectiveness, effective communication links, understanding of information and communication technology and other scientific advances and other similar themes. Quality leadership & people management emerged from the combination of themes such as understanding the community needs, people management and leadership skills, people management and communication, understanding emotional and psychological conditions of disaster victims, knowledge of how to help people, decision making skills among others. All other classifications listed were formed in similar ways and they all have influence on relationships, people cohesion and social resilience at the different stages of property development.

Table 5 Classification of needs and skills for enhancing social resilience

		Resilience Dimension	**Property lifecycle stages**				
No.	**Classifications**	**Social Resilience**	PS	DS	PCS	CS	US
1	Supply chain management	x	x	x	x	x	x
2	Consultancy services	x	x	x		x	x
3	Procurement & contract administration/practice	x	x		x		
4	Building regulation & planning	x	x	x		x	
5	Health & safety	x	x	x	x	x	x
6	Work progress & quality management	x	x	x		x	x
7	Quality leadership & people	x	x	x	x	x	x

	management						
8	Team working	x	x	x	x	x	x
9	Governance	x	x	x	x	x	x
10	Stakeholder management	x			x		
11	Business planning	x	x		x	x	
12	Environmental assessment	x	x	x	x	x	x
13	Management of the built environment	x	x	x		x	x
14	Insurance	x	x				
15	Time management	x	x	x	x	x	
16	Communication & negotiation/Information systems	x	x	x	x	x	x
17	Cross cultural awareness in global resilience	x	x	x	x	x	x
18	Project management	x	x	x	x	x	x
19	Asset/Resource management	x	x	x	x	x	x
20	Disaster management	x		x			
21	Continuing professional development	x					x
22	Emergency management	x	x	x		x	x

4.1.5 Market needs and skills enhancing technological resilience

The needs and skills identified under technological resilience resulted in thirteen (13) classifications as shown in Table 6. It is believed that the satisfaction of the items listed will enhance technological resilience. Some of the items listed have been explained in an earlier section of this paper e.g. consultancy service, building regulation and planning, environmental assessment and some others. Governance is a classification that resulted from political structure, initiative from government authorities and similar themes, work progress and quality management emerged from the combination of provision of resilient infrastructure facilities, knowledge of how to build existing properties back better, sustainable drainage system, resilient buildings and infrastructure, and similar themes. Construction technology and environmental services as a classification emerged from the combination of knowledge and experience of construction, knowledge and experience of construction technology, resilient infrastructure and resilient building construction methods and materials.

Table 6 Classification of needs and skills for enhancing technological resilience

No.	Classifications	Resilience Dimension Technological Resilience (TR)	Property lifecycle stages PS	DS	PCS	CS	US
1	Supply chain management	x	x	x	x	x	
2	Consultancy services	x	x	x	x	x	x
3	Building regulation & planning	x	x	x	x	x	x
4	Health & safety	x	x				x
5	Work progress & quality management	x	x	x	x	x	x
6	Governance	x	x	x	x	x	
7	Environmental assessment	x	x	x	x	x	x
8	Management of the built environment	x	x	x		x	x
9	Communication & negotiation/Information systems	x	x	x	x	x	x

10	Asset/Resource management	x		x	x	x	
11	Risk management	x	x	x			x
12	Continuing professional development	x					x
13	Construction technology & environmental services	x	x	x	x	x	x

5 Discussion of Findings

Several skill and needs that can enhance societal resilience were derived from the interviews and presented above. As mentioned in the earlier part of this paper, this is part of a bigger research that is concerned with the identification of labour market/industry needs and skills. Jo da Silva et al. (2010) described post-disaster reconstruction or recovery as a complex process that requires multi-sectoral involvement, range of skills, and consumes very significant resources. The study divided key considerations in post-disaster reconstruction in to three key sections; the sections are planning, design and construction. It described planning as a stage when decisions relating to whether and how the process of reconstruction will proceed. It is important to state that although Jo da Silva et al. (2010) focused on post-disaster reconstruction and its interest was not on the needs and expectations of any stakeholder group in the disaster resilience theme, the submissions of the study has been corroborated by this research. This is evident in the number of times that issues relating to community participation and mobilization, effective use of community groups, user involvement in design process, use of local skills and local knowledge, empowering and engaging communities, multi-stakeholder management was mentioned and emphasized. Similarly, the need for enhancement of local council capacities, understanding of political structure, senior level management availability and similar issues were also prominent especially under social and institutional resilience. Multi-stakeholder engagement practically implies the deployment of a range of skills and consequentially the consumption of huge resources. Due to space constraints, there were no elaborate discussions on the just mentioned items in this paper; some of the items were briefly discussed but were all merged accordingly with related ones to form the classifications listed in the tables.

5.1 Final set of classifications

The classifications derived from labour market needs with respect to resilience dimensions across property life stages were filtered to generate a total list of 29 classifications. The 29 classifications derived with their respective related resilience dimensions and property life stages are presented in Table 7. The classifications were achieved after matching related needs and skills like-for-like with reference to literature where necessary.

Table 7: Final set of Classifications

		Resilience dimensions					Property lifecycle stages				
No.	**Classifications**	ER	EvR	IR	SR	TR	PS	DS	PCS	CS	US
1	Budgeting & financial planning	x					x	x	x	x	x
2	Quantification & costing of construction works	x					x	x	x	x	
3	Supply chain management	x		x	x	x	x	x	x	x	x
4	Consultancy services	x		x	x	x	x	x	x	x	x
5	Procurement & contract	x		x	x		x		x		

		Resilience dimensions					Property lifecycle stages				
No.	**Classifications**	ER	EvR	IR	SR	TR	PS	DS	PCS	CS	US
	administration/practice										
6	Building regulation & planning		x	x	x	x	x	x	x	x	x
7	Legal/Regulatory compliance			x			x	x	x	x	x
8	Health & safety	x	x	x	x	x	x	x	x	x	x
9	Work progress & quality management	x	x	x	x	x	x	x	x	x	x
10	Quality leadership & people management			x	x		x	x	x	x	x
11	Team working	x		x	x		x	x	x	x	x
12	Governance		x	x	x	x	x	x	x	x	x
13	Stakeholder management			x	x		x	x	x	x	x
14	Business planning	x		x	x		x	x	x	x	x
15	Environmental assessment	x	x	x	x	x	x	x	x	x	x
16	Management of the built environment	x	x	x	x	x	x	x		x	x
17	Insurance	x		x	x		x	x	x	x	x
18	Time management			x	x		x	x	x	x	
19	Communication & negotiation/Information systems	x		x	x	x	x	x	x	x	x
20	Project audit & reporting	x		x			x		x	x	
21	Management & dispute resolution procedures			x			x	x	x	x	x
22	Cross cultural awareness in global resilience			x	x		x	x	x	x	x
23	Project management	x		x	x		x	x	x	x	x
24	Asset/Resource management	x		x	x	x	x	x	x	x	
25	Disaster management	x	x		x		x	x			
26	Risk management	x		x		x	x	x			x
27	Continuing professional development		x	x	x	x	x	x	x	x	x
28	Emergency management			x	x		x	x		x	x
29	Construction technology & environmental services					x	x	x	x	x	x

Key:

Preparation Stage – PS, Design Stage – DS, Pre-Construction Stage – PCS, Construction Stage – CS, Use Stage – US and Economic Resilience – ER, Environmental Resilience – EvR, Institutional Resilience – IR, Social Resilience – SR, Technological Resilience – TR.

6 Conclusions

The resilience of societies remains the ultimate target of all disaster resilience researches. This study has contributed in a peculiar way as it concentrated on an area of practice and viewed resilience through the eye of a key stakeholder group. The resilience of communities has a strong link with the resilience of other stakeholders groups since they all belong to one community or the other "geographically", it is just that their lines of practice define them better than their geographic positioning. Hence, the real operators and administrators of the community are in a better position to speak for the community. This study has identified the needs that can enhance societal resilience at different stages of property cycle, it is expected that the satisfaction of these needs will enhance the performance of built environment professionals and enhance societal resilience to disasters across all domains of resilience. The findings of the study will help in enhancing the services of construction professionals since the specific needs of those they serve in disaster situations have been largely revealed. It will also help in streamlining the practice of construction industry professionals with the attributes and indicators of disaster resilient communities as described by Cutter et al. (2008), Twigg (2009) and (Burton, 2012) among other authors. This study and similar ones conducted with other stakeholder groups as mentioned in the research method section will be synchronized with existing international policy documents and moulded into modules for a professional doctorate programme.

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References

Alexander, D. E. 2013. Resilience and disaster risk reduction: an etymological journey. *Nat. Hazards Earth Syst. Sci.,* 13**,** 2707-2716.

Benson, C. & Twigg, J. 2007. Tools for mainstreaming disaster risk reduction: Guidance notes for development organisations. Geneva: International Federation of the Red Cross and Red Crescent Societies/The ProVention Consortium.

Bosher, L., Dainty, A., Carrillo, P., Glass And, J. & Price, A. 2007a. Integrating disaster risk management into construction: a UK perspective. *Building Research & Information,* 35**,** 163-177.

Bosher, L., Dainty, A., Carrillo, P. & Glass, J. 2007b. Built-in resilience to disasters: a pre-emptive approach. *Engineering, Construction and Architectural Management,* 14**,** 434-446.

Burton, G. C. 2012. *The development of metrics for community resilience to natural disasters.* PhD, University of South Carolina.

Cacioppo, J. T., Reis, H. T. & Zautra, A. J. 2011. The Value of Social Fitness With an Application to the Military. *American Psychologist,* 66**,** 43 - 51

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. & Webb, J. 2008. A place-based model for understanding community resilience to natural disasters. *Global Environmental Change,* 18**,** 598-606.

Fearon, J., Humphreys, M. & Weinstein, J. 2008. Community-Driven Reconstruction in Lofa County: Impact Assessment.

Flick, U. 1998. *An Introduction to Qualitative Research,* London, Sage Publications.

Holling, C. S. 1973. Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics,* 4**,** 1-23.

Hossain, M. A. 2013. Community Participation in Disaster Management:

Role of Social Work to Enhance Participation. *Antrocom Online Journal of Anthropology* 9 159 - 171.

Jo da Silva, Lubkowski, Z., Batchelor, V. & Kabir, R. 2010. *Lessons from Aceh: Key Considerations in Post-Disaster Reconstruction,* United Kingdom, Practical Action Publishing.

Manyena, S. B. 2009. *Disaster resilience in development and humanitarian interventions.* Doctoral, University of Northumbria at Newcastle. .

Sapountzaki, K. 2007. Social resilience to environmental risks. *Management of Environmental Quality: An International Journal*, 18**,** 274-297.

Sekaran, U. 1992. *Research Methods for Business,* New York, NY, John Wiley & Sons.

Seneviratne, K., Baldry, D. & Pathirage, C. 2010. Disaster knowledge factors in managing disasters successfully. *International Journal of Strategic Property Management,* 14**,** 376-390.

Thurairajah, N., Palliyaguru, R. & Williams, A. Incorporate disaster management perspective into built environment undergraduate curriculum.

Twigg, J. 2009. *Characteristics of a Disaster-resilient Community (Version 2),* UK, Department for International Development.

UNISDR 2005. Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters Geneva.

UNISDR 2009. UNISDR Terminology on Disaster Risk Reduction. Geneva, Switzerland: United Nations.

Wildavsky, A. 1991. *Searching for Safety,* New Brunswick, Transaction Publishers.

Enhancing investment in Disaster Resilience of the built environment of SMEs: Developing a conceptual framework

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Abstract

The importance of the resilience of the built environment in the overall disaster resilience agenda cannot be overemphasized. Achieving societal resilience requires the joint effort of both the public and the private sector but investments in resilience is much more skewed to the side of the public sector to date. Assessment of HFA priorities for actions performance by UNISDR revealed that Priority 4 is the least performing. Priority 4 is about reducing underlying risk factors; this has to do with the protection of facilities, integrating strategies for climate adaptation, ensuring recovery schemes and social safety nets among others. Recent records revealed that SMEs are not sufficiently prepared for disaster events despite their significant place in the economy. Economic loss which is reportedly on the increase is usually caused by property damage, job loss, service and business disruption among others. SMEs are obviously contributing hugely to the volume of economic loss as a result of poor resilience to disasters. This paper describes a study that intends to investigate issues relating to private investment in disaster resilience and thereafter develop a framework that encourages investment in disaster resilience of the built environment of SMEs through the analysis of disaster resilience levels, risks associated with these levels and economic impact calculations. The relationship between built environment resilience levels, economic loss as well as social loss will be established in the detailed version of the framework. This study focuses on investment at the property/company level i.e. the built environment of SMEs. The built environment is being given a prominence as its ability to absorb the impact of disaster guarantees a faster return of business operations and a reasonable reduction in loss. A conceptual framework anchored on the principle of self-evaluation and self-improvement is hereby presented.

Keywords: building resilience, built environment, disaster resilience, investment, private sector, SME.

1. Introduction

Lawrence and Low (1990) labelled the built environment as an abstract concept used to describe the products of human building activity and include any physical alteration to the natural environment. In this study, the built environment is referring to human made surroundings. Property destruction as a result of disaster shock leads to direct financial loss, expenditure on repair and business interruption (See Figure 1). It should be noted that a disaster will strike the built environment before every other system that depends on the built environment gets distorted. Therefore, the importance of the resilience of the built environment in the overall resilience agenda cannot be overemphasized (UNDP, 2013). Holling (1973) used the word 'resilience' to describe a ''measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables". "Resilience" has been described by many authors to mean different things afterwards, to the extent that Twigg (2009) described the existence of varieties of definitions as confusing. Interestingly, the study decided to settle for broad definitions and easily understood characteristics. Alexander (2013) acknowledged the multidisciplinary nature of the term resilience and this has been supported by a number of researchers. The multidisciplinary nature of the term is obviously contributing to the seeming confusion in its definition. However, UNISDR (2009) defined resilience as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions". This definition will be adopted in this study as the definition of disaster resilience.

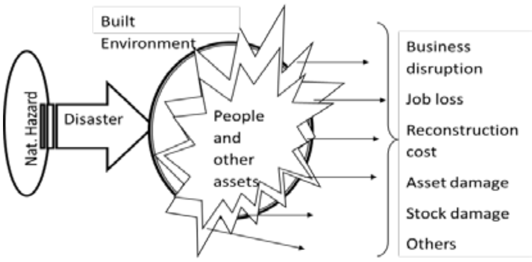


Figure 1 Disasters and the built environment

ADPC (2013) and United Nations (2013) stated that organizations have a major part to play in enhancing disaster resilience. The contribution of these organisations towards disaster resilience can be based on the type of services they offer. For example, investment banks can establish a low interest loan scheme to property owners to enhance the disaster resilience of their properties. Similarly, a risk based premium scheme can be encouraged by insurance companies. Also, the insurance companies and investment banks as well as other organisations need to build their own resilience to disasters and even support the enhancement of the resilience of their network. Interestingly, there are strategies for enhancing disaster resilience. In the built environment the adoption of building codes and land use planning considerations, hardening of properties or the use of disaster resilient materials are some of the strategies but all the strategies attract additional direct or indirect initial cost. Therefore, a systematic approach for encouraging or unlocking investment in disaster resilience is necessary.

The purpose of this paper is to present the conceptual framework developed as part of an ongoing PhD study aimed at developing a framework that encourages investment in disaster resilience of the built environment for the business sector. This paper presents the research problem, describes the key themes for the study, described the method designed for the research study and went further to discuss the conceptual framework developed. The paper concludes by emphasizing the grave need for research in the area of investment in the disaster resilience of the built environment and SMEs at large.

2. Research Problem

Enhancing a property's resilience to disaster attracts additional initial costs; this has been hampering the adoption of disaster resilience enhancement strategies (Warhurst, 2006, Neumayer et al., 2014). As a result of this, property damage and its consequential effects are contributing significantly to the magnitude of economic loss. Therefore, there is a need to encourage investment in the use of strategies that can reduce the extent of damages from disaster. For instance, in the case of flood events, apart from building codes and land use planning considerations, toilet bungs, the use of anti-flood air-bricks, flood defenders, backwater valve, steel security flood door and other installations are suitable choices for ensuring pleasant built environment performance after flood events. These installations have been done on properties in South of Bristol, ,North Yorkshire, and Worcestershire among others places (Dhonau et al., 2013). Similar strategies are available for other types of hazards. For instance, Orion, a New Zealand company made an investment of US$ 6 million on seismic protection (UNISDR, 2013). Ideally, the built environment should be able to absorb or accommodate occasional disruptive events, but that is not the case in many locations.

According to Neumayer et al. (2014), there are two main strategies for reducing the expected cost or impact of disasters. One is to avoid settling or operating in high risk areas, two is to construct buildings of little or no probability of being damaged when known hazards strike. On most occasions, high risk areas have economic advantages, so, there is opportunity cost for not settling or operating in such areas. Likewise, there are additional costs for putting up disaster resilient structures. While continuity of operations remains a key concern after disasters, funds for repairs are not readily available. Ideally, it appears more logical to invest in risk reduction for resilience rather than repairs and recovery. For instance, UNISDR (2013) reported that the New Zealand Company Orion, invested US$ 6 million on seismic protection; consequently, the investment saved the business up to US$ 65million among others. Although, Wedawatta (2013) stated that disaster costs are seemingly being underestimated and this is negatively affecting the Cost-Benefit Analysis (CBA) of disaster resilience and Disaster Risk Reduction (DRR) measures, fresh submissions like the Orion case are confirming the superiority of benefit to the cost of disaster risk reduction and building disaster resilience. Since the operation of SMEs depend on the built environment (premises) and others assets, all considerations for the enhancement of investment in the resilience of the built environment (business premises) in this study are made with due attention to other assets that make up an organisation. The other assets are people, supplies/suppliers, stakeholders or investors, equipment or machine, and information.

3. Goals and Scope of the study

The specific aim of the study is to develop a framework that encourages investment in disaster resilience of the built environment for the business sector through the analysis of disaster resilience capability level and risks associated with each level. The study will develop an instrument for assessing disaster resilience capability level of the built environment of SMEs; assess the relationship between built environment disaster resilience maturity level and expected economic loss from a disaster; and develop and validate the framework that incorporates disaster resilience capability level and economic loss.

This study is limited to investment in the resilience of the built environment of small and medium-size enterprises (SMEs); it focus on enhancing resilience at the company/organisation/property level (See Figure 2). SMEs (businesses) provide resources and many services on which communities and a nation depends before and after a disaster. SMEs make up 99.8% of private sector business enterprises, it provides about 67.1% of private sector jobs in Europe (European Commission, 2008). In South East Asia, SMEs make up about 96% of businesses (ASEAN, 2013). The above figures underline the importance of the need to make SMEs disaster resilient. This is because the ability of the built environment to withstand, resist or absorb the impact of disasters will enhance the quick return of businesses to operation after a disaster. The overall focus is to ensure that SMEs continue to provide services, probably during but definitely soon after a disaster. Also, achieving a reduction in damage to assets by disasters will result in the desired reduction in economic loss from disasters. This study will focus on the enhancement of the resilience of the built environment of SMEs to flooding. This is because flooding (See Figure 3) is one of the frequently occurring natural disasters in the world so also the United Kingdom (UK) which was selected as the geographical scope of this study.

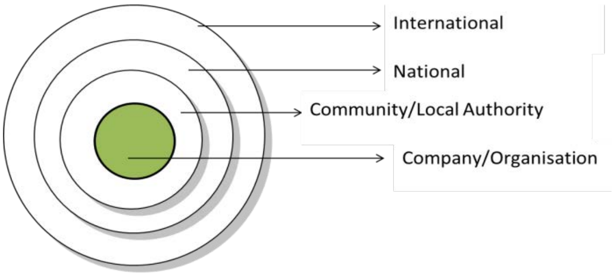


Figure 2 Investment in built environment resilience can be made at any of the layers identified

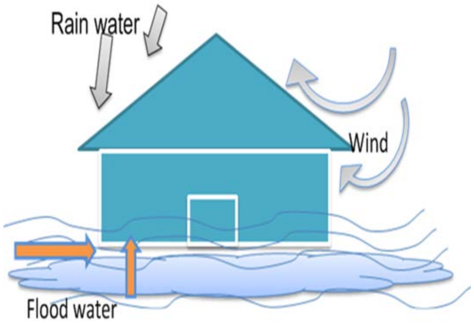


Figure 3 Flood events and how they interact with properties

Presented in the next section is the flowchart of steps and actions to be undertaken towards achieving the goals of this study. Thereafter, the themes considered and engaged in the development of the conceptual framework are discussed.

4. Research Method

The method proposed for achieving the ultimate goal of this study is presented in Figure 4 below.

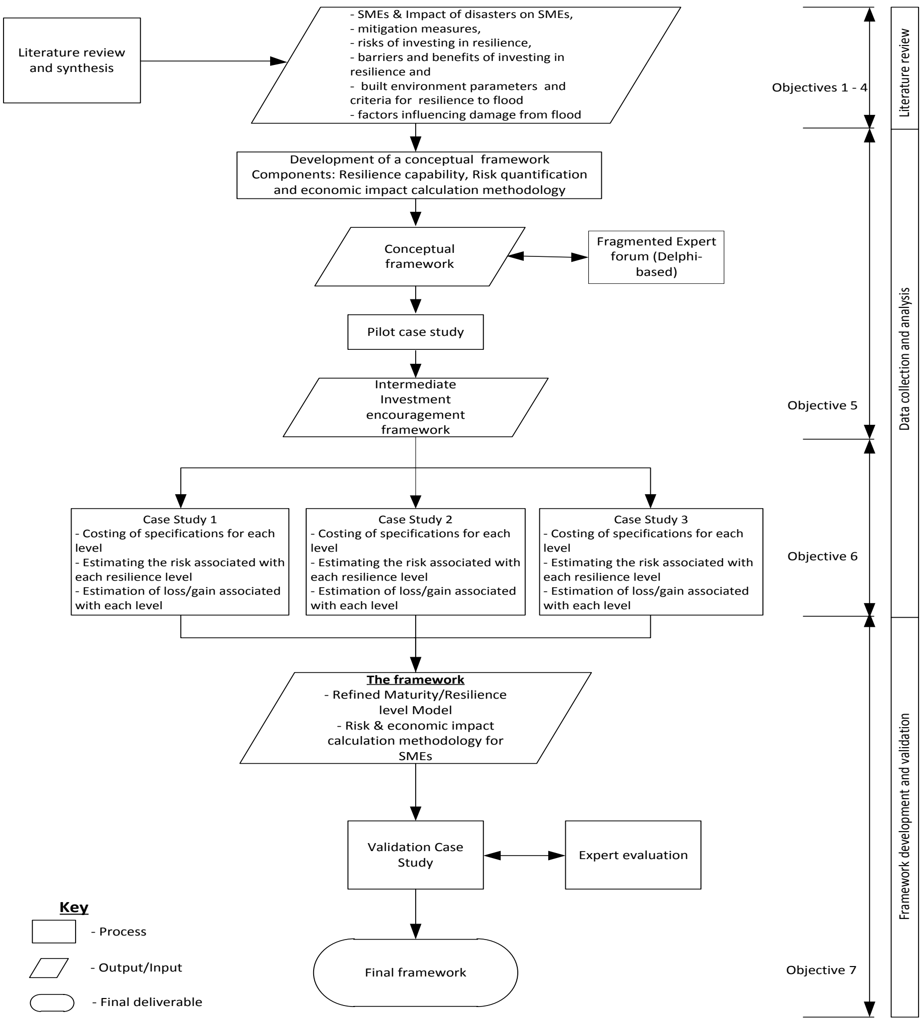


Figure 4 Methodology flowchart

Brief description of activities and expected output at each stage as contained in Figure 4 is presented below.

Literature review – Issues relating to SMEs & Impact of disasters on SMEs, mitigation measures, risks of investing in resilience, barriers and benefits of investing in resilience and built environment parameters and criteria for resilience to flood, factors influencing damage from flood as well as the resilience of SMEs, built environment of SMES and investment as presented in the first output box in Figure 5 have been extracted. This was done to provide adequate understanding of issues relating to SMEs and resilience.

Development of a conceptual model – A conceptual model that contains three main components has been developed *(More details in section 6, The Conceptual framework)*.

Expert forum – A team of experts will be selected based on defined criteria and engaged on their specific areas of expertise on the framework, the expert forum will be Delphi based, and the framework will thereafter be tested on a pilot case study. An intermediate investment enhancement framework is expected to be produced afterwards and this will be further tested with case studies as described below and also shown in the flowchart.

Multiple case studies – Interviews, documents and cost data and all information relevant for the use of the framework will be collected and processed in line with the goal of the study.

Validation case study - this will be employed to validate the framework developed; it will be followed by **expert evaluation**. Afterwards, the final framework will be produced.

5. Key themes selected for the study

5.1 Need for investment in disaster resilience in the built environment

More investments are expected on properties and infrastructures in the nearest future. According to Global Construction Perspectives and Oxford Economics (2011) expenditure on projects in urban areas will grow by 67%. Global expenditure on construction is expected to be around US$97.7 trillion by 2020 with construction industry's contribution to global GDP rising to about 13.2 percent. Indeed, the projections are significant and heart-warming, as it assures of a better economic future, but if it is not properly managed it will lead to an increase in disaster risk, potential higher economic loss from disasters and of course a reduction in societal resilience to disasters. It is clear that the worth of economic loss from disaster is dependent on the magnitude of wealth concentration in the disaster affected community (Bouwer et al., 2007, Neumayer and Barthel, 2011, Pielke et al., 2008). The developments predicted and the potential growths are not real concerns but the readiness and capability of systems in managing the growth with adequate consideration for disaster resilience. IIHS (2012) reported that infrastructure is still being developed in hazard prone zones in Delhi, India, similarly, policy frameworks and regulations have not stopped the development of properties in flood plains in the UK (Committee on Climate Change, 2012). Some people prefer to live with disasters despite potential consequences though. With about 1100 homes damaged in UK flooding in 2012 (AON Benfield, 2012) – determined by the number of claims – and different magnitude of losses are being recorded in other locations, it is simply ideal to do the needful with regards to prevention, protection and property or infrastructure hardening where necessary. This is indeed important so as to utilize the expected future developments in achieving a disaster resilient future.

Unfortunately, there is much dependence on post-disaster benefit and insurance compensations (ADB, 2013) rather than pre-disaster preventive, mitigation and resilience measures. It is already been projected that insurance might not be affordable and/or available to some assets with time (Dhonau et al., 2013). The earlier all stakeholders adopt the culture of building disaster resilient built environment the better. On a similar note, there is a perception of low net return on investment in resilience, whereas building resilience should be seen as a way of making all properties and businesses more attractive, safe and preserved in the long term. It is important that the initial great value placed on short term returns by businesses and other stakeholders be modified to favour sustainability and disaster resilience (United Nations, 2013). Figure 2 describes the different levels of SMEs investment in enhancing disaster resilience.

5.2 Small and Medium Sized Enterprises (SMEs)

SMEs make up 99.8% of private sector business enterprises, it provides about 67.1% of private sector jobs in Europe (European Commission, 2008). SMEs are largely important to the well-being of several economies; obviously, their failure will have a huge impact on these economies. Currently, SMEs are regarded to being highly vulnerable to disruptions basically because of the limited human and financial resources available to them (Bannock, 2005). According to European Union definition of a SME is “is an enterprise which employ fewer than 250 persons and which has an annual turnover not exceeding €50 million, and/or an annual balance-sheet total not exceeding €43 million” (European Commission, 2006). Crichton (2006) stated that SMEs are the most vulnerable to disasters in the UK economy. Similarly, Finch (2004) stated that although large organisations are also affected SMEs feel the impact more. The fact that SMEs are often rooted to a local community makes them more vulnerable (Bannock, 2005). On most occasions SMEs only operate at a single location, once disaster strikes at that location, the establishment will be out of business and probably the whole of the organisations asset will be lost. On the contrary, a larger organisation faced with a similar situation can still sustain her business position by controlling operations from another branch. A number of authors concluded that SMEs are not adequately prepared for catastrophes (Yoshida and Deyle, 2005, Dlugolecki, 2004). Woodman (2008) discovered in a study that only 30% of small businesses have business continuity plan. It is indeed important to work towards enhancing the resilience of these organisations through all possible medium.

5.3 Built Environment disaster resilience

The magnitude of resilience of the built environment has a strong influence on the volume of risk and the eventual cost of any disaster. Worthy of emphasizing is the ability of an effective built environment in protecting people and other assets from disasters (UN ESCAP and AIT, 2012). Beyond protection, built facilities are supposed to be functional all through the phases of a disaster (McAllister, 2013), this will ensure adequate response and management of shocks caused to people by the catastrophe. Bosher (2008) described a disaster resilient built environment as one that is “designed, located, built, operated and maintained in a way that maximises the ability of built assets, associated support systems (physical and institutional) and the people that reside or work within the built assets, to withstand, recover, and mitigate for, the impacts of extreme natural and human induced hazards”. The definition appears to be comprehensive enough that the scope of the definition might paints a thought of how difficult it might be to achieve in ones mind. Describing the possibilities of achieving a disaster resilient built environment, UNDP (1994), Rossetto (2007) and Lamond et al. (2013)provided a list of necessary considerations, among these are hazard resilient designs, construction methods, specifications, materials and technologies, consideration for climate change effects, accurate assessment of hazards, alignment of structural designs with hazard levels. According to Lamond et al. (2013) one of the major reasons for damage from natural disasters is the structural inadequacy of the built environment. It is indeed reasonable to submit that the level of resilience of a typical property determines the magnitude of damage that the property will experience from a disaster and also the duration of repair and return to full functionality.

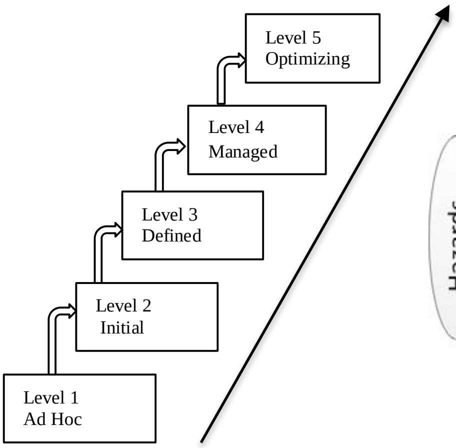
5.4 Self-evaluation and self-improvement principle

The concept of this study is anchored on the principles of the benefit of self-evaluation and self-improvement. In order to continually monitor the level of disaster resilience or disaster resilience capability of a typical business premises and the business, an assessment instrument will be developed. This will assist in confirming the extent of investment in disaster resilience, level of resilience and as well charge stakeholders to improve investment and in turn improve resilience. The theory of performance measurement, goal setting and expectancy theory are indeed relevant to this study and are also providing theoretical reinforcement for the research. The aforementioned theories underline the link between a defined goal, performance and the drive to attain the set goal.

5.5 Resilience Capability model

You can only improve if you know how you are doing. Capability maturity modelling is a methodology used to model capability levels. It provides a framework for describing process improvement strategies. It helps to describe current capabilities and performance improvement options (Yeo and Ren, 2009). It originated from the software industry and has been applied in other areas such as project management (Kerzner, 2002), systems engineering, product development (Dooley et al., 2001), construction industry among others. The original version of capability maturity model classified software organisations into five levels based on defined characteristics for each level (See Figure 5). Capability maturity model methodology is being adapted to produce a resilience capability maturity scale. The resilience of the built environment use to be a mere theoretical description until when UN/ISDR started the development of scorecards (resilience assessment tool) for measuring the resilience of local government and city resilience (UNISDR and GFDRR, 2012). Some studies have attempted to develop tools for assessing resilience at the community, tourism and economic perspectives (Achour et al., 2014, Holladay, 2012), none of the works focused on the built environment and SMEs.

This study sets out to address the aforementioned gap by using the capability maturity concept. Figure 5 shows a representation of maturity levels, level 1 to level 5 describes different levels of resilience of the built environment to disaster. The attributes of each level will be defined with sophistication and resilience ability increasing from level 1 to level 5. Details of the scoring system will be available in subsequent publications, though it will be briefly described in section 6 (see page 9). In Figure 5, the maturity levels are represented with lines numbered 1 to 5, the diagram indicates that the higher the maturity/resilience level an SME the lower the loss of functionality (depth of impact) and the shorter the recovery time and vice versa. Each capability level will have cost attached to its specifications, there will be risk associated with being in each capability level and this will be quantifiable, then the magnitude of loss or gain an organisation/company will record if disaster strikes can be estimated.



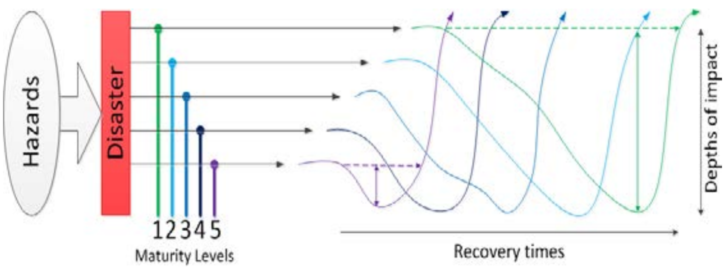


Figure 5 Capability Maturity levels

Figure 6 Representation of the research idea

5.6 Economic impact of disasters on organisations

Organisations depend on the functionality of built facilities to operate; these are definitely provided by several parties. On some occasions the provision of the facilities are localised so as to limit interconnectivity that usually results in a bigger loss once the source is struck by a catastrophe. For instance, if a single bridge is destroyed by any disaster event, a whole community might be isolated thereby resulting in a huge business loss for workshops, sale outlets, suppliers among other resident in that community. With the current level of interconnection of businesses, a business organisation should also labour to assist the resilience of his supply chain. A seemingly interesting paradigm is to establish a cluster of suppliers and vibrant consumer markets that are “hardened” as much as possible, this leaves much more to discuss. Local disasters are experienced in some locations but their impacts cascade through regional and even international markets.

Norrington and Underwood (2008) discovered that property/stock damage to and reduction in customer visits is the major impacts of South East of England flood on SMEs. The study also submitted that damage to property/stock are the main effect of flooding and wind while high and low temperature reduces customers visit. Staff travel and working condition are also affected are other impacts identified by the study. Woodman (2008) and Research (2008) listed some of the impacts of catastrophes on SMEs, the studies listed unavailability of staff, flooded premises, disruption of supplies and increase in total cost of operation, decrease in turnover, damage to building and assets as the main negative effects of disasters on SMEs respectively. A lot deserved to be noticed here but the quick return of business premise and associated facilities can help in mitigating the influence of other impacts. Presented in the next section is the conceptual framework for a research study that intends to encourage investment in the built environment (i.e. business premises) and other assets of SMEs towards enhancing the resilience of SMEs.

6. The Conceptual framework

"A conceptual framework explains, either graphically or in narrative form, the main things to be studied – the key factors, constructs or variables – and the presumed relationships among them" (Miles and Huberman, 1994). It was stated that a conceptual framework can be rudimentary, elaborative or commonsensical, theory-driven descriptive or even casual. An initial conceptual framework has been developed for this study; this will be updated as the research progresses. Yin (2003) submitted that conceptual frameworks are basically for researchers to illustrate or describe the main concepts relating to their study, the interrelationship between the concepts and the circumstances within which the interrelationships can be said to be true within the ambit of the phenomenon being studied. Miles and Huberman (1994) also submitted that the development of a conceptual framework is iterative; it is bound to be revised and updated. Conceptual frameworks guide the thinking of a researcher and different researchers can conceptualize the same phenomenon for research separately. Figure 7 shows the conceptual framework developed for this particular study. It was mentioned in section 3 of this paper that the aim of this study is to develop a framework that encourages investment in disaster resilience of the built environment for the business sector through the analysis of disaster resilience capability level and risks associated with each level.

A brief explanation of the conceptual framework, made up of three main components is presented below.

Resilience Capability assessment

One of the specific objectives of the study is to develop an instrument for assessing disaster resilience capability level of the built environment of SMEs with due consideration for other assets of an organisation (e.g. people, supplies stakeholders or investors etc.), this aspect is addressed in the box titled capability assessment in Figure 7 below. Resilience capability of the premises of organisations will be based on the extent of use of resilient materials and technologies for each element of the property; a yes or no answer evaluation is being adopted. The evaluation of the resilience capability of other assets will be based on a list of measures of resilience extracted across the following headings – situation awareness, preparation and management of vulnerabilities, coping capacity, adaptive capacity, and resilience ethos. The measures will be assessed on likert scale.

Risk quantification

Another objective is to assess the relationship between built environment disaster resilience capability and risk associated with levels of capability; this will be done by relating assessed capability with parameters such as hazard occurrence probability, vulnerability, exposure, using the mathematical relationships presented in the risk quantification box in Figure 7 below.

Economic implication and options for investment enhancement

Quantification of risk as described above is expected to result in a risk score, the risk score will be used in probability estimating for disruption scenarios so as to establish expected economic loss or gain associated with a typical organisations resilience capability level (Note: *This study focuses on flood hazards alone)*. The process is being anchored on the principles of evaluation and improvement i.e. the decision to improve resilience or not will be a function of the calculated magnitude of impact on the organisation. Informed guide on available investment sources and actions to take will be embedded in the framework as shown in the conceptual version in Figure 7. Framework validation will be done as described in Figure 4.

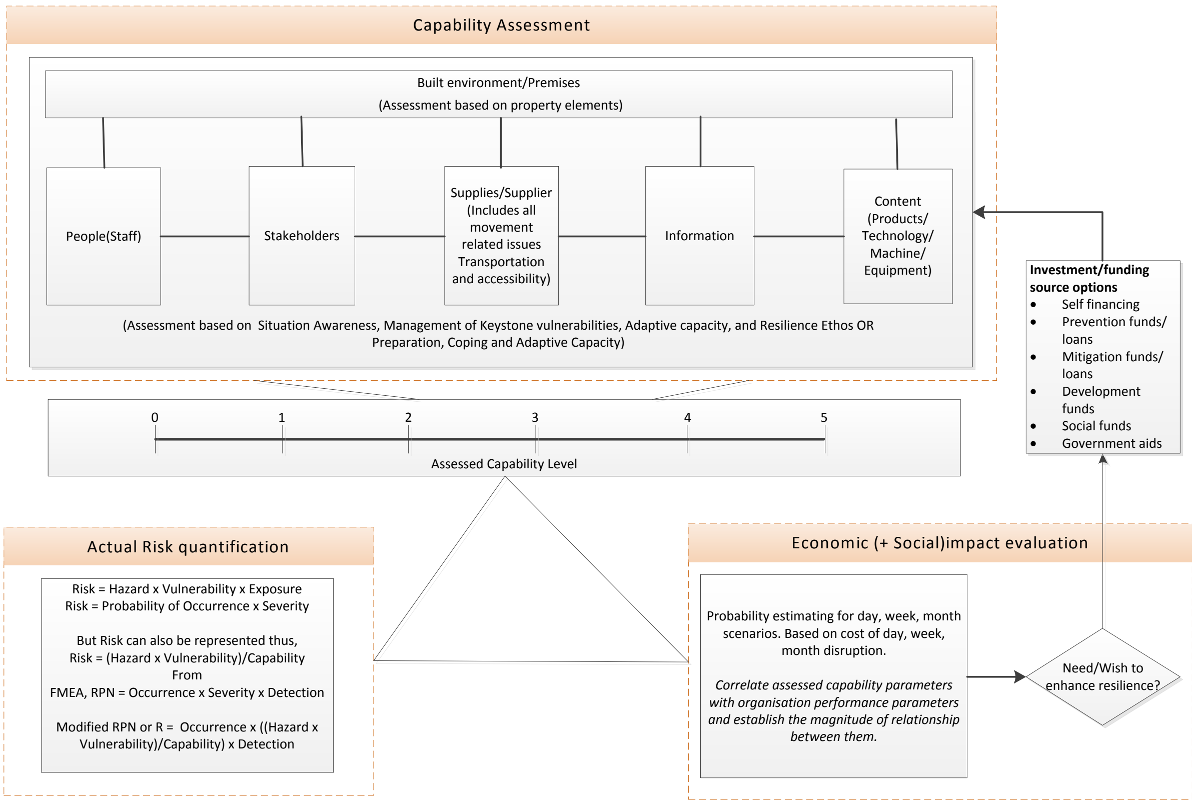


Figure 7 Conceptual framework

The theory of performance measurement, goal setting and expectancy theory as well as the principles of evaluation and improvement clearly underline the link between a set goal, what it takes to pursue the goal and the drive or urgency felt about achieving the goal. The goals in this study are the resilience capability levels, what it takes to pursue the goals are the specifications and parameters that defines a level, the specifications and parameters have cost implications and the drive or urgency about the goal is the estimated risk associated with each level, the magnitude of risk defines the economic and social impact of being in a particular level on one's business if disaster strikes. The framework will be presented in a manner that permits its use by a typical organisation for the purpose of self-evaluation and resilience improvement.

It should be noted that all necessary variables and attributes will be introduced and the conceptual framework will continue to be developed.

7. Conclusion and further works

Investment in risk reduction and strengthening of properties towards achieving resilience should be given adequate attention in terms of real life action as well as research. The continual increase in economic loss from disasters demands that all stakeholders should deploy every possible strategy for enhancing disaster resilience. This study hopes to positively contribute to this cause by providing a framework that encourages investment in resilience of SMEs and consequently a reduction in the magnitude of economic loss from disasters. At this stage of the study, the conceptual framework developed is sufficient to influence thoughts in respect of existing discussions on investment and stir more debate on investment enhancement in both practice and academia. Further works will be carried out as described in the method section of this paper.

References

Achour, N., Miyajima, M., Pascale, F. & Price, A. D. F. 2014. Hospital resilience to natural hazards: classification and performance of utilities. *Disaster Prevention and Management,* 23**,** 40 - 52.

ADB 2013. *Investing in resilience: ensuring a disaster-resistant future,* Philippines, Asian Development Bank.

ADPC 2013. Private Sector Engagement in Disaster Risk Reduction. Bangkok: Asian Disaster Preparedness Center.

Alexander, D. E. 2013. Resilience and disaster risk reduction: an etymological journey. *Nat. Hazards Earth Syst. Sci.,* 13**,** 2707-2716.

AON Benfield. 2012. Impact Forecasting: November 2012 Global Catastrophe Recap. Available: http://thoughtleadership.aonbenfield.com/Documents/201212_if_monthly_cat_recap_november.pdf.

ASEAN 2013. ASEAN Strategic Action Plan for SME Development (2010 - 2015). Jakarta: Association of South East Asian Nations

Bannock, G. 2005. *The economics and management of small business: an international perspective,* Psychology Press.

Bosher, L. 2008. The need for built in resilience. *In:* BOSHER, L. (ed.) *Hazards and the built environment- Attaining built-in resilience.* Oxon: Routledge.

Bouwer, L. M., Crompton, R. P., Faust, E., Höppe, P. & Pielke Jr, R. A. 2007. Confronting disaster losses. *Science-New York then Washington,* 318**,** 753.

Committee on Climate Change 2012. Adaptation Sub-Committee Progress Report 2012: Climate Change. Is the UK preparing for flooding and water scarcity? London, UK.

Crichton, D. 2006. *Climate Change and its Effects on Small Businesses in the UK,* Axa Insurance.

Dhonau, M., Wilson, G., McHugh, A. & Burton, R. 2013. *Homeowners Guide to Flood resilience,* Staffordshire, RAB Consultants.

Dlugolecki, A. 2004. A changing climate for insurance: A summary report for chief executives and policymakers. *London, Association of British Insurers*.

Dooley, K., Subra, A. & Anderson, J. 2001. Maturity and its impact on new product development project performance. *Research in Engineering Design,* 13**,** 23-29.

European Commission 2006. The New SME Definition: User guide and model declaration.

European Commission 2008. *Putting Small Businesses First: Europe is good for SMEs, SMEs are good for Europe* Brussels, European Commission.
Finch, P. 2004. Supply chain risk management. *Supply Chain Management: An International Journal,* 9**,** 183-196.
Global Construction Perspectives and Oxford Economics 2011. Global construction 2020: A global forecast for the construction industry over the next decade to 2020. London, UK.
Holladay, P. J. 2012. *An integrated approach to assessing the resilience and sustainability of community-based tourism development in the Commonwealth of Dominica.* 72.
Holling, C. S. 1973. Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics,* 4**,** 1-23.
IIHS. 2012. The Role of Private Sector in Reducing Disaster Risk in Large Scale Infrastructure and Real Estate Development, Case of Delhi. Background Paper prepared for the 2013 Global Assessment Report on Disaster Risk Reduction. . Available: http://www.preventionweb.net/gar.
Kerzner, H. R. 2002. *Strategic planning for project management using a project management maturity model*, John Wiley & Sons.
Lamond, J., Proverbs, D., Booth, C., Mannakkara, S. & Wilkinson, S. 2013. Build back better principles for post-disaster structural improvements. *Structural Survey,* 31**,** 314-327.
Lawrence, D. L. & Low, S. M. 1990. The Built Environment and Spatial Form. *Annual Review of Anthropology,* 19**,** 453-505.
McAllister, T. 2013. Developing guidelines and standards for disaster resilience of the built environment: a research needs assessment. *NIST technical note 1795.*
Miles, M. B. & Huberman, A. M. 1994. *Qualitative data analysis: An expanded sourcebook,* Sage.
Neumayer, E. & Barthel, F. 2011. Normalizing economic loss from natural disasters: A global analysis. *Global Environmental Change,* 21**,** 13-24.
Neumayer, E., Plümper, T. & Barthel, F. 2014. The political economy of natural disaster damage. *Global Environmental Change,* 24**,** 8-19.
Norrington, H. & Underwood, K. 2008. Climate change and small businesses: How directors are responding to the challenges of climate change - Research Findings. Guildford, Climate South East.
Pielke, R., Gratz, J., Landsea, C., Collins, D., Saunders, M. & Musulin, R. 2008. Normalized Hurricane Damage in the United States: 19000-2005. *Natural Hazards Review,* 9 29-42.
Research, H. 2008. Climate change effects,. Breda: Heliview Research.
Rossetto, T. 2007. Construction Design, Building Standards and Site Selection. *In:* BENSON, C. & TWIGG, J. (eds.) *Tools for Mainstreaming Disaster Risk Reduction: Guidance Notes for Development Organisations.* . Geneva: International Federation of Red Cross and Red Crescent Societies / the ProVention Consortium.
Twigg, J. 2009. *Characteristics of a Disaster-resilient Community (Version 2),* UK, Department for International Development.
UN ESCAP and AIT. 2012. Integrating environmental sustainability and disaster resilience in building codes. . Available: http://www.unescap.org/sites/default/files/Summary-report-building-codes.pdf [Accessed 30 April 2015].
UNDP 1994. *Disaster Mitigation,* New York, UNDP.
UNDP 2013. Analysing the vulnerability of Micro, Small, and Medium Enterprises to natural hazards and their capacity to act as drivers of community recovery. Geneva: UNISDR.
UNISDR 2009. UNISDR Terminology on Disaster Risk Reduction. Geneva, Switzerland: United Nations.
UNISDR 2013. *From Shared Risk to Shared Value -The Business Case for Disaster Risk Reduction. Global Assessment Report on Disaster Risk Reduction.,* Geneva, Switzerland, United Nations Office for Disaster Risk Reduction.
UNISDR & GFDRR 2012. How to Make Cities More Resilient: A Handbook for Local Government Leaders. Geneva.
United Nations. 2013. *Private sector must engage in disaster risk reduction to avoid economic losses – UN* [Online]. New York: United Nations. Available:

http://www.un.org/apps/news/story.asp/www.unaids.org/en/html/story.asp?NewsID=44911&Cr=disaster&Cr1=risk [Accessed January 12 2014].

Warhurst, A. 2006. Disaster Prevention: A role for business? Geneva: Provention Consortium.

Wedawatta, G. 2013. *Resilience of Construction SMEs to Extreme Weather Events*. PhD, University of Salford, UK.

Woodman, P. 2008. *Business continuity management 2008,* Chartered Management Institute London.

Yeo, K. & Ren, Y. 2009. Risk management capability maturity model for complex product systems (CoPS) projects. *Systems Engineering,* 12**,** 275-294.

Yin, R. 2003. *Case study research: Design and methods (3rd ed.)*, Newbury Park, CA, Sage Publications.

Yoshida, K. & Deyle, R. E. 2005. Determinants of small business hazard mitigation. *Natural Hazards Review,* 6**,** 1-12.

Flood risk vs property value: A sector specific market perception study of commercial properties

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Abstract

This study examines the perception of commercial property occupiers in the context of flood risk and property value. Relevant literature was reviewed to understand the factors affecting perception of commercial property occupiers. Questionnaire survey was conducted within selected areas of the two regions in Wakefield and Sheffield in the UK. Respondents were examined on a sector specific manner their response to vulnerability of property value towards flood risk. Apart from understanding the overall situation, the focus was on the perception of repeatedly flooded respondents to understand impact of flood memory of previous events within the system. Majority of the respondents from all sectors agreed that indirect impacts of flooding have a lingering effect on recovery activities and loss of income as a result of reduced usability of property as a business unit. Flood risk in general is not perceived to have a major economic impact but they are aware of the impact of reduced value or historical incidences of flooding can make value of properties to be vulnerable. Those with memory within the system in the form of experience of repeated incidents of flooding perceived the risk slightly differently in terms of importance of resilience enhancement against flood risk to minimise reduction of utility of commercial properties during flood events. The perception of commercial property owners were then validated by response from real estate commercial property experts via email survey. Since risk is not equal for all property sectors it is important to understand the perception of people separately for proper asset management, to make well informed investment plans and enhancing resilience against the vulnerability of value in the real estate market.

Keywords: repeat flood; perception; property value; commercial properties; memory

1. Introduction

In the UK, as elsewhere, commercial property sector makes a significant contribution to the economy. The value of core commercial properties in the UK which includes retail, office and industrial properties, according to Property Data Report in 2013 is £683 Billion (Bristish Property Foundation, 2014). The UK endured a number of major flood events in the last few years which resulted in large scale damage and disruption of the commercial property sector both directly and indirectly. Pitt’s review after 2007 flood recommended the need for appropriate advice to flooded property owners (Pitt, 2008). Based on the level of vulnerability in commercial property sector, there is a need for understanding the attitude of the commercial property holders towards the existing flood risk in order to make future decisions on property value (Bhattacharya and Lamond, 2011). Economic theory, suggests that flood risk might have an impact on property value, however empirical evidences are either mixed or tentative in this field (Wyatt, 1996). Due to the differences in location of study areas, data availability, characteristics and nature of properties it becomes difficult to compare the results from those studies to gain understanding of the level of vulnerability and the perception of people at risk. While this line of enquiry is relevant it is also important to understand the perceived change in economic value of properties from the perspective of potential owners and occupiers of different sectors of commercial property, as nature of use of property can influence their attitude towards investing in properties in future. Perception of property value in terms of flood plain development, hazard adjustment and risk evaluation have been performed in the field of residential properties with respect to contaminated land (Raaijmakers et al., 2008; Syms, 1997), however insights gained from such studies in commercial property sector involving real estate experts are minimal. Therefore this study sought to measure perception of future vulnerability as an alternative to more conventional market transaction oriented studies in the field of real estate research.

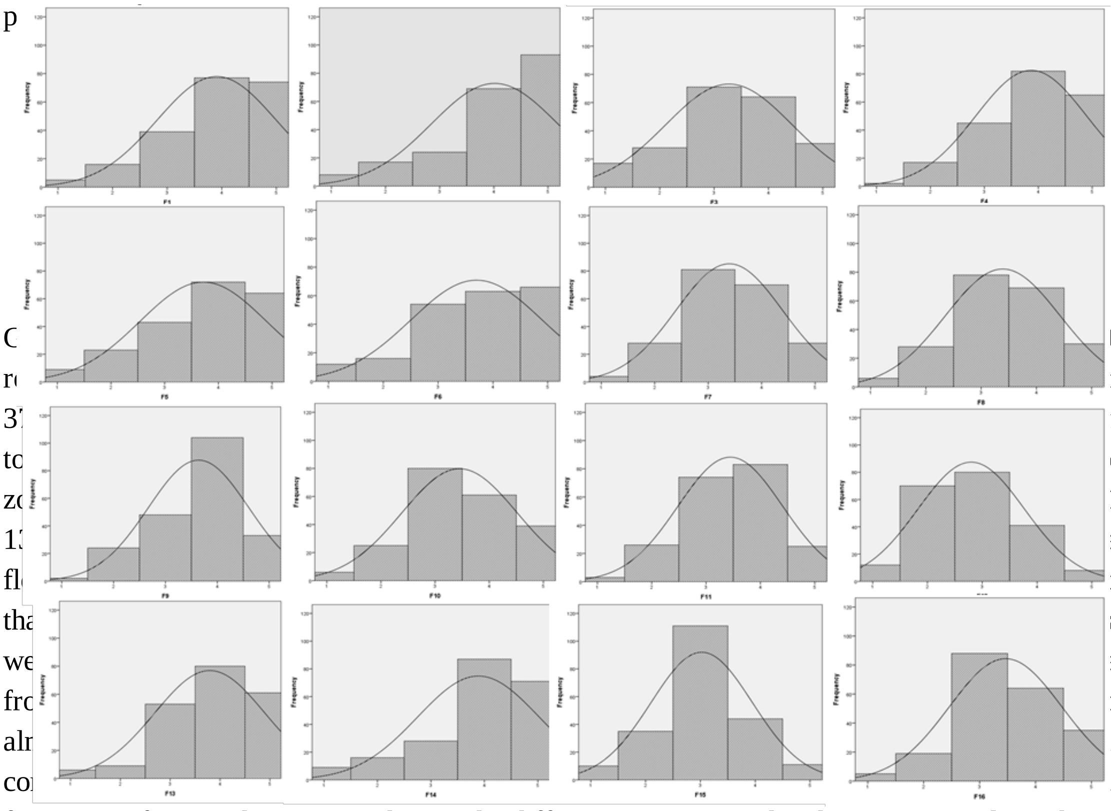
In psychology, risk perception is defined as a subjective evaluation of the occurrence of future event and the potential damage that may be caused as a result of such event (Miceli et al., 2008). Evaluation of environmental risk in this case will deal with the concept of property value and the differences in perception among different sectors within the commercial property sector. Literature emphasized that emotions and perceptions can serve as a basis for lay and expert assessment of the probability of occurrence of an event in future and that individuals react based on their past experiences (Bhattacharya-Mis and Lamond, 2014a; Slovic et al., 2004). A single generalization that risk of flooding may precisely have an impact on property value is difficult to ascertain. This is mostly because of the specific influences of factors such as income generation, locational characteristics and so on for different sector of commercial properties. Therefore taking a sectoral perception approach will be able to provide better information for sector specific vulnerability and risk administration. However it is possible to identify the causes that might influence the perception of people towards potential changes in property value. It was argued that there is a link between perception and management of risk based on the manner risk is demarcated by organisations (Tierney, 1999) such as delineation of risk zones by Environment agency in the UK. Such demarcations may have direct influence on people’s perception. Birkholz *et al* (2014) indicated that stakeholders at different risk levels and holding different interests in their properties can prioritize their flood risk management strategies. The psychological issue of vulnerability not only refers to event consequences on an individual but can have a wider impact on the whole real estate market. It was observed in literature that perception can have an impact upon issues of preparedness and recovery from an event (Bhattacharya-Mis and Lamond, 2014b; Kienzler et al., 2015). Therefore it becomes more important to better understand the perception of commercial property occupiers at different risk levels with varied experience of flooding. This leads to the following questions which require further investigation:

1. Which characteristics are perceived to influence property value in the context of flood risk and how do they differ within different sectors at different level of risk and flood experience?

2. How does the commercial property holder's perception of the criteria and their impacts on property value compare with the perception of real estate experts?

2. Method and Measures

To understand perception of commercial property holders towards vulnerability of value, the average sector wise perception of flood plain respondents' selected postcodes in Wakefield and Sheffield, Yorkshire, UK was analysed in terms of flood risk. Some of the respondents from specific sectors had experienced flooding (once or repeatedly) more than others while some were less experienced or inexperienced. The choice of population was based on their level of risk delineated by Environment Agency flood maps. Similarly, the perspective of real estate experts in commercial property market with experience in dealing with properties affected by flood was also essential to gain an understanding of the assessment criteria from the market perspective. Since the 2007 flood event had a major impact on the commercial property sector in the UK, the two locations flooded during this event were selected as the case study areas. The selection of the study areas was based on the maximum number of affected commercial properties, historical flooding in the area and their present flood risk. Based on the data produced after 2007 flood event, the selected areas matched the criteria as suitable areas of interest (Environment Agency, 2009). A two phase questionnaire survey was conducted to gather the perceptions among commercial property occupiers and to validate the result with the real estate experts in the commercial market. The first phase consisted of a postal questionnaire which was distributed among commercial property holders in selected postcodes of Wakefield and Sheffield. The understanding of perception of commercial property occupiers in the context of their potential attitude towards change in property value was the prime focus. The postal questionnaire consists of three sections dealing with business and ownership information, flooding and property value viewpoints based on respondents perception and nature of risk, impact of flooding and experience of recovery. The main themes around which factors were selected to analyse perception of people were the utility of property, its desirability in the market and the actual impact on marketability in short and long term. These themes were divided into sixteen statements and included in the questionnaire using a Likert style scale. The Likert style scale ranged between 1 to 5; where 1 indicates complete disagreement, 3 indicate neutral attitude and 5 indicates full agreement. A total of 3660 questionnaires were distributed in the region out of which 300 responses were received and 213 had the full information useful for the analysis. In the second phase of data collection, a web based survey instrument was designed for property experts based on questions dealing with changes in property value as a result of change in flood risk status. A stratified sampling strategy was implemented from a database obtained from CoStar commercial property agents' online list. Sampling criteria was based on experts having experience of dealing in properties at high and medium risk of flooding in the selected area. The identification was done by overlaying property transaction database associated with particular real estate expert with environment agency risk maps using GIS software. The broad themes and factors included in the questionnaire were flood risk perception in property deals and factors affecting commercial property values. The purpose of the questionnaire was to gain better understanding of external market condition and the potential effect of flooding on the property transaction deals. Total 11 real estate experts responded to the questionnaire and these results were compared with the results from the commercial property owners/ occupiers. Based on the data collected from the respondents and the real estate agents, exploratory descriptive statistical analysis such as histogram generation and median value calculation was performed to understand and compare the p



frequency of respondents responding to the different perception related statements indicated in the questionnaire which were based on the themes described earlier (section 2) through Likert scale of agreement. The questions associated to the main themes are indicated as index of perception statements in Fig 1. Based on the spread of responses it is clearly perceptible that in case of high flood risk having an impact on property utility (F1, F2) the agreement is fairly strong, showing that commercial property holders in general are aware of the direct and indirect impacts of flooding. They are in agreement that reduced utility of property can have an impact on the income generation caused in case of longer recovery time (F13, F14) while higher expected income may help in increasing the demand for the property (F8). However the importance of prime location (F3) showed a broad spread of perception. Respondents also agreed that with cheap and easily available insurance (F4, F5) there might be increased probability of achieving high value in the market. Attitude of all respondents towards flood history and its impact on value (F6) as well as historical low value (F10) of property as a result of flooding leading in lower demand in future both received fairly high agreement with some neutral responses. In case of protection and mitigation measures (F9, F11) the perception represented an understanding of the importance of the measures with some agreement towards their effect in the long run (F12). Both for flexible lease terms and easy mortgage availability (F7, F15) leading to high demand for properties were responded with mostly neutral response. A mixed message is seen among respondents towards the perception that with increased risk level there might be lower potential of staying and continuing business and intentions to move

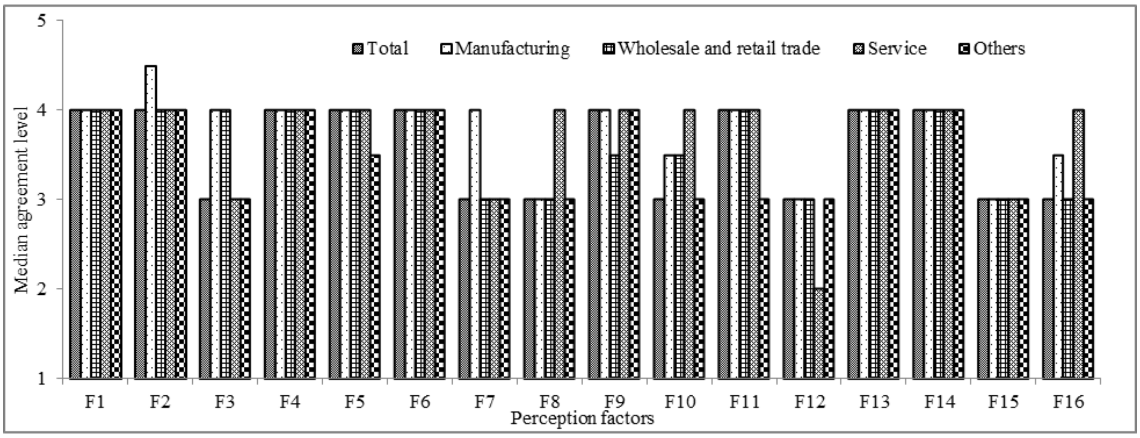
Index of perception statements from top left to bottom right			
F1:Higher risk lower income	F2: Lower income lower value	F3:Prime location high value	F4:Easy insurance high value
F5:Cheap insurance high value	F6:Historical flood low value	F7: Flexible lease higher desirability	F8: Higher expected income high demand
F9: Higher protection high value	F10: Historical low value and low demand	F11: Higher mitigation high demand for property	F12: Lowering risk has no long term effect
F13: Higher loss in income longer recovery	F14: Longer recovery lower utility	F15: Easy mortgage high demand	F16: High risk low desirability to stay
The x axis indicates the agreement level from 1 to 5 and y axis shows the frequency of respondents			

Figure 1 Market perception for Vulnerability of value among flood plain commercial property respondents in Wakefield and Sheffield

to areas with lower risk (F16). The histograms are showing a generalized view of all the sectors; however since flood risk does not affect all sectors equally it is necessary at this point to explore the results in a sector specific manner.

3.2 Perception of different sectors

When the same factors of perception were plotted (median value of agreements observed from the Likert scale) stratified by specific sectors a general consensus can be observed across many of the factors but there were some exceptions as seen in figure 2. All sectors showed primary concern about high flood risk (F1), importance of easy and cheap insurance (F4, F5), impact of historical flood on property value (F6) and higher loss of income as a result of longer recovery time (F13, F14). As for property marketability, all respondents perceive that with higher loss of income and longer recovery time loss of utility can result in making value vulnerable to changes in the market. The repeatedly flooded respondents, although fewer in number, showed higher agreement towards the factor of recurring loss in income due to longer recovery time. It was unanimously perceived that with lower income for lower utility of the property the value might be potentially affected (F2).



Index of perception statements			
F1:Higher risk lower income	F2: Lower income lower value	F3:Prime location high value	F4:Easy insurance high value
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F9: Higher protection high value	F10: Historical low value and low demand	F11: Higher mitigation high demand for property	F12: Lowering risk has no long term effect
F13: Higher loss in income longer recovery	F14: Longer recovery lower utility	F15: Easy mortgage high demand	F16: High risk low desirability to stay

Figure 2 Sector specific perceptions of commercial property owners/ occupiers for vulnerability of value

A difference in opinion among manufacturing, retail and wholesale with service and other commercial sectors regarding prime location (F3) can be observed. It is understandable that for wholesale and retail sectors location can be an important factor for gaining customers. As for the manufacturing sector the importance of location may be related to their need to be close to suppliers. Regarding availability of easy and cheap insurance (F4, F5) the general agreement is high among all sectors as mentioned before with fewer neutral views who are predominantly repeatedly flooded especially for the factor that cheap insurance premium can improve the properties desirability in the market. It is possible that they recognize the importance of easy and cheap insurance in terms of marketability of property but due to repeated flood experience there is increased probability of getting higher insurance premium at the time of renewal which might reflect in neutral attitude. More repeatedly flooded responses from the commercial property sector are necessary to validate this aspect of perception in the future. Despite some neutral responses majority of respondents are concerned about the history of flooding (F6) and for historical low value (F10) service sector showed the highest agreement. The decrease in demand as a result of low historical value in a property is effectively perceived as condition that may have an impact on future property value. Flexible terms of lease (F7) are perceived to have higher impact on property desirability by the manufacturing sector while others represented a neutral attitude. Majority of the manufacturing sector (48%) have internal repairing and insuring type of lease while few have Full repair and insurance lease terms (26%) and the rest are either not sure or did not answer. The internal repair and insuring type of lease does not permit tenants to make changes in their property without landlord’s knowledge; therefore these property holders have less freedom in adopting risk reduction measures which might have influenced them to show fairly high agreement towards flexible lease terms. In terms of investment towards risk reduction through resistance and resilience measures (F9) majority of the commercial property respondents showed high agreement towards their efficiency in reducing risk; few other mixed commercial sectors respondents showed a neutral attitude towards higher mitigation leading to high demand for property in the market (F11) while majority agreed to its usefulness. With little disagreement from the service sector properties, manufacturing, wholesale, retail and other sectors indicated neutrality in their attitude towards the perception that lowering risk has no long term impact on value (F12). The general agreement of all flood affected respondents towards mortgage (F15) and demand for property was neutral. Similar neutral attitude was observed among all sectors when they have been asked to perceive the high flood risk factor and their desirability to move out to a location with less risk (F16) except manufacturing and service sectors. This confirms the earlier result (F3) that location is more influential for these sectors and they would be more reluctant to move. It is perceived that due to the inherent memory of previous floods into the system as a result of experience, some of the perception factors for example importance of insurance (F4, F5) or moving out of the high risk zone (F16) received slight differences of opinion between repeatedly flooded respondents from the general agreement. This is now important to understand how the perception among respondents with or without flood experience compares with the real estate market commercial property experts. This can be observed by comparing and validating the collected perception data with that of real estate experts. The next section will elaborate on the data collected from the real estate experts with experience of dealing in flood affected properties to analyse their perception on potential changes in property value.

3.3 Perception of real estate experts

Real estate experts were asked to indicate their perception towards selected variables and the impacts these factors have on property value. The outcome from this exercise was intended to compare perception of the experts to commercial property holders' criteria those were perceived to have potential effect on property value in the market. The criteria included: high risk of flooding, measures taken to reduce risk, history of flooding and reduced value as a result of previous memory of flooding within the system, locational advantage compared to risk of flooding, availability of mortgage and importance of mitigation measures. Figure 3 illustrate the comparative perception of all respondents from both study areas and the commercial real estate experts. The responses were based on a 5 point Likert scale where a value less than 3 indicated lower agreements and value above 3 indicated higher agreement with 3 being neutral. The general pattern of perception reveals that both property occupiers and property experts were prone towards keeping their opinions neutral. Neutral attitude of commercial property holders could be observed towards factors like flood defences and mitigation measures, mortgage availability and locational advantages, while the experts also showed lower agreement towards these issues except for locational advantages. The most likely reason for the difference in opinion for existing mitigation and mortgage availability can be the result of the lack of understanding of commercial real estate experts towards flood risk as an issue of concern in the real estate market. It is expected that respondents who are living with risk will provide a better understanding towards the importance of mitigation activities. Consequently defences and mitigation activities were not perceived to have much influence on value as to their perception the more frequent transaction of renting properties does not get affected by risk reduction measures; as for the mortgage issue, it seems that the sudden changes in the economic climate might have affected that perception which some real estate expert indicated in the form of notes in the space provided within the questionnaire.

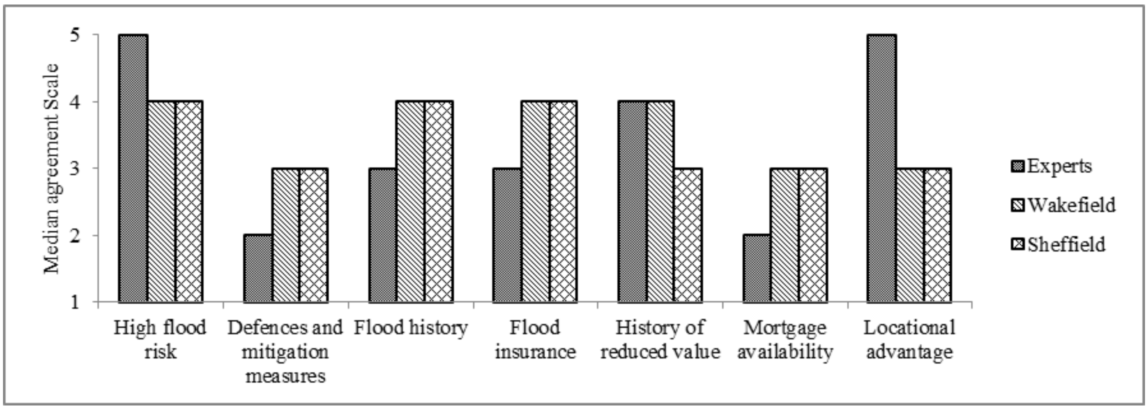

Figure 3 Comparative analyses of perception of flood risk and vulnerability of value of among real estate experts and commercial property holders in Wakefield and Sheffield

The agreement among all commercial property respondents in Wakefield and Sheffield showed very similar perception with minor differences. It should also be noted that there were no total contradictions where high agreement among commercial property holders corresponded to high disagreement among experts or vice versa. The general perception of both experts and property occupiers established to the criteria of high flood risk having impact on property value showing the growing awareness among the stakeholders. While commercial property occupiers both total and repeatedly flooded agreed highly towards availability and accessibility of flood insurance to have effect on property value, experts were neutral on that issue. The consequence of historical flooding and historical value reduction showed higher impact on property's present value. Commercial property holders with repeated flood experience showed higher agreement towards the issue but the experts seem to have neutral view towards this. This attitude can be due to the case specific nature of the issue. Sometimes based on the perception of some buyers, history of flooding and previous value reduction can be an important aspect in negotiation of property value while for others that may not be an issue. As in terms of empirical evidence such cases are hardly visible, the factor of historical flooding is not perceived to be an important aspect in the real estate market. It is acknowledged that, due to low sample sizes within the sectoral breakdown and repeatedly flooded respondents, the observations contained here were not subjected to formal tests of significance and cannot be held to be generalisable. It is acknowledged that a larger sample in this or other locations can provide more robust results and also reveal differences from one location to another depending on level of risk, awareness, experience and knowledge. However these results indicate that it is important to consider sectoral and experience factors when assessing the vulnerability of value to flood risk and historic floods. Comparative responses from both data sources showed general evidence of agreement on the bigger picture around the role of flood risk still there appears to be a knowledge gap between the real estate experts and commercial property holders regarding the importance of operational factors that might affect value. This lack of understanding could lead to conflict between the two sides of the demand and supply curve. This is acknowledged that flooding is one of the several factors that might have an impact on the peoples' perception. For instance the impact of memory of previous floods and other flood experiences before 2007, the sense of belonging to the place where as a result of their stay in the area for a long period of time, local cultural heritage where the commercial properties feel part of the community may influence their perception and with changes in such factors the overall perception might also vary. Improved understanding of the perception of commercial property occupiers (demand side) could inform the property professionals to provide operational advice and has potential to provide greater incentives to commercial property holders to take risk preventative actions.

4. Conclusion

The research outputs described in this paper is an attempt to overcome the problems of data inadequacies in the field of flood risk and its interaction with real estate value, by bringing together perceptions from different property sectors and those affected or unaffected by flooding.

The approach presented integrated understandings derived from the conventional methods of market studies for understanding flood risk and its impact on property values with societal perception. The study found that the differences in opinion between flooded and non-flooded population as well as among different sectors were limited and that there was general agreement around broad risk factors and their potential to reduce utility, marketability and desirability of property at risk in the future. However the exceptions where perceptions were seen to differ revealed the importance of two main experiential factors. First, understanding of the utility of property with respect to functionality and prime location differed among sectors, with certain sectors and those with flood experience expressing greater tolerance of risk in balance with other value factors such as location. Second those with flood experience had a greater knowledge of, and belief in, the impact of mitigation activities such as insurance than the real estate experts. This reflects the current lack of market concern with flooding as a major issue in the property market and reinforces the need to study vulnerability of value rather than rely solely on market based analysis of transaction prices. The repeated flood experience reflects that living with risk has provided the commercial property occupiers an understanding to better deal with risk based on memory of flooding than those inexperienced respondents. Wider propagation of this knowledge may simultaneously inform better investment decisions while improving the take up of sector appropriate mitigation and protection to minimise future flood losses and damages. The contribution from this research provide particular promise as starting points for renewed research agenda around flood risk perception stratified among different commercial property sectors.

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References

Bhattacharya, N. and Lamond, J. (2011), “Flood Vulnerability and Hazard Adjustment of UK commercial sector : A synthesis of Research”, Kandalama, Srilanka.

Bhattacharya-Mis, N. and Lamond, J. (2014a), “Socio-economics complexities of flood memoryin building resilience: An overview of research”, in Haigh, R., Amaratunga, D., Keraminiyage, K. and Menaha, T. (Eds.),*4th International Conference on Building Resilience*, Procedia Economics and Finance, 18, pp. 11-119, Media City, Salford, UK.

Bhattacharya-Mis, N. and Lamond, J. (2014b), “An investigation of patterns of response and recovery among flood affected businesses in the UK”, in Proverbs, D., Brebbia, C.A. (Ed.),*Flood Recovery, Innovation and Response IV*, WIT Transactions on Ecology and the Environment,184, Poznan, Poland, pp. 163–173.

Birkholz, S., Muro, M., Jeffrey, P. and Smith, H.M. (2014), “Rethinking the relationship between flood risk perception and flood management.”, *The Science of the total environment*, Vol. 478, pp. 12–20.

Bristish Property Foundation. (2014), *Property Data Report 2014*.

Environment Agency. (2009), “Flooding in England : A national assessment of flood risk”, Bristol.

Kienzler, S., Pech, I., Kreibich, H., Müller, M. and Thieken, a. H. (2015), “After the extreme flood in 2002: changes in preparedness, response and recovery of flood-affected residents in

Germany between 2005 and 2011”, *Natural Hazards and Earth System Science*, Vol. 15 No. August 2002, pp. 505–526.

Miceli, R., Sotgiu, I. and Settanni, M. (2008), “Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy”, *Journal of Environmental Psychology*, Vol. 28 No. 2, pp. 164–173.

Pitt, M. (2008), *The Pitt Review- Learning Lessons from the 2007 floods*, London: Cabinet office.

Raaijmakers, R., Krywkow, J. and van der Veen, A. (2008), “Flood risk perceptions and spatial multi-criteria analysis: an exploratory research for hazard mitigation”, *Natural Hazards*, Vol. 46, pp. 307–322.

Slovic, P., Finucane, M.L., Peters, E. and MacGregor, D.G. (2004), “Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality”, *Risk Analysis*, Vol. 24, pp. 311–322.

Syms, P. (1997), “Perceptions of risk in the valuation of contaminated land”, *Journal of Property Valuation & Investment*, Vol. 15 No. 1, pp. 27–39.

Tierney, K.J. (1999), “Towards a critical sociology of risk”, *Recherches sociologiques et anthropologiques*, Vol. 14, pp. 215–242.

Wyatt, P. (1996), “The development of a property information system for valuation using a geographical information system (GIS)”, *Journal of Property Research*, Routledge, Vol. 13 No. 4, pp. 317–336.

Serendipity: a Design Approach for Lifecycle Management and Risk Mitigation of Buildings in Natural Hazard-prone Regions

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Abstract

Recently, increasing numbers of natural disasters and associated losses have pointed out the need for a different approach to protect and preserve buildings, ecosystem, and society.

In the aftermath of a natural disaster, the recovery should focus on restoring, reducing the risk factors, and building the long-term health and stability of buildings, environment and vulnerable populations.

An effective lifecycle management approach considers the interaction between environmental footprint and materials, quality and vulnerability of structures and environment, features and conditions of natural sites, and social needs.

This process represents the idea of Serendipity: an experience/research that involves a mix of related requests and insight and results in a valuable outcome. The general concept of Serendipity is translated in material and structural terms, and it evolves in a combined, cognitive method based on two different functions. The first one describes the frame performance under the effect of natural loads, while the second one describes the environmental efficiency of a system.

The aim is to design and preserve the architectural identity, extend the life span, and decrease the environmental footprint of buildings in hazardous areas. This paper is the result of a more-than-40-year worldwide research focused on studying ancient civilizations, building materials, construction techniques, and environmental conditions and vulnerabilities.

Combining low-tech building technology and sustainable eco-material, we propose an original design approach that can extend the structural life expectancy, while reducing the risk of future failure in natural hazard-prone regions.

This procedure has been applied to more than 2500 real projects in order to provide long-lasting structures.

Keywords: longevity; low-tech building technology; natural disasters; risk mitigation; sustainable eco-material

1. Introduction

Serendipity is such a mysterious, difficult word to translate. British aristocrat Horace Walpole coined it in 1754. He noticed the fabled Three Princes of Serendip were “always making discoveries, by accidents and sagacity, of things they were not in quest of” (H. Walpole, *Letter to a Friend*, 1754).

The chemist Louis Pasteur said that “in the fields of observation chance favours only the prepared mind” (R. Vallery-Radot, *The Life of Pasteur*, 1919, p.76). In other words, he talked about a sagacious mind that is open to the unexpected, and capable of interdisciplinary thinking.

Serendipity is anything but sheer accidents. It is a strategic process through which we discover unknown unknowns and share ideas. Serendipity is a state of mind and a property of networks, which means it can be analysed, engineered, and rationally implemented. Besides, resilience can be described as a process of successful adaptation to and recovery from extreme experiences. At the highest level of resiliency Serendipity comes out: the ability to adapt oneself to a change and to turn a difficult situation from a tragic event into a chance of renovation and improvement.

When it comes to research and innovation the challenge is first recognising the needs and potentials, then create the best conditions for reacting wisely. A serendipitous approach to life can be the right way to manage the unknowns.

An effective lifecycle management approach considers the interaction between environmental footprint and materials, quality and vulnerability of structures and environment, features and conditions of natural sites, and social needs. This process represents the basic idea of Serendipity: a multidisciplinary experience/research that results in valuable outcomes. For instance, in a structure affected by a sudden-onset disaster, joints are the main elements fitted for absorbing and reacting to the shock of earthquake or the power of tsunami. The quality of joint influences and almost regulates the whole response of a structure. And this efficiency represents the Serendipity of a joint.

As for structures, material itself also results in affecting the lifespan of buildings. Serendipity of new materials may be discovered by understanding chemical reactions between elements.
An existent building will get longer life by maintaining, replacing or reinforcing its main or sub-frame. Otherwise, a new one will last through the years if any component is well conceived by itself, and in relation to the whole system and boundary conditions. The essential claim is simply that Architecture lives along with environment and people. Because of its complex nature, the lifecycle management of a building cannot be reduced to a self-referring analysis.

In view of these considerations, this paper presents the key points of a more than 40-year research on studying ancient civilizations and architectures, building materials, construction techniques, environment, and vulnerabilities.

From a serendipitous point of view, whatever structure is considered, the final aim of this research is to extend the life of buildings, while reducing risk to natural hazards, using an original, and flexible cognitive approach

2. Serendipitous synergic system

The imprint of climate change is growingly visible. It fundamentally alters the risk profiles of natural disasters.

The nature, extent, duration, and effects of climate change vary depending on region.

Changes in weather patterns are resulting in increasing the frequency, intensity, and extension of disasters. Tsunami, earthquakes, storm surges, floods and droughts severely affect vulnerable urban systems and are likely to intensify over time. Furthermore natural hazards and climate change cause a wide range of indirect incremental impacts on urban systems and society.

Recently, increasing numbers of natural disasters and associated losses have pointed out the need for a different approach to protect and preserve buildings, ecosystem, and society. In the aftermath of a natural disaster, the recovery should focus on restoring, reducing the risk factors, and raising the long-term health and stability of buildings, environment and vulnerable communities. Dealing with change requires resilience. And resilience implies a combination of anticipation and serendipity: a resilient strategy should be based on a trade-off between efficiency (related to the level of performance of a method) and flexibility (related to adaptation bandwidth of a method).

Considering design in an epistemological way, the Possession Energy Theory (Imagawa N., Tsuboi Price 1999) offers an alternative perspective on a system performance. It establishes the interdependence between main characteristics that define a building and its performance under external loading conditions (frame’s own potential energy). The relationship is described through the following *Structural Design Function* (1).

$$F_{ESD}\left\{M_x S_y L_z J_n C_\alpha D_\beta (EI)_\gamma\right\} \geq \begin{cases} \text{natural conditions} \\ \text{social environments} \\ \text{required performances} \\ \text{past and present design} \end{cases} \tag{1}$$

The left side shows the relationship between *materials, frame, loads, joints, cost, durability and erection/*inspection.

The right side lists the efficiency needs that must be satisfied. It includes environmental condition (i.e. natural hazards), social context (e.g. local laws), client/user demand/needs and past design experiences and knowledge.

The "≥" symbol means that the structure defined by F_y agrees at least with local laws and it potentially satisfies the efficiency needs listed on the right side by higher design quality and performance.

The Possession Energy Theory explains by analysis of materials, frame, loads, joints, cost (i.e. monetary cost and environmental cost), durability and construction techniques what a well-conceived multitasking approach may be for the support and satisfaction of social, environmental and structural needs.

While raising awareness of and promoting action in heritage preservation and long-lasting design in natural hazard-prone regions, it provides an opportunity to debate on climate change and sustainability.

3. Material and basic structure system of Serendipity

The world can be seen as a synergetic system, based on energy, movement, exchange and transformation, where carbon dioxide plays a prominent part. From an ecological point of view, it needs for maintaining the wellbeing of humans, species and environment.

Environment is the complex of all observed experiences of all life. It is the present scene, along with all the past scenes. It is an aggregate of energy events at various rates and magnitudes of severity. Some of the events are of long duration and others are short. In other words, the environment represents the whole behaviour of nature, and the interaction between nature and structures.
There is a major pattern of energy in Universe wherein the very large events, i.e. earthquakes, and so forth, occur in any one area of the planet Earth. In the patterning of total evolutionary events, there comes a time when a large energy event happens and is so disturbing that threatens the overall balance.

Building lifespan has been dramatically reducing in recent years. Assuming a building life of more than 50 years, an average of 15% of total energy used occurs in the material production and construction process (*embodied energy*; 21% in Japan), while about 85% of total energy used is in the operational phase of the building (*operational energy*; 79% in Japan). Since the impact of embodied energy is more significant if the building lifespan is shorter, the lifetime decrease has a negative outcome on the environmental footprint of materials and systems over time. Therefore, a lower embodied energy can contribute to reduce the overall environmental impact of the building.

Considering natural hazards, the probability that a major adverse event affects a system is in direct ratio to the long-life of the building structures. Durability and maintenance factors greatly influence the life expectancy of a building.

The lifespan can be extended by adopting proper construction systems and techniques, planning maintenance and repair right in advance, and using compatible building materials.

Thence, in response to broad concerns regarding the impact of climate change and natural disasters, this paper outlines an original point of view and approach to life cycle management and risk mitigation that considers how buildings interact with time and environment. It presents an integrated methodology that is focused on the building as a whole dynamic system for effectively contributing to improve its performance and resilience particularly in natural hazard-prone regions. The general concept of Serendipity is translated in material and structural terms, and it evolves into a combined, cognitive method based on two different functions. The first one describes the frame performance under the effect of natural loads, while the second one describes the environmental efficiency of a system. The aim is to design and preserve the architectural identity, extend the life span, and decrease the environmental footprint of buildings in hazardous areas. The method proposed includes the assessment of the Potential Frame Energy, which depends on both material quality (Young Modulus) and amount of material volume involved in, and the performance assessment (i.e. vulnerability and material degradation and aging evaluation) of building subject to natural forces (tsunami and earthquake) and deterioration process. The evaluation of CO_2 emission related to construction materials (i.e. environmental footprint).

3.1 Structural performance evaluation

Basing on the abovementioned theory and assumptions, the life cycle of a building can be investigated through an approach that firstly defines the potential energy possessed by a certain frame (2).

$$E_{ss} = \sum_{n=1}^{n} E_n * V_n = \left[kN * m \right] \tag{2}$$

where E_n is the material Young's modulus and V_n is the material volume.

This energy depends on forces (e.g. gravity, earthquake, tsunami, etc.) that affect the structure. Therefore the workload condition defines the frame performance under the load effect.

Since the elastic modulus generally predicts the elongation or compression of a material, the (2) also describes how each modulus of Young works. This mechanical characteristic is relevant whenever a system is subject to impact load. Comparing two buildings with the same volume of materials, the one with a higher E_{ss} shows worse performance and efficiency, while the frame with lower E_{ss} does efficient workload.

Once the potential energy has been evaluated, it is necessary to define the *energy density* possessed by that structure.

Usually the energy density is the amount of energy stored in a given system or region of space per unit of volume. The energy density considered in this paper represents the energy stored by the structure and can be defined as follows (3).

$$U_{ss} = \frac{E_{ss}}{V_s} = \left[\frac{kN}{m^2}\right] \tag{3}$$

It depends on material quality and volume and it refers to the whole volume of the building. It shows how efficient (low E_{ss}/V_s) or inefficient (high E_{ss}/V_s) a frame is when forces act on it. That is the frame potential performance (*potential possession frame energy density*).

3.2 Environmental footprint evaluation

The dynamic response of a building to both environmental actions and use loads changes over time: the reliability decreases, while the vulnerability to natural (or man-made) hazards increases.

Every building has got its own identity: it is almost unique. The need for maintenance, repairs and renovations varies depending on several factors, such as age, construction quality, design details, environmental conditions, and so on. Anyway it has been proved that generally buildings follow a similar pattern as they pass through different processes over the service life: conception, construction, operation, fitting, mending, re-use, recycle and demolition. Understanding this basic process enables to predict the future behaviour development of the structure and make decisions about operating strategies (maintenance, fitting, repairs and renovations).

Whenever a loss of performance bears the need for repairing or replacing, these interventions increase the CO_2 discharge and impinge upon the environment. From a life cycle point of view, environmental footprint due to maintenance/retro fitting actions must be taken into account in order to evaluate the performance of any intervention strategy. The level of CO_2 discharged during material manufacturing is a crucial factor for assessing the environmental efficiency of a building. Most of the energy used in the production of building materials derives from fossil fuels, and the embodied energy is a significant index of the influence of different materials on carbon cycle. It measures the total energy used to transform raw materials into ready-to-use building products. It varies with the structure characteristics and position. The environmental efficiency of a building is investigated through the definition of the whole initial embodied CO_2 emitted by a system (4).

$$E_{CO_2} = \sum_{n=1}^{n} E_{(CO_2)_n} * V_n = [kN] \tag{4}$$

where E_{CO2n} is the material initial embodied CO_2 emission, i.e. the amount of CO_2 emitted during the material manufacturing process and V_n is the material volume.

Recurrent embodied energy and recurrent embodied CO_2 emission of the materials added later to the building must be considered too. Thereby the Life Cycle CO_2 emission ($LCCO_2$) results as the sum of CO_2 emissions incurred during the entire life of a building. Some materials, such as timber or stone, have relatively low embodied CO_2 costs due to small amounts of CO_2 produced over the manufacturing process (e.g. extracting, sawing, drying and transportation). Otherwise materials like steel and glass have relevant embodied CO_2 costs due to very energy-intensive manufacturing processes with high levels of CO_2 emissions.

The embodied CO_2 emission density describes the amount of CO_2 discharged by materials, related to the system volume as follows (5).

$$U_{E_{CO_2}} = \frac{E_{CO_2}}{V_S} = \left[\frac{kN}{m^3}\right] \tag{5}$$

Considering both the potential energy density possessed by a frame and the embodied CO_2 emission density allows the definition of a building global performance within general life cycle management.

For a sustainable perspective, a system may be considered durable when its useful service life is fairly comparable to the time required for related impacts on the environment to be absorbed by the Ecosystem. Thence a potential life expectancy index can be introduced by the relation (6).

$$I_{LE} = \frac{U_{SS}}{U_{E_{CO_2}}} \tag{7}$$

where U_{SS} is (3), and U_{ECO2} is (5)

4. Joints for Serendipity

Any structure is the incidental resultant to inter-relatability of parts. A system can be reduced to three main characteristics: members, joints, and reactions. Joints are critical points where members collect, collide, and interact. The function of a joint is to relate the parts. For instance, considering a common RC rigid frame system (Fig. 1) subjected to seismic lateral loading and gravity loading, beam-to-column connections have been identified as potentially one of the weaker components.

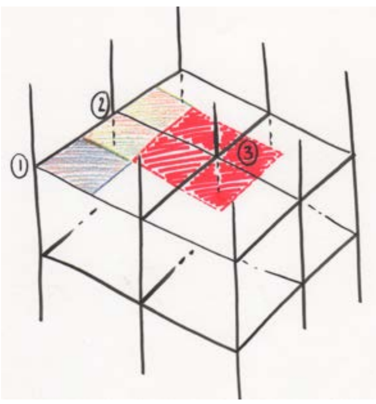

Fig. 1. RC rigid frame system scheme with beam-to-column connection typologies (i.e. 1-corner joint, 2-exterior joint, 3-interior joint) and influence areas related to each joint type.

As shown in Figure 1 there are 3 type of beam-column joints related to 3 different influence areas: corner joint (type 1), exterior joint (type 2), and interior joint (type 3). Type 3 is assumed to be the weakest link.

Typically, under moderate to severe seismic load distribution, beams develop nominal flexural strength at the joint perimeter, while column longitudinal reinforcement carries tensile stress that approaches the yield stress. Beam and column moments transfer into the joint through tension force resultants carried by the frame-member longitudinal reinforcing steel and compression force resultants carried by frame-member concrete. Shear forces transfer into the joint through concrete nearby the frame-member flexural compression zones.

From the Serendipity point of view, what may appear vulnerable at first sight, then turns out to be a challenge to define a methodology for designing the optimal beam-column joint.
Since what makes a structure performing well is how its members are connected to the building itself and to each other, to make a structure better, we have to engineer the joint serendipity. The basic idea is to design the beam-column joint referring to just the real area of stress concentration. The stress-rising region is represented by red cubic volume in Figure 2.

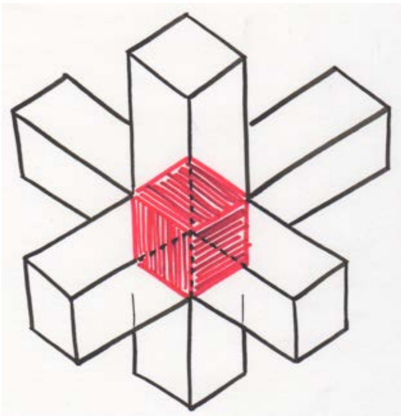

Fig. 2. Type 3 beam-column joint. The region of stress concentration is highlighted in red.

Thus the engineering of beam-to-column connection might be pursued through the investigation of material, volume, and strength of the cube. Although there is still much room for improvement, this first attempt shows the potentialities of designing and optimising beam-column joints considering the region of stress concentration. The development of this methodology would be useful for managing the life cycle of buildings and mitigating the risk from natural disasters. The investigation of strength related to materials and structural elements, along with the application of the method to real case studies will be the next steps.

5. Materials for Serendipity

Stone/brick, timber, iron, and concrete are the major construction materials commonly used in modern structural design. In ancient time local natural materials like stone were the most used

material in building. Stone can be considered as the oldest building material ever. Stone masonry has proven to be the most resilient construction technique after 5000 years.
In the last decades we are facing several atmospheric changes, which result into severe environmental issues. Nowadays the prevention of global warming represents one of the most pressing challenges. And the development of environmentally friendly construction materials that restrain the release of carbon dioxide is considered essential.

Modern construction processes are a major contributor to carbon emissions. Reinforced concrete is a composite, versatile construction material. It has been widely used for over a century as a major building material because of its mechanical properties. Nevertheless it inherits the disadvantages of concrete and steel as well. Cracking of concrete cover due to corrosion-induced expansion of steel rebar is one of the main causes of deterioration in reinforced concrete. Because of this weathering the usable lifespan of RC structures is quite short (almost 50 years).

Recently several new materials are available. Although "green" buildings are more energy efficient and use renewable resources for materials, the material manufacturing process and the construction process still expend large amount of energy and oxygen, while expelling carbon dioxide. On the other hand, using locally available materials decrease transportation and processing costs.

During organic photosynthesis, carbon dioxide and sunlight are used to create energy. The by-product of this process is oxygen. A photosynthesis-like process has been considered in seeking for a new ecological structural material, called *Eco-Structure*. Inspired by the process of photosynthesis, the Eco-structure aims to reduce the carbon emissions during the manufacturing. In particular, it aims to absorb carbon dioxide during the curing process.

CO_2 Eco-Structure is a non-reinforced material with the equivalent compressive strength (approximately F_c equal to $24N/mm^2$) and comparable tensile strength to reinforced concrete.

The base material for Eco-structure is Silica sand, a readily available chemical compound (SiO_2) and one of the most abundant materials on the surface of the planet.
The final and main goal is to develop a material that possess high-performance characteristics in terms of rigidity, strength, impact resistance, durability, waterproofing, chemical resistance, and stability, as well as excellent stress relaxation characteristics, shape conformability, and workability during shaping.

In a modern society with problems of global warming and carbon emissions to solve, such a bio-inspired and environmentally compatible structural material would help to cope with the damaging effects of modern construction techniques and manufacturing processes.
Moreover in natural hazard-prone regions, how to extend the life expectancy of buildings considering the effects on the natural environment has become more and more urgent. Thence the development of an alternative, eco-friendly and high-performance material should become a priority.

Because Eco-structure mixes high-tech technology with low-tech construction methods, it can be easily employed in temporary emergency housing. In September 2011 a temporary pavilion was built in the courtyard of Tokyo International Forum (Fig. 3).

Fig. 3. Example of CO_2 Eco-Structure: temporary pavilion built in front of Tokyo International Forum in September 2011.

It was a 4 meters high, 9 meters diameter masonry dome composed by CO_2 Eco-Structure inverted T-shaped moduli. It took a day to be completed by students and common people. The short time of execution can be attributed to the short hardening time and easy-to-assemble characteristic of CO_2 Eco-Structure. This temporary pavilion can be considered as an example of the application of serendipity to materials.

CO_2 Eco-structure is still in development, but new adaptations have been done. And the realisation of a fast-hardening, eco-friendly concrete alternative that absorbs carbon dioxide is getting closer and closer. In February 2015, we have changed the base sand component by obtaining it from a different source. It is still a natural, readily available material, but the composition is different.

6. Nature of structure and structure of Nature

Any living entity in Nature has a structure. Since the very beginning of the history of life, Nature has built itself through an evolutionary process based on selection and optimisation. Thence the Natural World should represent a source of inspiration for the problems that man faces. In fact, nature regularly builds structures with functionality that human-built structures could usefully emulate.

Three different but almost complementary ways of looking at Nature can be defined: Nature as Model, Nature as Measure, and Nature as Mentor.

Nature as Model means to take inspiration from its processes and structures.
Nature as Measure means to use it as an inventory, a source of useful data. Furthermore Nature becomes a standard against which to judge the rightness of approaches and innovations.

Finally, Nature as Mentor means to see it as a source of ideas rather than a mere source of raw materials. This would radically change the way of thinking about Nature: *learning* from Nature instead of *extracting* goods from it.
Basing on these assumptions, the rationale for protecting communities, ecosystem and building heritage becomes self-evident.

According to American biologist Janine Benyus, most of the problems that have ever existed have already been solved by Nature. In her book, Benyus (2009) emphasises that learning from Nature would be the perfect tool for solve human problems. She has brought to the fore the concept of *Biomimicry*. And because Nature is the foundation in developing biomimical products and processes, the result should be sustainable and environmentally friendly.

The term *Biomimetics* (from *bios*, life, and *mimesis*, to imitate) was coined by polymath Otto Schmitt in the 1950s for the transfer of ideas and analogues from biology to technology.
Assuming that among all needs of living creatures, mechanical stability and structural performance are dramatically prominent, it comes out that *tensegrity* (i.e. contraction of *tensile* and *integrity*) represent the structural model of a natural system. Tensegrity structures consist of a continuous network of tension elements (i.e. cable) supported by discontinuous compression elements (i.e. struts). Tensegrity systems are the optimal structures considered so far in terms of strength to weight ratio. This condition comes from their natural configuration of pure tension and compression elements.

In 1932 U.S. engineer and architect Buckminster Fuller stated the necessity to use forces (e.g. forces of nature, like plate-tectonic forces, gravity, etc.), rather than to fight them. He was one of the most prominent designers who applied the concept of biomimicry to solve design problems. Particularly, he was the first to look upon tensegrity structures from an original engineering point of view.

Buckminster Fuller describes *tensegrity factor* as an “island of compression inside an ocean of tension”.

Today is generally admitted that artist and Fuller’s assistant Kenneth Snelson’s structure X-Piece (Fig. 4) represents the birth of tensegrity concept, or better the *Nature of Strcuture*.

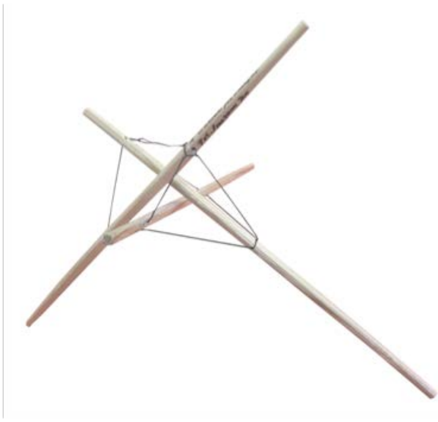

Fig. 4. Nature of Structure basic minimum unit made of chopsticks and silk string by K. Snelson.

The fact that Tensegrity describes a system while Nature of Structure concerns the essence of structure in Nature, represents the basic difference between the two concepts. Connection is the very generative action in Snelson's sculpture. Snelson describes the material universe as an ordered arrangement of parts in space. The idea of infinite perfection of connections is the accurate description of his sculpture; it points directly to a vision of creation that pervades all of his endeavors. The application of Nature of Structure to building design represents another type of Serendipity. There is no coincidence, but the common aim to control forces, and understand and optimise the efficiency and resilience of systems. Natural world and man-made world both speak to a fundamental understanding of the ingenuity of self-assembling structures and their methods of balancing harmony and stability. The concept of Nature of Structure reflects the design of natural functional living systems and can extend to green building practices, eco-societies, and environmental protection the natural principles of security, evolution, and lifespan extension. Durability is derived from the capacity to distribute tension throughout the structure as well as respond to and neutralise tensional forces with specialised compression. This is a vision of cooperation and symbiotic relation with Nature in order to create sustainable backgrounds for human living.

7. Conclusion and future of serendipitous approach

Natural disasters can be so overwhelming that communities and environment have to radically change their response to cope with consequences. An approach towards resilience may represent the proper strategy to deal with risks in natural hazard-prone regions. Resilience is the capacity of a system to absorb disturbance and reorganize itself while undergoing change. From this perspective, resilience and Serendipity, (i.e. capability of adaptation and innovation) are almost synonyms or at least they are complementary.

In the aftermath of a natural disaster, major efforts should focus on recovering the long-term health and stability of buildings, environment and communities. An effective lifecycle management method considers the interaction between environmental footprint and materials, quality and vulnerability of structures and environment, features and conditions of natural sites, and social needs. Based on the previous assumption, this paper introduces the key points of an original synergic design approach to protect and preserve buildings, ecosystem, and society in vulnerable areas. The aim is to provide a flexible tool to be used for identifying sustainable and durable design solutions, and managing strategic policies in natural hazard prone regions. The implementation of this serendipitous approach into an appropriate risk-mitigation strategy can have a positive influence on lowering the risk.

The authors are aware that this research is still ongoing. The definition of the potential frame age, the investigation of ecological structural materials, the development of the method for designing and optimising the beam-column joint will be the next steps. The assessment of the potential lifespan can provide a tool to preserve the identity and integrity of a system and significantly extend the durability of structures and their ability to withstand seismic and tsunami loads. By indirectly improving social, economic and environmental conditions, the integration of the proposed procedure in common decision-making process seeks to enhance the life quality for present and future generations.

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8. References

Akaiwa, D., Imagawa, N., Tosaka, N., (2015). *Development of New Eco-Structural Materials. Serendipity between Architecture and Chemistry*, IASS WG12+18 Joint International Colloquium on Bio-based and Bio-inspired Environmentally Compatible Structures. Tokyo, Japan, paper #15T-43.

Basso, N., Imagawa, N., (2015). *Multitasking Approach for Managing the Life-Cycle of Buildings in Natural Hazard-prone Regions*, IASS WG12+18 Joint International Colloquium on Bio-based and Bio-inspired Environmentally Compatible Structures. Tokyo, Japan, paper #15T-29.

Imagawa, N., Suematsu, S., Inoda, D., Yamamoto, N., (2009). *Attempt of Quantitative Design Recognition of Space Structure to Use Possession Energy Theory of Space Frame-Shell and Spatial Structures*. In: Domingo Cabo, A. (Ed.). IASS 2009. Evolution and Trends in Design, Analysis and Construction of Shell and Spatial Structures, Editorial Universitat Politecnica de Valencia, 742-753.

NOAA Paleoclimatology Program, National Climatic Data Center (2008). *A Paleo Perspective on Global Warming*. [Online] Available from: http://www.ncdc.noaa.gov/paleo/globalwarming/what.html [Accessed: 20 May 2014].

Benyus, J. M., (2002). *Biomimicri*. *Innovation Inspired by Nature*. New York: Harper Collins.

An exploration of the relationship between building resilience, uncertainty and “no regrets” adaptation

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Abstract

The challenges of coping with the increased disaster risk caused by rapid urbanisation and climate change within social, economic and ecological systems have been instrumental in creating concepts of resilience. Understanding and relating these concepts to existing policies and structures in sustainable development, risk management and adaptation planning is a constantly evolving debate with multiple stakeholder voices and nuances relating to the type of hazard and development context. Despite this diversity of perspectives discourse around building resilience to urban flooding is shifting inexorably in line with flood risk management policy from a structurally focused engineering perspective towards a more holistic social and ecological understanding. Preparedness, emergency management and recovery strategies may gain more emphasis while flood prevention and maintenance of the status quo is regarded as unrealistic and ultimately self defeating goal. This reflects a gathering trend in resilience thinking to emphasise adaptability of systems and the capacity to accept change in order to enhance long term risk reduction. The concept of “no” or “low” regrets adaptation is an emerging theme within the climate adaptation literature. This concept relates to the difficulty in optimising long term adaptation strategies in the face of massive uncertainties in future projections of climate, urbanisation and social and economic scenarios. No regret approaches adhere to the principles of sustainability; meeting present needs for risk reduction without disadvantaging future generations by increasing their risk or constraining their economic development. In the area of flood adaptation this may lead to the implementation of more adaptable engineered structures and flexible non-structural approaches to risk reduction. A key linking theme between these concepts is related to the flexibility and incremental nature of preferred approaches whether to climate adaptation or disaster risk reduction. This highlights the importance of building social and economic capacity and resilience in respect to flooding in the face of irreducible uncertainty while still aiming to reduce the short term risk.

Keywords: Adaptation, resilience, flooding, urbanisation, uncertainty

1. Introduction

Flood management sits firmly within the intersection between disaster risk reduction and climate adaptation as noted by Lisa *et al.* [1] as it is a natural hazard that is expected to increase in frequency and intensity as a result of climate changes. Flooding poses a serious and frequent risk that challenges the lives of citizens of many major cities around the world [2]. It ranges in onset from very sudden in the case of pluvial to predictable short term onset in the case of fluvial and some coastal flooding. Traditional, structural, approaches to dealing with flood risk have been successful across the centuries in all continents using high level technology such as tidal barriers or low level measures such earthworks. Direct, rather than indirect, impacts from major flood events, as witnessed for example in New York City, Lagos, Pakistan, Mississippi and Australia, are often thought to represent the biggest risk to life and property [3]. Therefore the shock and recovery cycle model of flood management has led to a historical understanding of resilience tending towards earthquakes rather than droughts [4]. Vulnerability rather than resilience has been the focus of social and physical measurement in order to prioritise the placement of the structural defences. A drift in the policy towards floodplain management rather than flood defence owing much to the “father of floodplain management” Gilbert White [5] has led to risk management approaches that aim to live with water and make space for it in urban environments. Acceptance of the inevitability of event exceeding designed protection and pressures of urban expansion have driven the desire to examine the resilience of urban and natural systems as a first rather than a last resort.

No-regrets approach to adaptation is said by Siegel and Jorgensen [6] to have emerged from the precautionary principle in sustainable development and to be actions that increase resilience to multiple hazards that can be justified from economic, social, and environmental perspectives whether climate change or other deterministic and probabilistic scenarios occur or not. It is worthy to note that the roots within sustainable development colour the discourse towards dynamism and reduce the importance of the do nothing scenario. In their definition no-regrets is seen to include the concept of resilience (defined in this case as the ability to deal with hazards “in a timely, efficient and equitable manner”) implying that all no-regrets measures will be resilient. However, the underlying concept is one of increasing general resilience of populations to all rather than adapting to a specific hazard so the question arises – is no-regrets embedded too far in developmental goals to be helpful as a concept within specific hazards, such as flooding and targeted adaptations to those hazards?

2. Concepts of Flood Resilience

Resilience is not a new concept in disaster management research. For example Turton and Turton [7] described the resilience of Ethiopian communities exposed to drought risk moving their farming to higher ground and adapting their traditional way of life to ensure continued survival. Resilience definitions are numerous and contested [8] but there has been a shift from the “bounce back” notion of returning to the previous equilibrium state to the transformative normality model that focuses on maintaining system functionality in new and potentially stronger states [9]. The preponderance of resilience studies has accelerated in recent decades such that social and cultural resilience as described by Pelling [9] and others such as Tierney and Bruneau [10], Gallopin [11], Defra/Environment Agency [12], Institution of Civil Engineers [13] and Folke *et al*. [14] is now commonly accepted.

These newer concepts of resilience seem to have emerged from a development perspective in communities where indirect effects, such as disease; reduced nutrition; disrupted education; and loss of livelihoods, can have pernicious long-term effects, eroding community capacity and development goals [15]. In the developing world resource constraints often render technical and engineering measures impractical. Resilience is also rooted in ecosystem thinking and these definitions themselves naturally to systems based approaches in the natural environment and in agricultural and environmental settings [16] where engineering is an inappropriate response.

Different hazard contexts also create nuanced understandings of resilience, for example in sudden onset hazards such as earthquakes there is little that can be done to cope within an event and pre-event design and post-event recovery planning is critical whereas in slow onset of extreme weather events such as drought the ability to continue to adapt throughout phases of the event and behavioural responses are potentially more relevant [7].

By 1998 the terms "flood resilience" and "coastal resilience" were common currency [17] such as the Geographical Journal special issue in that year amply illustrates [18]. Increased resilience is related to reduced vulnerability, although the relationship between vulnerability and resilience is not easy to specify [19]. However measures that reduce vulnerability can also be said to increase resilience and this may be reflected in the strengthening of four capacities within the built environment:

- Threshold capacity is the level to which flood hazard must reach before damage and disruption is widespread.
- Coping capacity reflects the ability of communities to continue to function despite the threshold capacity being exceeded,
- Recovery capacity is related to the speed and effectiveness of the return to normal operations of the city after a flood and
- Adaptive capacity denotes an ability to use the recovery period and the time between events to enhance the other three capacities

De Graaf [20] among others has linked resilience to vulnerability and four capacities. However, while increased resilience results from decreased vulnerability of people and assets it may also result from a general adaptability or coping ability and underlying socio-economic and political factors quite divorced from the flood hazard [21].

Increasingly the concepts of resilience are being applied to urban settings and to social and cultural resilience. Implied in the concept is a holistic treatment of built and human elements of the urban setting that has proved attractive within a development literature that seeks to maximize the reach of resources through mainstreaming, capacity building and multi-functional programmes [22]. As the notions are being adopted by researchers in developed contexts the challenge has been that a larger asset base has led to greater reliance on and preference for structural risk reduction and financial compensation. The debate around competing "business as usual" and "build back better" definitions resurfaces due to the reluctance to abandon existing equilibrium states that influential stakeholders have vested interest in and also a technocratic mindset in the risk management community [23, 24]. Defensive, incremental and adaptive definitions of resilience are included in these settings so that resilience is sometimes seen as an extra to be called upon when traditional resistant approaches fail.

3. Concepts of uncertainty and no regrets

Within the field of climate adaptation a dominant theme is the uncertainty surrounding predictions ranging from climate itself to the impact of climate on weather patterns and sea level rise. For the purposes of mitigation it is most important to know whether gases are having an impact on climate and the estimate of that impact is not critical to the decision to act. However uncertainty in estimates for the purposes of adaptation, particularly for infrastructure such as flood defences that are designed to last long into the future can lead to:

- Over-adaptation, such as building a sea wall against sea level rise that never occurs.
- Under-adaptation, such as failure to build extra capacity into drainage systems. In some cases, (for example the levee effect), under-adaptation actually increase the impacts of climate change.
- Mal-adaptation or taking the wrong action, such as relocating residents at risk of flooding to an area that becomes at greater risk from landslides.

Climate adaptation and disaster management overlap in the region of flood risk management (and some other hazards such as drought) because future patterns of flooding are expected to be different to the present day [25]. Therefore uncertainty can lead to indecision and inaction especially if decisions are costly and might be unpopular or even make flood impacts worse in the case of wrong predictions.

There are different sources and types of uncertainty and some well established methods to cope with and minimise their impact in project evaluation and adaptation decisions in projections. Climate projections are one major source of uncertainty in designing climate adaptation but many other assumptions necessary to make decisions may also be rough estimates, uncertain, or subject to political whim. For example, trends in urbanization or national or international intervention in eco-markets may change over time and make options more or less profitable. Disasters are by their nature uncertain and therefore probability assessments and expected losses are part of the natural language of disaster management. Inclusion of climate change adds a further source of uncertainty to the future cost and benefit flows and multiplies the number of different possibilities that need to be considered.

Strategies can include: attempting to quantify the uncertainty (e.g., via confidence intervals around estimates of future losses within a climate scenario); sensitivity analysis to assess the impact of uncertainty on chosen action (e.g., climate scenarios); or avoidance of uncertainty by taking actions that have fewer uncertainties associated with them (e.g., no regrets or robust alternatives). Wilby and Dessai [26] among others argue that future climate projects are subject to high levels of systemic uncertainty and indeterminacy and therefore robust and “no regret” solutions are necessary. However, choosing the "no regret" solution still requires good understanding and analysis of the uncertainties to be avoided.

Ranger *et. al.*[27] have brought some insight to this question through examination of potential adaptation to flood risk; with structural defences identified as potentially high regret and insurance and early warning as two examples of low regret options. Two dimensions are considered: robustness to uncertainties; and cost benefit. However it is well recognized that in the case of flood risk reduction the potential to make large reductions in hazard through engineered solutions is a feature of integrated schemes and that placement of infrastructure will rely on future uncertain predictions of (for example) sea level. Therefore there is a need to distinguish between a no or low regret option and a no-regret approach to an inherently inflexible and long term investment.

Characteristics of a no regret approach within adaptation to future flood risk can are summarized to include measures, and variations of measures that reduce flood risk and are:

- Worth doing
    - Reduce flood risk
    - Cost beneficial
- Robust to uncertainty
    - Zero or low cost to install and maintain
    - Have a short payback period
    - Cost benefit is robust to future scenario
    - Fails gracefully if the unexpected happens
- Adaptable
    - Possible to reverse at low cost
    - Possible to apply incrementally
    - Adaptable in the light of future changes
- Have other benefits
    - Acceptable/desirable in social/cultural context
    - Have other benefits in a social/cultural context

As with resilience capacities these four main characteristics do not have to be present in every scheme and the no regrets characteristics are desirable for any flood risk adaptation scheme. By listing the characteristics in this way the overlap between resilient and no regret concepts becomes easier to observe and the major differences appear to be related to low or flexible costs and the emphasis on social acceptability and/or co-benefits.

4. Evaluation of measures

This section first examines two key disaster risk reduction measure that is regarded as enhancing the resilience of urban systems to flooding: early warning and preparedness and property level flood adaptation, first the claims to flood resilience are scrutinized and then the presence or absence of characteristics of no regret adaptation are noted.

4.1 Early warning system and emergency preparedness

Early warning systems do nothing to prevent flooding – they are designed to enhance the coping capacity within the flood event by providing advanced notice of impending flooding. To be useful warning systems need to be backed up by emergency plans and preparedness. Once warned populations can evacuate or take damage prevention actions that will potentially save lives and property but this will be most productive if the actions are known and agreed on in advance. Trained and prepared populations can be highly resilient as demonstrated by the events of December 2013 in England. The coastal surge event that occurred in December 2013 on the East coast of England was of a similar magnitude to the 1953 coastal surge. In contrast to the 1953 event where 307 were killed, in 2013 18,000 people were evacuated in advance of flooding and not one life was lost despite the fact that 2,600 properties were flooded and 6,800 hectares of land were inundated [28]. The reduction in loss and damage caused by the emergency action allows for a faster recovery – not only is there less damage to rectify but the population is in better physical shape to undertake any repairs. Adaptive capacity is also enhanced as the population and the authorities learn lessons from each real or training event in order to tailor warnings and set up better systems in the future. In these multiple ways they improve the resilience of populations to flood events and are widely adopted.

As an adaptive measure flood warning and emergency preparedness does not immediately spring to the fore. However if the concept of no regret is applied to emergency warning and preparedness it appears that it has many useful characteristics as an adaptation measure. Early warning systems are low cost – in relation to many other potential measures and generally have a high cost benefit ratio [29]. Beyond the informational costs of developing the base knowledge and forecasting required to operate the warnings, the cost of setting up the warning system and emergency planning is related to the scale of the area and population to be warned [22]. The major costs of such a protection measure are incurred when mass evacuation takes place, either as a drill or in a real disaster. In this sense cost is proportionate to the real risk and not subject to mal-adaptation because costs are incremental and (apart from drills) will not be implemented if the disaster does not occur. Drills can also be held flexibly and the frequency and scope scaled up and down to suit current levels of risk as they evolve. Therefore the impact of future scenarios on cost benefit ratios is small. Warning and preparedness have side benefits of improving knowledge of risk and social cohesion within prepared areas [30]. The importance of this can vary – in developing regions the training of local people to operate and cooperate with the system can enhance technical capacity that may be useful for other purposes [30,31]. Trust and a feeling of solidarity can be built in developed communities that may enhance civic capacity to participate in other local causes.

4.2 Building codes/ Property level flood protection

Relying on property level protection rather than community defences can be seen as a resilient strategy because it accepts flooding of areas while reducing the damage to property [32]. In this case there is an impact on threshold capacity – if property is adapted then damage to buildings may not occur unless a high magnitude event occurs. Recovery capacity is enhanced due to lower damages. Recovery is also likely to be swifter and can include reconstructing buildings to be more flood resilient than before the flood – thereby having an adaptive nature in the face of a flood event.

In climate adaptation terms property level protection can be seen as no-regrets in several respects. It is worth doing if the property level adaptations are low cost or cost beneficial and not intrusive on the normal functioning of buildings in the non-flood period. There are many adaptations that limit flood damage such as water resistant materials that can be incorporated in new builds or in repair or planned refurbishment at low or no cost. These measures can be seen as no regret because of their cost. Other adaptations have high cost benefit ratios such that uncertainty of future flooding will have little impact on their desirability. Property level protection can be designed to fail gracefully, particularly wet-proofing type adaptations, and can often be removed with minimum cost, particularly barriers and temporary measures. Finally some adaptations may have other benefits such as improving the general standard of buildings, improved air tightness or structural stability that make these desirable buildings enhancing the urban environment. Property level protection is incremental in spatial scale – as risk level changes the areas subject to strict codes can be changed but there will be a need to retrofit existing buildings. Therefore a carefully selected and informed scheme is necessary to maximize the flexibility to future hazard scenarios while minimizing the current cost. When looking from an adaptation perspective it is important to separate out those adaptations that are easy and low cost to retrofit from those that need to be built in at the start [33].

5. Discussion and Conclusions

The linkage and overlap between objectives for disaster risk reduction, sustainable development and climate adaptation is worthy of increased attention and is important because misdirected effort in disaster risk reduction in the short term can have detrimental impacts on adaptation and development in the long run. Within developed economies the policy shift to “living with “water” rather than flood control implicitly reflects this reality and has led to an increase in resilience thinking and increased preference for softer rather than hard engineered flood measures. However it is also important to explicitly examine proposed measures through the language of both disaster and adaptation in order to understand and reconcile the multiple, potentially conflicting, objectives and ensure schemes are sustainable.

Future sustainability of measures can be focused through the extreme precautionary lens of no-regrets adaptation. This approach acknowledges the massive uncertainty of future climate and other risk contributing factors and seeks to minimise the potential for mal-adaptation. The importance of co-benefits is an explicit feature of the no-regrets approach. Resilience concepts bring greater emphasis to risk reduction in the near term and enhancing inherent adaptability of systems. In resilience thinking co-benefits are recognized, often expected or implied but not integral. Two flood resilient management approaches are therefore subjected to evaluation within the context of no regret adaptation. It is apparent that these resilient approaches have many no regret characteristics. These are linked to adaptive capacity and the flexible and incremental nature of measures that seek to reduce vulnerability rather than reduce exposure via threshold raising approaches.

Informed by the concept of no-regret, however, the implementation of measures may be subtly influenced as no-regrets promotes the consideration of a wider range of future scenarios and more explicitly seeks co-benefits either in a development concept or, as this paper argues, in other settings. In the two examples given this could lead to a greater emphasis on training and capacity building for early warning systems and a selection of property level adaptation measures that have the potential to benefit property occupiers and owners in times between floods wither materially or in social or well-being terms. In both cases this could boost social cohesion and community resilience.

References

[1] Lisa, E., Schipper, F., Thomalla, F., Vulturius, G., Johnson, K. & Klein, R. J. T. (2014) Climate change and disaster risk reduction. *Background paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction*, Stockholm Environment Institute: Sweden

[2] Jha A, Lamond J, Bloch R, Bhattacharya N, Lopez A, Papachristodoulou N, Bird A, Proverbs D, Davies J, Barker R (2011) Five Feet High and Rising - Cities and Flooding in the 21st Century. *Policy Research Working Paper 5648.* The World Bank, Washington

[3] Department for International Development (2005) Natural Disaster and Disaster Risk Reduction Measures: A Desk Review of Costs and Benefits. DFID, London

[4] Bruneau M, Chang S, Eguchi R, Lee G, O'Rourke T, Reinhorn A. et al (2003) A framework to quantitatively assess and enhance the seismic resilience of communities. *Earthquake Spectra* 19 (733-752)

[5] White, G. (1945) *Human adjustment to floods: a geographical approach to the flood problem in the United States*. Chicago: University of Chicago.

[6] Siegel, P. B. & Jorgensen, S. (2011) "No-Regrets Approach to Increased Resilience and Climate Change Justice: Toward a Risk-Adjusted Social Protection Floor". *International Conference: "Social Protection for Social Justice"*. Institute of Development Studies, UK.

[7] Turton, D. & Turton, P. (1984) Spontaneous resettlement after drought: An Ethiopian example. *Disasters,* 8**,** 178-189.

[8] Plodinec, M. J. (2009) Definitions of resilience: an analysis. Community and Regional Resilience Institute (CARRI).

[9] Pelling, M. (2003) Social capital, hazards and adaptation strategies for the vulnerable. *Justice in Adaptation to Climate Change. Seminar for Connective Environmental Research.* University of East Anglia.

[10] Tierney, K. & Bruneau, M. (2007) Conceptualizing and Measuring Resilience, A Key to Disaster Loss Reduction. *All-Hazards Preparedness, Response, and Recovery.TR News* 250, 11-17

[11] Gallopin, G. (2006) Linkages between vulnerability, resilience and adaptive capacity. *GLOBAL Environmental Change,* 16**,** 293-303.

[12] DEFRA/ENVIRONMENT AGENCY (2011) Understanding the risks, empowering communities, building resilience – the national flood and coastal erosion risk management strategy for England. Bristol:Environment Agency

[13] Institution of Civil Engineers (2008). Flooding: engineering resilience. London: ICE.

[14] Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., Walker, B., Bengtsson, J., Berkes, F., Colding, J., Danell, K., Falkenmark, M., Gordon, L., Kasperson, R., et al. (2002) Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *Scientific Background Paper on Resilience for the process of The World Summit on Sustainable Development* The Environmental Advisory Council to the Swedish Government.

[15] UN Habitat (2010) The State of African Cities 2010: Governance, Inequality and Urban Land Markets. Nairobi: UN Habitat.

[16] Stanley, E. H. & Fisher, S. G. (1992) Intermittency, disturbance and stability in stream ecosystems. In: Robarts RD, Bothwell ML (eds) *Aquatic ecosystems in semi-arid regions: implications for resource management* Saskatoon, Environment Canada,,

[17] Rosenthal, U., Bezuyen, M., Van Duin, M. & 'T Hart, P. (1998) Flood Response Dynamics: Local Resilience and Administrative Flexibility. *In:* ROSENTHAL, U. & 'T HART, P. (eds.) *Flood Response and Crisis Management in Western Europe.* Springer Berlin Heidelberg.

[18] Nicholls, R. J. & Branson, J. (1998) Coastal Resilience and Planning for an Uncertain Future: An Introduction. *The Geographical Journal,* 164**,** 255-258.

[19] Adger, W. N. (2006) Vulnerability. *Global Environmental Change,* 16**,** 268-281.

[20] De Graaf, R. E. (2008) Reducing flood vulnerability of urban lowland areas. *11th International Conference on Urban Drainage,*. Edinburgh, Scotland, UK.

[21] Adger, W. N., Hughes, T. P., Carl Folke, S., Carpenter, R. & Rockstrom, J. (2005) Social-Ecological Resilience to Coastal Disasters. *Science,* 309.

[22] Jha, A., Lamond, J. & Bloch, R. (2012) *Cities and flooding: a guide to integrated urban flood risk management for the 21st Century,* Washington, GFDRR/World Bank.

[23] Gandy, M. (2004) Rethinking urban metabolism: Water, space and the modern city. *City,* 8**,** 363-379.

[24] Potter, K. (2012) Finding "space for water": crossing concrete policy thresholds in England. . *Making space for the river: governance experiences with multifunctional river flood management in the US and Europe.* London, UK: IWA Publishing.

[25] IPCC 2012. Managing the risk of extreme events and disasters to advance cliamte change adaptation. *In:* FIELD, C. B., V. BARROS, T.F. STOCKER, D. QIN, D.J. DOKKEN, K.L. EBI, M.D. MASTRANDREA, K.J. MACH, G.-K. PLATTNER, S.K. ALLEN, M. TIGNOR, AND P.M. MIDGLEY (ed.) *Special report of Working Groups I and II of THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE.* Cambridge, UK, and New York, NY, USA,: Cambridge University Press.

[26] Wilby RL, Dessai S (2010) Robust adaptation to climate change. *Weather* 65 (7):180-185

[27] Ranger, N. & Garbett-shiels, S.-L. (2011) How can decision-makers in developing countries incorporate uncertainty about future climate risks into existing planning and policymaking processes? London: Centre for Climate Change Economics and Policy, Grantham Research Institute on Climate Change and the Environment, World Resources Report.

[28] Beardall, C. (2014) Review of the impact of the East Coast Tidal Surge 5/6 December 2013. *Suffolk Coast Forum*

[29] United Nations (2006) Global Survey of Early Warning Systems. UN.

[30] Phaiju, A., Bej, D., Pokharel, S. & Dons, U. (2010) Establishing Community Based Early Warning System Practitioers handbook. Lalitpur, Napal: Mercy Corps.

[31] Neussner, O. (2009) Local Flood Early Warning Systems - Experiences from the Philippines (Manual). Tacloban, Phillipines: Technische Zusammenarbeit (GTZ) GmbH.

[32] Joseph, R., Lamond, J., Proverbs, D. & Wassell, P. 2011. An analysis of the costs of resilient reinstatement of flood affected properties: a case study of the 2009 flood event in Cockermouth. *Structural Survey*, 29**,** 279 - 293.

[33] BACA Architects, UEA, UWE, Sweett Group, Lanpro, Serruys Property (2013) *Climate Adaptive Neighbourhoods (CAN) Final Report*, London, UK: Technology Strategy Board.

A DYNAMIC MASTER PLAN FOR THE 21ST CENTURY
A Paradigm Shift within the Eastern European Urban Planning System

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Abstract

Urban development has become less predictable and more difficult to manage today. Hence, strategic planning needs a thorough change in attitude: first, it needs to change its ways of analyzing urban phenomena, and second, it needs to change its ways in managing them. These two major changes result in a need for flexible regulations for an efficient urban development. The team working for the Dynamic Master Plan for Bucharest has constructed a methodology based on insights gained form complex system theory, self-organization and scenario building techniques. This approach has a structure governed by four overlapping fields: the field of urban planning, encompassing urban functions and urban structures; the field of spatial data analysis; the structural field, comprising urban development goals and collaborative planning techniques, and fourth, the operational field, which includes the management of urban development opportunities.

Keywords: Urban Transformation, Flexible Planning, Dynamic Spiral of Urban Development.

1. Introduction

We understand the city as a complex system [1]. Simply put, complexity arises from multiple combinations between relations, emerging among the system and its subsystems. Such combinations are further complicated, within the field of urban planning by the institutional reality they are embedded in.

Nonetheless, there are four basic principles that we can use to grasp such complex systems: the principle of hierarchy, the principle of functional specialisation, as well as two further related principles, i.e. the principle of compatibility and the principle of incompatibility. All four principles become visible in a given territory.

2. Theoretical Framework

Thus, within the same urban structure, we can observe different degrees of complexity [2]. These different degrees of complexity are more easily explained, if we imagine the dynamics of complexity in geometrical terms. First, let us consider a two-dimensional representation of complexity dynamics, as they appear in Figure 1: we can observe that two different degrees of complexity can be explained using the concepts of evolution and governance. Thus, evolution implies a rise in complexity, whereas governance implies a decrease in complexity. Along its path, the process of evolution passes through four consecutive stages: an initial development among the relations within the system, which is followed by a functional specialisation of the system’s elements. These two initial stages result in a free hierarchy formation, which eventually crystallises in a form of meta-organisation. It is here that the system reaches an increased level of complexity. After this particular point, governance sets in, and the complexity starts to decrease. The initial phase is one of organisation, which is followed by a confinement of the system’s degrees of freedom. After these degrees of freedom have been constrained, the system enters a phase of vulnerability control. Finally, the vulnerability control results in a set of governance rules, which push the system into a different state, this time with a reduced degree of complexity.

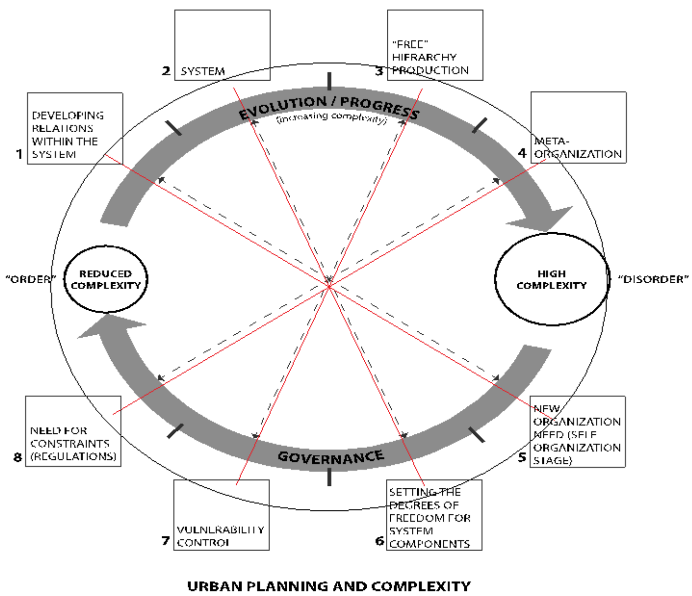

Figure 1: Urban Systems and Complexity.

Two points need stressing at this time: first, that each stage belonging to either process, has a corresponding stage within the other process; second, that after the process of governance has run its course, the resulting level of complexity is not identical to the initial point of departure.

To illustrate this latter point, let us take a look at Figure 2: Here, we have transformed the initial circle into a wave-like pattern. This second drawing has certain advantages: It displays the difference between different levels of complexity in relation to time, and it charts the continuous, ascending character of the urban development path. What we are interested in this second illustration is the lower limit of the development path. This lower limit is set within the urban planning process, which constantly needs adapting to the wave-like pattern of urban development.

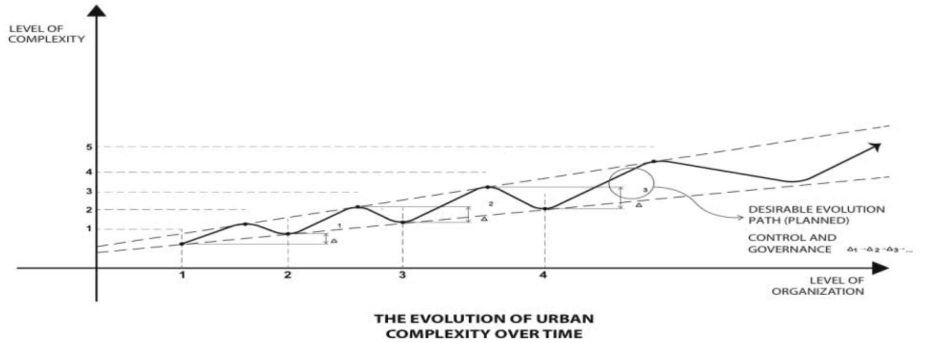

Figure 2: The Evolution of Urban Complexity over Time.

If, however, we are to translate this second illustration into three-dimensional space, we arrive at Figure 3.

The wave-like pattern has now become a spiral, which is bordered on the left hand side by governance and on the right hand side by the limits to the process of evolution. Thus, we can set two sets of priorities, each corresponding to a border. First, there is a set of priorities relating to the field of information technologies (IT) and urban planning. The IT field includes the correlation between the developing relations within the system and the need for organisation, while the urban planning field correlates the functional specialisation of the various elements within the system to their corresponding degrees of freedom. Somewhat symmetrical, the policy field controls the relation between hierarchy and controlling vulnerability, while the administrative field oversees the relation between the emerging meta-organisation and the need for rules.

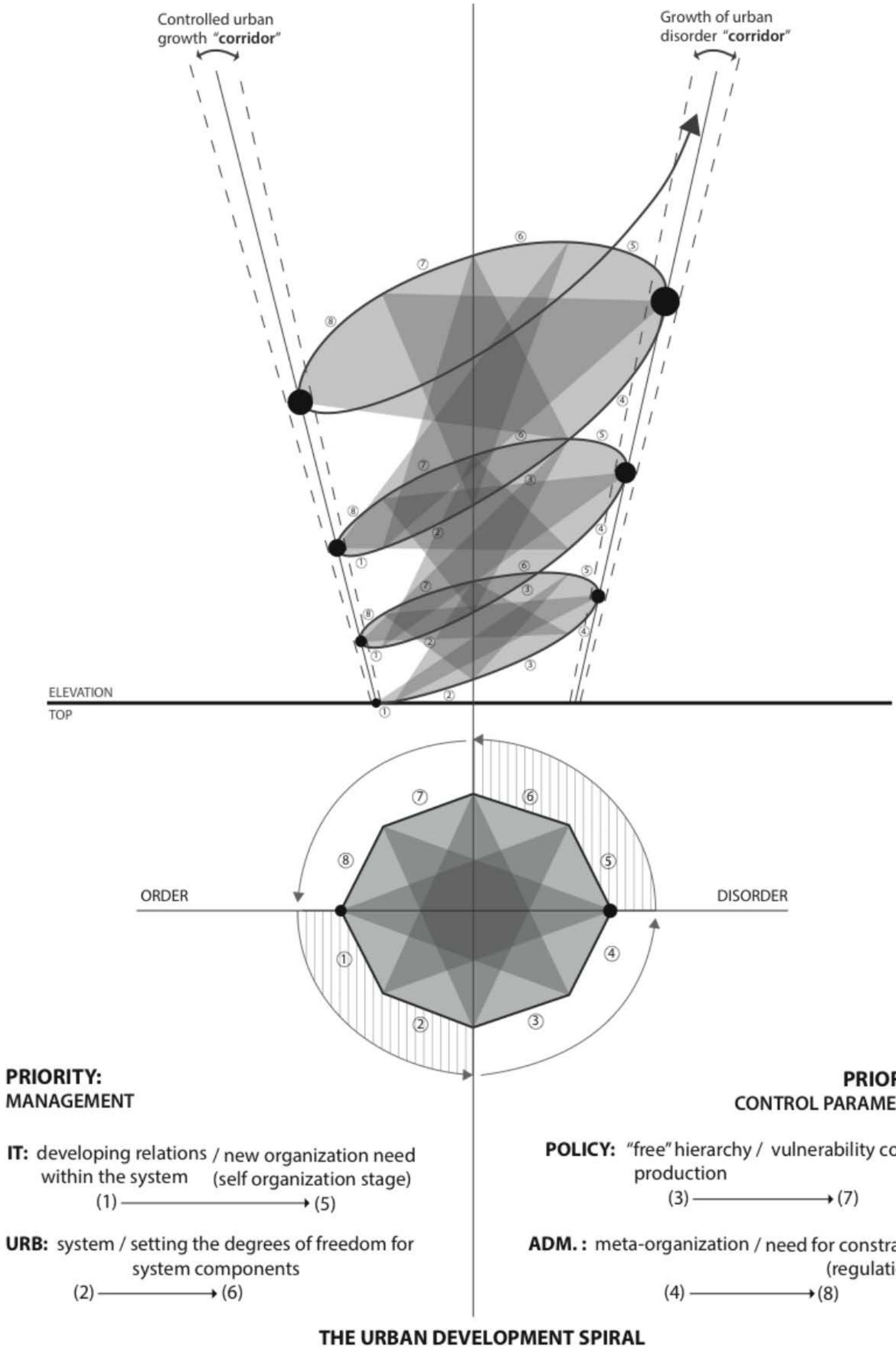

Figure 3: The Urban Development Spiral.

Graphically, these four sets of priorities produce certain overlaps. These overlaps are precisely the different degrees of complexity that spring up across the urban structure.

3. Methodology

In the context of current urban development, the field of urban planning has to deal with an accelerated development, which becomes increasingly harder to predict, but not impossible to manage. Given the complexity of the urban phenomenon, methods employed in strategic planning, such as forecasting and adjustment techniques, need constant adjustment [3].

Figure 4 shows the four overlapping elements, which we find essential for this adaptation:

- The field of urban planning, characterised by urban structure and urban functions or amenities;
- The field of IT management of geospatial data (GIS), characterised by the structure of the database structure and its associated functions;
- The structural field, containing elements relating to the field of urban planning and to the field of modern planning and management instruments. The former category includes urban objectives, regulations, co-operation between urban actors, etc., while the latter is centred around standardized data models, intra- and inter-institutionalised co-operation regulatory frameworks. Both categories serve to guarantee an effective security for urban development;
- The functional field, containing functions and their associated actions, which contribute to urban development. These include opportunity management techniques, foreseeing and safeguarding future development corridors within the city, as well as prioritising regulations and interventions. Furthermore, this field encompasses the GIS maintenance programme.

To date, GIS assisted urban planning practices have proved to be effective in monitoring and guiding urban development.

The overlap between the structural and the functional fields, which characterizes GIS applications, ensures dynamic data management. This, in turn, leads to a new concept, which we have called a dynamic GIS**.**

Furthermore, the integration between the structural and functional fields, along with adaptable regulations, have the potential to trigger a paradigm shift for the 21st century, which we believe is the dynamic urbanism. This new type of urbanism is entirely evolutionary and adaptable in nature.

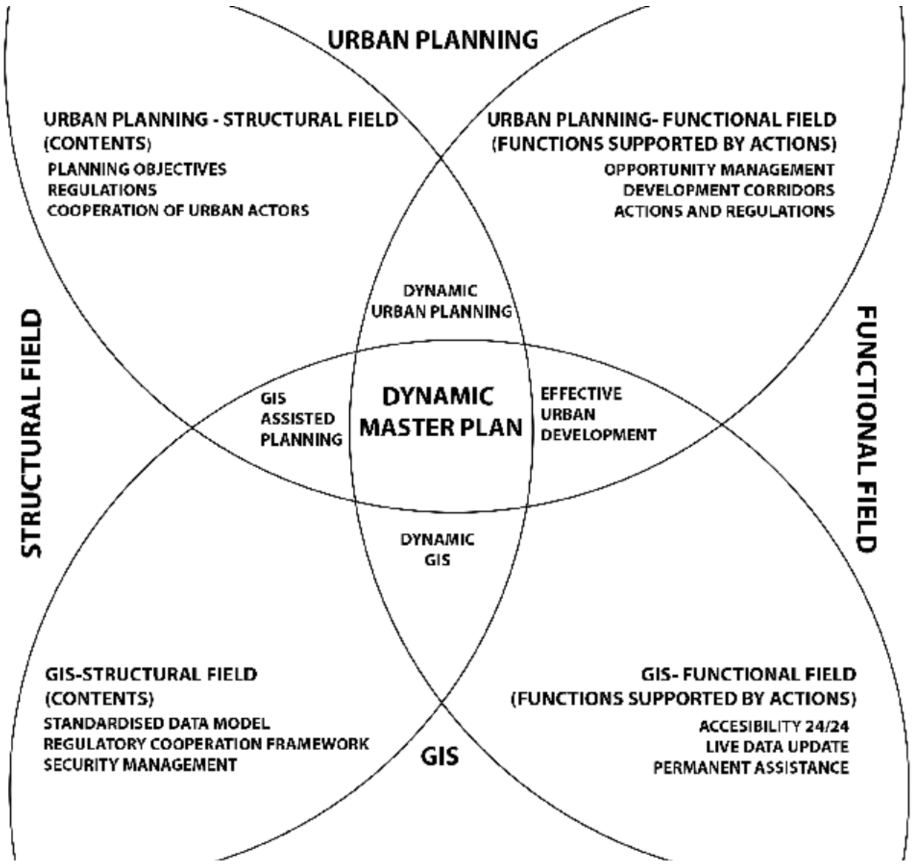

Figure 4: The Dynamic Master Plan.

By combining the dynamic GIS approach with the dynamic urbanism paradigm, we intend to present, for the first time, a methodological approach of an urban planning documentation having an innovative character. Its innovative character lies in its operational nature, within the context of the current legislation. At the same time, it serves as a platform for future optimisations in the fields of legislation, urban administration and planning practices [4].

4. The New Dynamic Master Plan

4.1 A Matter of Identity

The new type of Dynamic Master Plan is deeply embedded within the context of its municipality. It is therefore dependent on each municipality's historical development path and on its specific planning history. More precisely, the Dynamic Master Plan takes into consideration the evolution within the urban structure, but concentrates upon particularities resulting from interrupted development paths. Translated into spatial terms, fractured development paths become highly visible in the fabric of districts. Districts are powerful as planning units, as they embody the collective memory of their inhabitants. Furthermore, they have recorded the entire history of socialist planning, leading to the major challenges faced today.

In short, districts incorporate certain traits of permanence, related to the urban transition of the 1950s, when cities became mono-centric and largely mono-functional. This was a period of extensive growth, when urban historical development was largely neglected. It was also the period when most districts were formed, thus shaping the current image of Romanian cities.

After the fall of the communist regime, their character was altered by the newly imported concept of the shopping mall. It had a somewhat perverse effect on public space, as it marketed private space as belonging to the city's network of public spaces. What is even more peculiar is that this sort of appropriation gained widespread public acceptance and support.

This privatisation of public space was accompanied by an administrative neglect of the built environment and the urban fabric, which began corroding the quality of public space as well.

Hence, the subject matter on which dynamic master plans operate is a distinctively varied one.

4.2 Objectives and Their Implementation

The Dynamic Master plan aims to become a regulatory and management instrument for urban transformation. Its main focus is to define a series of reasonable objectives, to be measured, monitored and controlled afterwards.

In this way, we can determine the bounding limits of the desired development corridors, as well as the tolerable limits of urban "disorder" (*cf.* Figure 3). The series of objectives should also permit to determine the flexibility level for elements related to the urban life, during the planned development stages.

The Dynamic Master Plan, with synergetic benefits from the GIS system, has the capacity to make use of the instrumental and operational objectives in two different ways:

- Generating a management and evaluation system, together with the GIS system, which can guarantee basic monitoring, with the help of performance indicators describing the present state of urban development This basic monitoring makes the correct evaluation of the current state into the objectives' implementation possible;
- Generating a coherent and clear plan for implementation, which connects objectives, to programmes, to actors, to resources, and to implementation stages.

The Dynamic Master Plan thus aims to structure, under the umbrella of an interactive IT platform, the way these correlations are made during the implementation process. This entails a platform where each objective is linked to specific programmes, and where the main actors involved in the development are mentioned. The same platform contains all the different stages of the implementation process, in relation to their priorities and their financial, human, instrumental resources.

4.3 The Dynamic Master Plan as an Operational Instrument

The Dynamic Master Plan concept, compared to other previous Master Plans, which were developed and implemented in the traditional system, benefits from the power of evaluation and analysis, conferred to it by the GIS system. Therefore, the new Dynamic Master Plan concept is oriented towards the integration of all urban interventions, in various areas of the city, through analysis, monitoring, evaluation and constant regulatory calibration. Moreover, the GIS system introduces the capacity of evaluating simultaneous urban development scenarios, by comparing them with the Dynamic Master Plan regulations and their effects.

In addition, the Dynamic Master Plan becomes a model of urban development approach at the national level too, thus making the transition from static and reactive programming to a more dynamic, proactive one, which is connected to international trends.

The Dynamic Master Plan will also create a valuable offer of programmes and projects for every city, followed up by the necessary information for their implementation, therefore easing foreign investments, which create the premise for economic development.

Both private—public partnerships, as well as private or public investments will find within the Dynamic Master Plan the necessary funding support, continuous implementation assistance for projects and reduced execution times.

4.4 Regulations

The Dynamic Master Plan puts forward three degrees of regulations, applicable to three different types of urban areas:

- Firm regulations are destined for consolidated or representative areas within the city. They imply fixed samples of amenities and flexible urban and qualitative indicators. Their specific values are allocated to different ranges, which are later used for benchmarking purposes;
- Flexible or adaptable regulations apply to urban areas containing mixed amenities. They work with classes of amenities that receive different weights, as well as a maximal and minimal value. Within this type of regulations, the urban indicators are flexible;
- Strategic guidelines apply to deeply disorganised areas, which undergo processes of development. They work with preset amenities, determined by the specific character of each area. In contrast to the previous types of regulations, strategic guidelines work with global indicators.

In order to be in a permanent connection with the urban, economic and social development, the Dynamic Master Plan will be updated and recalibrated in two manners:

- First, by permanently updating the GIS database with all interventions within the city's confines;
- Second, by monitoring the state of development within the three types of areas and subsequently reincorporating them into a superior regulation level.

We consider these three types of regulations to be in stark contrast with current planning practices in Eastern Europe, which are still caught between a relatively rigid planning process and an uncontrollable urban development.

4.5 Simultaneous Scenarios for Development

The Dynamic Master Plan concept can become one of the factors that can determine economic growth in cities, by increasing their appeal as attractive areas for economic activities, employment and investments. We have to take into account the fact that a city's needs and expectations, particularly those related to economic development, are constantly changing.

Therefore, the Dynamic Master Plan must have the potential to continuously adapt, not only to present city's requirements and needs, but also to those that will occur during execution and validity period. Thus, the proposed master plan is a dynamic one, taking into account valuable economic initiatives for the betterment of the society.

The dynamic aspect implies determinations and regulations, so that the city's economic development is built on several simultaneous management scenarios, which can respond to new realities and requirements. This character is highly relevant in our present recession times, where the need for innovative and alternative solutions becomes crucial, in order to induce dynamism and, as a consequence, employment opportunities on an international scale.

The proposed economic development strategy can respond to present and future challenges, because:

- It continues to promote and stimulate the location of strategic economic activities, such as advanced services for financial businesses. However, they need more consistency and coherent implementation across the municipality, at the same time encouraging competitive and productive activity;
- It capitalises urban land in undeveloped areas for future productive activities for which their location, dimension and functionality is attractive for investments;

- It puts forward a polycentric city with spatial coherence and with diversified productive activities.

By simultaneous and alternative development scenarios, as well as by the diversity of proposed economic activities corresponding to different demands, the Dynamic Master Plan posits maximum urban diversity, as well as urban interventions, which lead to economic development for each scenario:

- Conversion of unstructured urban spaces into places housing productive, integrated and sustainable activities;
- Rehabilitation of present uncompetitive productive activities, by proposing a new urban development model, in accordance with new urban amenities;
- Re-location of new productive activities in order to stimulate development of innovation sectors;
- Spaces for research and creative activities, related to academic and cultural spaces;
- Spaces for activities related to continuous professional formation, in partnership with universities and research centres;
- Spaces destined for technological activities and logistics, sectors which underdeveloped within the Romanian economy and which pertain to the innovative features of cities;
- Promoting activities related to urban centrality, for example cultural tourism; historical and architectural values are representative and attractive for prestigious corporations that relocate in central areas;
- Consolidation of public works sector and the re-orientation of construction activities towards emergent sectors, encompassing sustainable rehabilitation and consequent stimulation of headquarters re-location;
- Co-existence of various commercial typologies; this “commercial biodiversity” provides free market access for consumers;
- Planning for urban development, by taking into account mechanisms and legal instruments that state the implementation of strategies proposed by the Dynamic Master Plan;
- Establishing the intervention strategy of the Dynamic Master Plan, via flexible programmes, in order to revitalise and consolidate the economic activity within the city, as well as to promote the location of new industries, as a mechanism that generates bigger opportunities for economic development and labour supply;

- Proposes a normative model to guide the implementation of the legal framework. This model is structured as a regulation system for building approval; the model defines flexible clauses and establishes new superior development limits, referring to urban indicators;
- Decision making processes for various developments alternatives and economic development scenarios, which are calibrated in accordance to public interest;
- Defining a new performance indicators system, which evaluates the decision process, by constantly comparing it to the limits established by the Dynamic Master Plan.

4.6 The Question of Urban Resilience

The new Master Plan for Bucharest will be the first Romanian master plan to explicitly tackle the issue of resilience. This is a rather daunting task, as there is still no satisfactory theory of urban resilience [5]. Hence, we have approached the matter differently, employing a planning practice perspective.

We took the following definition as our starting point: Resilience denotes the capacity of a system, in our case the city, to undergo change when facing an external challenge, while still retaining its basic functions and its main structure [6]. In principle, such a system would have the following set of attributes, which seem to be coherent and consistent with our experience [6]:

- Transformability, which simply means that the urban system can adapt to a different development path after being struck by crisis;
- Adaptability, i.e. the ability of society to maintain its development options after being diverted towards a different development path, can be viewed as a complementary quality of transformability;
- Robustness, in the sense of withstanding a given amount of stress, without experiencing major degradation and loss of basic functions. At first sight, this quality overlaps the earlier definition of resilience. However, we believe that robustness is linked more to crisis management practices than to the urban fabric itself, albeit with some notable exceptions, such as strategic infrastructures;
- The speed of recovery largely determines the level of robustness of the overall system. This is again a crisis management attribute, as it is basically the speed of which basic functions can be restored. It therefore relates to the ability of the system to recover from disturbances;

- The speed of recovery is dependent, in turn, upon the degree of connectivity, both physical and organisational. Connectivity is an interesting quality in itself, because it links the architecture of the urban system to its sensitivity to vulnerabilities.

Although conceptually fairly straightforward, all the attributes listed above are difficult to translate directly into practice. First, this is because most of them relate both to management practices and to the city fabric itself. And second, because they require heavy modelling, in order to become operational.

Furthermore, the behaviour of the urban system might be utterly different when dealing with various natural, as opposed to preventing and recovering from man-made disasters.

Nonetheless, there are some features that make Bucharest interesting as a case study for resilient planning. First, it is one of the densest cities in Europe, displaying a highly mono-centric profile. Second, it is highly prone to earthquakes, as it was impacted by no less than four major earthquakes over the past two hundred years.

Thus, on average, Bucharest is hit by magnitude 6 earthquakes roughly every decade, by magnitude 7 earthquakes every thirty years or so, and by magnitude 7.5 earthquakes, or above, every eighty years. As a point of reference, the latest major earthquake of 7.1 M_w in magnitude struck on the 30th of August 1986, even though a more devastating one, of 7.2 M_w in magnitude, happened in 1977, which ended with a recorded death toll of 1,578 dead and 11,300 wounded. It severely damaged the urban fabric and produced construction hazards that still exist today.

On the other hand, except for the bombings during Second World War, Bucharest did not experience any major man-made disasters.

From an planning perspective however, Romanian planning practices are currently ill prepared to deal with hazards and disasters of either sort. For example, building ordinances have changed, as a result of the 1977 earthquake, but the poor construction quality, especially after the fall of the socialist regime in 1989, largely offset the gains resulting from these redesigned ordinances.

In contrast, zoning ordinances do not even tackle the issue of resilience. This state of affairs is not particularly new, as they did not address matters related to resilience during the socialist period either, except when applied to grand infrastructure projects, such as the underground.

So, there is little background support we can rely on. Within such a context, we have decided to refashion existing planning tools from a resilience perspective. There are basically two fields within which we can put these tools to good use: first, within the field of ecological reconstruction, and second, within the field of urban regulations.

In the first stance, we have decided to work with a system of spatial environmental goals [7], which then translate into environmental audits [8]. This approach is new for Romanian planning practices, but it has shown promise within German planning.

In the second stance, we are striving to link the three-tiered regulation model to existing assessment models currently in practice, in an effort to obtain functional scenarios. The World Bank has generously supported us in this endeavour, by sharing their expertise in urban development, mobility and emissions modelling.

There would be a third avenue for action, albeit somewhat indirect. Reviewing past developments across Bucharest and perusing the dedicated literature [9], [10], [11], [12], we have developed a keen interest in developing a setting for sustainable urban design. However, the regulatory nature of the Master Plan prevents us from delving deep into the field of urban design. Nonetheless, we strive to imbue all three regulation tiers with design oriented provisions, in the hope that they will take hold, and eventually change Romanian planning culture.

Essentially, what we are trying to do is to engender a marked shift within the Bucharest planning perspective. Up until now, investor dominance has impacted negatively both on the quality of urban spaces and on the diversity of urban ecosystems. Little has been done to improve this state of affairs. Thus, if successful, the New Master Plan will be the first operational framework for introducing resilience oriented urban policies.

5. Conclusions

The methodology for the new Dynamic Master Plan is the product of an international interdisciplinary team, composed of urban planners, architects, economists, traffic and environmental engineers, as well as IT specialists. Their expertise includes major projects, spanning from Europe to Asia and from Australia to the United States.

In addition, the methodology for the Dynamic Master Plan has been optimized for its use within the municipality, by constructing the following Institutional co-operation mechanism (*cf.* Figure 5) [13]: during the ‘evolution’ process, as explained in Figure 3, planners and developers work together in producing new proposals. The proposals are evaluated and then monitored by planning professionals within the municipality, with the aid of IT professionals.

In addition, the municipality works on its own strategies and policies, relying on public participation methods. At this point, the Dynamic Master Plan offers a place-based dimension, necessary for coherent policy packages.

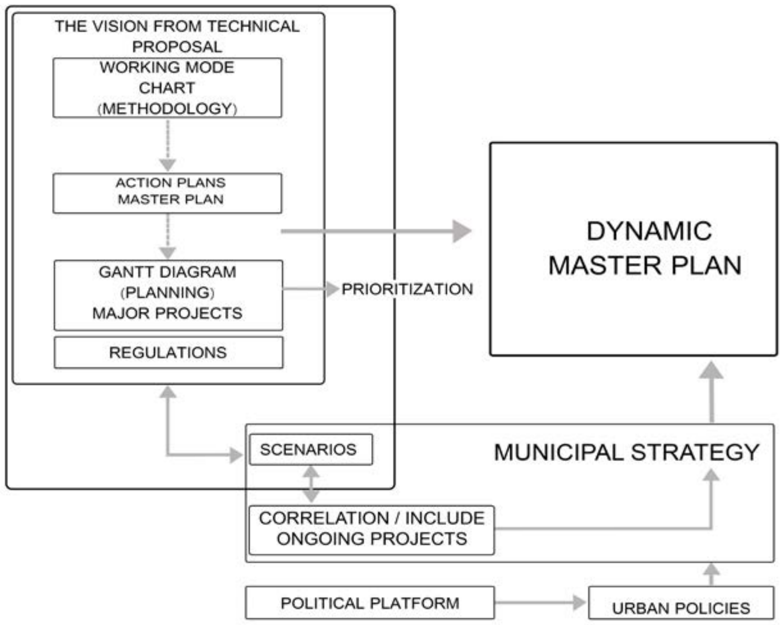

Figure 5: The Institutional Co-operation Mechanism.

Thus, the proposed model of a Dynamic Master Plan adapts its proposals and measures to the real time evolution within the territory, by the continuous update of the IT product. Furthermore, the model addresses urban management by adaptive tools, their hierarchy being established by importance, by municipal priority and by degree of intervention:

- Measures and regulations dedicated to common management;
- Measures and regulations dedicated to necessary urban interventions;
- Measures and regulations dedicated to possible major urban interventions that can occur in future.

Management and control tools are designated for the enhancement of actual urban practices, by introducing new urban management tools, based on simultaneous development scenarios, which are continuously correlated with prescriptions within Local Regulations.

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References

1. P. M. Allen, *Cities and Regions as Self-Organizing Systems Models of Complexity,* Taylor and Francis, London (1996).
2. V. Dumitraşcu, *Surâsul haosului. Managementul sistemelor hipercomplexe* [Hyper complex Systems Management], Sedcom Libris, Iași (2010).
3. S. Albeverio, D. Audrey, P. Giordano and A. Vancheri (eds.), *The Dynamics of Complex Urban Systems. An Interdisciplinary Approach,* Physica–Verlag, Heidelberg (2008).
4. 'Ion Mincu' University of Architecture and Urban Planning (UAUIM), *Bucharest Dynamic Master Plan. Technical Proposal,* Bucharest (2012) (unpublished).
5. Eraydin, A. and Tașan-Kok, T., *Introduction: Resilience Thinking in Urban Planning,* in A. Eraydin and Tașan-Kok, T. (eds.), *Resilience Thinking in Urban Planning,* Springer, Dordrecht (2013), pp. 1-16.
6. Tașan-Kok, T., Stead, D. and Lu, P., *Conceptual Overview of Resilience: History and Context,* in A. Eraydin and Tașan-Kok, T. (eds.), *Resilience Thinking in Urban Planning,* Springer, Dordrecht (2013), pp. 39-52.
7. W. Kieslich and H.-P. Neumeyer, *Räumliche Umweltziele,* Dortmunder Vertrieb für Bau- und Planungsliteratur, Dortmund (2000).
8. H. Kanning, *Umweltbilanzen,* Dortmunder Vertrieb für Bau- und Planungsliteratur, Dortmund (2001).
9. A. Washburn, *The Nature of Urban Design. A New York Perspective on Resilience,* Island Press, Washington, D.C. (2013).
10. H. Ernstson, S. E. van der Leeuw, C. L. Redman, D. J. Meffert, G. Davis, C. Alfsen and T. Elmqvist, *Urban Transitions: On Urban Resilience and Human-Dominated Ecosystems,* in ***AMBIO: A Journal of the Human Environment,*** 39(8), pp. 531-545 (2010).
11. R. Leichenko, *Climate Change and Urban Resilience,* in ***Current Opinion in Environmental Sustainability***, 3, pp. 164-168 (2011).
12. J. Bengtsson, P. Angelstam, T. Elmqvist, U. Emanuelsson, C. Folke, M. Ihse, F. Moberg and M. Nyström, *Reserves, Resilience and Dynamic Landscapes,* in ***AMBIO: A Journal of the Human Environment,*** 32(6), pp. 531-545 (2003).
13. M. Röber, *Auf dem Weg von "New Public Management" zu "Good Urban and Regional Governance"*, in H. Sinning (ed.), *Stadmanagement. Strategien zur Modernisierung der Stadt(-Region),* Dorothea Rohn, Dortmund (2007).

Structural methods for multi-hazard risk reduction in protected central areas of cities

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Abstract

Bucharest, the capital of Romania, is one of the European cities with a vast protected central area particularly exposed to earthquakes. In our approach, the architectural and urban strategies for patrimony protection, as well as for structural and non-structural management, are based on the ratio of built space qualities, as reported value (cultural, functional and community perception) in relation to the vulnerability. These strategies are structured as on emergency term and perspective. Long-term interventions are considered as maintenance, improvement and transformation. Depending on vulnerability from the risk scenarios, the emergency management proposal identifies those places that may become security centers.

Keywords: Protected areas, multi-hazard risk reduction, risk scenarios

1. General worldwide requirements for risk reduction within the concept of resilient cities

The resilience at global, national and settlements level, is not a quite recent term, since within the UN-ISDR Hyogo Framework for Action 2005-2015 [1], resilience was already defined as: “The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (http://www.unisdr.org/we/inform/terminology). The Sendai Framework for Disaster Risk Reduction 2015-2030 [2], reiterated the states commitment to disaster risk reduction and the building of resilience to disasters to be addressed with a renewed sense of urgency in the context of sustainable development. The need to be integrated into policies, plans, programmes, and budgets at all levels and considered within relevant frameworks was pointed out again.

The identified gaps indicate a need to develop an action-oriented framework implemented at all levels by relevant stakeholders, especially to identify disaster risks to be managed and guides investment to improve resilience. Although the concepts are widely accepted, the need of practical instruments and case studies is obvious.

The Sendai Framework 2015-2030 requires a focused action at local, national, regional and global levels in four priority areas:

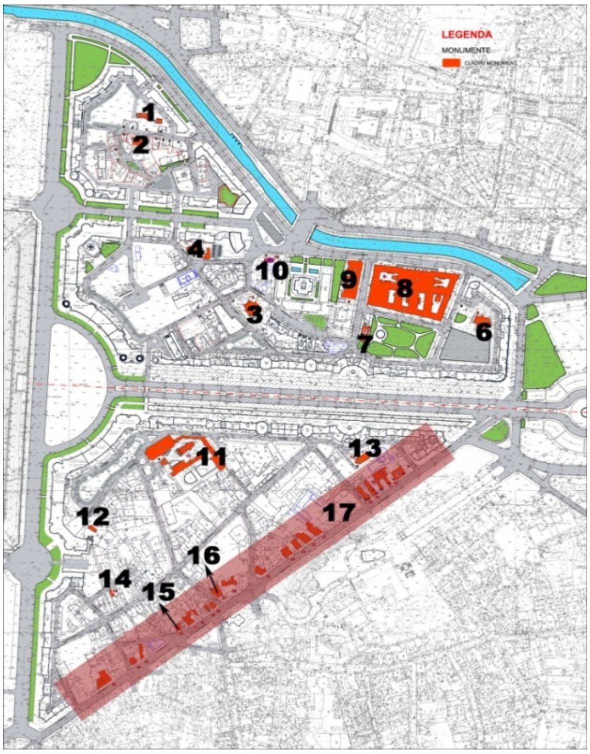
1. Understanding disaster risk;
2. Strengthening disaster risk governance to manage disaster risk;
3. Investing in disaster risk reduction for resilience;
4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction.

From this perspective, the priority 3 is related to structural and non-structural measures, while the priority 4 is related also to addressing disaster-induced human mobility to strengthen the resilience of affected people and that of host communities as per national laws and circumstances.

Romania is prone to strong and damaging earthquakes, and Bucharest suffered large losses, as it was in March 4, 1977, reported in Balan et al [3]. Later on, a large area of this city sufferedd a demolition followed by a large scale reconstruction, similar to other totaliarian and communist regimes (more than 450 ha), pretending to be a kind of structural post disaster intervention, but in fact being an attempt to change by force the historical living pattern and community memory. This paper intends to present goals and objectives of the Romanian project for multi-hazard risk reduction in a Bucharest protected area, in conjunction with the recovery of the patrimony patterns, whose results intend to fit the ISDR Hyogo and Sendai Frameworks priorities.

2. Built area exposed to multi-hazard, vulnerability and risk in Bucharest protected area

Some issues and results of the Project URBASRISK - "Urban Blocks in Central Protected Area in Multiple Hazard Approach - Assessment, Mapping and Strategies for Risk Mitigation. Case Study: Bucharest Destructured Zone by Razing Occuring in the Communist Period was presented elsewhere, as in Florescu et al [4], Georgescu et al [5, 6], Gociman et al [7, 8], [9]. The studied area is located in Bucharest in front of the Parliament, along Bd. Unirii, towards Unirii Square, limited by Regina Maria at South and Dambovita River at North. The local geology is of a former meadow and marsh of Dambovita River, drained in the XIX-th Century, thus, the water table is rather high. After the political changes at the end of 1989's, the area was proposed as protected area, but in fact there is under urban stagnation and decay. A protected area are natural or constructed area which contain natural or cultural heritage is under the requirements provided by the Law No. 5/2000 of National Teritory Planning [12] and Law of Historic Monuments Protection No. 422 /2001 [13].



1•The Assembly of Mihai-Vodă Monastery of 17th Century, No.4, Strada Sapientei nr.4, moved from Dealul Mihai Vodă; The Church"Sf. Ierarh Nicolae" (St. Nicholas) - Mihai Vodă, Strada Sapienţei nr.4;

2• The "Assumption of Mary" Church – Strada Sapienţei nr.5;

3• "Oprea Soare" House, Strada Apolodor nr.1, 1914, Architect Petre Antonescu

4•Assembly of the Church "Sf. Apostoli" (The Apostles), Strada Sfinţii Apostoli nr.1; Parochial House 16th – 20th Centuries; •Foundations of the Tarnovului Monastery 16th Century;

6• The "Înălţarea Domnului" (The Exaltation) Domniţa Bălaş

7•Residential building – Prof. Dr. Marinescu, Strada Danielopol Gheorghe nr.3, first half of the 20th Century

8•Palace of Justice Splaiul Independenţei nr.1,1927; Architect Ion Mincu - Andrei Ballu.

Figure 1: Historical monuments in the area of study

9• High Court of Justice, Splaiul Independentei nr.5

10• the Church "Sf. Spiridon"

11•Group of the Antim Monastery, 29, Strada mitropolit Ivireanu Antim: The Church "Toţi Sfinţii" (All Saints), 1714; Chapel, 1715;Shrines; Kitchen,1715;Bell Tower, 19th Century;

12• Schitul Maicilor (Nuns Skete)

13•The Church "Sf. Ilie" (St. Elias"– Rahova, 79, Strada Silvestru Constantin (1838)

14•House no. 12A, Strada Gladiolelor; House no. 12, Strada Gladiolelor; beginning of the 20th Century;

15•House no.15, Strada Poiana Florilor; 19th Century;

16•House no. 36, Strada Justitiei.

17•Group of homes on Maria Boulevard

It is obvious that the real estate pressure is acting randomly, many buildings are left without maintenance and the major and minor architectural heritage is under a threat of gradual decay. Exampples of heritage buildings are given in figures 2 and 3. Although the hopes were towards the positive impact of regaining private property Cartier et al [10], the market principles do not act in favor of keeping a community memory, while the possible impact of an earthquake may lead to a total loss.

Figure 2 Church "Sf. Ierarh Nicolae" Mihai Voda sec.XVI

Figure 3 House Oprea Soare-Arch. Petre Antonescu -1914

In accordance with zonal urban plan of Bucharest, in the site of the protected area in study there are 4 such zones: zone no. 76 (monuments 1-2), zone no. 90 (monuments 3-10), zone no. 86 (monuments 11-14), zone no. 9 (monuments 15-17) which remain in back of big blocks flats or institution of new axis of communist regime urban planning.

Because the destructured fabric of the protected area needs of special care, in case of post-earthquake intervention, and much-more in case of multi-hazard impact, it is very difficult to set the target of reconstruction as in usual situations. Thus, the chosen approaches must observe the regulations, but be sufficiently accessible both to owners and public institutions.

3. Methodology

Given the inter- and trans-disciplinary character of the project, the stages were determined by referring to the following relevant aspects: the potential of multi-hazard at the site, evaluation of the urban tissue, existing habitat, architectural heritage of the towns - significance and vulnerability value and the changes of paradigms, from the intervention per built object to the radical one, of urban remodelling or recovery that are to be taken into account in each subfield, in correlation with the level of development, in order to choose the approaches applicable in the territory.

4. Risk analysis

4.1 Multihazard assesments

Geological scenario hazards are: seismic hazard from intermediate Vrancea source, in two alternatives, as intensity VIII (as in March 4, 1977; Balan et al [3], Sandi et al [11] and VIII ½ (in order to take into account the cumulative vulnerability); local soil hazards, as liquefaction and/or settlements of foundations.

Climatic and hydrologic hazard: high differences in temperature (- 30ºC in winter, +40ºC in summer); wind, urban vortex-tornado, raising water; rain and excess water floods, snow, snow-storm, frost; thunderstorm; flooding from the accidents outside the study area, as the break of a water control and supply lake under heavy rain with lack of gates control.

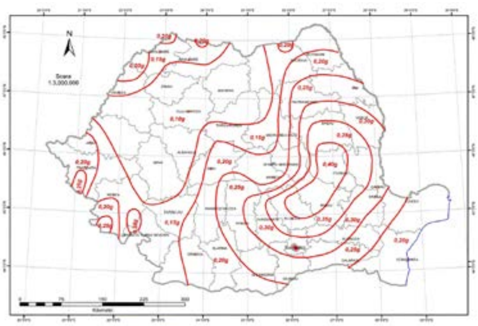


Figure 4: Romania – Seismic zonation for design of buildings; Peak Ground Acceleration for Mean Recurrence Interval of 225 years and 20% exceedance probability in 50 years (Code P100-1/2013, MDRAP, 2012)

Man-made hazards: explosions with chemical release, under Seveso Directive in the city, reaching the protected area; moderate spilling of ammoniac NH_3; explosions in the gas network or in houses, or moderate LPG recipients etc; manifestation, strikes; terrorist attack on the public institutions, with impact upon the neighboring communities.
Hazard by urban fire are from houses and other buildings, with propagation and combination with other hazards.

Combined anthropic hazards – Na-tech are a successive developed events like earthquake, explosion, fire and floods caused by failure of Dambovita river dam. Only few of these hazards were detailed in the study, especially those with higher presumable impact, depending also on available data.

4.2 Exposed risk elements assessments

4.2.1 Built space - cultural value analysis

In this research, the concept of cultural value has been amplified by detailing the scoring criteria and methods. Starting from the 6 stages of value from the Monuments Law 422/2001, I considered an approach synchronous with them is required and is also suggested 6 evaluation stages. This concept of cultural value has been enhanced in this research theme by 13 criteria details and grading artistic, architectural, urbanistic, functional, structural, technical execution, decorative, furnishing conception, local, religious, ethnical, seniority, historical, political or memorial references. The authors believe in a synchronous approach and therefore, six evaluation stages have been recommended, from 0 to 5. At first we proposed to analyse the intrinsic value of genuineness and secondly associated values of the relative artistic, technical, rarity, cultural identity values. The grading value obtained by the evaluation will form criteria for value classification.

Table 1 – Built space – Value classification

Actual total score	Minimum score by criteria	Classification of values
≥65p	Min. 25p Authenticity Min. 20p Relative artistic and technical value Min. 20p Rarity value	Special cultural value
30-50p	Min. 10p Authenticity + Min. 10p Relative artistic and technical value Min. 10- Rarity value	Typological cultural value
20-30p	Min.10p Relative artistic and technical value Min. 10p Cultural identity value	Ambient cultural value
10-20p	Min. 5p Relative artistic and technical value Min. 5p Cultural identity value	Cultural identity value
5-10p	Min. 5p Relative artistic and technical value or Min. 5p Cultural identity value	Minor cultural value
0p	0p	No value

4.2.2 Built space - Functional value analysis

The functional value of the built fund must take into account the provisions of code P100/2006 on the classes of importance of the buildings and of course, the provisions of the general urban planning (GUP) of Bucharest regarding the functional area and is evaluated through the same operation scale as C- central zone, M – mixt zone, L-housing zone, V- green spaces, T – transports zone , G – communal household, S – special equipment.

4.2.3 Built space - Affiliation analysis

Affiliation analysis take in consideration the react of individuals, communities in relations with built space like – affinity, familiarity, attraction, rejection or institutional pressure scoring 6 steps from 0 to 5.

4.2.4 Built space - The reporting value

This is the average of cultural, functional and affiliation values and is a fundamental determination for community perception.

Table 2 – Reporting value

	Criterion	0	1	2	3	4	5
1	Cultural value						
2	Functional value						
3	Affiliation value						
	Reporting value Ɛ(1,2,3)/3						

4.3 Exposed risk elements - Vulnerability analysis

4.3.1 THE BUILT SPACE - Vulnerability (state) analysis

The value of the state use is defined in compliance with Romanian Law 10/1995, "Quality in Constructions" [14] and defines how the listed requirements are met. The state of the building and its value of use is the result of how users have used it and also the result of sudden or slow hazards which it has been exposed to over time.

Table 3 – Built stock and value of vulnerability

No.	Criterion	Vulnerability values					
1	Safety	0	1	2	3	4	5
1.1	- structural safety						
1.2	- safety in operation						
1.3	Safety to fires						
	Average value of safety						
2	Quality of the environment						
2.1	Hygiene, health, environment						
2.2	Thermal protection, energy saving,						
2.3	Noise protection						
2.4	Waterproofing						
2.5	Sunlight						
	Average quality value of the environment						

We have grouped these criteria from the law into two groups – safety and quality of the environment. Every criterion may be developed into specific subcriteria.

4.3.2 (STRUCTURAL) SAFETY ANALYSIS

The analysis based on the score from the Code P100-3/2008 for structural design requires a lot of data which would impose special time to analyse each building. According to the evaluations the Ministry of Constructions has proposed a list of valued and exposed buildings. The elements exposed to risk are classified to estimate the vulnerability, depending on the structural type, height and construction period. Residential buildings are classified into combinations of 7 types of materials, 6 classes or periods of age and 5 classes or regimes of height.

4.4 Risk analysis

The study used specific vulnerability functions for earthquake impact, calibrated and adjusted after Balan et al [3], Sandi et al [11] and simplified methods and expert opinions for other hazards, under an average occupation ratio per house. In this respect, the Mean Damage Degree was used as a proxy for detailed vulnerability analysis. When relevant for exposure, some hypotheses of day and night have been used. [9]

Earthquake scenario damage and casualties resulted as follows: the number of buildings with significant damage was accounted for the alternatives of seismic intensity I=VIII as being around 63 and 165 for seismic intensity I=VIII½, involving mostly low-rise structures. The heavy injured number is 29 and 64 respectively, while live loss were 59 and 92, respectively, resulting some 1809...3061 evacuated persons from such unsafe buildings, these indicating a need of shelter. However, since the number of people from heavy damaged houses is only of some 355...677 and houses, and they have gardens and yards, some shelter can be arranged nearby.

The day-time exposure scenario lead to a number of casualties reduced by 50%, recorded in residential houses, but it resulted an extra exposure of 10,120 persons in public institutions around, and 1.000 clients in commercial places, 1,400 in offices and 800 in schools, while 400 can be in churches. Since such buildings are less vulnerable, there are only 26 light injuries and 1 hospital entry. Although the number of heavy damage is not excessive, the scenario for I= VIII½ indicates a need of investigations for safety assessment and possibly a need of a greater number of temporary or long-term evacuation for repairs and structural strengthening, this community is protected but already weak and heritage buildings need careful and time-consuming works.

The terrorist scenario blasting considered 3 hypotheses: explosive in quantity to be carried by one person; explosive in quantity to be carried by a compact car; explosive in quantity to be carried by a urban track. Figure 5 gives an example of how spread can be the impact even for a small amount of explosive.

Figure 5: Radiuses of specific zones in a specific location within the study area. Explosive in a quantity to be carried by one person.

The results of the scenario of terrorist blasting have shown that, as the explosive quantity increases, the impacts would affect larger areas and would lead to irreparable building damage in densely inhabited areas, with fragmentation and debris spreading and with great potential of wounding and casualties. Anyway, these impacts are more or less nominal, since higher buildings could provide a shielding effect. The scenario of urban fire can reach a disaster level in case of some streets with adjacent buildings having wooden roofs.

The scenario of climatic and hydrologic hazards is dominated by an extreme event of accidental flooding and only an early warning can save the community persons, but not the built area. The water cover can be as high as 2.5 m and all 2 story houses as well as first 2 stories of condominium would be under water.

Disaster risk reduction can be obtained through non-structural and structural method. The non-structural methods are related with legislation, education, and interventions planners. This research propose to develop scientific instruments and a data base for urban and territorial planning, like a support for intervention in the territory in general and in a central area of city in detail. Another aspect it is the transparency of well analyse and the involvement of citizens in future decisions. Organising the security center it is in our opinion a structural method because means direct and rapid decision for protect the people which ca be affected by a hazard.

5. Specific intervention strategy in protected area

Proposals for both structural and non-structural management are based on the ratio of built space qualities reporting value (cultural, functional and community perception) in relation to the value of the state of vulnerability. (fig. 6 and 7).

Figure 6: Reporting value map

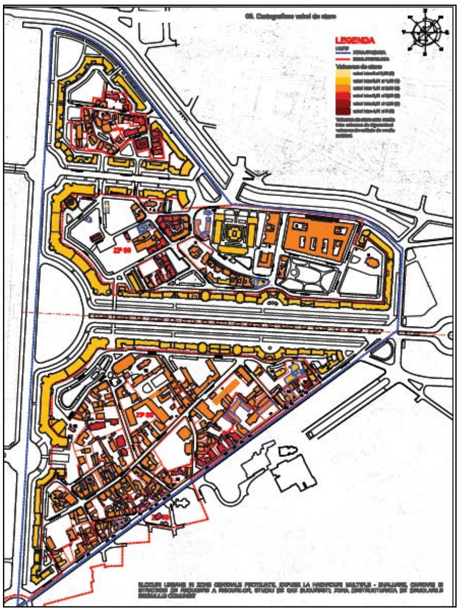


Figure 7: Vulnerability value map

These strategies are structured on two time levels, within the emergency term and perspective. Long-term interventions built on the proposed space, suggested by the research, are evaluated and mapped in 3 groups, as maintenance (A-current maintaneance: repairs, local restoration / B-conservative maintenance: idem A+ local strengthening interventions), improvement (C – conservative works : works meant for the conservation and insurance of functionality of the building, strengthening or restoration of some structural components with analogous or compatible materials and tehniques; D - Restoration and strengthening) and transformation (E - Partial restricting: demolition and reconstruction works for some components; F-Global restricting: demolition and reconstruction of the building: repartitioning at the level of the building, extensions, modifications of the closings by keeping value characteristics in relation to the assembly / reconstruction; G – demolition; H – new proposals) , each with specific subgroups.

Table 3 : Table Final decisions

Reference value	State value (vulnerability)					
	0	1	2	3	4	5
5	A	B	C	D	E/F	G/H
4	A	B	C	D	E/F	G/H
3	A	B	C	D	E	F
2	A	B	E	F	G/H	G/H
1	A	B	E	F	G/H	G/H
0	A	B	E	F	G/H	G/H

These interventions are the the basis of the architectural decisions on the analised object or the urban ones, in reference to the neighborhood urban areas, which must be supported by administrative decisions.(fig. 7)

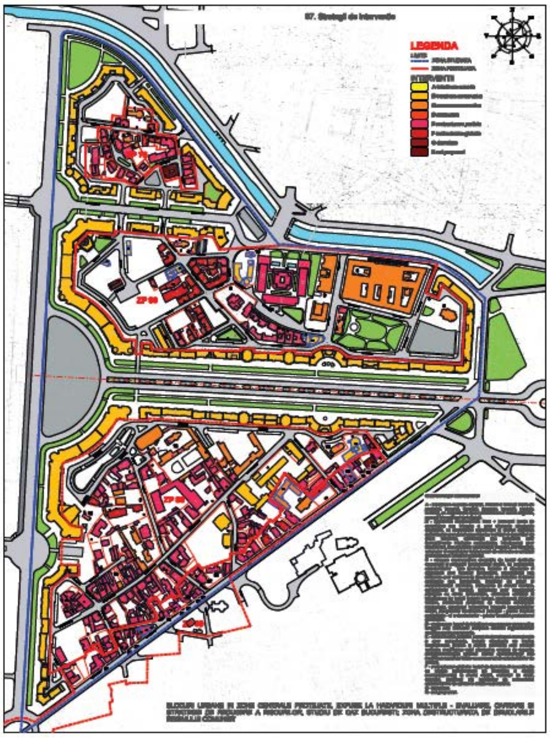


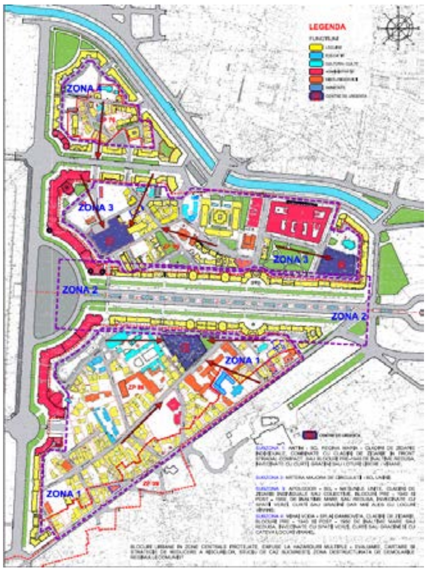
Figure 7: Map of intervention decisions

5.1 Security center

According to the results of scenarios, the need and possibility to create shelters and security centers was evaluated in the protected area and in nearby zones, as follows:

- for seismic hazard scenarios, considering only structural impact on buildings, one can create a security center in Mihai Eminescu College (fig. 4a, 4b);
- for hidrologic hazard, as the flooding is supposed to cover all areas, the refuge and shelter area in a higher place, near Academy House / Parliament;
- for terrorist scenario and/or other explosions, the impact is rather moderate, thus the security center of Mihai Eminescu College or Izvor Pak is recommended;
- for extreme climatic hazards, as well as for the damage and lack of function of urban infrastructures, the security center in Mihai Eminescu College can play mainly a role of daily feeding and social care, as well as commnunity information;

Figure 4 a: General view of Mihai Eminescu National College precinct to be used as security center.



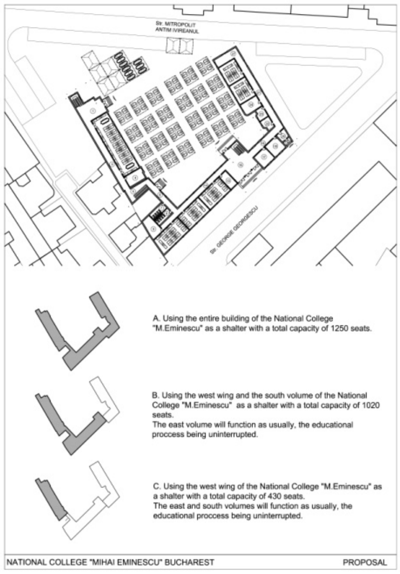


Figure 4 b: Left side-Choosing a possible security center in protected area. Right side-Case study of Mihai Eminescu National College precinct as security center

6. Conclusions

The pilot study allowed us to background stuctural methods for risk reduction along with the priorities of UN-ISDR and Sendai / Hyogo Framework. Depending on the resulted vulnerability, from the risk scenarios, the emergency management proposal identified those areas that may become security carriers, mainly in the community or very near, to prevent the alienation and loss of memory. Network security centers, connected by an independent communications system, corroborated with proper traffic management and emergency intervention can create a stable logistical support for an expected event and also generate a polynuclear support system in urban development.

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References

[1] Hyogo Framework for Action 2005-2015: Building Resilience of Nations and Communities to Disasters. A/CONF.206/6. World Conference on Disaster Reduction, 18 - 22 January 2005, Kobe, Hyogo, Japan. United Nations Office for Disaster Risk Reduction (UNISDR), 25 p, 2007, accessed on March 28, 2015 at http://www.unisdr.org/we/inform/publications/1037

[2] Sendai Framework for Disaster Risk Reduction 2015-2030. A/CONF.224/CRP.1.Third World Conference on Disaster Risk Reduction, 14 - 18 March 2015, Sendai, Miyagi, Japan, accessed on March 28, 2015, at http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf

[3] Balan, St., Cristescu, V. and Cornea, I., (coordinators) (1982): The Romania Earthquake of March 1977 (in Romanian, with English abstract). Editura Academiei, Bucharest, Romania.

[4] Florescu, T., Moscu, C. I., Gociman, C. O., Georgescu, M. S., Dragomir, C. S., Craifaleanu, C. S., Georgescu, E. S. (2014): Urban Heritage and Multi-Hazard Threats. Case Study of Seismic Vulnerability Assessment and Mapping in a Protected Area of Bucharest, Romania. Proc. The 1st Huixian International Forum on Earthquake Engineering for Young Researchers August 16-19, 2014, Harbin, China

[5] Georgescu, E.S., Georgescu, M. S., Albota E. (2010). Towards a multi-hazard engineering and architectural-urbanistic design in seismic zones of Romania”, Proc. 14 EEEE, Ohrid, Macedonia, August 29-Sept. 3, 2010

[6] Georgescu, E. S., Gociman, C. O., Craifaleanu, I. G., Florescu, T., Moscu, C. I., Georgescu, M. S. , Dragomir, C. S. (2014): Urban Heritage Value and Seismic Vulnerability Mapping: Challenges for Engineering and Architectural Assessments. Case Study of a Protected Area in Bucharest, Romania, Paper no. 431, "Ear thquake Risk Mitigation Policies and Methodologies (EAEE Session), Second European Conference on Earthquake Engineering and Seismology, 2ECEES, Istanbul, 24-29 August 2014. ISBN 978-605-62703-6-9.

[7] Gociman, C. O., Florescu, T., Moscu, C. I., Georgescu, E. S. (2014): Decisions on Building Stock Survival and Conservation in a Multi-Hazard Environment: Cultural and Functional Identity vs. Safety and Environment Values in Protected Areas. International Conference in Climate Change, Ecology, and Conservation (ICCCECE 2014). The Venetian Macao, Macau, China, February 13-14, 2014.

[8] Gociman, C. O., Moscu, C. I., Georgescu, E. S. (2014): The relation between identity and vulnerability values in carrying out interventions in protected urban areas. The 9-th International Conference on Urban Regeneration and Sustainability. Sustainable City 2014, 23 – 25 September, Siena, Italy.

[9] Project URBASRISK - Project “Urban Blocks in Central Protected Area in Multiple Hazard Approach - Assessment, Mapping and Strategies for Risk Mitigation. Case Study: Bucharest Destructured Zone by Razing Occuring in the Communist Period”2012-2015. UAUIM and UEFISCDI Agency. Retrieved on March 28, 2015 from http://www.uauim.ro/cercetare/urbasrisk/en/(2014).

[10] Cartier, S., Vallette, C., Mediene, H. (2012): Urban Seismomorphoses Seismic Vulnerabilities, an Embarrassing Legacy. Journal of Risk Analysis and Crisis Response, Vol. 2, No. 2 (August 2012), 96-106. Published by Atlantis Press. Retrieved on April 6, 2012 from www.atlantis-press.com/php/download_paper.php?id=2940

[11] Sandi, H., Pomonis, A., Francis, S., Georgescu, E. S., Mohindra, R., Borcia, I. S. (2008): Development of a nationwide seismic vulnerability estimation system. Proc. Symp. Thirty Years from the Romania Earthquake of March 4, 1977, Bucharest, Romania, March 1-3, 2007, CONSTRUCTII, No. 1/2008, pp. 38-47, Retrieved from http://constructii.incerc2004.ro/Archive/2008-1/2008-1-5.pdf

[12] Law no. 5/2000 of National Territory Planning. The 3-rd Section on Protected Zones. Official Gazette No. 152, 12.04.2000. Accessed on 24.06.2015 at www.mmediu.ro

[13] Law of Historic Monuments Protection No. 422 /2001, republished in 2006. Official Gazette No. 938/20.11.2006, Accesed on 24.06.2015 at www.cimec.ro.

[14] The Law No. 10/1995 of Quality in Constructions. Official Gazette No. 12/24.01.1995. Consolidated version republished in 2013, accessed on 24.06.2015 at www.dreptonline.ro

Rural People: Resilient Futures Uncovering a Leadership Model for Building Resilience

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Abstract

Although there appears to be inherent social resilience in rural communities, rural areas of Victoria, Australia are experiencing the impacts of climate change. There exists a significant gap in the management of climate impacts and the compounded issue of exacerbated vulnerability in disadvantaged populations. According to the Victorian Council of Social Services [1]the impacts of climate change will be felt most by those that are already subject to social or economic marginalisation. Additionally, disadvantaged groups are generally less able to manage risks of all types because they lack financial, social, educational or other resources. Moreover according to Costello et al… "While the wealthier parts of the population will be inconvenienced, the poor will die" [2]

Through a Victorian State government pilot project in affiliation with the local municipality and associated primary health network, means to increase the resilience of vulnerable populations under a changing climate was the overarching goal. Investigation into the definition of vulnerability in the context of rural populations, how this will change under climate change and means to attenuate this exacerbated vulnerability has been investigated through a social learning lens. The investigation has uncovered a leadership model using a local health network as a key platform to facilitate health and community agencies and build capacity to enhance resilience. Rural health agencies have strong investment in their community and connections to vulnerable groups but generally have limited capacity to respond without leadership and support. This paper discusses learnings from the perspective of the engaged health and community services practitioners in an attempt to share experience, and promote a co-generated model of adaptation and resilience for vulnerable rural communities.

Keywords: *Social Resilience, rural communities, vulnerable*

1. Background

Climate change impacts on health and wellbeing have been identified in the literature vary, and according to the Global Climate and Health Alliance [3] occur through many different pathways. They span the full breadth of the immediate and underlying determinants of health, including: the direct impacts of heat and extreme weather events; access to the essentials of life such as clean water, nutritious food and shelter, forced migration, conflict and societal disruption and loss of biodiversity. Research by organisations such as the World Health Organisation [4] reveals that disadvantaged groups have poorer health compared with communities of higher socio-economic advantage. The fact that climate change has the ability to amplify disadvantage, suggests the potential for climate change to have a negative impact on the health status of disadvantaged groups. Summed up by Costello [1] (2009) commenting that under climate change the wealthier parts of the population "will become inconvenienced (…) the poor will die"[i]

Southern Grampians Glenelg Primary Care Partnership (SGGPCP) is a partnership of 20 health and community agencies working together to enhance community health and wellbeing. SGGPCP operate under a philosophy that supports innovation and collaboration and recognised the need to support the partnership to understand the impacts of climate change and health. This led SGGPCP to formulate a framework for action documented in 2008 [5]. Since then SGGPCP have initiated collaborative projects and strategic approaches to increase the capacity of its partner agencies to enhance community resilience through climate change adaptation. This has also involved engaging with research and non-traditional health agencies and resulted in participation in significant research through the Victorian Centre for Climate Change Adaptation (VCCCAR) which set the pathways for the Rural People: Resilient Futures project.

2. Methodology

This paper will describe the leadership model that was uncovered through implementation of the Rural People: Resilient Futures (RP:RF) Project in south west Victoria. RP:RF was funded through the Victorian Department of Environment and Primary Industry through the Victorian Adaptation and Sustainability Partnership and was a collaboration between the Southern Grampians Shire Council, Southern Grampians Glenelg Primary Care Partnership (SGGPCP) and RMIT University. The paper will discuss the methods used to communicate and engage with health and community service agencies to demystifying complex issue of adaptation planning and relating adaptation to everyday experiences while also uncovering the local context of vulnerability.

The RP:RF Project was implemented over four phases during a 12 month period from 2014 – 2015. The phases were designed to enable a local understanding of vulnerability to be established and then to further investigate with agencies how climate change interacts with local vulnerability.

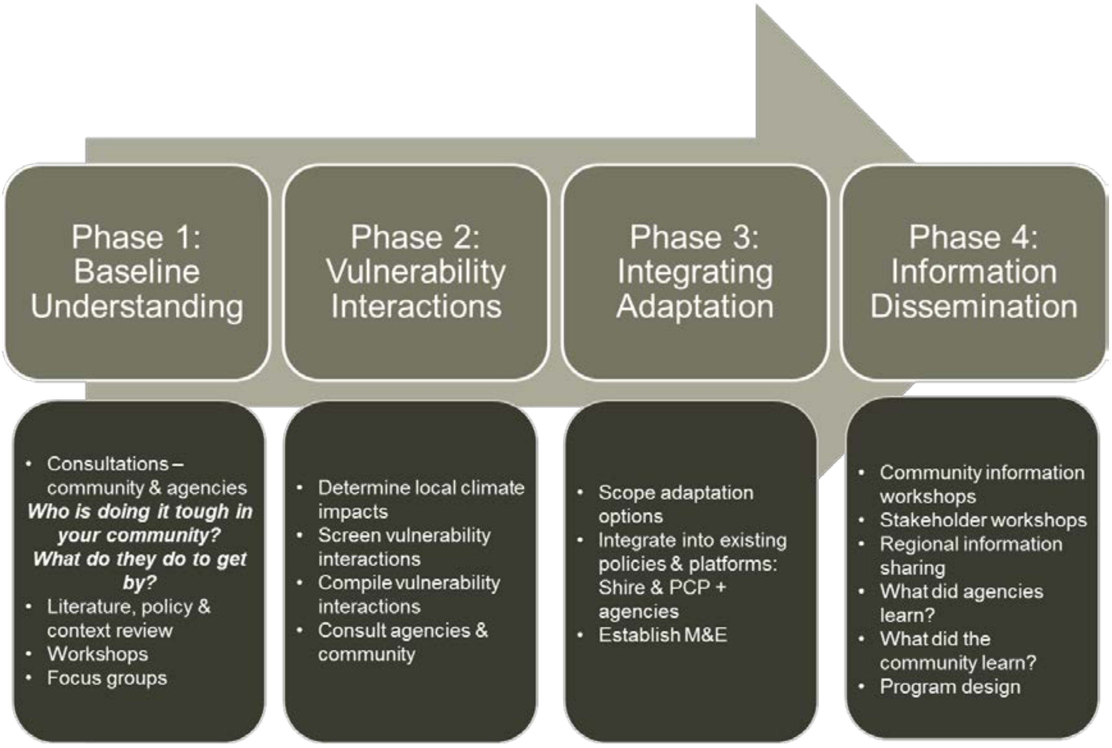

Figure 1: The 4 phases of the RP:RF Project

Phase 1: Baseline Understanding

Key questions were developed to investigate vulnerability locally. These were: 1) Describe the community you live in, who lives here and what do they do? 2) What makes life difficult for people who live here? 3) What makes life easier? 4) Who do you think is “doing it tough” in your community? 4) Reflect on the heatwave of last year: what were the impacts that you saw locally? What could be done to reduce these impacts?

Using the SGGPCP partnership platform and capitalising on the already existing relationships, SGGPCP consulted initially with partner agencies in the Southern Grampians Shire using the key questions through interview or focus group. Agency representatives were asked to reflect on the questions using their local knowledge and then to link SGGPCP to other networks and community members for further consultation. These consultations were conducted between March and June 2014.

A literature review was undertaken to investigate how social vulnerability is defined in academic and grey literature, and how this framing is currently being considered in the context of climate change, particularly in rural areas

Phase 2: Vulnerability Interactions

A climate change adaptation workbook was developed to assist agencies reflect on recent practice and document adaptation plans and actions. This workbook was based on the UKCLIP adaptation Wizard [6] and the UK National Health Service workbook [7]. The workbook was designed as a tool work through the adaptation process

Eight SGGPCP partner agencies within the Southern Grampians Shire were identified to approach to participate in phase 2 of the RP:RF Project. These agencies included: Balmoral Bush Nursing Centre, Mental Illness Fellowship Aspire, Mulleraterong Centre, Southern Grampians Shire Council, Hamilton Community House, Western District Health Service, SalvoConnect and Winda Mara Aboriginal Cooperation. One to One consultations with agencies were conducted using the workbook as a guide. SGGPCP transcribed the results of these consultations into individual workbooks recognising the limited capacity of agencies. Agencies then reviewed and commented on resultant documents. The consultations were supported by stakeholder workshops to enable an opportunity for agencies to develop linkages and networks which led the participants into phase 3 of the project. The workshops presented agencies with reflective questions and problem solving as well as scenario simulation activities designed for the participants to consider the cumulative impacts of the events. Participants were instructed to think about what is already in place to manage these extreme climate impacts, who they would involve, what assistance would be available and whether it would be adequate for the extent of the impact. After the six days of flood and heat/bushfire scenarios, participants were taken to a disaster point where loss of life occurred.

Phase 3: Integrating Adaptation

The scenario planning exercise at the completion of phase 3 bought participants to a disaster point during an emergency situation (extreme heat and fire, and an extreme rainfall and flooding scenario). Post the disaster scenario, facilitators took participants 'back in time' to develop actions aimed at avoiding the disaster point. This exercise was to highlight the role that agencies can play in adaptation planning and start a conversation around possible actions that agencies can integrate in to their everyday operations, planning, procedures and policies. Project team staff completed follow up meetings with agencies to support their planning. A final workshop was held with agencies to share ideas and actions and decide on further planning for agencies.

Phase 4: Information Dissemination

Communication and information dissemination was a significant component of the project alongside the key objectives of the Victorian Adaptation and Sustainability Partnership Program objectives. A stakeholder list was developed identifying agencies, groups and individuals to receive information about the project and understanding that there are differing capacities to engage in the project fully and a variety of communication techniques were employed. Key methods of communication included:

- A one page summary of the project – *Project on a Page*
- Stakeholder bulletin
- Project Launch
- Community and Stakeholder workshops
- Media (Radio, TV and print)
- Ongoing email and telephone communication
- Production of a short film

3. Results

Baseline understanding of Vulnerability

A systematic review of the academic and grey literature [8] found that defining vulnerability highlights a range of complexities. Overwhelmingly the review found that vulnerability occurs at multiple spatial and temporal scales and is not a static state, which makes it complex to manage. Moreover, social vulnerability is not a static attribute of an individual or a system but is characterised by a host of complex social and economic factors, often associated with entitlements and access of individuals or groups to resources relative to the geographic and institutional context in which these individuals or groups live. Social vulnerability is understood as a dynamic state experienced by an individual (or group), who through various and interacting individual and broader socio-economic characteristics, is susceptible to stresses that may leave them negatively affected when compared to someone in the same setting who does not experience these same socio-economic characteristics.

The review also uncovered that climate change impacts have the potential to alter the make-up of social groups, amplifying existing socio-economic drivers that contribute to social vulnerability which can increase the complexity of social vulnerability and its management. In a local setting, the Glenelg and Southern Grampians Shires are considered relatively disadvantaged in relation to the Victorian Socio-Economic Indexes For Areas (SEIFA) regional average, with higher proportions of low-income households, high disability rates, and an ageing and socially more isolated population. These factors of relative disadvantage are likely to be exacerbated by climate change impacts, in particular by an increase in the frequency and/or intensity of extreme weather events, which are of high prevalence in the region, such as flooding, bushfire, heatwaves as well as drought and water scarcity.

Current social and climate change policies and initiatives at Federal, State and Local levels require critical examination of existing social vulnerability, how this is likely to evolve under climate change, and what support will be necessary to reduce an aggravation of social disadvantage and vulnerability through locally relevant management mechanisms. In conclusion, therefore managing social vulnerability under climate change needs to be highly contextual and requires local community engagement to better understand effective ways for individuals and communities to adapt to a changing climate and its socio-economic consequences.

The consultation with agencies and communities found that there were 4 cohorts who were significantly reported as “doing it tough”. These were low income families, farming families living in isolated areas, socially isolated individuals and people who have cognitive difficulties.

Participants were also asked ‘what makes life easier’ for those they considered vulnerable in their community. Findings from this consultation question reflected high concern over social isolation as a social vulnerability factor in their communities. Participants responded that community support and social engagement was one of the best management options .This was reported alongside improved access to services including transport access, support from community service organisations and access to health services.

Vulnerability Interactions

Eight agencies within the Southern Grampians Shire were identified to work through the tailored climate change impacts work booklet. Six agencies continued the process through to completion with 2 agencies citing limited capacity to participate as main reasons for withdrawal from phase 2 and 3 of the project. One of these agencies continued to engage in the project through review and evaluation while the other agency was experiencing workforce change and was unable to continue.

The key findings from Phase 2 of the project indicated that agencies are already vulnerable to impacts associated with climate and weather. Participants reported that their agencies have largely been impacted by climate change through extreme heat days, bushfire, flood, drought and storms. The direct and indirect impacts associated with these events not only affect the organisations themselves, through their operations, service delivery and staff, but also the clients they support.

Phase 2 also highlighted that agencies were already attempting to implement a range of strategies to reduce the impacts of the climatic events including development of policies and procedures, utilising departmental guidelines to guide policy development, using local knowledge to inform planning, developing vulnerable persons lists, education and awareness raising with clients and staff, recommending physical retrofitting and acting as a community hub. Participants also highlighted areas for improvement including creating consistency between existing policies within organisations, creating more awareness of existing policies , identification that staff protection during extreme events not enforced , there was a lack of knowledge around specific impacts and where to go for information and that there could be more engagement between agencies to improve networks and planning.

Integrating Adaptation

Phase 2 and 3 identified that agencies were already using their local knowledge and experience to implement a range of action within their agencies. The simulated disaster scenario that facilitated looking back in time highlighted a range of actions staff could take over the range of differing timelines (6months, two years, five years). These moved from centring on preparedness for an extreme weather event to building more community resilience. Key actions that were highlighted across all timescales included improved service coordination and delivery between all agencies and scales; staff education on the considerations of climate impacts in their roles and awareness of existing policies and procedures; promoting linkages between agencies, shire, emergency services and State Government; using local knowledge to promote resilience within the wider community and monitoring and reviewing to test the effectiveness of actions already in place.

Communication

A range of communication strategies were implemented throughout the project to allow for the diversity of capacity around the region to participate and recognising the significance of the results across a broad stakeholder network. The project summary page proved very useful information to assist to explain the project across a wide range of networks while the stakeholder bulletin (n= 4) provided ongoing progress updates.

The project received significant media coverage with the project launch receiving coverage through the print media and facilitating conversations at the launch event to inform consultations and future engagement in the project.

Six community and stakeholder workshops were completed throughout the project enabling workshop opportunities for up to 60 participants over the length of the project.

A short documentary was filmed and launched in Hamilton narrating the story of the project and highlighting local participants and case studies. Six case studies have been published enabling each agency involved the opportunity to share their experience with a further stakeholder network.

4. Conclusion

Climate change is a reality for communities in the Southern Grampians shire and agencies engaged through the RP:RF project are already experiencing the impacts and conveyed their experiences around extreme climatic events. Agencies identified that they had limited knowledge and capacity to focus on preparedness of their clients and their service and discussed their behaviour as mostly reactionary and in line with emergency management and occupational health and safety. Considering that climate change predictions predict a rise in extreme events and acknowledging that even over the summer of 2013/2014 communities experienced significant numbers of days above 35 degrees, agencies identified that planning needs to shift from an emergency management focus to adaptation and integration into everyday policies, procedures and practices.

Although agencies recognised that they have are major role to play and are well placed to enhance resilience in their communities, they overwhelmingly identified the limited capacity to drive action. The extensive project evaluation undertaken uncovered the significance of the platform that SGGPCP provides to fill that gap to drive action and be a conduit to link government and research agencies to the community and health agencies. The existing relationship of SGGPCP with partner agencies is built on trust and established understanding of local needs while also connecting with external stakeholders including government and the research sector. This network is now at a state of readiness and the model could be further developed to provide a leadership platform for agencies to support agencies drive action at a local level.

This research has highlighted the significance of understanding vulnerability at a local level and the importance of appreciating the context. All agencies reported having developed vulnerability lists in line with organisational requirements, however many admitted to using their own local knowledge to add to these lists dependent on the situation. Although it is difficult to identify vulnerable cohorts within society, aligning our thinking with livelihood assets or “five capitals” assists us to understand the context in more detail. The 5 capitals are described as human, social, natural, physical and financial and when there is a major deficit in one or more of the capital there is increased likelihood of vulnerability. This reminds us that the creation of a generic vulnerability list requires more interrogation in order to accurately identify an individual's vulnerability in a given situation.

RP:RF uncovered not only the leadership platform of the PCP but reinforced the trusted relationships that local health and community agencies have with their community. Models of disaster resilience refer to the significance of strong community connection. Health and community service agencies have declining resources and increasing demands. More often services are being retracted to regional centres decreasing the capacity of agencies to maintain and develop local connections.

Recognising the valuable role that health and community agencies play in enhancing community resilience and building capacity of these agencies through platforms such as PCPs or other umbrella organisations should be a priority for future action. As demonstrated through the RP:RF project, agencies have a trusted relationship with communities and are well placed to build on connections to enhance resilience.

Acknowledgements

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References

[1] Victorian Council Of Social Service (VCOSS) (2007). Climate Change and Drought Policy: Context and recommendations for VCOSS

[2] A. Costello, M. Abbas, A. Allen, S. Ball, S. Bell, R. Bellamy, S. Friel, N. Groce, A. Johnson,M. Kett, M. Lee, C. Levy, M. Maslin, D. McCoy, B. McGuire, H. Montgomery, D.

Napier, C.Pagel, J. Patel, J. A. P. de Oliveira, N. Redclift, H. Rees, D. Rogger, J. Scott, J. Stephenson,J. Twigg, J. Wolff, and C. Patterson, “Managing the health effects of climate change,” Lancet, vol. 373, no. 9676, pp. 1693–733, May 2009.

[3] The Global Climate and Health Alliance (2014)Climate Change Impacts and Opportunties. A summary and discussion of the IPCC Working Group 2 Report.

[4] World Health Organisation (WHO) (2000) Social Determinants of Health: The Solid Facts

[5] Rowe, R. and Thomas, A. (2008) Policy Signpost 3. Climate Change Adaptation: A Framework for Local Action. Southern Grampians and Glenelg Primary Care Partnership. The McCaughey Centre.Melbourne University of Population Health. The University of Melbourne

[6] UKCIP Adaptation Wizard http://www.ukcip.org.uk/wizard/

[7] National Health Service Adaptation to Climate Change for Health and Social Care Organisations

[8] Rance, A. and H. Fünfgeld (2014): Rural People: Resilient Futures – Social vulnerability to climate change in rural contexts. Centre for Urban Research, RMIT University, Melbourne.

Disasters have direction: understanding cascading events

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Abstract

It is common for communities to be enjoined to take an "All Hazards - Maximum of Maxima" approach to planning. The basic premise is that if a community plans for the worst of the worst, then it will be prepared for whatever may actually happen. But disasters often trigger a cascade of consequences that are unexpected. Thus, while the community may be prepared for a specific triggering event the follow-on cascade may overwhelm its resources. Even worse, a community may not be subject to a particular type of disaster, but may be severely impacted if a disaster strikes another community to which it is tied, e.g., if it receives its water from a community that is susceptible to industrial pollution.

As an aid in predicting the cascade of consequences, the Community and Regional Resilience Institute (CARRI) has developed a concept called "Disasters Have Direction." The initial point(s) of impact of extreme events on the community vary according to the type of disaster. The point of impact or attack of a pandemic will be the members of the community. Recessions initially impact a community's economy. A hurricane's primary impact is likely to be on the natural and built environment. As each of these are damaged or fail they may initiate a cascade of impacts on the rest of the community.

CARRI has used this concept to develop a method and supporting tools a community can use to predict the cascading impacts of any extreme event. The method consists of four steps:

1. Identification of the triggering events the community may face.
2. Identification of the components of each community system located outside the community. Losses of service from these components are then included in the set of extreme events the community may face.
3. Determination of the point(s) of attack for each triggering event – the community systems initially impacted.

Determination of secondary impacts: deducing which community systems will be impacted because of their tight coupling and dependence on the initial point(s) of impact. This is then repeated until all impacts are identified.

Keywords: Community resilience; resilience; disasters; cascade of consequences; interdependencies.

1. Introduction

In the United States, communities are enjoined by the federal government to take an "All Hazards - Maximum of Maxima" approach to planning. The basic premise behind this is that if a community is prepared to respond to the worst case of each hazard that faces them then the community will be resilient to whatever disruption they may actually face. While the principle may seem correct, we unfortunately do not live in a principled world. As pointed out by Alesch and Holly (2005), the tight coupling within a community (e.g., between coal-powered electricity generation and the community's water supply) and between the community and external agencies (e.g., between the community and a regional utility that provides its electricity or water) means that the impacts of any disaster may well extend far beyond the initial point of impact.

From the standpoint of a community this means that the community may be prepared for a specific triggering event but may not be prepared to respond to or recover from the follow-on cascade of consequences. These cascading effects are the result of the tight connections binding one part of the community to another. If other parts of a community depend for essential services on one that bears the initial brunt of an extreme event, then its failure may mean that they fail as well. And their failure may in turn result in further damage to the community's vitality.

As an example, the ice storm experienced in South Carolina in 2014 caused a large amount of physical damage to the communities affected. A primary impact was the loss of electricity. This resulted in damage to the local economy as well. Small businesses closed because of prolonged (greater than one month) power outages; some workers found their jobs had disappeared; local governments in turn saw reduced tax revenues. In fact, some jurisdictions were not able to complete debris removal for several months after the storm because of a lack of revenue to complete cleanup.

Even worse, a community may not even be subject to a particular disaster, but may be severely impacted if a disaster strikes another community to which it is tied, e.g., if it receives its utility services from a community that is struck by an extreme event. For example, Anne Arundel County (MD) produces only about one-third of the water it uses each day. About half of the rest comes from Baltimore County. A terrorist attack on the Port of Baltimore with a dirty bomb, or a severe hurricane that results in a leak of stored chemicals causing extensive contamination, might well have little physical impact on Anne Arundel County but likely would compromise its water supply. The chemical spill that leaked into the Elk River (West Virginia, USA) in 2014 and contaminated the water supply of 300,000 people in communities well downstream of the leak site is a practical example (Plodinec and Smith, 2014). Similarly, many of the Gulf Coast communities impacted by the BP oil spill suffered no physical damage or even contamination, but suffered severe economic consequences because of their reliance on fishing or tourism (Butler and Sayre, 2012).

Thus, communities need a straightforward, practical yet accurate method to identify these "tight couplings" – the interconnections and interdependencies both within the community and from the community to external agencies so that they can develop strategies to either mitigate or prevent these cascading consequences. Unfortunately, the efforts of the research community have not provided the tools needed by the leaders of civil communities. The research performed to date falls into two categories:

- Modeling studies based on systems theory. Examples include Akhtar and Santos (2013), Crowther, et al. (2007), Helbing (2006), Kadri, et al., (2014), Little (2002), Neumayer and Modiano (2013), Peters, et al., (2008) and Rinaldi (2004). These studies are valuable contributions to the study of past events but are impractical for use by community leaders wishing to stave off disaster. The research methods used involve sophisticated modeling tools that are simply not available to a community leader. However, a key feature of these studies is the spotlight they shine on the need to know and understand the connections within the community, and from the community to external agencies. For example, Peters, et al. (2008) found that their simulations of disasters "clearly demonstrate" that the topology of – the connections within – a network (e.g., a community or a community system) are a crucial factor both for understanding what happens during an extreme event, and for developing strategies for successfully coping with both the immediate disaster and the resulting cascade of consequences.

- Studies looking at the cascade of consequences resulting from a specific disaster or type of disaster. Examples include Krausman and Cruz (2013), Xie, et al. (2014) and Zhou, et al. (2013). This type of study provides valuable insights about the specific events. However, few community leaders peruse the research literature, and the studies themselves often do not lend themselves to generalization.

The objective of the work described here is to provide a general method that a community leader can use to identify the potential cascading consequences resulting from any extreme event.

2. Disasters Have Direction

Inherent in the idea of a cascade of consequences is the recognition that an extreme event has one or more initial points of impact on the community. These point(s) of impact vary according to the type of disaster. The point of impact of a pandemic will be the members of a community. Recessions impact a community's economy. A hurricane's primary impact is likely to be on the natural and built environment. As each of these is attacked and fails, they initiate a cascade of impacts on the rest of the community.

A community is a system of systems. Consider an idealized community with the systems that provide essential services. Some of these provide economic services to the community; some provide environmental services (both natural and built); some provide support to individuals and families while others support the community as a whole. All of these are bound – coupled – by the community's social capital: the flows of information and resources among these systems, as shown in Figure 1.

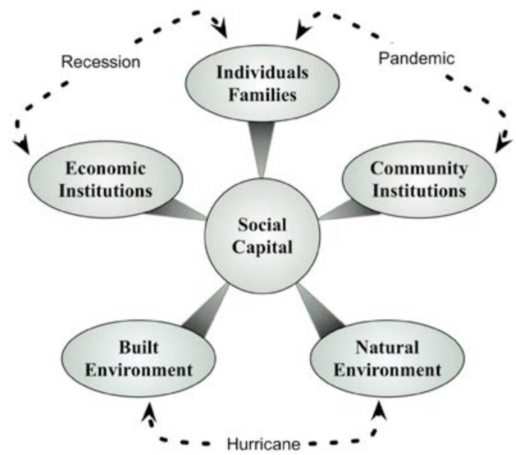

Fig. 1. Points of impact of extreme events on an idealized community.

Of course, this is an ideal community; real communities may have a strong economy but be weak in terms of community institutions. Some have a decaying infrastructure but a flourishing natural environment. The impact on the community will depend not only on the "direction" of attack, but the robustness of the community at the initial point of impact.

If a community is struck by a hurricane, the initial impact on the community is going to be on the physical layer; buildings are going to be blown down, debris will be strewn about, flooding may occur. The other parts of the community will be impacted because of these physical blows. Suppose the notional community depicted above has a strong built environment (e.g., because of enforcement of appropriate building codes) but an unprotected natural environment. There would be relatively little damage done to the built environment, but the natural environment would experience much greater damage (at least in relative terms) because it is weaker. Thus, economic entities that depend on the natural environment (e.g., recreation) might suffer.

In a pandemic, there is no immediate physical damage. Any that occurs most likely happens because the humans who normally maintain infrastructure, for example, are not able to do so. This disaster impacts individuals and families, and – because they are closely tied to the human layer – the community organizations that meet social needs. If there is relatively little capacity in these community institutions, they will be particularly hard hit – most likely overwhelmed. There is good reason to expect a community's social capital to be impacted, as well.

A severe economic downturn impacts the community from another direction. Businesses lay off workers; some close. Many individuals and families experience severe economic hardships. There is no immediate impact on the other parts of the community ecosystem. Eventually, however, all will be affected.

This simple picture implies that the vulnerability of a community to a specific threat will depend on both the direction and magnitude of the extreme event (the nature of the threat), and the relative strength of the community at the point of impact. A community may be weak in a certain direction (e.g., in terms of its community organizations), but if it is never attacked from that direction, then its weakness may never be exposed. Conversely, if the community is strong in some way (say, a robust infrastructure and a flourishing natural environment), the community will be able to withstand events that might crush a lesser community.

Thus, in seeking to identify cascading consequences, a community should first identify the extreme events that it faces. The community should then consider the point(s) of impact of each, and the community's ability to resist each type of extreme event at the point of impact. For those extreme events likely to overwhelm the community's defenses at the point of impact, the community must then identify the "tight couplings" that make it vulnerable to cascading consequences, especially those between the weaker points of impact and the rest of the community.

3. Identifying interconnections – "tight couplings"

The simple picture of a community in Figure 1 does not provide sufficient detail to help a community identify the tight couplings that are likely to lead to cascading consequences. As discussed elsewhere (Plodinec, et al., 2014), the Community and Regional Resilience Institute

(CARRI) considers communities in terms of the systems that provide essential services. This is based on the assumption that all communities provide the same essential services to their members; they only differ in how – and how well – they provide them. CARRI's "Whole Community" approach to fostering community resilience has been successfully applied to both civil communities and "communities of scholars" (i.e., institutions of higher education). The community systems defined by CARRI span the environmental, economic and social arenas; in fact all of those represented in Figure 1. For each of these, the community system is comprised of human elements and non-human assets. A key feature of CARRI's approach is that it requires that agencies geographically outside the community that participate in providing an essential service to the community are explicitly included in the relevant community system. For example, a rural community may not have a hospital within its town limits. However, if the community relies on a regional hospital – even if tens of miles away – for emergency or longer term health care, then the community should consider the hospital as part of its health care system.

Thus, each community system is in effect a supply chain that provides one or more essential services to the community. Tight coupling within each of these systems usually will lead to efficient delivery of services but may also lead to cascading effects. These systems are also entangled in various ways, increasing the vulnerability of the community to cascading consequences.

In working with community leaders and even many subject matter experts in each service system, CARRI discovered that it was difficult for them to consistently and reliably identify each part of their community system. Their inability to consistently identify the parts of each community system meant that in some cases community leaders were unable to identify potential cascading effects even though they could clearly define the point of impact. This inability also meant that community leaders were unlikely to recognize that disruptions or disasters that occur outside the community might have dire impacts on their own community.

To remedy this, CARRI has developed generic "system maps" for each community system. These are based on the functions needed to deliver the service provided by the system. Thus, for example, the generic map for health care includes (among other elements) the community's public health department, hospitals, physicians, ambulance services, and suppliers of medicine and medical supplies, but does not include something like the "XYZ Community Hospital." Each system map also explicitly identifies the other community systems with which it is entangled (i.e., connected). So, for example, the "system map" for health care explicitly identifies the connections between the health care system and the transportation, energy and water systems.

The generic system map for a community's energy system is shown in Figure 2. The components of the system are shown within the functional boundary (e.g., generators, consumers, suppliers); other community systems to which the energy system is tightly coupled are connected to the functional boundary (Note that the dotted line between the utility and consumers indicates that consumers may generate electricity that is put on the grid.).

In practice, these are used in the following manner. Stakeholders (usually represented by subject matter experts) in each system are brought together under the aegis of community leaders using the system map to identify who should be involved. The stakeholders then convert the system map from a generic document into something specific to the community (e.g., a community-specific health care system map might identify the XYZ Community Hospital but no longer would have a generic "hospitals" block). Each stakeholder is explicitly identified and the connections among the stakeholders and from the service system to other tightly coupled community systems are detailed.

- These community-specific system maps are then used in three ways:
- Stakeholders look at each of the potential extreme events striking the community (e.g., these might be identified in the community's hazard mitigation plans) and determine the susceptibility of each of the stakeholders to damage and loss of functionality. If one or more are found to be susceptible, the system maps are used as a guide to determine whether there will be cascading effects. As an example, if an electric distribution substation is located in a low-lying area and a flood occurs, some local liquid fuel retailers might not be able to dispense gasoline. Energy system stakeholders would then work together to develop strategies to mitigate these indirect impacts of the flood.
- Stakeholders look at each of the potential extreme events striking the community and consider each of the other community systems to which they are tightly coupled particularly those that could be considered consumers of their service(s). In the example of an electric substation susceptible to flooding, they would alert the business "community service system" of the possibility and then work with potentially impacted businesses to develop mitigation strategies.
- For those stakeholders that are outside of the community (e.g., a regional utility), a loss of service is assumed. The stakeholders within the community are then directed to identify the impacts of that loss of service within the community in the manner described in the first two bullets. For example, if most of the electricity for the community is generated in another state, the stakeholders of the energy system and of other community systems tightly coupled to the energy system would assume a loss of electric power and then identify the impacts on the services they provide.

4. Example – energy for San Diego, CA, USA

San Diego, California, provides an interesting hypothetical example of this approach. A sizable portion of the power provided by the local utility (San Diego Gas and Electric - SDGE) is generated in other states (primarily Arizona and Nevada). A fraction is generated in Mexico. Another large portion of its power is purchased from qualified facilities outside San Diego to its north. One of SDGE's substations is approximately 400 m from the San Diego River near the University of San Diego. This area experienced a massive flood in 2010 and is subject to winter flooding.

Using the system map in Figure 2, energy system stakeholders would consider the susceptibility of each part of the system within San Diego County to damage and loss of service due to flooding. The substation might be considered susceptible (depending on its elevation). Gasoline stations and other businesses nearby served by the substation would be warned of the potential for loss of service due to flooding. In this case, SDGE would also notify other institutional customers who rely on the substation (e.g, the University) of the potential for loss of service. Those customers would then plan for potential losses of electric power due to flooding even though they might not experience any direct damage at all (For example, the University is located well above the flood plain.).

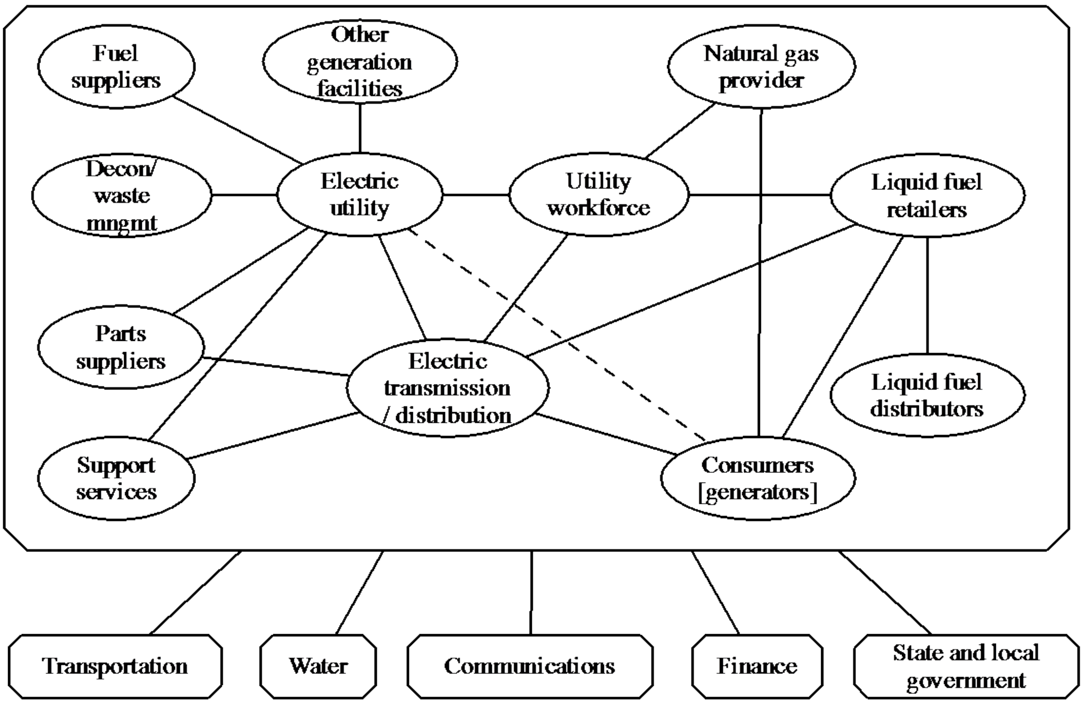

Fig. 2. System map for community energy system.

As part of implementing a mitigating strategy, SDGE would work with the County's Public Works Department to determine impacts of flooding of the river on major transportation routes (e.g., Interstate 8) that would bring in personnel and equipment to repair the substation.

Since so much of the County's electricity is generated outside the County, county leaders would factor loss of power (without damage to San Diego) as one of the potential risks facing the County. Mitigation plans would be formulated to deal with this.

5. Summary and path forward

Cascading consequences of an extreme event are difficult to recognize prior to the event and are often as much or more devastating to a community than the event itself. A cascade of impacts arises from the tight coupling of community systems, i.e., the interdependencies of these systems. As part of its effort to help communities become more resilient, the Community and Regional Resilience Institute developed a method that enables communities to recognize potential cascading effects of extreme events so that strategies can be developed to mitigate or prevent the cascades from occurring. The method involves four steps:

1. Identification of the triggering events the community may face.
2. Identification of the components of each community system located outside the community. Losses of service from these components are then included in the set of extreme events the community may face.
3. Determination of the point(s) of attack for each triggering event – the community service systems initially impacted.
4. Determination of secondary impacts: deducing which community systems will be impacted because of their tight coupling and dependence on the initial point(s) of impact. This is then repeated until all impacts are identified.

This straightforward process – with the system maps as supporting tools – provides a consistent means for communities to identify the cascading impacts from each extreme event and to develop strategies to mitigate those impacts. The process has been tested in several communities (e.g., the food supply system in St. Louis, MO, USA and health care in Charleston, SC, USA) and found to be useful in identifying the cascading consequences of disaster.

The system maps themselves have also been shown to be useful tools in ways that transcend identifying cascading impacts. As mentioned above, they can assist in organizing a community resilience effort by identifying which organizations should be involved. By bringing the right people to the table, these maps also facilitate information sharing about continuity and emergency response planning so that the assumptions these plans are based on reflect the planned actions of other connected organizations.

However, refinement of this approach will continue. As currently implemented, community system maps only reflect organizational relationships and do not represent either interpersonal relationships or critical assets that make up each system. This is not significant for systems that provide physically tangible – “harder” – services (e.g., electricity, water) because in general these services are provided through organizations and it can be assumed that any critical asset belongs to one of these organizations. However, for community systems that provide “softer services” or that require interpersonal relationships to be successful (e.g., CARRI’s “Individuals and Families” system) the system maps developed so far are not yet as useful as those for the systems providing “harder” services.

Refinement will also continue in another direction. When the process was applied to the health care system in Charleston, it disclosed a dependence of the health care system on local hotels and motels. This dependence was not on any one establishment but rather on the collective “asset” represented by having a large number of beds available for transient use. This is currently not well-represented in either the present generation of system maps or in the CARRI process as a whole; efforts are continuing to refine the system maps so that they can better reflect this type of coupling as well.

Acknowledgements

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6. References

Akhtar, R., Santos, J. R., 2013. Risk-based input–output analysis of hurricane impacts on interdependent regional workforce systems. Natural hazards, 65(1), 391-405.

Alesch, D. J., Holly, J. N., 2005. Tight coupling, Open Systems, and Losses from Extreme Events. Paper delivered at US-Japan Eqrthquake Engineering Conference, Kobe, Japan.

Butler, D. L., Sayre, E. A., 2012. *Resilience and Restoration after a Large-Scale Disaster: An Analysis of the BP Deep Water Horizon Oil Spill.* Report prepared for the Southeast Regional Research Inititaitve, SERRI Report 80040-02, Oak Ridge national Laboratory, Oak Ridge, TN, USA.

Crowther, K. G., Haimes, Y. Y., Taub, G., 2007. Systemic Valuation of Strategic Preparedness Through Application of the Inoperability Input-Output Model with Lessons Learned from Hurricane Katrina. Risk Analysis, 27(5), 1345-1364.

Helbing, D., Ammoser, H., Kühnert, C., 2006. Disasters as extreme events and the importance of network interactions for disaster response management. In *Extreme events in nature and society*, Springer Berlin Heidelberg, 319-48.

Kadri, F., Birregah, B., Châtelet, E., 2014. The impact of natural disasters on critical infrastructures: A domino effect-based study. Journal of Homeland Security and Emergency Management, 11(2), 217-241.

Krausmann, E., Cruz, A. M., 2013. Impact of the 11 March 2011, Great East Japan earthquake and tsunami on the chemical industry. Natural hazards, 67(2), 811-828.

Li, J., Chen, C., 2014. Modeling the dynamics of disaster evolution along causality networks with cycle chains. Physica A: Statistical Mechanics and its Applications, 401, 251-264.

Little, R. G., 2002. Controlling cascading failure: Understanding the vulnerabilities of interconnected infrastructures. Journal of Urban Technology, 9(1), 109-123.

Neumayer, S., Modiano, E., 2013. Assessing the effect of geographically correlated failures on interconnected power-communication networks. In *Smart Grid Communications (SmartGridComm), 2013 IEEE International Conference*, 366-371.

Ouyang, M., 2014. Review on modeling and simulation of interdependent critical infrastructure systems. Reliability engineering & system safety, 121, 43-60.

Peters, K., Buzna, L., & Helbing, D., 2008. Modelling of cascading effects and efficient response to disaster spreading in complex networks. International journal of critical infrastructures, 4(1), 46-62.

Plodinec, M. J., Edwards, W., and White, R., 2014. Applications of a "Whole Community" Framework for Enhancing Community or Campus Resilience. Procedia Economics and Finance, 18, 9-16.

Plodinec, M. J., Smith, A., 2014. Cemical spill in West Virginia. Natural Hazards Observer, 38(4), 1 and on.

Rinaldi, S. M., 2004. Modeling and simulating critical infrastructures and their interdependencies. In *Proceedings of the 37th annual Hawaii international conference on System Sciences, 2004*, 8-24.

Xie, W., Li, N., Li, C., Wu, J. D., Hu, A., Hao, X., 2014. Quantifying cascading effects triggered by disrupted transportation due to the Great 2008 Chinese Ice Storm: implications for disaster risk management. Natural hazards, 70(1), 337-352.

Zhou, F., Wei, L., Chen, K., & Cheng, J., 2013. Analyses of cascading failure in mine ventilation system and its effects in a serious mine gas explosion disaster. Journal of failure analysis and prevention, 13(5), 538-544.

Development of an Area Disaster Resilience Management System Model for Healthcare

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Abstract

Conventional Business Continuity Management Systems (BCMS) are usually prepared to enhance the business continuity of a single organization. However, ensuring healthcare continuity during a disaster requires more than enhancing the business continuity of a single hospital. Moreover healthcare has characteristics that the needs increase after disaster. To enhance the area resilience against disaster, municipalities, hospitals, clinics, traders, and other resources must be coordinated. Further, as the social and economic environments, business environments, and the probability of occurrence of natural disasters change over time, the importance of establishing a Management System (MS) to maintain, perform, and improve area resilience for healthcare has recently begun to be recognized.

To enhance the healthcare resilience of a community, a MS for healthcare composed of the municipality and healthcare-related organizations must be established. In this paper, we call it Area Disaster Resilience Management System for Healthcare (ADRMS-H). However, the proper form and best method of establishing such an ADRMS-H have not yet been established. This study develops an ADRMS-H model for use by target organizations and verifies its effectiveness. As a first step, we propose an organizational structure and then describe the function of an ADRMS-H, and the documentation required for an ADRMS-H.

Keywords: Natural Disaster, Area Healthcare Resilience, Safe & Secure Society

1. Introduction

Japan faces a high risk of natural disasters such as earthquakes, during which it is essential that countermeasures are taken to secure business continuity. During the 2011 Great East Japan Earthquake, Japan found that a failure in its healthcare infrastructure hindered its social and industrial activities and created social dysfunction.

A Business Continuity Management System (BCMS) is therefore prepared to ensure that business continuity and restoration procedures are implemented in the event of natural disasters, pandemics, and similar crises. Furthermore, studies have been conducted into the most effective form of BCMS.

A conventional BCMS is usually prepared to enhance the business continuity of a single organization; however, ensuring healthcare continuity during a disaster requires more than enhancing the business continuity of a single hospital. Moreover, some aspects of healthcare need to increase following a disaster. To enhance an area's resilience to disaster, municipalities, hospitals, clinics, traders, and other resources must be coordinated. Further, as social, economic, and business environments, as well as the probability of natural disasters occurring, change over time, the importance of establishing a Management System (MS) to maintain, undertake, and improve an area's healthcare resilience has recently begun to be recognized.

To enhance the healthcare resilience of a community, an MS for both municipality and healthcare-related organizations must be established—in this paper, we call it an Area Disaster Resilience Management System for Healthcare (ADRMS-H). However, the proper form for and best method of establishing such an ADRMS-H have not yet been determined, and so this study develops an ADRMS-H model for use by target organizations and verifies its effectiveness. As a first step, we propose an organizational structure and then describe the function of and documentation required for an ADRMS-H.

While models of management systems in various areas, such as quality and the environment, have been studied, the ADRMS model has not yet been investigated; moreover, a model for healthcare composed of multiple organizations has never been proposed. The outcomes of this study therefore assist in enhancing area healthcare resilience in several regions and contribute to fostering a safe and secure society.

In this study, the target area is the city of Kawaguchi, which is located in the southeast of Saitama Prefecture, north of Tokyo, and has a population of around 600,000 people. Possible natural disasters around this area include northern Tokyo Bay earthquake, the Kanto earthquake etc., the basic data for which has been collected. The core medical organization is the Kawaguchi Municipal Medical Center (KMMC), an acute care hospital with 539 beds, and the core disaster-based hospital, a designation which is given to only one hospital in each prefecture.

2. Approach

To design an ADRMS-H, we explored the essential healthcare functions and the organizations responsible for those functions, which not only differ from normal operations during disasters but also change over time. Therefore, all the factors to be taken account quickly accumulate: essential functions, relationships between relevant organizations, plus the type of disaster (e.g., earthquake, flood, tornado, pandemic). However, it is hard to design an ADRMS-H that can respond to every disaster and is valid for every point in time.

In this paper, we create an ADRMS-H specific to an earthquake and investigate what steps would be necessary in the hyper-acute phase, which is one to three days after the disaster. We then identify the organizations involved in the ADRMS-H and examine the relationship between them.

Most importantly, we enumerate the functions necessary to the ADRMS-H and transform them into concrete action items: examining which organizations should be responsible for those functions and specifying the information, people, and materials to be exchanged between the organizations. Furthermore, we clarify the necessary document system required for an ADRMS-H, based on the results of the analysis.

In summary, having instigated the introduction of the ADRMS-H into Kawaguchi, we analyze the activities and results of the exercises to verify the model and identify future issues.

3. Initial Healthcare Activities in the Hyper-acute Phase

3.1 Necessary functions

In preparation for designing our ADRMS-H, we first examined the initial healthcare activities in the hyper-acute phase—we will discuss the necessary organizations in section 3.2.

Several investigations were conducted to determine those functions that must be implemented to sustain the continuity of healthcare services during a large earthquake. First, we investigated the records of the Great East Japan Earthquake to understand the activities of the local municipality and hospitals following the event [1][2]. Next, we examined the regional disaster prevention plans of several cities, in which action plans were delineated for the municipality, hospitals, fire brigades, and residents; we reviewed several plans to allow for the possibility that a single plan may have omitted some essential functions [3][4][5]. We investigated Hospital MIMMS (Major Incident Medical Management and Support) which is a medical support system model in major incident) as well [6].

Furthermore, we interviewed two doctors who had provided healthcare services at hospitals when the Great East Japan and Great Hanshin–Awaji Earthquakes occurred: the interview included when, where, and how healthcare services were provided.

Consequently, we identified the numerous functions (numbered (1) to (7) in Figure 1) needed to ensure the continuity of healthcare services during the three days immediately after an earthquake.

In Figure 1, the green, yellow, and red arrows indicate the relocation of patients, while the black arrows show the relocation of the deceased. Triage, or determining treatment priority based on the severity of a patient's condition, is essential for seriously injured patients to be transported quickly to key disaster-equipped hospitals. While functions (1) to (3) represent triage, treatment, and transportation, it is also important to provide the resources (function (4)) required for continued treatment, as well as (5) Management of the Bodies of the Deceased, (6) Support Assisted Persons, and (7) Inform Residents about Medical Relief.

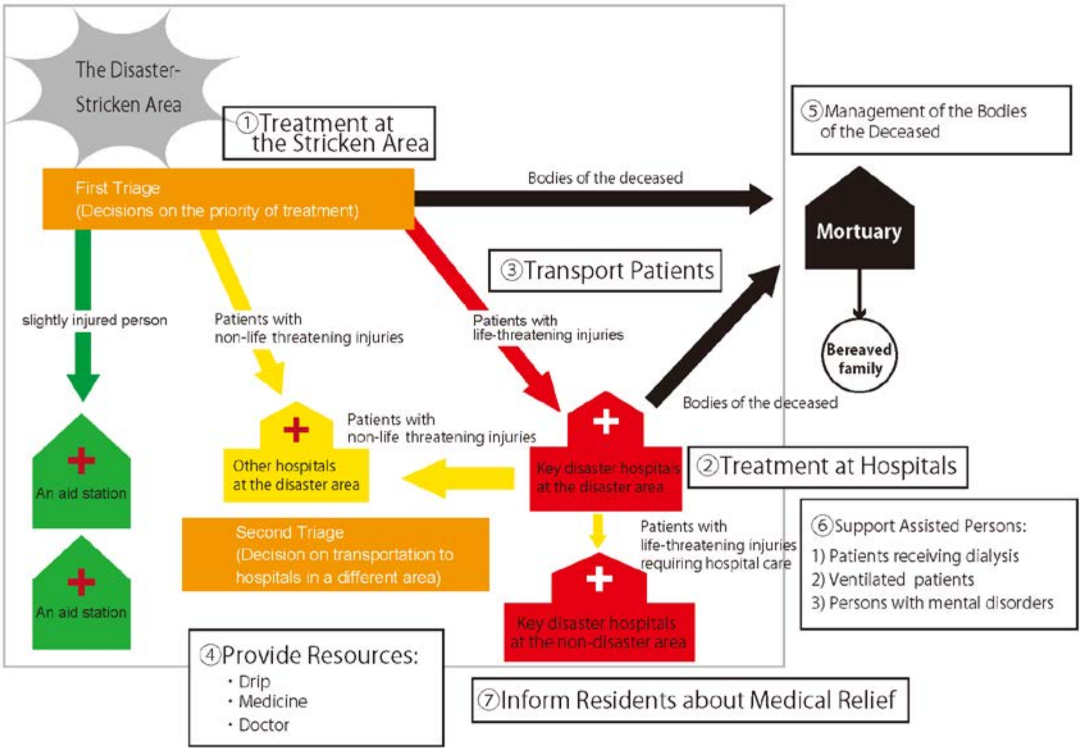


Figure 1: Initial healthcare activities in the hyper-acute phase

3.2 Necessary organizations and their interrelationship

It is difficult to conduct functions (1) through (7) without the coordination of organizations that ensure the continuity of healthcare services. Therefore, we identified the relevant organizations and clarified the relationship between both the necessary functions and these organizations.

KMMC, a key disaster hospital, continues to provide healthcare services during a disaster, and the Kawaguchi city office also plays an important role, but neither organization can implement all the essential functions alone. Therefore, we examined the organizations and traders with whom KMMC and Kawaguchi city office had made agreements with regard to disaster assistance. These organizations and traders are thus considered to be the related organizations necessary to fulfill the various functions.

We assessed the coordination between these related organizations in fulfilling the functions in Figure 1 by referring to the regional disaster prevention plan of Kawaguchi city and the agreements made with Kawaguchi city office and KMMC. The results of this assessment are shown in Figure 2.

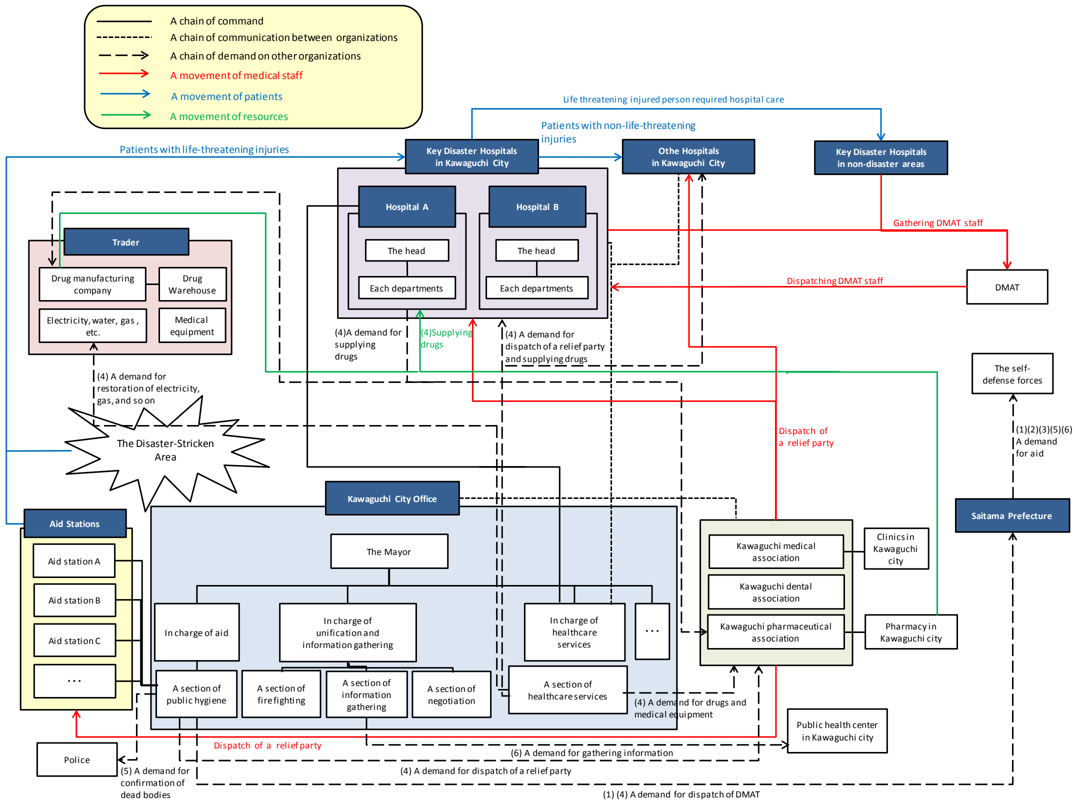


Figure 2: Coordination between related organizations

In Figure 2, the related organizations are depicted as squares, while straight lines, dotted lines, and arrows indicate the coordination between each. The organizations are Kawaguchi City Office, key disaster hospitals in Kawaguchi, other hospitals in Kawaguchi, Kawaguchi medical association, Kawaguchi dental association, Kawaguchi pharmaceutical association, traders and so on. A number on the arrow not only corresponds to the number of the function in Figure 1 but also shows the correlation between coordination and function. The type of coordination is indicated by the arrow or line (straight or dotted) and the arrow's color, and includes: chain of command, chain of communication between organizations, chain of demand from one organization to another, and supply of staff and/or medication. For example, we see in Figure 2 that coordination is needed to supply staff (doctors and nurses), medication, and other resources between multiple hospitals: to compensate for any shortages, hospitals in non-disaster areas should provide extra resources to key disaster hospitals in the disaster-stricken area.

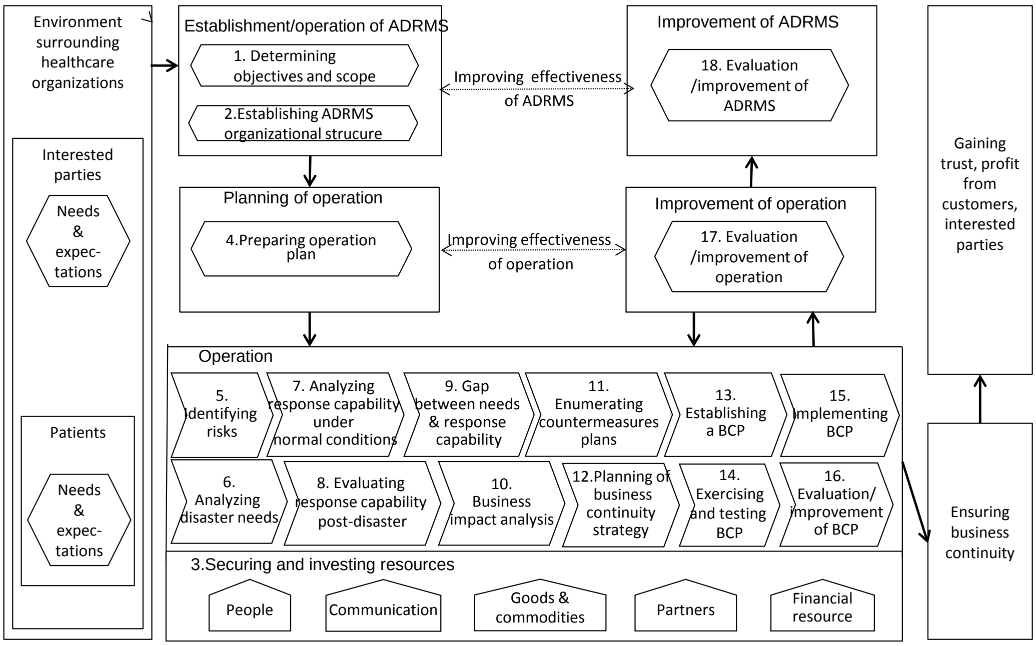
Therefore, Figure 2 clarifies the role of each organization by using both lines and arrows to depict the coordination between each that ensures continued healthcare services. For example, the role of the Kawaguchi city office is to request that: Kawaguchi medical associations dispatch a relief party, Saitama Prefecture dispatch a DMAT (Disaster Medical Assistance Team), and the police confirm the number of fatalities.

4. Designing the ADRMS-H

4.1 Enumeration of the necessary functions

We investigated several sources in order to enumerate any functions necessary for ADRMS-H, beginning with the BCP guidelines published by the government, municipalities, and hospitals. To construct the relationships between these functions, we next assessed the basic elements of each by comparing them with ISO 22301 [7], which is an international standard of BCMS, and Annex SL, which is a high-level structure for ISO management system standards. We then assigned the various functions extracted in the first step to the basic elements identified in the second step. It should be noted that all these investigations examined general ADRMS.

Finally, we defined the specific characteristics of healthcare, such as emergency procedures, increasing healthcare needs during a disaster, and added or modified the necessary functions based on these characteristics. From our analysis, we proposed a list of the ADRMS-H functions



shown in Figure 3.

Figure 3 ADRMS-H model

We verified the validity of the model by interviewing medical professionals and its comprehensiveness by checking the functions shown in Figure 3 against the case of the Great East Japan Earthquake. This verification helped to confirm that the proposed model provided a proper foundation for an ADRMS-H.

4.2 Allocation of functions

The ADRMS-H model described in section 4.1 identified the necessary functions; however, we did not clarify which organization was responsible for each function. This was achieved by means of a matrix, in which the vertical axis showed a function listed in Figure 3 and the horizontal axis an organization listed in Figure 2. We then analyzed which organization should ideally be responsible for each necessary function.

4.3 Extension beyond the hyper-acute phase

We continued with our analysis after the hyper-acute phase, using the same method described in sections 4.1 and 4.2, to clarify whether the necessary functions and related organizations change in the restoration stage. We found that the necessary functions for the normal operation of healthcare and provision of healthcare during a disaster change according to the service being provided and the ability to provide it; thus, we divided the restoration stage by type of service and ability to provide it. This stage was divided into four phases, with the hyper-acute phase defined as phase 1.

In summary, we found that the necessary functions differ from phase to phase, but the related organizations remain the same as in phase 1, which are shown in Figure 2. The details of each phase are too extensive to be described here, and so will be included in another paper.

4.4 ADRMS-H documentation system

We determined the documentation necessary based on the hierarchy of functions identified in section 4.1. As a result, we prepared an ADRMS-H documentation system with a hierarchical structure, comprising ADRMS-H regulations, ADRMS-H action plan, operation standard for disaster response, and procedure manual, including action card.

We have not yet completed all the documentation, but we are performing exercises and preparing the related documents.

5. Results and Discussion

The development of an ADRMS-H for the Kawaguchi city area was initiated in response to our proposed ADRMS-H model. The core organization in that plan is KMMC, and while the development of the plan is not complete, the related organizations are already aware of the necessity for an ADRMS-H and are in communication with one another. We found, and discuss, the following results:

(1) Introducing ADRMS-H by forming a liaison council

The ADRMS-H is an MS composed of several organizations related to healthcare provision during a disaster. Usually in organizational management, the chain of command and communication takes a top-down approach, but this is not the case where several organizations are involved. Thus, we formed a liaison council composed of representatives from each organization, under whose supervision a working group was established to actually implement the ADRMS-H.

The council discusses the role of each organization, using Figure 2, and details their responsibilities. The council also acts as a place for education.

Once the council was formed, the introduction of the ADRMS-H commenced and the related activities proceeded smoothly. Establishing a means and a place for communication thus proved valid for promoting ADRMS-H.

There is a difference in commitment between the organizations, however: for example, as the Fire Department undertake relief activities daily, it has a high level of awareness with regard to disasters; in contrast, we need to explain the problems encountered during the Great East Japan Earthquake to the Medical Association, which is a union of clinicians, to raise their awareness, because they rarely practice medicine during disasters.

(2) Exercises

As the probability of a real disaster occurring is quite low, it is essential to conduct exercises and rotate Plan–Do–Check–Act (PDCA) cycles to ensure that the ADRMS-H is valid. These exercises could take various forms, such as a triage exercise, accepting a large number of sick and wounded people. However, such exercises focus on one aspect only of disaster management, and the exercise conditions are determined by past experiences. The necessary type of exercises required to verify that ADRMS-H can work has not been clarified, therefore.

In this study, we conducted exercises for disaster responses while preparing operation standards and procedure manuals for those tasks. Thereby, we could clarify any problems in operational procedure and improve the documents.

We interviewed the participants after an exercise and analyzed the change in their disaster awareness. We found that repeating exercises can increase participants' awareness of the importance for healthcare during disasters, and thus enhance their commitment.

(3) Integration with a Quality Management System (QMS)

KMMC introduced and promoted the use of a QMS as well as the ADRMS-H. In general, as hospitals have no experience of operating a management system, it takes a long time to introduce an ADRMS-H. However, as KMMC already had a QMS, we were able to skip the explanations of necessary concepts and terms and design the ADRMS-H over a short period. We therefore argue that as a QMS and ADRMS-H are essential for every hospital, introducing the QMS is a first step to introducing the ADRMS-H.

As the QMS is in operation daily and the ADRMS-H is not, it is difficult to motivate essential personnel to maintain and practice ADRMS-H protocols. One solution could be to integrate the ADRMS-H into the QMS: for example, internal audits and management reviews could involve checking elements of both the QMS and ADRMS-H.

6. Conclusions and Future Issues

In this paper, we examined the functions and organizations necessary for ADRMS-H in initial healthcare activities during disasters, and we designed a basic framework for an ADRMS-H based on the results. We divided the restoration stage into four phases and examined the changes in functions and organizations; we found that the necessary organizations remained the same as those in the hyper-acute phase, but that the necessary functions did not. Moreover, we clarified the necessary documentation system.

Although we have just started implementing ADRMS-H, we have confirmed the validity of forming a liaison council to introduce and promote ADRMS-H. We must also periodically educate related organizations with regard to healthcare provision during disasters.

As the true validity of the ADRMS-H cannot be verified unless an actual disaster occurs, we advocate rotating PDCA cycles incorporating exercises to demonstrate the plan’s effectiveness. In fact, we can state that we have presented the foundation for the PDCA cycles in our proposed ADRMS-H model.

Continuing to introduce and refine the ADRMS-H are future issues, for as earthquakes occur frequently in Japan, interest in the ADRMS-H is growing. However, as there are various disasters occurring worldwide, verifying the validity of the model for other disasters is also a future issue.

References

[1] Ishii, T. (2012) The record of provision of healthcare services in Ishinomaki city during the Great East Japan Earthquake. Kodansha, JAPAN.

[2] Ishinomaki Red Cross hospital and Yui, R. (2011) 100 days at Ishinomaki Red Cross hospital. Shogakukan, JAPAN.

[3] Kochi Prefecture (2013) Guidelines for disaster countermeasures in healthcare. Kochi Prefecture, JAPAN.

[4] Tokyo Metropolitan Government (2012) Guidelines for business continuity plan. Tokyo Metropolitan Government, JAPAN.

[5] Tottori Prefecture (2012) Basic matters for developing business continuity plan in healthcare. Tottori Prefecture, JAPAN.

[6] Carley S. and Mackay-Jones, K. (2005) Major Incident Medical Management and Support. Blackwell Publishing, UK.

[7] ISO 22301-2012 (2012) Societal security – Business continuity management systems – Requirements. ISO.

The functions of related organizations that ensure continuous healthcare services in a disaster

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Abstract

Japan is one of the most natural disaster-prone countries in the world. In the case of a natural disaster or mass casualty incident, a large number of injured people are likely to go to hospitals. Consequently, hospitals need to provide increased healthcare services during these times. Therefore, it is necessary to coordinate with more than one hospital, municipality, medical association, pharmaceutical association, trade association, and so on. For example, coordination between multiple hospitals is important when transporting patients to another hospital if they cannot be examined at the first one. Therefore, there is a pressing need to establish Area Disaster Resilience Management System for Healthcare (ADRMS-H) to increase medical resilience. It is necessary to clarify the functions and coordination that related organizations need to perform to ensure the provision of continued healthcare services in a disaster to develop ADRMS-H. Because the needs of medical care in a disaster change by the hour, the functions required to ensure continued healthcare services change by the hour. This study aims to identify the functions that related organizations need to perform in order to ensure continued healthcare services in a disaster. The results of this paper enable the ADRMS-H model with regard to the coordination between organizations.

Keywords: Disaster medicine, Resilience, Area Disaster Resilience Management System for Healthcare (ADRMS-H), Coordination, Area

1. Introduction

Japan is one of the most natural-disaster-prone countries in the world and is especially vulnerable to large earthquakes. In such events, it is very important for Japan to consider the continuation and restoration of business. In particular, a lack of ability to provide healthcare services has a great influence on the surrounding area. In the case of a natural disaster or mass casualty incident, a large number of injured persons are likely to come to hospitals. Consequently, hospitals need to provide increased healthcare services during these times. Therefore, it is necessary to establish a medical care system that can provide continuous healthcare services in case of a disaster.

Business Continuity Planning (BCP) considers business continuity against disaster risk (ISO, 2012; Japan Institute for Promotion of Digital Economy and Community, 2013; Japanese Standards Association, 2013). When a disaster occurs, BCP ensures the continuation and restoration of business. Business Continuity Management System (BCMS) for maintaining, performing, and improving BCP are increasingly being implemented by various companies (ISO, 2012; Japan Institute for Promotion of Digital Economy and Community, 2013; Japanese Standards Association, 2013).

In the case of a natural disaster or mass casualty incident, hospitals need not only to continue providing healthcare services to the regular inpatients and outpatients but also to give medical treatment to a large number of injured persons. Thus, hospitals need to attain a balance between general medical treatment and disaster medicine. This is a feature of medical services that other businesses do not have. Furthermore, the needs of medical care in a disaster change by the hour.

Creating BCP in a single organization is not enough for dealing with the aforementioned features and to ensure the provision of healthcare services. In the case of disaster medicine, it is necessary to coordinate more than one hospital, as well as the municipality, medical associations, pharmaceutical associations, trade associations, and so on. In other words, it is difficult to continue the provision of healthcare services without the cooperation of many organizations. The following examples illustrate how coordination ensures continued healthcare services.

- Coordination between multiple hospitals is important when transporting patients to another hospital if they cannot be examined at the first one.

- Inaccessible roads during a disaster make it difficult to supply medical devices and medication. Therefore, coordination between hospitals and suppliers of pharmaceuticals and medical devices is necessary.

In order to continue the provision of healthcare services with the cooperation of many organizations, there is a pressing need to establish an Area Disaster Resilience Management System for Healthcare (ADRMS-H) to increase medical resilience.

In order to develop an ADRMS-H, we need to clarify the functions and coordination that related organizations require in order to ensure the provision of continued healthcare services in a disaster. Because the needs of medical care in a disaster change by the hour, the functions required to ensure continued healthcare services also change by the hour.

This study aims to identify the functions required of related organizations so that they can ensure continued healthcare services in a disaster, especially a large earthquake. The purpose of this paper is as follows:

- To consider how to divide phases in discussing the functions that change by the hour.
- To enumerate the functions that related organizations need to perform in each phase.
- To discuss the contribution of the results in this paper to establishing ADRMS-H model.

The results of this paper enable development of an ADRMS-H model in terms of coordination between organizations.

2. Previous studies

Several investigations by Kajihara et al. (Kajihara, 2014) have clarified the functions needed to ensure continued healthcare services during the three days immediately after a large earthquake; however, their discussion is limited to the first three days after the earthquake. The functions required to ensure continued healthcare services change by the hour because the needs of medical care in a disaster change by the hour. Therefore, it is necessary to clarify the functions during the week or month after an earthquake, based on changes in needs.

Watanabe et al. (Watanabe, 2007) proposed a development of medical management and support system against disaster in Shiga prefecture. They have shown that a medical managing and support system is divided into three phases.

- First phase: Within three hours after outbreak of disaster

- The emergency medical teams are dispatched to the disaster site in order to collect and report the firsthand information in close coordination and cooperation with both ambulance and police officers.
- Second phase: From three hours to three days after outbreak of disaster
- The emergency medical team triages and treats the injured, and then transports seriously injured persons rapidly and systematically to key disaster hospitals.
- Third phase: After three days of disaster
- Medical and health management with various support systems should be provided to the injured for medical and psychological care.

Bureau of Social Welfare and Public Health, Tokyo Metropolitan Government (Bureau of Social Welfare and Public Health, 2015) has divided a disaster response into six phases by the hour. Furthermore, both the needs of medical care and the medical activities that hospitals should provide have been clarified by each phase.

Several organizations have introduced a timeline, which is a disaster prevention plan based on time scales (Iijima, 2014). For example, the state of New Jersey dealt with Hurricane Sandy that hit the US in 2012 along a timeline. As a result, they succeeded in reducing the damage.

Thus, WATANABE et al. and Tokyo Metropolitan Government have clarified the disaster response of each phase. However, both of these sources focus on disaster medicine rather than general medical treatment. When disaster occurs, providing both general medical treatment and disaster medicine is important. This paper, therefore, discusses the need for and functions of general medical treatment and disaster medicine.

Moreover, previous authors have divided phases by time elapsed after a disaster, but the response times in a disaster differ depending on its scale. Therefore, this paper analyzes both the changes in the provision of healthcare services and changes in medical management and the support system, and then determines the phases based on the results of the analysis.

3. Functions of related organizations for ensuring continued healthcare services

3.1 The division of phases

The establishment of an ADRMS-H model aims to ensure that healthcare services are continued in a disaster. When a disaster occurs, the needs for healthcare service increase. On the other hand, hospitals' capability for providing healthcare services decreases because hospitals in the disaster area suffer significant damage. We therefore discuss how to reduce the gap between the need for healthcare services and the capability of hospitals for providing healthcare services in order to ensure continued healthcare services in a disaster.

Hospitals' ability to provide healthcare services against the overwhelming need for them during a disaster is limited. Therefore, we considered a change in healthcare services that hospitals in a disaster area will be able to provide within the resource limits and with the cooperation of related organizations. We then considered it by focusing on both general medical treatment and disaster medicine.

Hospitals experience a sharp decline in their capability to provide healthcare services during the first few weeks after a disaster. It is necessary to obtain the cooperation of related organizations and non-disaster areas. Hence, we considered a change in medical management and support systems for continuation of healthcare services with the cooperation of non-disaster areas, and so on.

We considered the changes in both, the healthcare services as well as medical management and support systems, by using the following data:

- There are many reports or records on the Great East Japan Earthquake and Great Hanshin/Awaji Earthquake. The reports show results of efforts by many hospitals at the disaster stricken areas. This study referred to the reports "The record of provision of healthcare services in Ishinomaki city during the Great East Japan Earthquake (Ishii, 2012)" and "The report on the Great East Japan Earthquake at Sendai City Hospital (Sendai City Hospital, 2012)," to understand the activities of the hospitals.
- We reviewed several guidelines for disaster countermeasures in healthcare (Kochi, 2013; Tokyo, 2012; Tottori, 2012).
- We investigated Hospital MIMMS (Major Incident Medical Management and Support), which is a medical support system model to tackle major incidents (Carley, 2005).

We analyzed the provided healthcare services, the time taken to provide healthcare services, and the medical management and support systems, by utilizing the aforementioned literatures. Subsequently, we arranged the provided healthcare services in the order of provision, and developed a list of the medical management and support systems that corresponded to the provided healthcare services. As a result, we divided the phases by considering both changes in the healthcare services that hospitals will be able to provide and changes in the system. The results of these considerations are shown in Table 1.

Table 1. A change in both provided healthcare services and medical management and support system

		Phase 1	Phase 2	Phase 3	Phase 4
Changes in provided healthcare services	Disaster medicine	・Lifesaving ・First aid at stricken area	・Emergency and critical care to injured persons − Transport seriously-injured persons to non-disaster areas ・Autopsy ・Support for assisted persons - Patients receiving dialysis - Ventilated patients, etc.	・Continue to treat the injured ・Continue to provide support for assisted persons ・Treat for chronic diseases - Prescribe medicine ・Treat persons with mental disorders	・Continue to treat persons with mental disorders ・Receive patients who are then transported to other areas
	General medical treatment	・Ensure safety of both inpatients and outpatients ・Life-support treatment ・Scaling back of general medicine - Stop outpatient care - Stop receiving new inpatients	・Provide minimum required treatment to inpatients ・Implement emergency tests	・Resume scheduled tests and operations ・Resume outpatient care	・Resume reception of new patients
Changes in medical management and support systems		(Hospitals in disaster area) ・Deal with treatment using only staff in hospitals (Disaster-stricken area) ・Lifesaving with one's fellow residents ・Fire fighters and police officers are dispatched to the disaster site for lifesaving purposes	・Receive resources from non-stricken area - Disaster Medical Assistance Team (DMAT) - Medicine - Equipment ・Request to accept emergency patients	・Request for support from Red Cross and neighboring clinics ・DMAT withdraws from disaster stricken area	・Red Cross withdraws from disaster stricken area ・Suppliers are restored

We divided phases into four sections based on the results of the changes in both provided healthcare services, and medical management and support systems (see Table 1).

First, we explained disaster medicine. Because the number of injured patients, especially externally injured persons, increases suddenly <u>immediately</u> after a big earthquake, it is necessary to treat the patients in phase 1 and phase 2. Furthermore, patients with life-threatening injuries, as well as those receiving dialysis and so on, need to be transported to hospitals in non-disaster areas. It is difficult for hospitals in a disaster area to provide enough healthcare services because a disaster area has limited resources. Although the number of externally injured persons decreases slowly over several days, medical staff still has to treat patients with chronic diseases in such matters as routine prescription of medicines. After a disaster occurs, many people are forced to live as refugees. As a result, the number of patients who suffer from mental stress increases. Therefore, it is also important to take care of persons with mental disorders. In phase 4, hospitals in stricken area should accept patients who are transported to other areas.

Next, we explained general medical treatment. It is necessary for the staff in a hospital to ensure the safety of inpatients, outpatients, and visitors when disaster occurs. In order to receive injured persons, hospital should scale back in providing general medical treatment by stopping both care to outpatients and acceptance of new inpatients. Hospitals should limit treatment to inpatients to the minimum required when they are receiving injured persons. Then, step by step, hospitals can resume emergency tests, scheduled tests and operations, outpatient care, and receiving new inpatients.

Finally, we explained a medical management and support system. Because support teams are not dispatched from outside the area immediately after a disaster, the staff from hospitals in the disaster area, people's neighbors, and the municipality must provide the initial treatment. In the case of a big earthquake, medical assistance teams are dispatched to disaster stricken areas from other areas. In particular, Disaster Medical Assistance Teams (DMAT) are dispatched to the disaster site in order to triage and treat the injured within a few hours after the disaster, but DMAT is limited to providing emergency and critical care. Therefore, it is necessary to continue providing healthcare services in temporary refuges with the cooperation of the Red Cross, neighboring clinics, and so on.

3.2 Identify the functions of each phase to ensure continued healthcare services

We considered the functions of each phase that related organizations need to perform in order to ensure continued healthcare services in a disaster within the limits of the medical management and support system shown in Table 1. We referred to several records of and guidelines based on the Great East Japan Earthquake, as well as Table 1. We also examined the regional disaster prevention plan of several cities, in which action plans were delineated for the municipality, hospitals, fire brigades, and residents. The functions of phases 2 and 3 are shown in Figures 1 and 2 as an example.

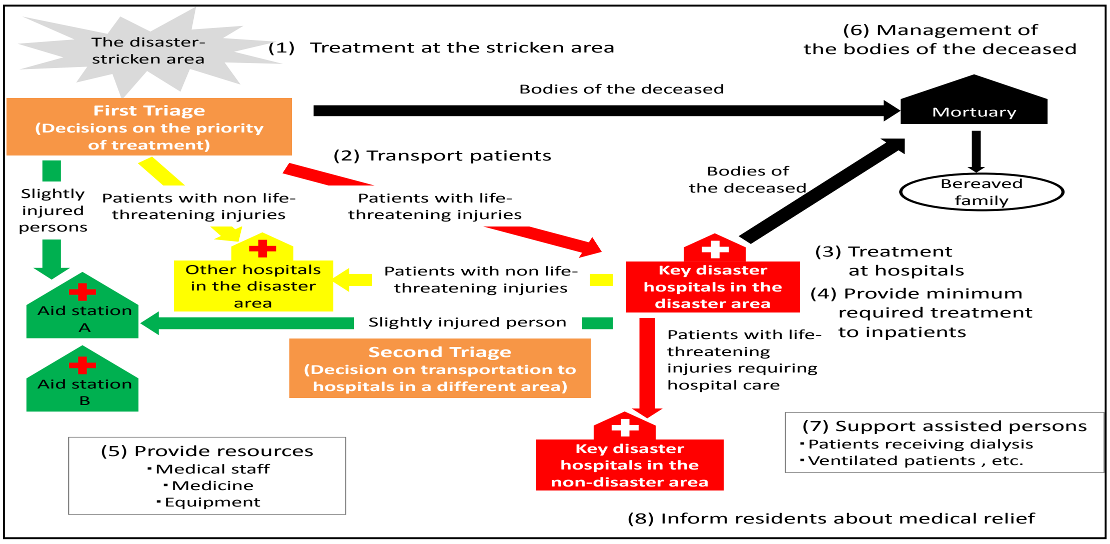

Fig. 1. The functions of phase 2

A detailed explanation of Figure 1 is offered as an example. In Figure 1, the arrows indicate the relocation of patients, bodies of the deceased or medical staff. The required functions are shown from (1) to (8). Triage—determining the priority of treatment depending on the severity of a patient's condition—is very important, and seriously injured patients need to be transported quickly to key disaster hospitals. Functions (1) through (4) are triage, treatment, and transportation. To ensure continued treatment, it is important to (5) provide resources, (6) manage the bodies of the deceased, (7) support assisted persons, and (8) inform residents about medical relief. The functions of other phases were identified similarly.

It is possible to identify the functions of each phase that related organizations need to perform in order to ensure continued healthcare services in a disaster with regard to both general medical treatment and disaster medicine.

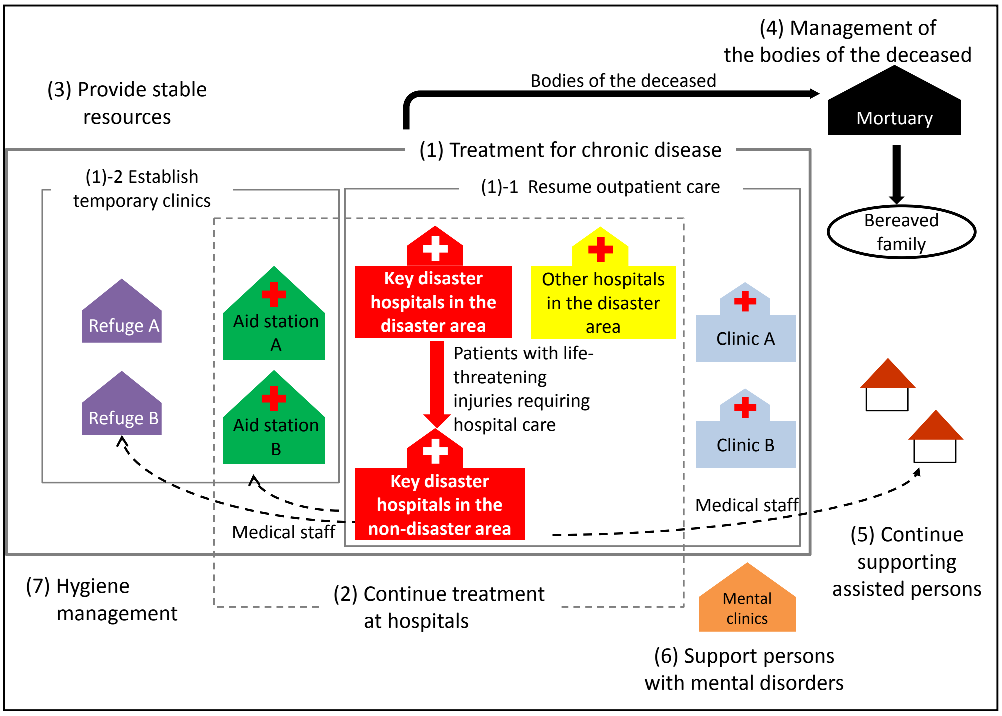

Fig. 2. The functions of phase 3

3.3 Identify the detailed functions

Figure 1 shows the functions of phase 2 and Figure 2 shows the functions of phase 3. However, the detailed functions and coordination have not been clarified. As a result, it is difficult to identify the role of related organizations.

Several investigations were conducted to consider the detailed functions required from related organizations to ensure that healthcare services are continued. First, we investigated records of the Great East Japan Earthquake to understand what the municipality and hospitals did when the earthquake occurred. Next, we investigated the regional disaster prevention plans of several cities, which delineate action plans for the municipalities, hospitals, fire brigades, and residents in a disaster. We investigated the plans of several cities because it is possible that the plan of one city may omit necessary functions. Prefectures and cities in the disaster stricken area released the records on the earthquakes and regional disaster prevention plans on their websites. We examined the websites of the prefectures and cities in the Great East Japan Earthquake stricken area. We identified the roles of each organization, such as municipalities, hospitals, and so on, from the records, and then examined the coordination between the organizations while effectively providing healthcare services and efficiently implementing the disaster prevention plans.

Furthermore, we interviewed two doctors who provided healthcare services at hospitals when the Great East Japan and Great Hanshin/Awaji Earthquakes occurred. We conducted a cooperative study with 10 hospitals, over about 10 years. We asked the doctors of the collaborating hospitals to participate in the interview. The interview items included when, where, and how healthcare services were provided during each earthquake.

As a result of several investigations, we developed (1) – (8) functions, as shown in Figure 1 in more detail to clarify the detailed functions. Table 2 shows these functions of phase 2.

We developed only the functions of phase 2 shown in Figure 1. Therefore, we will need to develop the functions of phase 1, phase 3, and phase 4 as in Table 2.

Table 2. The detailed functions ensuring continued healthcare services

Functions shown in Figure 1	Detailed Functions	
	First Hierarchy	Second Hierarchy
(1) Treatment at the Disaster Area	(1)-1 Gather the information on damages	Grasp the number of injured persons in target city
		Grasp the situation in relation to damages to hospitals and clinics etc.
		Grasp the traffic conditions
		Grasp the conditions of electric, gas, and water
	(1)-2 Establish aid stations	Decide places for the establishment of aid stations
		Dispatch a temp for the establishment of aid stations
		Provide resources to aid stations
	...	...
	(1)-4 Provide treatment	Implement first triage
		Take temporary measures
		Confirm amount of dead
(2) Transport Patients	(2)-1 Establish Stage Care Unit (SCU)	Decide places for the establishment of SCU
		Provide resources to SCU
		Establish SCU
	(2)-2 Secure a means of transportation	Demand ambulances
		Demand police cooperation
	...	...
(3) Treatment at Hospitals	(3)-1 Treatment at key disaster hospitals in the disaster area	Implement second triage
		Receive DMAT (Disaster Medical Assistant Team)
		Treat patients with life-threatening injuries
		Decide the patients to be transported to other hospitals
	(3)-2 Demand admission of patients needing hospital care at other hospitals	Look for other hospitals to take patients
		Demand admission of patients
	...	...
...	...	...

4. Discussion

4.1 The significance of this study

It is necessary to coordinate more than one hospital, municipality, medical association, pharmaceutical association, trade association, and so on in order to ensure continued healthcare services in a disaster. An ADRMS-H model is urgently needed to achieve coordination among related organizations. It is difficult to discuss elements of the ADRMS-H model before identifying the functions needed from related organizations for ensuring continued healthcare services. This study has attempted to identify the functions that ADRMS-H model should fulfill.

In the previous study, we only proposed the functions of Phase 2. However, the functions required to ensure continued healthcare services change by the hour. Therefore, we expanded the scope of the phases and identified the functions of Phase 1 to 4.

WATANABE et al. and so on have proposed medical managing and support systems and the activities that related organizations need to perform when disasters occur. However, most papers have focused only on disaster medicine activity. In order to continue the provision of healthcare services in a disaster, it is very important to attain a balance between general medical treatment and disaster medicine. This study has enumerated the required functions for focusing on both medical treatments. The results of this study, therefore, enable consideration of continuity in providing healthcare services more effectively than conventional methods.

Furthermore, WATANABE et al. and Bureau of Social Welfare and Public Health, Tokyo Metropolitan Government have divided phases according to the time elapsed from the disaster occurrence. However, the response time against a disaster differs depending on the scale of the disaster. For example, in the case of a small-scale disaster, transporting injured persons to key disaster hospitals will be finished in a few days. In a large-scale disaster, however, the period for transportation will extend to a few weeks. Therefore, it is not effective both to divide phases according to time and to discuss the functions in each phase because of the differing scales of disasters. Thus, this study aimed to focus on the gap between the needs of healthcare services and the capability of hospitals to provide them. Then, the phases are divided by the changes in both the provided healthcare services and the medical management and support system.

However, we have not yet verified the comprehensiveness of the proposed functions. Future issues include confirming whether or not all of the required functions are shown in Figures 1 and 2 before establishing an ADRMS-H model. We will investigate the records from big earthquake to understand the activities performed by related organizations in order to provide healthcare services. Then, we will confirm that the proposed functions correspond to the investigated activities.

4.2 Matrix of functions and related organizations

It is difficult to establish an ADRMS-H model with only the functions required to ensure continued healthcare services. First, we would need to identify the area of application for the ADRMS-H model. Thus, we need to enumerate related organizations that perform the functions of each phase, as in Figures 1 and 2. For example, the related organizations are municipalities, hospitals, medical associations, traders, and so on. Next, it is necessary to clarify both the role of each related organization and the coordination between certain organizations.

Such a matrix of functions and related organizations would enable us to identify the role of each organization. Therefore, in future research, we will need to create this matrix. Furthermore, it will be necessary to establish an ADRMS-H model so that functions can be fulfilled by related organizations, which will continue providing healthcare services effectively and efficiency.

5. Conclusion and future issues

This study has clarified the functions that related organizations need to perform to ensure continuation of healthcare services in a disaster. First, we analyzed the changes in both the provided healthcare services and the medical management and support system. Second, we divided the phases into four sections according to the aforementioned changes. Third, we discussed the functions of each phase to ensure continued healthcare services, thereby apprehending needed changes in the functions of each phase. Finally, we developed the detailed functions. The results of this study may enable identification of the functions that an ADRMS-H should fulfill.

In future research, we need to enumerate related organizations to ensure that healthcare services are continued in a disaster. Moreover, we need to create the matrix described in section 4.2. Both the role of each organization and the coordination between organizations will be clarified by means of this matrix.

6. References

Bureau of Social Welfare and Public Health, Tokyo Metropolitan Government, accessed 20 March 2015,

http://www.fukushihoken.metro.tokyo.jp/iryo/kyuukyuu/saigai//>.
Carley S. and Mackay-Jones, K. 2005, Major Incident Medical Management and Support, Blackwell Publishing, UK.
Iijima, N., 2014, Formulation of a timeline for large scale disaster, Public Works Management Journal (December, 2014), 27-29.
Ishii, T., 2012, The record of provision of healthcare services in Ishinomaki city during the Great East Japan Earthquake, Kodansha, JAPAN.
ISO 22301-2012, Societal security – Business continuity management systems – Requirements, ISO.
Japan Institute for Promotion of Digital Economy and Community, 2013, BCMS User's Guide – Corresponding to ISO22301:2012-, Japan Institute for Promotion of Digital Economy and Community, JAPAN.
Japanese Standards Association, 2013, Societal security –Business continuity management systems- Guidance (A translation printed side by side with the original text), Japanese Standards Association, JAPAN.
Kajihara, C., Munechika, M., Sano, M., Kaneko, M., 2014, The functions of related organizations that ensure continuous healthcare services in a disaster for Business Continuity Planning (BCP), Proceedings of 58th EOQ Congress Gothenburg, CD-ROM.
Kochi Prefecture, 2013, Guidelines for disaster countermeasures in healthcare, Kochi Prefecture, JAPAN.
Sendai City Hospital, 2012, The report on the Great East Japan Earthquake at Sendai City Hospital, Sendai city.
Tokyo Metropolitan Government, 2012, Guidelines for business continuity plan, Tokyo Metropolitan Government, JAPAN.
Tottori Prefecture, 2012, Basic matters for developing business continuity plan in healthcare, Tottori Prefecture, JAPAN.
Watanabe, S., Hase, T., Hirose, K., Hukui, M., Yamasiki, Y., Akitomi, S., Ukai, S., 2007, Development of Medical Management and Support System Against Disaster in Shiga Prefecture, Japanese Journal of Disaster Medicine, Vol.12, No.1, 62-73.

Policy Analysis in Prioritising Societal Challenges- the Case of Sri Lanka

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Abstract

The 30-year war ended in Sri Lanka in 2009. Country is now heading towards local, regional and national development through the development of infrastructure and services. However, there are obstacles along the way in achieving the required development targets set by the different levels of governments. These obstacles, for the purpose of this paper, can be identified as ‘societal challenges’. According to the largest ever research and innovation programme of the European Union named as Horizon 2020, there are seven areas of societal challenges, i.e. Health, demographic change and wellbeing; Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy; Secure, clean and efficient energy; Smart, green and integrated transport; Climate action, environment, resource efficiency and raw materials; Inclusive, innovative and reflective societies; and Secure societies. According to the EU, these seven societal challenges that need to be addressed for a country to prosper and move towards development. However, especially for a developing nation like Sri Lanka it is difficult to address these seven challenges all at once. It should happen as a systematic approach on a long-term basis. The paper, in this context, intends to investigate, of the seven challenges, which is/are the critical societal challenge(s) to be addressed first in the case of Sri Lanka. This is investigated using a questionnaire survey. Addressing the challenges needs to happen as a top-down approach. One of the first steps towards that is the implementation of effective policies. Therefore, the main focus of the questionnaire survey is to assess the availability and effectiveness of policies in relation to addressing the societal challenges. The survey was conducted among 54 Sri Lankan experts on the seven areas of challenges.

The findings reveal that secure societies is the most critical challenge to be addressed followed by climate action. According to the policy analysis, ‘health, demographic change and wellbeing’ is identified as the challenge, which has the highest number of related policies whilst the inclusive, innovative and reflective societies have the least.

It is further revealed that the correlation between the availability of policies and their effectiveness are not always linear.

Keywords: Societal Challenge; Policy Analysis; Questionnaire survey; Sri Lanka

1. Introduction

By 2050, the world population may reach nine billion people, and two fifths of that population will be over 50 years old. Three quarters of the global population will live in cities, and over 60% will live in small households - alone or with just one other person. These profound demographic changes will take place in the course of just a few decades. In this context, Horizon 2020, the biggest European Union (EU) Research and Innovation programme aims to solve some of society’s biggest challenges, from ageing populations to the need for clean energy, and keep Europe’s economy competitive over the long term. It mainly focuses on the following seven societal challenges:

1. Health, demographic change and wellbeing
2. Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy
3. Secure, clean and efficient energy
4. Smart, green and integrated transport
5. Climate action, environment, resource efficiency and raw materials
6. Europe in a changing world - inclusive, innovative and reflective societies
7. Secure societies - protecting freedom and security of Europe and its citizens

Within the context of societal challenges, the EU has initiated a strategic policy action under the Horizon 2020 scheme to strengthen international collaboration and to address these societal challenges with other countries. This is important not just in order to develop stronger linkages with emerging research and innovation hubs in Asia, Latin America and Africa, but also to benefit from new opportunities presented through international cooperation in Science, Technology and Innovation in a proactive manner [1]. However, Annerberg et al. [2] noted that there is a need for further enhancing international cooperation activities focused on ‘engaging with partners outside of Europe on equal terms and in programmes and activities of high mutual interest' and also highlighted the need for linkages with Asian countries given the region's rapidly growing research and innovation capacities and the urgency to address global challenges. In particular, there are poor levels of focus on the South Asian region.

South Asia, which is home to more than 40% of the world's absolute poor, will contribute nearly 40% of the growth in the world's working-age population over the next several decades [3]. Given this, an FP7 project on 'Collaborative Action towards Societal Challenges through Awareness, Development, and Education – CASCADE' was initiated to identify and prioritise societal challenges of mutual EU-Southern Asian interest as the basis for future bi-regional cooperation.

CASCADE is an opportunity for raising awareness of the potential for EU-Southern Asia cooperation and stimulating regional and international participation. With the active contribution of South Asian countries, the project attempts to pave the way for more advanced, inclusive and innovative societies. This paper is based on some of the findings relating to this project. Although the project focused wholly on South Asian Region, this paper will focus on the context of Sri Lanka. The discussions on the paper will be three-fold, firstly, an in-depth introduction to the societal challenges is provided. Secondly, the methodology adopted for the policy analysis is explained. Finally, the findings obtained from a policy analysis; finally, conclusions are presented to summarise and deduce the overall situation with regard to societal challenges in the context of Sri Lanka.

2. Societal challenges in Europe

This section provides an overview of the seven key societal challenges of Europe identified under Horizon 2020 scheme.

2.1 Challenge 1- Health, Demographic Change and Wellbeing

With decreases in some causes of death and also due to advances in preventive healthcare and socioeconomic and living conditions, significant improvements in the health of the European population were visible in recent decades [4]. However, with a rapidly ageing population, maintaining the improved health and wellbeing conditions have become an increasing burden in Europe [5];[4]. Brain disorders and diseases such as antimicrobial resistance have been identified as critical challenges which cost billions to EU society [5]. Therefore, the need of investing in research and innovation in the area to provide better health for all is significant.

2.2 Challenge 2- Food Security, Sustainable Agriculture and Forestry, Marine and Maritime and Inland Water Research, and the Bioeconomy

Europe has a very stable food security environment compared with the other regions of the world, which is placed second among the six regions ranked in the 2014 Global Food Security in terms of all three core areas assessed by the index: Affordability, Availability, and Quality & Safety [6]. Yet, Europe faces major challenges with its food production, consumption, processing, storage, recycling and disposal of biological resources because of the increasing population, decreasing fossil and food resources, increasing environmental pressures and climate change [5].

A transition is needed towards an optimal and renewable use of biological resources and towards sustainable primary production and processing systems to tackle these challenges and the bioeconomy has been identified as the key to this shift.

2.3 Challenge 3- Secure, Clean and Efficient Energy

With few energy reserves of its own, the EU has to import over half of its energy requirements making it the world's largest energy importer, consuming one fifth of the planet's reserves [5]. High energy consumption results in energy-related emissions which account for almost 80% of total greenhouse gas emissions in the EU that in turn contribute to global warming.

In this context, it is essential for EU to shift towards a reliable, sustainable and competitive energy system. Demonstrating its commitment towards this shift, the European Union decreased its CO2 emissions by 1.6% in 2012 compared to 2011 [7]. However, in order to make a steadier transition, the EU needs to further tackle challenges such as increasingly scarce resources, growing energy needs and climate change.

2.4 Challenge 4- Smart, Green and Integrated Transport

Transport is a significant sector for sustainable wealth and prosperity of Europe. However, the transport systems and practices in Europe are not sustainable [5]. They are over relying on fossil fuels for power, a resource which is environmentally unfriendly and also will become scarcer. Although the total amount of energy consumed throughout the world has remained relatively stable since 1973, consumption in the transport sector has increased by 23%, with the largest increase coming from road transport [8]. In 1998 in UK only, 42% of the country's energy cost was linked to the transport sector only on its direct energy consumption, i.e. vehicle operation [8]. Accordingly, Horizon 2020 aims to improve the conditions involved and achieve a European transport system that is resource efficient, climate and environmentally friendly, safe and seamless for the benefit of all citizens, the economy and society.

2.5 Challenge 5- Climate Action, Environment, Resource Efficiency and Raw Materials

Natural resources such as raw materials, water, air, biodiversity and terrestrial, aquatic and marine ecosystems in Europe are constantly under pressure from climate change, urbanisation, pollution, overexploitation of resources [5]. It is estimated that heat-related deaths could reach about 200 000 per year in Europe by 2100 if climate change adaptation actions were not implemented whilst the cost of river flood damages could be more than EUR 10 billion a year [9]. In this context, activities supported by Horizon 2020 aims to help increase European competitiveness, raw materials security and improve wellbeing whilst assuring environmental integrity, resilience and sustainability.

2.6 Challenge 6- Europe in a Changing World - Inclusive, Innovative and Reflective Societies

Europe faces critical challenges in reducing inequality and social exclusion, overcoming the economic and financial crisis and tackling unemployment. An estimated 80 million people are at risk of poverty in Europe whereas 14 million young people are not in education, employment or training in the region [5]. Horizon 2020 programme aims at fostering a greater understanding of Europe, by providing solutions and support inclusive, innovative and reflective European societies with an innovative public sector in a context of unprecedented transformations and growing global interdependencies.

2.7 Challenge 7- Secure Societies – Protecting Freedom and Security of Europe and its Citizens

Ensuring the security of its citizens is one of the primary obligations of European states. In fulfilling the obligation, fighting crime and terrorism, protecting the citizens against natural or man-made disasters, providing effective cyber-security and protecting borders against illegal trafficking have been identified as the main issues to be tackled [5]. For example, the number and impacts of disasters have increased in Europe in the period 1998-2009 and the increase can be explained to a large extent by higher levels of human activity and accumulation of economic assets in hazard-prone areas [10]. Therefore, undertaking research and innovation activities needed to protect citizens, society and economy of the EU as well as its infrastructures and services, prosperity, political stability and wellbeing are critical in the region.

3. Methodology

CASCADE is an 18-month project, which ended in March 2015. The project had the participation of all seven South Asian countries (except India) including Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan and Sri Lanka.

The work carried out as part of the CASCADE project was divided into three phases. Phase 1 consisted of a policy analysis, Phase 2 of the study was carried out using semi-structured interviews and focus groups; and Phase 3 of the study was based on a stakeholder analysis. This paper presents the some of the findings obtained during Phase. During Phase 1 of the project a questionnaire survey was administered during a major Horizon 2020 Launch event targeted for the South Asian region by the EU. The participants of the event were either academics who have knowledge on societal challenges, experts on different areas of societal challenges or policy makers/government officials who are responsible in addressing these societal challenges within the South Asian region. The questionnaire was distributed to all 146 participants who attended the event, however, received only 67 responses back (33.5%). Of the 67 respondents, 54 (80.6%) were from Sri Lanka (see Table 1); one of the main reasons for this could be that the event was held in Colombo, Sri Lanka, thus there was, obviously, a high participation from there. Due to the low response rate from other countries, the findings presented in this paper are only based on the context of Sri Lanka.

Table 1:Distribution of respondents from targeted South Asian Countries

Country	Frequency	Percentage
Afghanistan	2	3.0
Bangladesh	1	1.5
Bhutan	1	1.5
Hong Kong	1	1.5
Maldives	3	4.5
Nepal	1	1.5
Pakistan	1	1.5
Sri Lanka	54	80.6
Thailand	1	1.5
United Kingdom	2	3.0
Total	67	100.0

The purpose of the questionnaire survey was to find answers to the following key questions (close-ended):

1. What is/are the areas that pause a main challenge for your country as a whole? Please rank the answer using 1 to 7 (1 for the biggest challenge and 7 for the least challenge).
2. Are there any policies available in the following areas of societal challenges? If the answer is 'Yes', please rate the level of effectiveness of these policies according to a 6-point likert scale, i.e. 1 – Very high level of effectiveness, 2 - High level of effectiveness, 3 – Medium level of effectiveness, 4 - Low level of effectiveness, 5 – Very low level of effectiveness, 6 – Not effective.

Before presenting the findings with regard to Questions 1 and 2 above, it is worthwhile carrying out a demographic analysis of the respondents to identify any bias, if any, in the survey sample.

3.1 Demographic characteristics of respondents

Table 2 shows the sector the respondents work. It is revealed that about 83% of the respondents are from the academia, whilst others are either industry experts (9.3%) or policy makers/government officials (7.4%). This shows that the expertise of the academia will be reflected in the responses heavily. This will also affect the final results. On a positive note, since a majority of the respondents are from academia, it can be assumed that most of the findings will be based research evidence. Thus, it could be assumed that the final results will be more valid and reliable.

Table 2: Sector of the respondents

Profession		Frequency	Percentage	
Academic		45	83.3	
Non Academic	**Private**	5	9.3	16.7
	Public	4	7.4	
Total		54	100.0	

With respects to respondents' experience, Table 3 provides a summary of years of professional experience. More than half of the respondents (51%) have high level of experience in the subject area/s (i.e. more than 10 years of experience); and about ¾th of the respondents (76.5%) have more than 5 years of experience. This implies that the responses are not based on mere assumptions, but are based on valid and reliable evidence based on their years of experience.

Table 3: Respondents' level of experience

Experience	Years	Frequency	Percentage
Low level experience	< 5	12	23.5
Medium level experience	5-10	14	25.5
High level experience	>10	28	51.0
Total		54	100.0

Table 4 provides an overview of the respondents' main expertise with regard to each and every area of societal challenge. This shows that majority of them (25.9%) have the knowledge and expertise on Challenge 1. The results, therefore, may have slight bias towards Challenge 1. However, the questions in the questionnaire were asked to reduce this bias in some ways, as this, i.e. majority of participants could come a particular area of challenge, was anticipated during the questionnaire design. Except Challenge 1, (moreover) similar number of respondents exists in all the other challenges (5 – 8 respondents). Given this, it could be assumed that there will be no major variations in the responses.

Table 4: Respondents' area of work

Challenge	Area of work	Frequency	Percentage
1	**Health, demographic change and well-being**	14	25.9
2	**Food Security, sustainable agricultures, marine and maritime research and the bio-based economy**	6	11.1
3	**Secure, clean and efficient energy**	6	11.1
4	**Smart, green and integrated transport**	5	9.3
5	**Climate action, resource efficiency and raw materials**	8	14.8

6	**Inclusive, innovative societies**	8	14.8
7	**Secure Societies**	7	13
Total		54	100.0

4. Findings and discussions

The 30-year war ended in Sri Lanka in 2009. Country is now heading towards local, regional and national development through the development of infrastructure and services. However, there are inherent obstacles in achieving the required development targets set by the different levels of governments. Effects of climate action affect most part of the Sri Lanka, Colombo in particular, faces frequent flash flooding due to heavy rainfall. Sri Lanka is mainly an agriculture-based economy and the climate change severely affects the agriculture in the country. Indian Ocean tsunami of 2004 also affected coastal communities in parts of Sri Lanka. Remoteness and high transport costs also constitute severe economic disadvantages to the country. Likewise many areas of societal challenges are very much pertinent to the Sri Lankan context. However, addressing all challenges at once is impossible due to many reasons. Lack of funds/resources could be one of the main reasons; thus, substantial investments are needed for reconstruction and rehabilitation of infrastructure in the post-war era. Even on occasions where funds are available, the lack of institutional capacity often results in poor mobilisation and management funds. Lack of institutional capacity means that there are inadequacies in terms of ‘accountability and transparency of institutions’ needed to prevent the misuse of funds [11]. Further reasons include, inter alia, lack of access to technological developments and innovative solutions.

Given all the reasons mentioned above, addressing the societal challenges need to happen in a step-by-step approach. For that, priority areas of challenges need to be identified as one of the first steps of post-war recovery. The main purpose of this questionnaire survey, as mentioned in the previous section, was therefore to, 1) identify main societal challenges in the context of Sri Lanka, and 2) availability of policies in addressing these challenges (and their level of effectiveness). The findings according to these two key areas are given below in sub-sections.

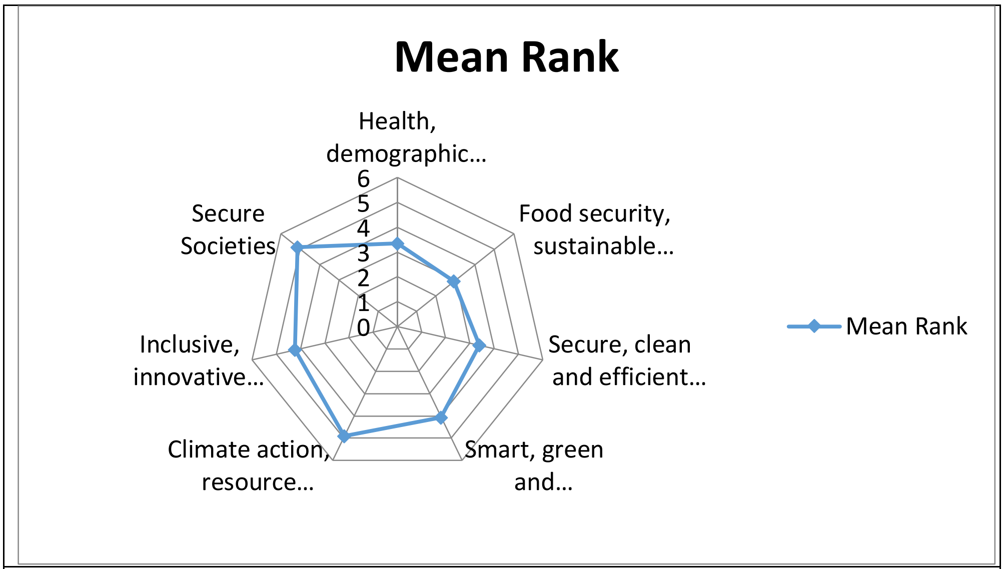
4.1 Question 1 - Main challenges

In order to understand the ranking of the challenges in the context of Sri Lanka, the Kendall’s W Test is computed and is presented in Figure 1 below. According to Figure 1, the biggest challenge appears to be ‘Challenge 2 - Food Security’ with a mean value of 2.92. Although Sri Lanka is primarily agriculture-based, the contribution of the agricultural sector to the GDP is declining gradually, highlighting the need to develop a sustainable, competitive agriculture sector. To add to the issue of declining agriculture, all natural forests are continuing to decline as well. Food safety is another issue under Challenge 2, as it happens in Sri Lank in an ad-hoc manner, with responsibility being dispersed to a number of government agencies and departments.

Therefore, a need exists in relation to formulating an overarching independent body (e.g. Food Safety Authority). The 2nd biggest challenge according to the Kendall's test is 'Challenge 1 – Health'. In the context of Sri Lanka, the main challenges faced by the health system include the growing burden of Non-Communicable Diseases (e.g. diabetes, mental health problems) and providing rehabilitation and long-term care, especially for the elderly.

Lack of awareness on health matters has exposed certain number of vulnerable groups to relatively high health risks as well. There is a lack of coordination and collaboration amongst different sectors in the provision/promotion of healthcare, as well as insufficient leadership, support and authority given in relation to health promotion to provincial governments. In terms of critical challenges, Challenge 1 is followed by 'Challenge 3 - Secure, clean and efficient energy' with a mean value of 3.4; 'Challenge 4 - Smart, green and integrated transport with a mean value of 4.06; and 'Challenge 7 - Inclusive, innovative societies with a mean value of 4.23.

As revealed in Figure 1, secure societies ranked the lowest with a mean value of 5.14. This shows that 'Challenge 6 - secure societies' is not a critical challenge in the post-war context of Sri Lanka. This is followed by 'Challenge 5 - Climate action' with mean value of 4.91, which means Challenge 5 is the 2nd least critical challenge. This could be due to the fact that, although climate change adaptation is critical to any country, it has been notably integrated in some of the rapid developments of Disaster Risk Reduction (DRR) programmes in Sri Lanka, especially after the Tsunami occurred in Dec 2004.



Test Statistics	
Kendall's W[a]	.152
Chi-square	44.595
df	6
Asymp. Sig.	.000

Figure 1: Kendall's W Test for Mean Rank

During the Kendall's W Test statistical significance of the aforementioned rankings were also developed. The Chi-square statistic (44.595) depicted above shows that there is a significant difference in this ranking. This result implies that the result is statistically significant at less than 1% (Asymp. Sig = .000). Also, the Kendall's Coefficient of Concordance .152 shows that the result is random with less degree of unanimity as its closer to zero than one. If the test statistic W is 1, then all the survey respondents have been unanimous, and each respondent has assigned the same order to the list of concerns but if W is 0, then there is no overall trend of agreement among the respondents, and their responses may be regarded as essentially random.

Intermediate values of W indicate a greater or lesser degree of unanimity among the various responses [12]. This may be due to the variations in demographic characteristics discussed in the previous section. The respondents come from different sectors (i.e. academic, governmental, and private), different years of experiences, and also work in different areas of work. In order to establish whether there is a significant impact of the respondent's area of work on the ranking of the challenges, a cross tabulation was carried out. The result of the Chi-square (of the cross tabulation) shows that, of all the challenges, it is only those working in the area of 'Challenge 1 – Health' had a significant difference in their ranking of the challenges. This is given in Table 5 with a Chi-square statistic of (70.2) $p < 0.001$.

Table 5: Area of work vs. ranking of Challenges - Chi-square test

Challenge/Area of work	**Test statistics**		
	Chi-square	**df**	**Sig**
1	70.2	36	.001*
2	43.173	36	.191
3	30.332	36	.735
4	39.933	36	.300
5	32.734	36	.625
6	31.138	36	.699
7	37.933	36	.381

* Chi-square significant at .01 level

A cross-tabulation test was also carried out in comparing the sector the respondents work against ranking of challenges. In Table 6, the results of the Chi-square test (of the cross tabulation) shows that, at 95% confidence interval, the impact of the sector the respondents work on ranking the challenges is not statistically significant for challenges 1, 3, and 4; while it is statistically significant for challenges 2, 5, 6 and 7. The implication here is that sector of the respondents does have some effect when ranking challenges.

Table 7: Experience vs. ranking of challenges - Chi-square test results

Challenge	**Test statistics**		
	Chi-square	**df**	**Sig**
1	7.317	6	.292
2	16.252	6	.012
3	5.412	6	.492
4	3.590	6	.732
5	14.887	6	.021

6	12.767	6	.047
7	13.896	6	.031

A cross-tabulation test was also carried out to compare level of experiences of the respondents against ranking of challenges. Tables 7 shows the result of the Chi-square test (of the cross tabulation). As shown in the Table, for all the challenges, the p values of all Chi-square statistics are > .05, which means that the results are not statistically significant. This implies that level of experience of respondents does not impact when ranking the challenges.

4.2 Question 2 - Policy Availability

In the questionnaire, the respondents were asked whether there were available policies that provide solution to the societal challenges, and if they have any, how effective these policies are in providing solutions. Table 8 summarizes the results with regard to the above. According to the Table, a higher percentage of the respondents attest to the fact that there are sufficient policies available to address societal challenges, with the exception of challenge 6 (Secure Societies). More than half of the respondents (about 54%) agreed that there are not any policies available for challenge 6. Given that challenge 6 is the least critical challenge (as discussed in the above section), perhaps it may not be a priority area as yet in terms of policy development. Challenges 1 (Health) and 2 (Food security) are ranked the highest in terms of policy availability. Nearly 91% of the respondents agreed that there are many health related policies available to address challenge 1, yet according to the ranking of challenges (Question 1), it is one of the main challenges in the context of Sri Lanka. Overall results of policy availability showed a (somewhat) positive correlation between the availability of policies and ranking of main challenges. This may mean that, for example, although a large number of policies exist covering many areas of Health (e.g. communicable diseases, non-communicable diseases, elderly care, maternity care, health of infants, etc.), it still remains a critical challenge due to problems exist in implementation or collaboration and coordination between different areas of healthcare. The same applies to challenge 2, i.e. a lot of policies are available, yet it still is the biggest challenge in the context of Sri Lanka.

Table 8: Policy availability in each area of societal challenge

Challenge	**Ranking of Main Challenges (Question 1)**	**Policy availability**			**Policy Effectiveness***		**SD**
		Yes (%)	**No (%)**	**Ranking**	**Mean value**	**Ranking**	
1	2	91.1	8.9	1	3.45	1	1.472
2	1	83.3	16.7	2	3.77	2	1.309
3	3	72.5	27.5	4	4.07	5	1.385
4	4	51.3	48.7	6	4.29	6	1.338
5	6	64.3	35.7	5	3.86	3	1.332
6	7	46.2	53.8	7	4.31	7	1.335

7	5	77.5	22.5	3	4.02	4	1.388

* 1 – Very high level of effectiveness, 2 - High level of effectiveness, 3 – Medium level of effectiveness, 4 - Low level of effectiveness, 5 – Very low level of effectiveness, 6 – Not effective.

In terms of level of effectiveness of policies (see Table 8), there was also a positive correlation between policy availability and policy effectiveness. For example, challenges 1 and 2 had the most positive results in terms of effectiveness of policies. However, even though the two challenges, comparatively, are the most effective in terms of policies (in terms of addressing the challenges), mean values (3.45 and 3.77 respectively for challenges 1 and 2) depict that the level of effectiveness leans more towards medium-low level of effectiveness. Challenge 6, as usual, was ranked the lowest in terms of effectiveness of policies with a mean rating of 4.31 (low-very low level of effectiveness); and Challenge 4 (transport) was not that far off either.

Overall results imply that, although policy availability is not an issue for many challenges, lack of strategies and effective action plans may have led to low levels of policy effectiveness. Further, the main issues in addressing the societal challenges lie with the relevance, implementation and impact of the policies. Moreover, since Sri Lanka is a developing country, low level of policy effectiveness could be down to lack of resources in policy implementation. Therefore, the policy makers need to develop a strategic approach together with appropriate institutional arrangements in addressing the issues aforementioned.

5. Conclusions

Within the Sri Lankan context, challenges 2 (Food security) and 1 (Health) were identified as the biggest societal challenges. Interestingly, the questionnaire survey findings also reveal that there is abundance of policies in addressing these two challenges and also other areas of societal challenges. However, the main issue lied with ‘effectiveness’ of policies. Herein, strategic approaches need to be taken by the policy makers in effective implementation (including monitoring and evaluation) of these available policies. This requires capacity building of relevant authorities and strengthening of governance structures for effective and informed decision making in several of the societal challenges. Apart from the policy makers, community levels should also be encouraged in the participation of development and implementation of policies. Government collaboration with private sector will also be needed to address funding/resource issues. Effective partnerships with the EU and other developed countries are needed through long term research and exchange programmes such as Horizon 2020. Sri Lanka should collaborate with SAARC (South Asian Association for Regional Cooperation) to build multi regional interaction of policy framework. If these measures are put in place, the barrage of challenges would be adequately resolved within the context of Sri Lanka.

References

[1] European Commission Communication, 2012. *Enhancing and focusing EU international cooperation in research and innovation: a strategic approach.* Brussels: European Commission.

[2] Annerberg, R., Begg, I., Acheson, H., Borras, S., Halle, A., Maimets, T., Mustonen, R., Raffler, H., Swings, J., and Ylihonko, K., 2010. *Interim evaluation of the seventh framework programme: report of the expert group*, Available at: <https://docs.google.com/viewer?a=v&q=cache:rwSurVx6Xt8J:ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/fp7_interim_evaluation_expert_group_report.pdf> [Accessed 15 December 2012]

[3] Nayar, R., Gottret, P., Mitra, P., Betcherman, G., Lee, Y. M., Santos, I., Dahal, M. and Shrestha M., 2012, *South Asia Development Matters - More and Better Jobs in South Asia*, International Bank for Reconstruction and Development. The World Bank, Washington D.C. Available at <file://lha-011/pers-I/000516CD/Downloads/A201213011623_20.pdf> [Accessed 12 April 2015]

[4] World Health Organization, 2013. *The European Health Report- Charting the way to well-being*, Denmark: WHO Regional Office for Europe

[5] European Union, 2013, *EU Research and Innovation: Tackling Societal Challenges*

[6] The Economist Intelligence Unit Limited, 2014. Food security in focus: Europe 2014, London: The Economist Intelligence Unit Ltd

[7] Olivier, J. G.J., Janssens-Maenhout, G., Muntean, M., and Peters, J. A.H.W., 2013, Trends in Global CO2 Emissions- 2013 Report, The Hague: PBL Netherlands Environmental Assessment Agency; Ispra: Joint Research Centre.

[8] Shaw, J., Farrington, J., and Walton, W. 2009. Sustainable Transport in Europe, in: Mather, A. and Bryden, J. (Eds) Area Studies - Europe (Regional Sustainable Development Review), UNESCO-EOLSS

[9] European Environment Agency, 2015. EEA SIGNALS 2015- Living in a Changing Climate, Luxembourg: Publications Office of the European Union.

[10] European Environment Agency, 2011. Disasters in Europe: more frequent and causing more damage, Available at http://www.eea.europa.eu/highlights/natural-hazards-and-technological-accidents [Accessed 30 June 2015].

[11] Corder, G.W., Foreman, D.I. (2009). *Nonparametric Statistics for Non-Statisticians: A Step-by-Step Approach Wiley*, ISBN 978-0-470-45461-9

[12] World Bank, 2012, *Countries and Regions.* Available at: <*http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/0,,pagePK:180619~theSitePK:136917,00.html*> [Accessed 14 December 2012].

Emergency service demand in Queensland during natural disasters

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Abstract

Community resilience is a growing research area due to increased frequency, intensity and the extent of damage caused by recent natural disasters. There are different aspects which need to be accounted in a community resilience model. One key area that needs to be examined in this context is the mobility of people. Natural disasters cause changes in travel demand before, during and after the event. Travel demand in these three phases significantly varies in terms of need, pattern and mode of travel. The need for mobility of people also varies around a natural disaster, and hence, it expects a change in travel patterns for emergency services, general household activities and reconstruction activities. Demand for emergency services generally expects to be peaking in time of the incident starting a few hours before the event, for natural disasters like floods and bushfires. These variations in travel demand may depend on the intensity and frequency of the natural disaster, impact on the community and the duration of the event. Studying travel demand variations due to natural disasters are an important aspect in developing a resilience model, particularly for road infrastructures such as bridges, culverts and floodways. This paper examines emergency service demand variation in Queensland, Australia during bushfires and floods. The paper highlights that demand for emergency services depends on the type of natural disaster, the demographic and geographic characteristics. Future resilience models should, therefore, include emergency service demand variation for different types of natural disasters and demographic and geographic characteristics of the region.

Keywords: Travel demand; natural disasters; road infrastructures; mobility; household travels; emergency services; reconstruction activitie

1. Introduction

The resilience of communities has been repeatedly questioned by the Mother Nature all across the world at different levels and faces ranging from Tsunamis, earthquakes, flooding, bushfires, hurricanes or severe thunderstorms. Queensland, the third highest populated state in Australia, is one of the regions that have been repeatedly affected by severe flood events, bushfires and cyclones in recent time. For an example, the 2011 Queensland flood event caused a devastating impact to the community (Queensland Floods Commission of Inquiry, 2011). This event not only highlighted major overhauls in the knowledge, experience and preparedness of the community, but also highlighted concerns over climate change and new challenges that the whole world is facing in this century or foreseeable future. Side effects of this event raised questions over some of the engineering terminologies and definitions on merits of clarity of meaning, technical correctness, practicality, and acceptability. For an example, Bureau of Meteorology now defines the accumulated rainfall over a given period of time using the term Annual Exceedance Probability (AEP) replacing the old terminology Annual Recurrence Interval (ARI), for the interest of the public and to avoid confusions made on some decision makers (Bureau of Meteorology, 2015). On the other hand importance of enhancing the resilience of communities were identified and recognized by individuals, communities and government bodies.

In Australia, flooding has been reported as the most expensive type of natural disaster (Wahalathantri et al., (accepted)). The 2011 Queensland flood event was one of the extreme and widespread floods that caused huge social and economic impact to the Australia (IBISWorld, 2011). Many lifeline infrastructures were damaged across Queensland, leaving communities completely or partially isolated. In this context, damage to road infrastructures such as bridges, culverts, and floodways created short-term as well as long-term adverse impacts on communities. Higher damage bills combined with budget restraints of local governments caused delays in the repair and reconstruction of damaged road infrastructures, leaving rural communities completely or partially inaccessible for extended periods of time. Road infrastructures in some regions in Queensland such as the Lockyer Valley Regional Council (LVRC) area were severely damaged for another time during the 2013 flood event, before the aftermath of the 2011 flood were rectified (Lokuge et al., 2014). Many of the reconstructed road infrastructures were severely damaged in the 2013 flood leading to longer repair and reconstruction activities, not only due to the budget constraints but also due to the concerns over design and construction practices.

Delays in reconstruction works of road infrastructures have direct and indirect impact to the mobility of people. The mobility of people can be broadly categorized into three clusters, namely, general household travels, emergency related travels and travels for construction activities. General household travels are the primary source of mobility which includes work, health, education, shopping, entertainment, socialization and religious related activities. Emergency related travels can be generated due to health, security and natural disasters. Emergency travel needs in case of a natural disaster can include warning services, evacuation procedures and rescue activities. Travels related to construction activities can include new projects, reconstruction or repair activities for infrastructures. Demand for each of the above three broader clusters can vary before, during and after a natural disaster. Qi and John E (2014) have concluded that natural disasters perturb mobility of people and change the travel frequency. For an example, before a natural disaster event, warnings, and evacuation related activities can increase. During a natural disaster, demand for emergency services will be increased, but demand for general household travels such as recreation activities will be declined. Following a natural disaster, assessment, rehabilitation and reconstruction activities are expected to be peaked. Also, general household travels will gradually increase to its normal level following the disaster event. The degree of fluctuations for each of those activities can vary based on geographic and demographic features as well as the rate of recovery.

This paper examines emergency service demand variation during natural disasters in Queensland, Australia. The study is limited to the period between 2011 and 2014 and covers the emergency service demand variation during the 2011 and 2013 Queensland flood events in the LVRC area.

2. Total emergency service demand in Queensland

Demand for the emergency services is caused by many reasons and some are related to natural disasters. Emergency service demand during a natural disaster includes activities arising due to floods, bushfires, storms, cyclones and similar events. Examples of activities for a flood event are rescue operations, providing emergency medical services, assisting the police or local government bodies and providing or assisting with services such as water removal. Some examples of activities not related to natural disasters are: mobile property damage, building or structural fires and medical assistance. According to monthly statistics received from

Queensland Fire and Emergency Services (QFES), approximately 6000 incidents per month have been received requesting emergency services across the Queensland during July 2011 – June 2014. However, average incidents received in different months indicate a seasonal variation as shown in Figure 1. January 2013 indicates a peak that corresponds with the 2013 flood event. Similarly, the other peak during September – November period coincides with the increase in bushfire events across Queensland during the dry period. Therefore, emergency service demand fluctuates towards peak during periods which are more prone to natural disasters.

Fig. 1: Average number of incidents per month

Emergency service demand indicates significant variations across different parts of Queensland due to geographical, climatic and demographic changes. Queensland Fire and Emergency Services (QFES) have classified seven main regions in Queensland for their operational and maintenance activities, namely, Far Northern, Northern, Central, North Coast, Brisbane, South Eastern and South Western (Queensland Fire and Emergency Services, 2015) as shown in Figure 2. Brisbane region has about 36% of the total Queensland population within about 0.3% of the total land area in Queensland (Queensland Fire and Emergency Services, 2015). The South Eastern region includes the major cities of Gold Coast, Logan and Ipswich and regional councils of Scenic Rim, Lockyer Valley, and Somerest, is also relatively small in land area but heavily populated. Other regions are comparatively large in land area but low in population density.

Table 1 shows the distribution of the average number of incidents across seven QFES regions. The highest monthly average demand for emergency services has recorded in the Brisbane region, which has the highest population, followed by the South Eastern Region. Figure 3 indicates the monthly variation of emergency service demand for seven QFES regions. All regions indicate a similar pattern, except clear peak in January, 2013 for Brisbane, South Eastern, North Coast and Central regions. These peaks correspond with the 2013 January flood events and affected areas.

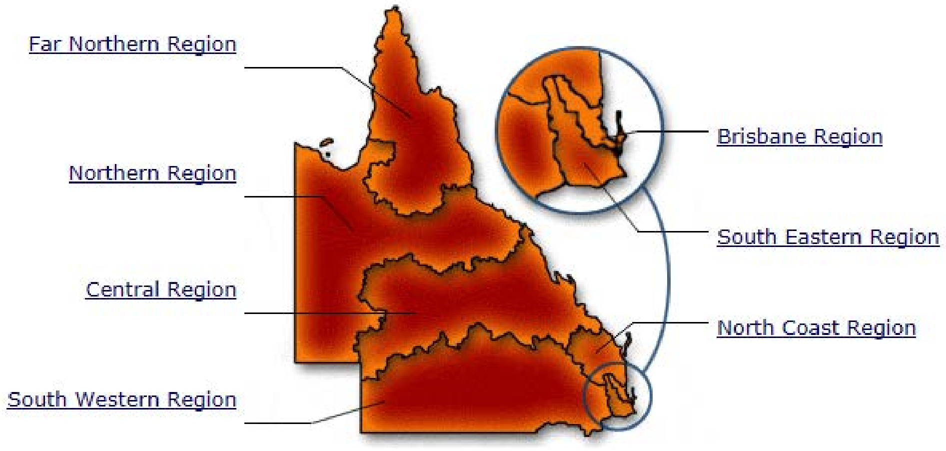

Fig. 2: QFES Regions (Queensland Fire and Emergency Services, 2015)

Table 1: Monthly average number of incidents received for the QFES

QFES Region	Emergency Service Demand for the period July 2011 – June 2014	
	Average Number of incidents	As a Percentage from total (%)
Brisbane	2013	33.3
South Eastern	1245	20.6
North Coast	738	12.2
Central	632	10.5
Northern	596	9.9
Far Northern	420	6.9
South Western	401	6.6

Fig. 3: Emergency Service Demands per Month for Seven QFES regions

3. Emergency service demand during natural disasters

Emergency service demand for natural hazards highly depends on the nature, frequency and the extent of the event. In this manuscript, emergency service demand variation due to bushfires and floods are analyzed.

3.1. Bushfires

Bushfires have the possibility to occur at any time of the year, but the numbers of events are reduced during wet seasons. In general, Australia has been divided into different bushfire prone periods based on past events and the climate of the regions by the Bureau of Meteorology, as shown in Figure 4. According to Figure 2 and 4, bushfire prone periods for different QFES regions are: Far Northern region during June – November, South Western region during September – February and other regions mostly during spring periods or September – November. This observation complies with the Queensland Parks and Wildlife (QPWS) wildfire events as shown in Figure 5.

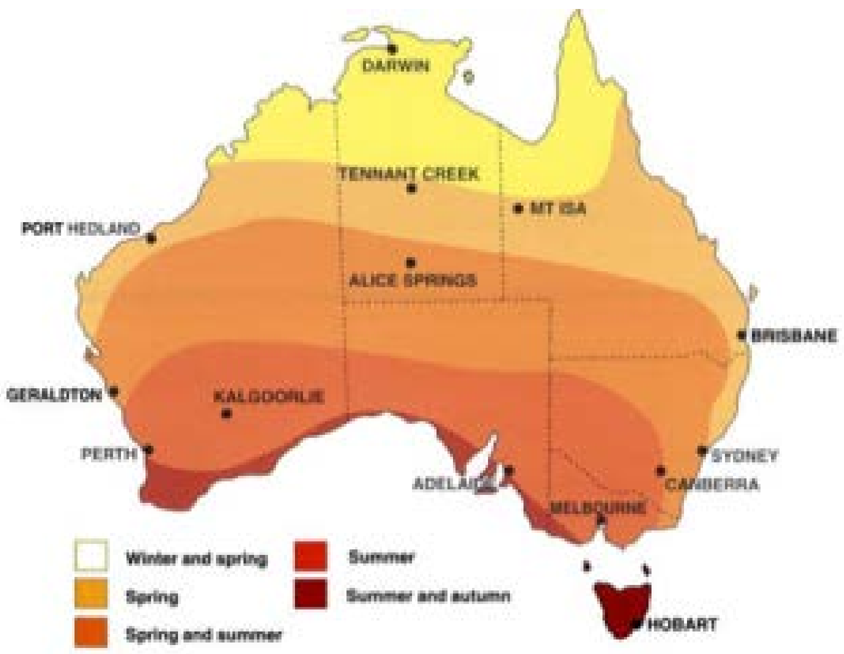

Fig. 4: Fire Seasons across Australia (Cary et al., 2003)

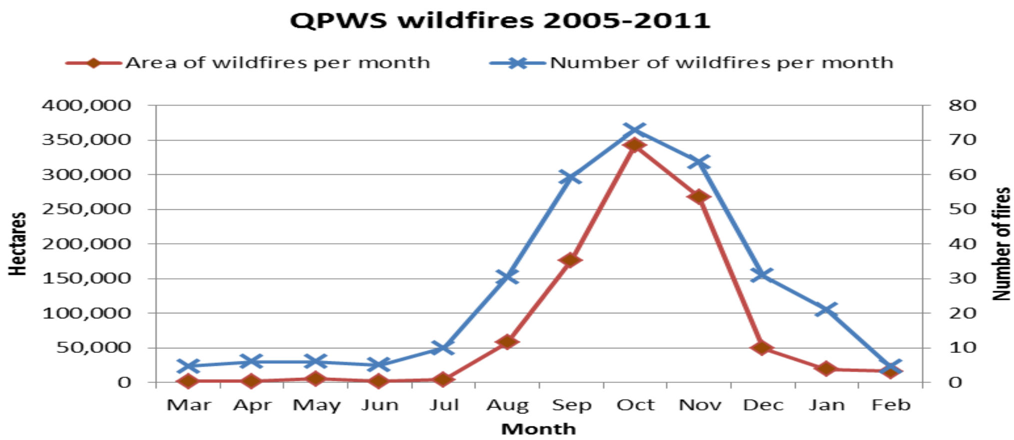

Fig. 5: Average QPWS wildfire numbers and burnt area in hectares per month (Leeson, 2013)

Figure 6 shows the percentage of emergency service demand due to bushfire related activities, compared to the total average number of incidents received on a monthly basis. More than 25% of total emergency service demand for September and October months were due to bushfire related activities in Queensland. This figure clearly indicates the clear relation between the increase in emergency service demand during the bushfire prone periods as indicated in Figure 4 and 5.

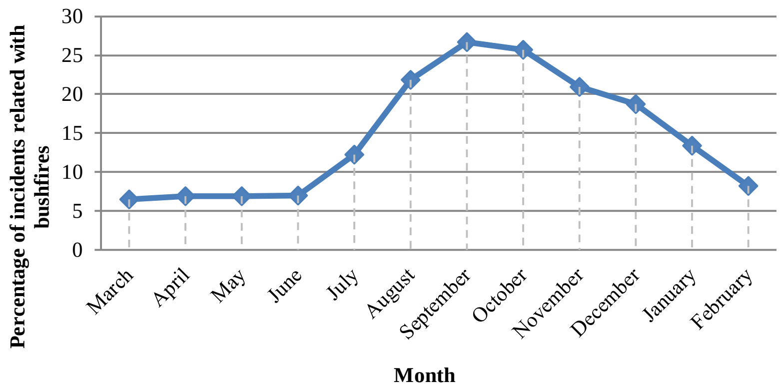

Fig. 6: Contribution of bushfire related activities based on the number of incidents received per month during July 2011 – June 2014

Emergency service demand due to bushfires across different QFES regions is presented in Table 2. About 22% of emergency service demands in the North Coast region were due to bushfire related events. More than 20% of emergency service demand for South Western and Central regions has also been risen from the Bushfires. Percentage of emergency service demand generation in Brisbane area due to bushfires is the lowest across QFES regions.

Table 2: Monthly average values for the emergency service demand due to landscape fires during July 2011-June 2014

QFES Region	Average Number of incidents related to landscape fires	
	Average Number of Incidents	As a percentage from total emergency service demand for the same area
Brisbane	154	7.7
South Eastern	197	15.8
North Coast	164	22.2
Central	132	20.9
Northern	104	17.4
Far Northern	68	16.2
South Western	86	21.4

3.2. Floods

Figure 7 shows that the total number of emergency service incidents received during the month of January in 2012, 2013 and 2014 for seven QFES regions. Brisbane, Central, North Coast, South Eastern and South Western regions indicate about 50% increase in emergency service demand during January 2013, compared with the January 2012 and January 2014. This corresponds with the 2013 flood event in Queensland.

The monthly data obtained from the QFES for the Queensland region cover only the 2013 flood event. However, these data provide an indication of emergency service demand for Queensland at a macro level. For detailed analysis, the Lockyer Valley Regional Council (LVRC) area and associated emergency service demand data for the 2011 and 2013 Queensland flood events were used. Both of these flood events were categorized as extreme events for the Lockyer Valley Regional Council area. Some areas of this region were severely affected by the 2011 flood event than the 2013 flood or the vice versa.

Figure 7: Emergency service demand variation during January

The LVRC is located about 90 km west of the Brisbane and bounded by the Great Dividing range, with a total population of about 37,000 within 2272 square kilometres of land area (Queensland Floods Commission of Inquiry, 2012). This area was subjected to heavy rainfall and flooding during 10th – 12th January 2011 and again during 26th – 29th January 2013. Rainfall data analysis indicated that the 2013 rainfall was higher in intensity, but limited in some regions as the downfall happened relatively within a short period of time compared with the 2011 event. Also, at the time of the 2013 flood event, people were more prepared as they had experienced the 2011 devastating flood and its repercussions. On the other hand, the 2011 flood event was a widespread in area with almost no previous experience across the community on how to react at once in a life time event. Figure 8 below indicates monthly totals for emergency service demand for flood related activities for the 2010/11 and 2012/13 financial years. It is clear that the community demand for the emergency services were significantly higher during the 2011 January flood event compared with the 2013 January flood event. This indicates that previous experience and frequency of natural disasters can have a significant impact to the community response and the resilience. However, the extent of the flooding should be accurately accounted for better decisions accounting population distribution and flood levels across different suburbs.

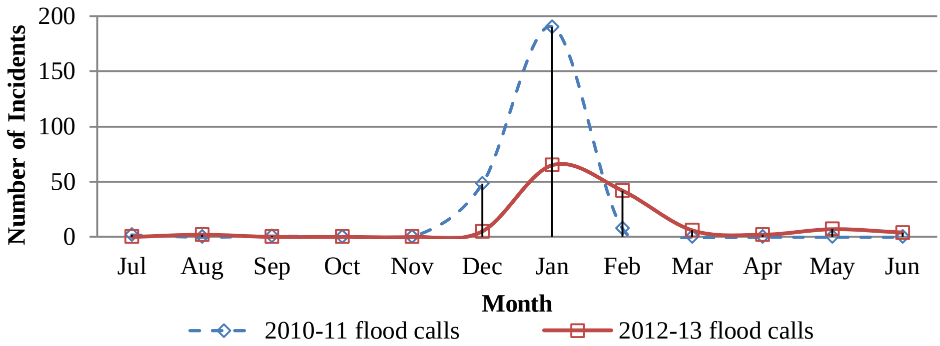

Fig. 8: Emergency service demand for flood related activities in LVRC

Total emergency service demand variation of the 7 day period during the 2011 and 2013 flood events is plotted in Figure 9. The clear peak on 10th January 2011 coincides with the period where the major flooding started across the LVRC area, including the Lockyer Creek and Sandy Creek (Bureau of Meteorology, 2011). Peaks of emergency service demand during the 2013 flood event are widespread compared to the 2011 event, indicating an improved or timely response to the flood event.

The emergency service demand derived using number of incidents received at the QFES indicates a general pattern for the bushfires, which reasonably agree with the number of bushfires, burnt areas and the month of the year. However, with regard to flooding, previous studies or publications are not available to justify the change in emergency service demand. Nevertheless, the presented data in this paper can be used to gain understanding of emergency service demand variation at different natural disaster events. These patterns can be generalized considering the extent of the event, demographic and geographic features of the area that is subjected to the natural disasters. Also, these data can be related with the number of emergency vehicles and people deployed to obtain travel demand across road infrastructures. These factors will be addressed as an extension of the present study with the aim to develop a resilience index for road infrastructures.

Fig. 9: Emergency service demand for flood related activities in LVRC

4. Conclusion

This paper analyses the emergency service demand variation in Queensland for bushfires and flood events. Emergency service demand due to bushfires in Queensland peaks during September – November periods. Bushfires account for more than 20% of total emergency service demand in North Coast, Central and South Western regions, but only 8% in Brisbane area. However, formation of a direct relationship between the extents of event was a difficult task, due to lack of information to correlate the emergency service demand to the number of bushfires and burnt area. Similar difficulty was encountered with respect to flood events. More informative relationships and understanding can be gained through coordinating and collating data on the extent of natural disasters and community responses. Creating a database to record activities around natural disasters at national level is recommended to gain broader understanding of the community resilience. Emergency service data received in the LVRC area indicate a clear peak around the time of major flooding during the 2011 flood event. However, demand for the emergency services in the same area has significantly reduced during the 2013 flood event. In general, bushfires and flood events have a preceding time for warning and response, in contrast to unprecedented events like earthquakes. Therefore, the data presented in this paper are useful to develop relationships for similar events which have a sufficient warning period for response. This information can be used to generate travel demand patterns for emergency services and study resilience of road infrastructures such as bridges, culverts and floodways.

Acknowledgement

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5. References

Queensland Floods Commission of Inquiry. 2011. *Queensland Floods Commission of Inquiry - Interim Report* [Online]. Available: http://www.floodcommission.qld.gov.au/__data/assets/pdf_file/0007/8782/QFCI-Interim-Report-Chapter-1-Summary-of-weather-and-flood-events.pdf.

Bureau of Meteorology. 2015.*Glossary: Bureau of Meteorology* [Online]. Available: http://www.bom.gov.au/water/designRainfalls/ifd/glossary.shtml [Accessed 30 April 2015].

WAHALATHANTRI, B. L., LOKUGE, W., KARUNASENA, W. & SETUNGE, S. (accepted). Vulnerability of floodways under extreme flood events. *Natural Hazards Review.*

IBISWorld. 2011. *Queensland floods: The economic impact Special Report* [Online]. 2011. Available: https://www.nci.com.au/NCINet/Secure/Resources/Pdf/QLD_floods_special_report.pdf [Accessed 20 April 2015].

LOKUGE, W., SETUNGE, S. & KARUNASENA, W. 2014. Investigating the performance of floodway in an extreme flood event. *1st International Conference on Infrastructure Failures and Consequences (ICFC 2014).* Melbourne, Australia.

QI, W. & JOHN E, T. 2014. Quantifying, Comparing Human Mobility Perturbation during Hurricane Sandy, Typhoon Wipha, Typhoon Haiyan. *Procedia Economics and Finance,* 18**,** 33-38.

Queensland Fire and Emergency Services. 2015. *Structure and Local QFES Contacts* [Online]. Available: https://www.fire.qld.gov.au/about/regions/default.asp [Accessed 22 April 2015].

CARY, G., LINDENMAYER, D. & DOVERS, S. 2003. *Australia burning: fire ecology, policy and management issues*, CSIRO PUBLISHING.

Queensland Floods Commission of Inquiry. 2012. *Queensland Floods Commission of Inquiry - Final Report* [Online]. Available: http://www.floodcommission.qld.gov.au/publications/final-report/ [Accessed 25 April 2015].

Bureau of Meteorology. 2011. *Detailed Reports on Notable Queensland Floods* [Online]. Available: http://www.bom.gov.au/qld/flood/fld_reports/lockyer_creek_fact_sheet_2011.pdf [Accessed 23 April 2015].

LEESON, P. 2013. *Queensland's fire weather* [Online]. Available: file:///C:/Users/U1064158/Downloads/Queensland%2527s+fire+weather_Part+1_full+article_web+version%20(2).pdf [Accessed 25 April 2015].

Is Business Continuity Management increasing Resilience of SMEs?

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Abstract

Small and medium enterprises (SMEs) are an important part of our business world, and as they are defined by the EU, constitute 99% of all European businesses, 96% of Australian businesses and 99,9% of USA businesses. Because of their size, they are generally more vulnerable to disruptions caused by disasters. Helping them back on their feet is crucial to our economies, and explains therefore the importance in looking into how we can strengthen their resilience. This paper will be comparing the resilience concept with the business continuity management (BCM), and how they are linked to SMEs. To be able to compare these two concepts, we will first look into the nature of both concepts resilience and how they evolved through the years. We will highlight the differences between both concepts and also how they complement each other, considering that BCM is a valid tool for increasing resilience. We will finally try to provide some considerations on how SMEs can use both concepts to increase their resilience.

Keywords: Resilience; BCM; SME

1. Introduction

The United Nations Office for Disaster Risk Reduction reports that between 2000 and 2012, we suffered from disasters' effects to an imaginable extend: 1,7 trillion US dollars in damages, 1,2 million people killed and 2,9 billion people affected (UNISDR, 2013). In 2010, the European Environment agency stated that Europe was experiencing increasing number of natural and technological disasters (EEA, 2010). Disasters have been costly, both on the economy and on communities, and we know that it has become more important to be prepared for them.

Small and medium enterprises (SMEs) constitute one of the pillars of our economies. Representing 99% of all enterprises in Europe and America (Savage, 2002), and 96% of Australian businesses (Commonwealth of Australia, 2012), they are often more vulnerable to disruptions because of their size. Disruptions can be of different nature, for example, economic crisis, unstable markets, or break in the supply chain. In this paper, the focus will be disasters and how to support SMEs becoming more resilient to disasters. Business continuity management (BCM) is known in most large enterprises, as a way to plan unexpected events. But can BCM be applied to SMEs, or are there other tools? Literature has also been discussing resilience as the new fashionable concept. But what is resilience, and what is the difference between resilience and business continuity management?

This paper will attempt to give clear definition of the resilience and BCM concepts, by looking into their nature and how they have been used through time. It will then do a comparison between both concepts and highlight their differences and their similarities. Finally, it will give recommendations on how SMEs can use these concepts in their every day business.

2. Resilience and Business Continuity Management

2.1. Resilience

The nature of the word "resilience" is traceable from the Latin *resilire, resilio*, meaning "bounce" linking to the idea of "bouncing back" (Manyena et al., 2011). Sir Francis Bacon has been accredited for the first known scientific use in English of the word in 1625, but it first appeared in a dictionary complied by Thomas Blount in 1656 (Glossographia). Blount's definition had a dual meaning: to rebound and to go back on one's word (D.E. Alexander, 2013). Then, Alexander (2013) observed that the word started to be used in mechanics around 1858 by a Scottish engineer named William J. M. Rankine. It was employed to describe the strength and ductility of steel beams and that is from that point, that we can trace the origin of the word resilience in civil protection. Alexander does explain it well: "A resilient steel beam survives the application of a force by resisting it with strength (rigidity) and absorbing it with deformation (ductility). By analogy, the strength of human society under stress is its ability to devise means of resisting disaster and maintaining its integrity (coherence), while the ductility lies in the ability to adapt to circumstances produced by the calamity in order to lessen their impact" (Alexander, 2013). In the 1950's, the word "resilience" was applied to the analysis of ecological assemblage and was also being used in psychology, particularly in the domain of child psychiatry. At the end of the 1990's, the term made a transition to social sciences, with the help of economists and geographers.

Looking at more recent definitions of resilience, the UN Office for Disaster Risk Reduction has the following definition: "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions." (UNISDR, 2009).

The Stockholm resilience Centre defines resilience has "the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about the capacity to use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking. Resilience thinking embraces learning, diversity and above all the belief that humans and nature are strongly coupled to the point that they should be conceived as one social ecological system."(Stockholm Resilience Centre, 2014).

Taking the premise that resilience is actually coming from a social-biological perspective is interesting to look into, because people and environment have been coexisting as long as we know it. Today, there are no ecosystems that are not shaped by people. We often tend to forget that these ecosystems are the reason why we can get clean air, water and food assuring our survival. And as Alexander (2013) retraced, the term "resilience" itself has been linked to environments. Urban areas, one of the environments we are living in now, are homes to more than half the world's population. The World Bank predicts that urban areas will accommodate almost all population growth over the next four decades. In particular in developing countries, the forecast is to rise from 2,7 billion people in 2012 to 5,2 billion in 2050 (World Development indicators, 2014). The urbanization of our world can have negative consequences on the environment and the productivity, and this is why we can't discuss resilience before we acknowledge the link between people and environment. One example of the effect of urbanization was villages in British Columbia, where the population was faced with changes in markets, technology, environmental legislation and resource base. They had to decide if they were to adapt or "die". Some people did abandon their towns, but others decided to regroup and form a community to face the challenges and find solutions. They became part of a resilient community.

In the SME context, we are looking at what is called organizational resilience. In their article "the Quest for resilience", Hamel and Välikangas (2003) stated that "to thrive in turbulent times, companies must become as efficient at renewal as they are at producing today's products and services. Renewal must be the natural consequence of an organization's innate resilience." Still according to Hamel and Välikangas (2003), organisations of all types would be fighting with four challenges if they wanted to achieve resilience: cognitive, strategic, political and ideological challenges. The cognitive challenge addresses the need for organizations to realize that the world is changing. Organisations have to recognize that changes can affect their success. The strategic challenge focuses on having alternatives or "plan B" for its current strategy. The political challenge focuses on planning to spend resources on future development and having several options for spending resources. Finally the ideological challenge is about being open to renewal, even if the organization is not in a state of crisis. With all these challenges, we can understand better why SMEs might have difficulty to achieve resilience.

Resilience is a complex stage to reach, and for SMEs, it can be a real challenge only to understand what resilience is and then how it can be applied to their organization. This can explain why most companies that have chosen business continuity management (BCM) as an option for resilience. This next chapter will define what BCM is.

2.2. Business Continuity Management(BCM)

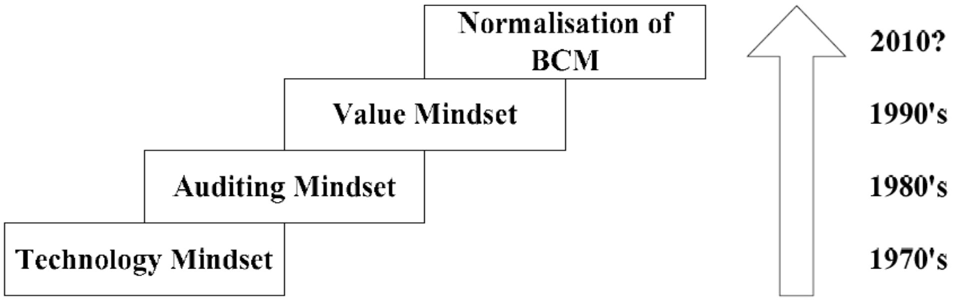
Since the attacks of 9/11, corporate resilience has been reinforced to integrate the notion of unexpected events. In the business world, this has been called business continuity planning (BCP) or business continuity management

(BCM).

Figure 1: Evolution of BCM concepts and drivers. Source: Elliott et al. (2010)

According to Elliott et al. (2010), business continuity management emerges from the need for information system protection in the 1970's (the technology mindset, see Figure 1). The assumption was that disasters were triggered by technology failure only and no other factors were considered. However, by the 1980's, the focus was moving from pure IT systems to end users' involvement and added a new layer to the concept which Elliott et al. (2010) identify as the "auditing mind-set": "The emergence of personal computers during the 1980s and the diffusion of control of IS among organizations (Panko, 1988) provided a basis for developing an auditing mindset in which a task for central IS departments was to regulate and police." (Elliott et al., 2010). However, there was no description on how human would influence prevention or how they could be the cause of an event. First with the "value based mind set", we can observe that organisations and employees are now considered in the equation. Within the value-based approach, Herbane et al. (1997) argue that the contribution to disruption (either as cause or prevention) is seen as central to BCM. It was now recognize that BCM was a combination of social and technological systems, and was adding value to business using BCM.

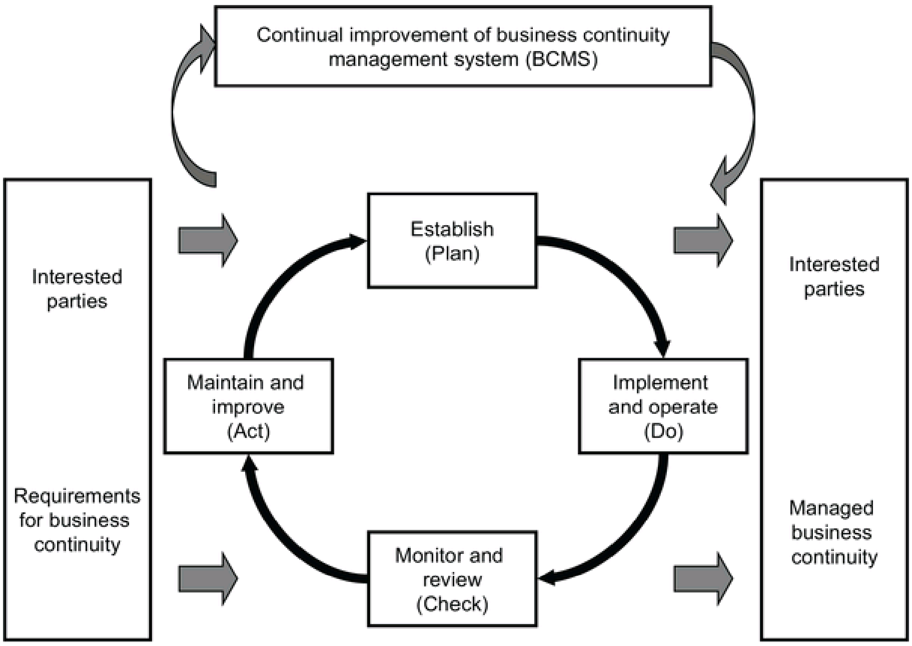
Events like 9/11 (2001), Tsunami in South East Asia (2004), Terrorist attacks in London



(2005), Hurricane Katrina (2005), just to name a few, have been determinant for the definition of BCM we know from the Business Continuity Institute (2006): "Business continuity management is a holistic management process that identifies potential impacts that threaten an organization and provides a framework for building resilience and the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand, and value creating activities." Unexpected events raised awareness amongst enterprises and focus on BCM increased.

In 2012, business continuity management became part of the ISO standards (ISO 22301:2012), applying the PDCA model (see figure 2) to planning, establishing, implementing, operating, monitoring, reviewing, maintaining and continually improving the effectiveness of an organization's Business continuity management systems (BCMS).

Figure 2: PDCA Model for BCM processes



The PDCA model illustrated on Figure 2, (**P**lan, **D**o, **C**heck and **A**ct) include policies, people, processes and documentation that are present within an organization, and focuses on identifying those which are increasing business continuity. ISO has chosen this model in order to assure consistency with other management system standards, and it can be applied to any organisation wishing to implement BCM.

3. Comparing the concepts

Now that we have established the nature of Resilience and BCM, as well as definitions, we can compare the two concepts. As previously mentioned, resilience is considering people, communities, organizations, ecosystems and everything in between, as systems which have the capacity to deal with change/ stress or shock and adapt and even grow. Because of its complexity, and how many systems it includes, it is difficult to find one framework or course of action that is applicable to all. Making a quick search on the internet will reveal several different frameworks: Hyogo framework for action 2005-2015 (UN), City resilience framework (Rockefeller Foundation), National disaster resilience framework (Australia), Strategic National Framework on Community Resilience (UK), etc. So how can SME's choose a framework that is applicable to their specific situation?

Sullivan-Taylor and Branicki (2011) also bring an important point by mentioning that when it comes to resilience, one size does not fit all, due to the capabilities SMEs might have. Managers are often not able to allocate the resources to manage the unexpected event and the cognitive and ideological challenges must be mastered. Therefore, adopting a resilient strategy or a framework is not necessarily an easy task for an SME.

On the other side, we have BCM with the ISO standard 22301 and the PDCA model. This framework is clear and precise, and even thought we will not go into details on how to use this model, it is a good illustration of how BCM can be applied. However, it is important to underline that even though the BCM approach has evolved from technology driven to more value-based driven, and that it has included humans as part of the cause or the solution/prevention, it does not necessarily include all systems. As Hill and Burgess (2003) point out, BCM often fails when plans are written when considering an individual building and not all elements. Hill and Burgess (2003) also mention other general problems with BCM, such as: businesses underestimating the total business effect of a disaster; plans being too detailed and so less effective; and/or organization not being realistic about what is possible after a disaster.

In 2011, AXA International collected data from 650 SMEs from ten different EU countries and 40% of respondents had no form of business continuity plans (BCP) in place. APEC's survey from 2012 looks at how many SME's had a business continuity plans in the Asia-Pacific region. The results demonstrated that 32% didn't have a plan and that 47% didn't know what a BCP was. The lack of awareness and the lack of planning are clearly a barrier to the implementation of BCM in SMEs.

As it is define, BCM provides a framework for building resilience, which means that BCM is part of the "solution" but can be considered alone as the way to achieve resilience. That is why, even though BCM has a clear framework, if we want to increase SMEs' resilience, we need to look at other variables because it can only bring us so far.

4. SMEs Today

Small and medium enterprises (SMEs) are an important actor in the world's economy and their significance has been clearly illustrated in this paper. We also mentioned that they were vulnerable because of their size. However, Ingirige et al.(2011) mentioned several other factors that can explain why SME's can't react effectively to extreme weather events: "lack of planning, vulnerability to cash flow interruptions, lack of capital for recovery, ineffectual interactions with national agencies, infrastructure problems, individual attitudes and organisational culture, access to expertise, business sector and perceived exposure to risk."

Can business continuity management help SMEs being more resilient to disasters? We do believe that BCM can be part of the solution. However, we also believe that we need to be careful applying the "standard model" as not all SME's are able to apply it simply because it doesn't fit their current situations. Sullivan-Taylor and Branicki (2011) have examined data in the UK and found that the organizational size, the financial resources and existing policies will have an impact on the capacity of each SME to be resilient. For example, policies can be a help in some cases, but also can constitute a constraint, if the goal for the implementation are set to high for SME's to be able to reach. Also, the language or the knowledge around the concept of resilience is another factor, since SME managers might not be able to translate the concept to applicable actions. Clearly each SME will have a unique situation that will demand a different level of planning and will have to consider different factors.

5. Recommendations

So what can we suggest that would be helpful for SME managers to consider, so that they can be more resilient to disasters? First, SMEs should be proactive. In order to be able to react better to disasters, SMEs need to recognize that the risk is present and do something about it. Burke et al. (2005) even mention that not only being proactive but promoting resilience is the key.

Then, SMEs have to be realistic as to what they can plan for and what will be possible post-disaster. As Tierney (2014) states, "disasters do no follow preordained scripts. Even in situations where there is extensive disaster experience, those seeking to respond invariably confront unforeseen situations." When SMEs do plan, they should be aware that unexpected events means that their plan might not be realizable and evaluate what they consider as crucial for the survival of the enterprise after a disaster.

Third, SMEs should do a risk assessment to assess the potential impacts of various events on all levels; for example, assessing the vulnerabilities of a supply chain or an infrastructure towards flooding, fire and storms.

Fourth, SMEs should not underestimate the importance of the people factor. As Hill and Burgess (2003) state in their paper, one of the most important lessons of September 11 is that plans are often made on the assumption that all employees will be available after a disaster. The reality is that not all employees might survive the disaster and we can predict how employees will react in stressful situations.

Fifth, communication, tying up with the first recommendation, should be use a promoting tool, as well as a way to involved everyone in the process. As stated earlier, not all enterprises have a plan and some might not know what the concepts of resilience or BCM mean. It is therefore important to assure that everyone, at all levels, are involved in some way. SME managers should make sure that all employees know the plan and even might consider involving them in the planning process.

6. Conclusion

This paper defined resilience and business continuity management by first considering the origins of both concepts. Investigating the provenance of these concepts facilitated the understanding of today's definitions. Clarifying what is resilience today is considered more complex, as several definitions exist. In this paper, definitions from the UNSDIR and the Stockholm resilience Centre we mentioned, as they include all systems and the social-biological aspect, crucial for emergency planning. This paper also identified issues with BCM which SME managers should be aware of, should they decide to apply it in their enterprises. And it also identified the fact that several resilience framework exists, which can be confusion for SME managers. What is clear is that finding one unique solution increasing resilience for all SMEs is not possible, as it will depend on each individual enterprise, and that raising awareness on the necessity of planning is essential. Finally short recommendations were made, so that SME managers can better apply resilience in their enterprises.

References

Alexander, D.E., (2013) Resilience and disaster risk reduction: an etymological journey. *Natural Hazards and Earth System Sciences*. 13. P-2707-2016.

APEC (2014) Preparing SMEs for Disasters. [Online] Available from: http://www.apec.org/Press/Features/2014/0324_smes.aspx. [Accessed: 17 February 2015].

Asian Disaster Reduction Center. (2012) *BCP Status of the SMEs in the Asia-Pacific Region 2012*. [Online] Available from: http://www.adrc.asia/publications/bcp/survey_2012.pdf. [Accessed: 27 February 2015].

Australia. The Treasury. (2012) Australian Small Business - Key Statistics and Analysis. Canberra: Department of Industry, Innovation, Science, Research and Tertiary Education.

AXA International (2011), *Small Business Report: Obstacles to Growth in 2012*. UK:AXA.

Bingunath, I., Jones, K., and Proverbs, D. (2011) Extreme weather events and construction SMEs: Vulnerability, impacts, and responses. *Structural Survey*. 29 (2).p.106-119.

Blundel, R., Baldock, R., Dadd, D., Schaefer, A. and Williams, S. (2014) Resilience and recovery: SME experiences of extreme weather events and other external threats. *Institute for Small Business and Entrepreneurship (ISBE)[*Online] Open Research Online. Available from: http://oro.open.ac.uk/41023/1/Paper%20for%20ISBE%202014%20%20Blundel%20Baldock%20Dadd%20Schaefer%20Williams%20FINAL.pdf [Accessed: 4 February 2015].

Burke, S., Wilson, K., and Salas, E.. (2005) The use of a team-based strategy for organizational transformation : guidance for moving toward a high reliability organization, *Theoretical Issues in Ergonomics Science*, 6 (6), pp.509-530.

Dahlberg R., (2014) Resilience and complexity. Unpublished.

EEA (2010) *Mapping the impacts of natural hazards and technological accidents in Europe: An overview of the last decade*, Luxembourg: Publications Office of the European Union (No13/2010).

Elliott, D., Herbane, B., and Swartz, E. (2010) *Business Continuity Management 2e: A Crisis Management Approach*, New York: Routledge.

European Union. (2015) *Fact and figures about the EU´s Small and Medium Enterprise (SME).* [Online] Available from: http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/ [Accessed: 27 January 2015].

Hamel, G. and Välinkagas, L., (2003) The quest for resilience. *Harvard business review.* [Online] September 20013. Available from: https://hbr.org/2003/09/the-quest-for-resilience.

Hill, R. and Burges, S., Issues in Business Continuity Management. *IDEA group publishing.* [Online] Irma-international. p.287-289. Available from: http://www.irma-international.org/viewtitle/32006/. [Accessed: 17 February 2015].

IFRC (2004) *World Disasters Report 2004 – Focus on community resilience*. [Online] London: Eurospan. Available from: http://www.ifrc.org/PageFiles/89755/WDR2004/58000-WDR2004-LR.pdf. [Accessed: 27 February 2015].

ISO (2012) *ISO 22301:2012 Societal security -Business continuity management systems – Requirements*. [Online] Available from: https://www.iso.org/obp/ui/#iso:std:iso:22301:ed-1:v2:en. [Accessed: 3 March 2015].

SBE Council. (2011) *Small Business Facts & Data*. [Online] Available from: http://www.sbecouncil.org/about-us/facts-and-data/ [Accessed: 27 January 2015].

Sullivan-Taylor, B. and Branicki,L.,(2011) Creating resilient SMEs: why one size might not fit all. *International Journal of Production Research*. 49 (18). p.5565-5579

Tierney, K. (2014)*The Social Root of Risk: Producing Disasters, Promoting Resilience*. Stanford University Press: California.

UNISDR.(2013)Dis*asters impact 2000-2012*.[Online]Available from: http://www.preventionweb.net/files/31737_20130312disaster20002012copy.pdf. [Accessed: 10 February 2015].

Building flood disaster resilience of SMEs in urban cities of Nigeria

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Abstract

The preponderances in the occurrence of flood disasters in Nigeria as a developing country poses a huge challenge for inhabitants with concomitant effects on the built environment. The effects however cannot be over-emphasized as sources of income and employment generation emanating from the engagement of residents in small, medium and large-scale enterprises are often brought to an abrupt halt. At the wake of flood events, such businesses as Small and Medium Enterprises (SMEs) are adversely affected as a result of inadequate preparedness and mitigation strategies, in some instances recovery and reconstruction in the aftermath may take a longer period of time and may be almost impossible because these businesses hardly take up insurance policies which is undoubtedly caused by high level of poverty. This implies amongst other overarching issues that revenue generated from taxes accruable to government will be affected; business owners will lose out on profits, employment levels will dwindle and on the long run the overall performance of the economy may be affected. This paper therefore uses an exploratory qualitative method to examine the effects of flood disasters on SMEs, explores through the use of literature review the concept of resilience and as well suggests a framework through which small businesses can be able to cope during and after flood disasters. The paper however reveals that SMEs that adopt resilient strategies can be able to sustain business activities during and after flood events. It therefore concludes that strategies, if applied may offer a long lasting solution to number of constraints SMEs face, significantly reduce economic losses and promote sustainability of businesses and livelihoods in the aftermath of flood events.

Keywords: Resilience, Flood Hazard, Small Medium Enterprises, Urban Cities, Nigeria.

1. Introduction

There is no doubt the globe is going through intense environmental dynamics, this is evident through an ever-increasing growth in population, rapid urbanization (which often results to anthropogenic activities that exacerbate land degradation) and climate change [1]. The significant changes in the mean measurements of climatic variables are however becoming a critical concern especially for vulnerabilities that depend on patterns of weather for food production as means of survival [2]. These dynamics have over the decades resulted to extreme natural hazard events which are mostly experienced through the intense heating of the earth resulting to drought leading to famine, melting of ice caps resulting in rise in sea levels and on the other hand heavy and prolonged rainfalls leading to flooding. Ingwe [3] however reports that an estimated 1.3million people have died due to natural hazards around the world and more than 2million people troubled every year in the last 2 decades. Despite control measures in form of infrastructures, urban areas around the world have been regularly visited by floods (as recorded in Taipei, Taiwan in 2001; Brisbane, Australia and Bangkok, Thailand in 2011) [2]. The ever increasing rate of migration of people from rural to urban settlements in pursuit of better sources of livelihoods have also amounted to increased urban population. According to Ajibola [4] 38,000 people were displaced in the 1997 flooding of Yuba California, with 15,500 acres of farmland and 1700 acres of industrial land flooded. About 48, 000 homes and 7,000 businesses were affected in the 2007 UK flooding which valued up to 3 billion pounds [5]. Abolade [6] therefore affirms that developing nations experience a huge chunk of impact especially in major cities.

It is factual that Africa has been described as one of the poorest continents in the world, evident through its characteristic negative growth in income per capita reported during 1980-2000; though economies of some African countries have relatively grown in the 1980s and 1990s, this growth has been attributed to the recovery of grounds lost in past decades [7], [8]. Small and Medium Enterprises have however been noted to be the major accelerator of economic growth and poverty reduction [9], [10], [11], [12]. SMEs could employ 1-250 people and have a turnover of over of 50 million Euros which signifies they are socially and economically important to a society; One of the strategies through which African countries have been able to improve on individual economies and reduce the rate of poverty has been attributed to the embrace of Small and Medium scale Entrepreneurship [11], [12]. While it is an established fact that SMEs contribute to successive economic growth, entrepreneurs are faced with the challenges as to how businesses can thrive in the aftermath of a flood disaster. At the wake of flood events, SMEs are adversely affected as a result of inadequate preparedness or mitigation strategies; in some instances recovery and reconstruction after the event may take a longer period of time and it's almost impossible because some businesses hardly take up insurance policies against potential risks, which are undoubtedly caused by high level of poverty. This paper however reveals that SMEs that adopt resilient strategies may be able to sustain business activities during and after flood events. It therefore concludes that strategies, if applied may offer a long lasting solution to number of constraints SMEs face, significantly reduce economic losses and promote sustainability of businesses and livelihoods in the aftermath of flood events. The limitation of this paper however dwells on the ethos that some of the resilient strategies mentioned is peculiar to SMEs alone and may differ between locations depending on their constraints, however research can be conducted for large scale enterprises to gain better understanding within the micro-economic confines in Nigeria.

2. Nigeria's Vulnerability to Flooding

According to the Nigeria's National Disaster Management Framework (NDMF) [13] the country like the rest of the world is exposed to both slow and rapid onset disasters that lead to loss of lives, property and environmental degradation, these include: drought, flooding, epidemics, communal clashes, etc. Flooding remains one of the major resultants of weather extremes that affect Nigerian cities. Flooding in Nigeria is mainly exacerbated by heavy rainfall, urbanization and poor waste disposal practices (which block drainage infrastructure), it occurs in three main forms: river flooding, urban flooding and coastal flooding [14], [15]. They also report that these causes are evident through past experiences of flood events at different intervals affecting the densely populated urban cities like Lagos, Port Harcourt, Aba, Ibadan, etc. According to Aderogba [16] flooding of Ogunpa stream in Oyo State occurred as a result of heavy and prolonged rainfall killing thirty-two people, completely halted socio-economic activities, submerged five hundred houses and had over one thousand people injured. Akani and Bilesanmi [17] also report how flooding in Lagos forced city dwellers to relocate. Over 2 million people were affected when the Challawa and Tiga dams' floodgates were unlocked to discharge water in River Niger [6] .The frequency in occurrences and magnitude however implies that several means of physical, social and economic livelihoods of people are threatened. This however implies that the hard-won development strides and economic gains of the vulnerabilities and the SMEs are exposed to such events especially in major cities characterized by a vast number of economic activities and an ever increasing population will constantly be on the verge of destruction if both structural and non-structural mitigation measures which reduces disaster risks and promotes resilience are not made a priority.

3. Impact of Floods on Small and Medium Enterprises in Nigeria

In 2012 Nigeria was hit by a devastating flood event, Federal Government of Nigeria (FGN) [18] reported that the event occurred between July and October 2012 (peak rainfall periods) causing an overflow of Nigeria's two major rivers (River Niger and River Benue) which resulted to the death of 363 people, got 5,851 people injured, 3,891,314 people affected and 6.1 million people displaced. Total worth of physical assets destroyed in the most affected states was estimated to have reached 1.48trillion naira (US$9.5 billion) [19]. Total losses from the economic sector were estimated at 1.1 trillion (US $7.3 billion) [18]. Income loss by affected trade workers of SMEs was estimated to be 49.5million naira in Adamawa State, 16.3miilion naira in Bayelsa and 16.9 million naira in Nasarawa state while number of working days lost was estimated as 45,000days in Nasarawa, 43,500 in Rivers, 33,000days in Adamawa state [18]. According to UNISDR [20] flood affects business operations and the negative effects also have impact on the revenue bottom line. As the prime factor that generates employment and wealth creation, small and medium enterprises suffer harsh disruption from flood disaster.

Table 1: Impact of 2012 floods on SMEs in Commercial Sector

Flood Impact on SMEs in Commercial sector					
	ADAMAWA	ANAMBRA	RIVERS	EDO	NASARAWA
No. of whole sale/retail SMEs	22	88	140	125	118
No. of affected SMEs	6	11	29	5	53
Estimated production losses (million naira)	101	181	465.3	79.1	840.3
Estimated value of damage (million naira)	45	80.7	35.3	207.3	374.3

Source: Federal Government of Nigeria (2013)

The impact of flooding on commercial sector as shown in table 1 indicates that 27% of whole sale/retail SMEs was affected in Adamawa state, 13% in Anambra state, 21% in Rivers state, 4% in Edo state and 45% in Nasarawa state [18]. However from another estimate, Anambra has the highest figure of 251 SMEs in the manufacturing sector that was affected by flooding [18]. This relatively high figure of SMEs in the manufacturing sector of Anambra State reflects its significance in the nation's SMEs manufacturing sector. Anambra State is recognised to have more concentration of manufacturing small-medium businesses with some of them having about

100 to 150 employees [18]. These set of enterprises are devoted to production of paper, plastics, motor-parts, chemicals, and agribusiness and so on. Onitsha, which is an industrial city in Anambra State, is estimated to have approximately 40,000 trading enterprises [18]. These enterprises are characterised with higher turnover and trading points for many goods that goes in and out of Nigeria. Therefore, these estimates suggest that there is significant contribution from SMEs to Nigerian economy in terms of creating wealth and employment generation. Hence, the impacts of flooding have affected the activities and operations of SMEs thereby making them less efficient. In addition, inability to operate business activities has equally resulted into workers lay-off leading to unemployment.

EKOS Consulting (UK) Ltd [21] enumerates critical short term impacts of flooding on small and medium enterprises to include but not limited to damage to building (office), machines and equipment, loss of stock, staff inconveniences, failure to carry out business activities and loss of revenue. Impacts categorised to be long term includes loss of revenue, higher insurance premium and interrupted cash flow [22]. Indirect impact of flood on small and medium businesses has been identified to be shops and offices being flooded, supplier activities disrupted and unavailability of employees at office [23]. Therefore, the significance of building resilient businesses becomes a crucial point of discussion in our contemporary business society.

4. Conceptual Framework of the study

Constraints facing the sustainability of SMEs in Africa have been identified within the confines of business management as administrative, operational, strategic and exogenous in nature [7], [24], [25], [10], [11], [26]. On the other hand, Runyan [27] affirms that the ability of SMEs to effectively react to various extreme weather events are affected by lack of planning, infrastructural problems, vulnerability to cash flow interruptions, lack of capital for recovery while Yoshida and Deyle [28] are of the opinion that access to expertise and perceived exposure to risks are limiting factors. These underlying themes and indicators are however inter-related, as consideration of such factors is vital for the survival of SMEs, which on the long run contributes to their resilience. The growth and survival of SMEs in Nigeria has been given very little attention [7] and has rarely been treated from a disaster management perspective. Gaps therefore exist with regards to the adverse impacts of floods on sustainability of SMEs, their constraints and how resilience can be strengthened in Nigeria within the context of disaster management. Given the huge role SMEs play in the growth of economies, national development and poverty reduction; building resilience of SMEs to floods in Nigeria forms a crucial basis through which business failure can be significantly reduced.

5. Concept of Resilience

Disaster resilience has emanated from an historic amalgamation of critical systems thinking in the process of planning for disaster risk reduction strategies. The concept of resilience has however gained wide recognition within literature, the United Nations International Strategy for Disaster Reduction [29] has defined resilience from a community perspective as the capacity of a system, community or society potentially exposed to hazards, to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. Within the confines of economics however, Paton [30] describes resilience as the ability of a system to withstand either market or environmental shocks. The two definitions however imply that resilience is an important trait society and businesses should possess to be able to flourish before and after disasters. Pelling [31] opines that resilience embraces both coping and adaptive strategies, while Beatly [32] noted resilience to be the ability of cities to effectively respond to disaster and recovery as well in a timely manner. Therefore, resilience may not only mean the ability of cities to recover from the damage caused by flood but the capability to live with it. Adewole [1] asserts that resilience as regards extreme weather could be the ability to recuperate after flood event. Burnard [33] affirm that resilience is the ability of any society prone to disaster to recuperate to the condition it was before the incidence. Hence, flood resilience is the ability to withstand flooding, and in case of catastrophe or calamity resulting from such, city should be able to adjust and uphold the present position while preventing loss of lives and properties. Kuei-Hsien [2] emphasises that building flood resilience is basically a process of adaption to flooding. Thus, resilience can be considered to be more appropriate in addressing flood issues as they pose a huge challenge for SMEs, reverse hard-won development and enhance poverty amongst other over-arching issues.

6. Building flood resilience

While resilience means the ability to cope with and recover from flooding, flood resilience has been described in an organisational context to be the ability of a business enterprise to create situation awareness, manage business vulnerabilities and ability to cope in a multifaceted and changing environment [34]. Linnenlueke and Griffiths [35] uphold that flood resilience in business environment is the ability of SMEs to prepare for the occurrence of flooding in terms of adequate response and also strategize or plan to reduce its impact and enable possible recovery. Therefore, capability and strategy are regarded as important elements of SMEs resilience.

Having gained knowledge on the constraints faced by SMEs, this paper therefore adapts the theoretical framework of [26] that classified decision making factors for maintaining a successful business and the common constraints faced by small businesses in Africa as administrative, strategic, operational and exogenous in nature. The theory however postulates that administrative constraints are influenced by organization's structure, and its ability to develop resources. Examples include: finance, personnel and management. The Operational constraints include the allocation of resources in an efficient manner relevance to the functional aspects of the business. For example: operations and inventory management. Strategic constraints however dealt with the capacity for entrepreneurs to meet up with the demands of their customers, this involves marketing and good management practices. The last is that of exogenous constraints which involves infrastructural concerns, technology and corruption.

Table 2: Framework of Flood Resilience for SMEs

Source/Context	**Indicators for SMEs Constraints**	**Resilience Components**
Ansoff (1965) Africa	Operational (i.e. operations and inventory management), Strategic (market and good management practice), Exogenous (infrastructural concerns and corruption) and Administrative (finance, personnel and management)	Micro-finance loans, Skill and technical expertise, Networking, Record keeping.
Okpara & Wynn, (2007) Nigeria	Infrastructure, Finance, corruption, management,	Management and Seminar workshops, Networking, technical and skill acquisition, expansion and maintenance of infrastructure, strong anti-corruption institutions
Wedawatta (2013) United Kingdom	Finance, Planning, Infrastructure	Financial subsidy for stock Insurance, Business Continuity Plans, Property level protection from extreme weather events

According to the table above, the constraints faced by SMEs in Nigeria and United Kingdom were similar in terms of indicators such as planning, infrastructure, and finance but differ relative to their coping strategies. According to Wedattawata [36] SMEs in United Kingdom are posed with the challenge of high insurance premiums; for instance, increased cost on building insurance by 3percent was estimated to cover damage by floods worth 3 billion pounds by June and July 2007 but the Association of Building Insurers in UK indicated that 800million pounds annual supplementary funding will be inadequate, hence it may be forced to increase the cost of insurance premiums or take off insurance of buildings which will leave SMEs vulnerable to adverse weather events. On the other hand, insurance schemes available in developed countries are unavailable in developing countries like Nigeria owing to the financial constraints, low levels of self-sustenance and would rather “wait and see” than invest in insurance which of course is a resultant of high level of poverty. Okpara [7] reports that inability for SMEs to raise the required capital for business maintenance is often an issue and as a result of this, application for loans from banks is often turned down. Wedattawata [36] however suggests that financial subsidy for stock insurance from governmental angle as well as technical advice for business interruption will go a long way in ameliorating financial issues. On the other hand, Okpara [7] is of the view that seeking loans from micro-finance banks or cheap/low-interest loans from commercial banks can help boost the financial strength of SMEs.

Another overarching issue facing the SMEs in Nigeria is corruption. Transparency International (TI) [37] reports that Nigeria is listed amongst world’s most corrupt nations. Within the boundaries of this discussion, Okpara and Wynn [24] reports that the Federal Government allocates technical and financial support to SMEs through programmes monitored at state level but such benefits do not often get to entrepreneurs as they are diverted to other programmes for self-benefit by corrupt government officials. This is however gradually becoming a thing of the past as the on-going agricultural revolution in Nigeria is making it possible for agricultural-based SMEs to be provided with fertilizers and other technical support. This can however be strengthened through a more proactive approach for close monitoring and strengthening of anti-corruption institutions. SMEs can therefore be more resilient to flooding events if they can benefit effectively from government support, as it will reflect positively through poverty reduction.

Very little knowledge on how SMEs can thrive in the aftermath of disasters is a critical area that needs to be given due consideration. Good management practices and skills in the operation of SMEs is however an imperative for its sustainability. Such good practices involve book keeping, risk assessment, inventory management etc. In the event of flooding, if such records and valuable information are kept safely, it can help SMEs continue with their normal activities when floods recede. Risk assessment can also help to provide solution and alternatives through which businesses can cope with flooding or any other potential risks that may arise. This will however depend on good risk management techniques, which involve using Business Continuity Plans.

[38] affirms that Business Continuity Planning however provides an organization with long-term strategic plans for the business to continue after disruption by an event. A business Continuity Plan however outlines methods and procedures that can be used by businesses to guarantee important functions which are sustained after a business disruption [38].

7. Conclusion

Considering the contribution of small and medium enterprises to the growth of Nigerian economy, an interruption in the normal business operations as a result of flood events however poses a huge threat to the physical, social and economic livelihoods of residents. This will also imply that revenue generated from taxes accruable to government will be affected; business owners will lose out on profits, employment levels will dwindle and on the long run the overall performance of the economy may be affected. It is however of great significance for SMEs to engage in flood resilient strategies that will ensure continuous operations. Government policies can also be designed to support and encourage SMEs through financial grants. Universities and Chambers of Commerce can organise workshops and seminars to build technical and business management skills for entrepreneurs to effectively make sound decisions useful for the growth and survival of their businesses. Relocation of traders from flood prone areas to safe regions can also go a long way in reducing impact of flooding. Infrastructures play a vital role in the survival of businesses; therefore flood proof building designs should be an integral consideration for the construction of buildings for SMEs. Finally, the adoption of risk management strategies such as business continuity planning will provide the required action plans for coping with flood events. These basic considerations will also promote the agenda of the Millennium Development Goals (MDGs) of poverty reduction, improve internal coping capacities and foster economic development. Given the contribution of small and medium enterprises to the economic growth of Nigeria and the incessant interruption of flood hazards to the SMEs operation, this paper seeks to recognise that building resiliency amongst SMEs in the urban cities is critical for the development of Nigeria.

References

[1] Adewole, I. F., Agbola, S. B. and Kasim, F. O. (2014). Building resilience to climate change impacts after the 2011 flood disaster at the University of Ibadan, Nigeria. Environment & Urbanization. Vol. 27, No.1

[2] Kuei-Hsien, L., (2012). A Theory on Urban Resilience to Floods—A Basis for Alternative Planning Practices, Ecology and Society. Vol.17, No. 4, pp48 doi.org/10.5751/ES-05231-170448

[3] Ingwe, R., (2013). Flood Resilience And Sustainable Development In Urban Nigeria: Integrating Traditional And Non-Structural Methods Of Mitigating And Adapting To Flooding In Cross River State, South-Eastern Nigeria. Riscuri Si Catastrofe. Vol.11, No.3

[4] Ajibola, M. O, Izunwanne, E. M, Ogungbemi A. O (2012). Assessing The Effects Of Flooding On Residential Property Values In Lekki Phase I, Lagos, Nigeria, International Journal of Asian Social Science. Vol.2, No.3, pp 271-282.

[5] Wedawatta, G., Ingirige, B. and Amaratunga, D. (2010). Building up resilience of construction sector SMEs and their supply chains to extreme weather events, International Journal of Strategic Property Management, Vol.14, No.4, pp362-375

[6] Abolade, O., Muili, A.B. and Ikotun, S.A. (2013). Impacts of flood disaster in Agege local government area Lagos, Nigeria, International Journal of Development and Sustainability. Vol.2, No.4, pp 2354-2367

[7] Sachs, J., Mcarthur, J.W., Traub, G.S., Kruk, M., Bahadur, C., Faye, M. and Mccord, G. (2004).
Ending Africa's Poverty Trap Brookings Papers on Economic Activity, Vol. 1, pp. 117-240

[8] Okpara, J. O. (2011). Factors constraining the growth and survival of SMEs in Nigeria: Implications for poverty alleviation. Management Research Review, 34(2), 156-171.

[9] Arinaitwe, J.K. (2006), "Factors constraining the growth and survival of small scale businesses: a developing countries analysis", Journal of American Academy of Business, Cambridge, Vol. 8 No. 2, pp. 167-78.

[10] Harris, M.L. and Gibson, S.G. (2006), "Determining the common problems of early growth of small businesses in Eastern North Carolina", SAM Advanced Management Journal, Vol. 71,No. 2, pp. 39-45.

[11] Eeden, S., Viviers, S. and Venter, D. (2004), "An exploratory study of selected problems encountered by small businesses in a South African context", Journal of African Business, Vol. 5 No. 1, pp. 45-72, 5.

[12] Sauser, W.I. Jr (2005), "Starting your own business? Prepare for success", SAM Management in Practice, Vol. 3 No. 1, pp. 1-4.

[13] National Disaster Management Framework (2010)
http://www.preventionweb.net/files/21708_nigherianationaldisastermanagementf.pdf

[14] Gwary, D. M., Nahunnaro, H., & Okusanya, B. O. (2010). Effects of the relationship between areas under disease progress curve of angular leaf spot and yield of seed cotton in north-eastern Nigeria. Archives of Phytopathology and Plant Protection, 43(12), 1225-1235.

[15] Adeoti, A. I., Olayide, O. E., & Coster, A. S. (2010). Flooding and Welfare of Fishers' Households in Lagos State, Nigeria. Journal of Human Ecology, 32(3), 161-167.

[16]Aderogba, K. A. (2012). Global warming and challenges of floods in Lagos Metropolis, Nigeria. Journal of Academy Research International, 2(1), 456.

[17] Akanni, O. and Bilesanmi, L. (2011). Flood: Lagos residents forced to relocate. ‘‘Drowning teenagerrescued” in Vanguard: Towards a Better Life for the People. Lagos: Vanguard Media Limited. (Friday, July10), p. 20.

[18] Federal Government of Nigeria (2013). NIGERIA Post-Disaster Needs Assessment 2012 Floods 2012, June. Retrieved from https://www.gfdrr.org/sites/gfdrr/files/NIGERIA_PDNA_PRINT_05_29_2013_WEB.pdf

[19]Internal Displacement Monitoring Center (2012). Disaster-induced Displacement Worldwide in 2012 http://www.rtcc.org/files/2013/05/IDMC-2012-Disaster-Displaced-Map-Large.jpg

[20] UNISDR (2013). Post-2015 Framework for Disaster Risk Reduction, Retrieved from http://www.unisdr.org/we/coordinate/hfa-post2015

[21] EKOS Consulting (UK) Ltd. (2008). Evaluation of Yorkshire Forward's Flood Response. Sheffield: EKOS Consulting (UK) Ltd.

[22] McManus, S. T. (2007). Organisational resilience in New Zealand, Doctorate Thesis, University of Canterbury, New Zealand

[23] Wedawatta, G.and Ingirige, B. (2012). Resilience and adaptation of small and medium-sized enterprises to flood risk, Disaster Prevention and Management, An International Journal. Vol.21, No.4, pp 474 – 488

[24] Okpara, J.O. and Wynn, P. (2007), “Determinants of small business growth constraints in a sub-Saharan African economy”, SAM Advanced Management Journal, Vol. 72 No. 2, pp. 24-35.

[25] Tushabomwe-Kazooba, C. (2006), “Causes of small business failure in Uganda: a case study from
Bushenyi and Mbarara Towns”, African Studies Quarterly, Vol. 8 No. 4, available at: http://web.africa.ufl.edu/asq/v8/v8i4a3.htm (accessed August 5, 2007).

[26] Ansoff, H.I. (1965), Corporate Strategy: An Analytic Approach to Business Policy for Growth and
Expansion, McGraw-Hill, New York, NY.

[27]Runyan R C (2006) ‘Small businesses in the face of crisis: Identifying barriers to recovery from a natural disaster’ Journal of Contingencies and Crisis Management, Vol 14, No 1. pp 12-26

[28] Yoshida K & Deyle R E (2005) ‘Determinants small business hazard mitigation’ Natural Hazards Review, ASCE, Feb 2005.

[29] United Nations Strategy for Disaster Risk Reduction (2005).Hyogo Framework for Action 2005-2015: Building Resilience of Nations and Communities to Disasters.

[30] Paton, D., Johnston, D. (2001). Disaster and Communities; Vulnerability, Resilience and Preparedness. Disaster Prevention and Management, 10, 270-277

[31] Pelling, M. (2003). The Vulnerability of Cities: Natural Disaster and Social Resilience, Earthscan, London.

[32] Beatley, T. (2009), Planning for Coastal Resilience: Best Practices for Calamitous Times, Island Press, Washington, DC.

[33] Burnard, K & Bhamra, R. (2011). Organisational resilience: development of a conceptual framework for organisational responses, International Journal of Production Research, Vol.49, No.18, pp5581-5599, DOI: 10.1080/00207543.2011.563827

[34] Linnenluecke M and Griffiths A. (2010) Beyond Adaptation: Resilience for Business in Light of Climate Change and Weather Extremes, Business & Society. Vol.49, No.3, pp 477-511.

[35] Wedawatta, H. G. (2013). Resilience of construction SMEs to extreme weather events (Doctorate dissertation). Retrieved from: usir.salford.ac.uk

[36] Transparency International (TI) (2005), “Corruption Index”, available at: www.transparency.org/policy_research/surveys_indices/cpi/2005 (accessed August 23, 2007).

[37] Zhang, X., & McMurray, A. (2013). Embedding business continuity and disaster recovery within risk management. World, 3(3).

Evaluation of a case study concrete bridge in Victoria under effect of bushfire

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Abstract

Australia's variable climate has always been a factor in natural disasters that have had significant impacts on its evolving road infrastructure as well as the communities which rely on the roads. Bushfires as one of the major natural disasters have impacted the country directly and indirectly. Bureau of Infrastructure, Transport and Regional Economics (BITRE) estimated 8.2 million dollars as an average annual cost of bushfires in Australia between 1967 and 2005 from which the state of Victoria has the highest proportion of 37% among other states (BITRE, 2008). Road network plays a vital role not only during the bushfires, but also after the natural hazards' events. As many roads are built across rivers, valleys and other roads, bridges become important part of the transportation network. The paper explores a case study of a Victorian concrete bridge in case of a fire exposure. The Isotherm method has been used for the assessment of case study bridge members where fire exposure duration is a variable in the study. Structural properties are evaluated in bridge components at different locations, during and after the extreme heat. Risk of failure has been evaluated and repair strategies recommended accordingly. The case study presented will assist road authorities to predict the potential damage to the road bridges and to proactively initiate strengthening programs to prevent catastrophic events or to prepare alternative strategies. Furthermore, emergency services can be informed of the potential risks of using the road network in response time of bushfire events.

Keywords: Bridge, Concrete, Fire Exposure, Risk, Strength Reduction.

1. Introduction

Australia has been prone to bush fires with 136 towns reportedly affected between years 1851-2009. Direct impacts of bush fires include damaged assets as well as casualties during the bushfire events whilst indirect impacts include service disruptions, loss of income and trauma. BITRE estimated 8.2 million dollars as an average annual cost of bushfires in Australia between 1967 and 2005 from which the state of Victoria has the highest proportion of 37% among other states (BITRE, 2008).

Road networks play a vital role not only during the bushfires, but also after the fire events. As many roads are built across rivers, valleys and other roads, they are known as lifeline infrastructure which provides a critical link in the transport network.

The behaviour of reinforced concrete under extreme temperature has been modeled and studied by numerous researchers (Terro, 1998, Khoury, 2000, Dotreppe et al., 1997. VicRoads, the state of Victoria's road authority has published a technical note on fire damage in reinforced concrete and with recommendation regarding assessment and repair practice on the affected components (Andrews-Phaedons, 2011). Required repair works for concrete under fire have been recommended in Lin et al., (1995), Garlock et al., (2012), andYaqub and Bailey, 2011. Furthermore, risk evaluation and damage indices have been investigated by Blong and Blanchi (Blong, 2003a, Blong, 2003b, Blanchi et al., 2002). However, a systematic method of assessing bridges prior to a bush fire event to establish the probability of failure is a current gap in knowledge. This paper presents a simplified method for assessing reinforced concrete bridges considering three possible failure scenarios.

This paper explores available methods and recommendations for assessment of concrete bridge structures under the extreme temperature of fire. Isotherm method is used for assessment of the bridge members where time and temperature are the variables in the study. Risk of failure has been evaluated and repair strategies have been recommended. The isotherm methodology is applied to ascertain the bridge structural behaviour not only to identify potential damage and recommend repair work, but also to evaluate the risk and damage index in concrete bridges under extreme heat based on fire exposure duration. A case study is presented to demonstrate the methodology of assessment of a bridge structure. Presented process will assist road authorities to predict the potential damage to the road bridges and to proactively initiate strengthening programs to prevent catastrophic events or to prepare for alternative strategies at the time of disasters. Furthermore, emergency services can be informed of the potential damages and risks of using the road network in the response time at a bushfire event. In addition, cost estimations can be made for recovery of the damaged bridges using the recommended repair works. Therefore, the paper creates a seamless procedure for emergency management of concrete bridges to cover the stages of Prevention, Preparedness, Response and Recovery (PPRR).

2. Review of bushfire impacts on concrete structures and methodologies

Literature and standards have been published to address the need for designing structures under the extreme heat of fire. There are a number of descriptive codes which cover deem to satisfy design of elements in extreme heat, which provide tabulated recommendations for members' dimensions and minimum covers for standard fire endurance. However, European codes have pioneered the use of performance based design methodologies. The second chapter of the ACI/TMS 216 and also the section 4 of the BS 8110 Part 2 specify requirements for determining fire resistance of concrete elements based on dimensions and minimum cover (ACI 2007, BS 1985). However, the British standard has been replaced by the Eurocode 2 since 2010. Structural components' fire testing methods are described in standards such as AS 1530.4 (2014), BS 476 and ASTM E119 (2014) in which testing procedures for construction materials are provided. Furthermore, national building codes provide specific requirements for fire resistance in buildings construction and selection of materials. National Building Code of

Canada (NBC 2010), National Fire Code of Canada (NFC 2010) and the Building code of Australia (BCA) (ABCB 2014) are examples of these codes .

Eurocode 2 (EN 2004) covers fire design for concrete structures. The code provides 3 different methods 1. tabulated data, 2. simplified calculation methods and 3. advanced calculation methods for designing concrete elements. Use of the tabulated data is simple; however, it has restrictions such as up to 240 minutes of fire exposure could only be considered using this method. Simplified methods which consist of 500ºC isotherm method (reduced section method) and the zone method (method of slices) can be used for standard and parametric fire events (EN 2004, Purkiss 2007). However, for global structural analysis, advanced calculation models are recommended by the Eurocode 2 (EN 2004). Phan et al. (Phan et al. 2010) states the BS 7974 as the most comprehensive code of practice for specific fire engineering design in any country. The code provides complementary guidance to Eurocode for calculation of structural fire resistance.

2.1. Overall impact

The impact of the elevated temperature caused by fire on material types used in construction of bridges could lead to degradation of structural or functional capacity of the structures and eventually failure of their elements. Responses of structures exposed to fire can vary, however, they could be categorised in thermal, mechanical & deformation responses. Some of the thermal properties of concrete affected by increase in temperature are thermal conductivity, specific heat, and thermal elongation (Li et al. 2003). Some of the mechanical properties of concrete affected by increase in temperature are the compressive strength, tensile strength, elastic modulus and creep strain.

Kodur (2014) states that the response of concrete to elevated temperatures are affected by temperature changes, composition, characteristics of concrete batch mix, heating rate and environmental conditions. Li et al. (2003) state that concrete is a composite material meaning the components will have different thermal characteristics and that concrete has properties which depend on moisture and porosity. Bilow and Kamara (2008) state that changes in properties of concrete at elevated temperatures are influenced by the type of coarse aggregate used in the concrete, the coarse aggregate being classified into three types: carbonate, siliceous and lightweight. In concrete, the high temperature of fire causes self-destructive stresses as well as chemical reactions, which create cracks, spalling and weakening of strength, stiffness and ductility of the concrete as a material (Astaneh-Asl et al. 2009). According to Phan et al. (2010), fire design would be the same as a normal structural design if the designer considers the following 7 points:

- Load changes on the structure during the fire
- Internal forces due to thermal expansion
- Strength reduction of the materials
- Cross section reduction of structural elements
- Reduction of safety factors due to smaller likelihood of the consequence
- Structural members deflection consideration
- Consideration of all possible failure mechanism

2.2. Typical failure modes of concrete bridges during a bushfire

Although concrete is one of the most resistance materials among the conventional bridge construction material, being exposed to extreme heat of fire, local and eventually global failure are inevitable in extreme cases. Common local failure mechanisms of concrete members under extreme heat are:

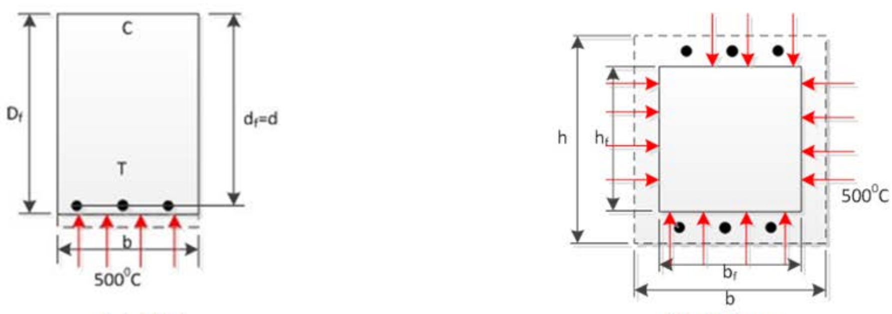
- Concrete spalling
- Concrete cracking
- Concrete delamination
- Compressive strength reduction
- Steel reinforcement and prestressed strands strength reduction

3. Methodology

500^{0}C isotherm method described in Eurocode for a standard fire exposure is used in this analysis. Reduced cross section is calculated at the beginning and then the reduction in the steel strength is calculated based on the data given in Eurocode 2. Afterwards, traditional calculation method can be adopted to find the moment capacity of the reduced section.

3.1 Reduced cross section at elevated temperature

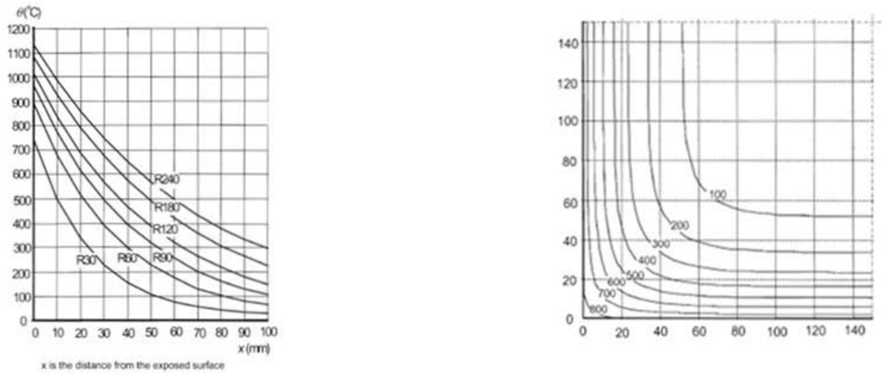
Damaged concrete is assumed not to contribute to the load bearing capacity of the member (Eurocode 2). Heat damaged zone (i.e. concrete with temperatures in excess of 500°C) at the concrete surface is disregarded and a reduced cross section thus resulted in is considered in the analysis. Figure 1(a) shows the reduced cross section of reinforced concrete slab fire exposure on one side while Figure 1(b) shows the same for a column with fire exposure on all four sides. The residual concrete cross-section retains its initial values of strength and modulus of elasticity.



(a). Slab (b). Column

Figure 1: Reduced cross section of reinforced concrete members

In order to find the isotherm of 500^{0}C for different exposure times for slab and column the figures given in Eurocode 2 were used (Figure 2). Figure 2(b) shows the temperature profiles only for an exposure time of 30 minutes as an example of all the others available in the Eurocode for more exposure classifications. Position of T500 for columns was calculated using the average of the minimum (from the edge) and the maximum (from the corner).



(a). Slab

(b). Column (R30)

Figure 2: Temperature profiles

3.2 Strength of steel at elevated temperature

Distance to the center of the reinforcing bars needs to be figured out using the cover. The temperature of the individual bars (taken to the center of the bar) can be obtained using Figure 2. Although some of the reinforcing bars may fall outside the new reduced cross section as shown in Figure 1(b), they will be included in calculating the ultimate moment capacity provided that the tensile strength is adequate. Strength reduction factors are given for tension and compression reinforcement for Class N and Class X types in the form of tables and equations in Eurocode 2. Due to the limitations in the length of the paper, those tables and equations have been omitted.

3.3 Failure Conditions

There are three scenarios where potential damage to the bridge and its strength should be considered.

1. The first scenario is during fire under dead load, where the strength of the members drop to such a degree that the structure can no longer support its self-weight. This is a critical failure condition, as no amount of emergency response (such as cutting off traffic) or remedial work can be undertaken to reduce the damage.
   Failure can be said to occur when the temperature in the rebar reaches 593°C which corresponds to 50% loss of steel strength. (Raut & Kodur 2009)
   The damage for this situation will be assessed using the reduced yield strength of reinforcing at the max temperature reached, and the reduced strength of concrete at max temperature reached, where all areas of concrete that have reached 500°C are counted as having f'c = 0.
2. Fire under dead and live load, where a vehicle will attempt to use the bridge during the fire event will be the second scenario. This will not be counted as a critical failure condition as it likely that traffic will not attempt to cross the bridge during the fire, and if it does so complete failure is much more likely making modelling of the degree of damage pointless.
3. The third scenario is after fire under dead and live load, where the residual strength of the members (after the steel strength has recovered to normal temperatures) is still not sufficient to support traffic loading.

The damage for this situation will be assessed using the residual reduced yield strength of reinforcing at the max temperature reached, and the reduced strength of concrete at the max temperature reached, where all areas of concrete that have reached 500°C are counted as having f'c = 0.

It is assumed that where any change in strength of the bridge is observed post-fire, repair will be required to return the bridge to pre fire capacity.

4. Case study

While an extensive amount of bridges are in use in Victoria, an older structure will be used in this cases study assessment with the age ranging from 50 – 59 years. Both reinforced flat slab bridges and reinforced decking unit bridges common through the region will be assessed. Based on the standards of the time an assumed cover depth of 30mm in beams/slabs and 40mm in columns will be used.

Figure 3: Case study bridge

The bridge was constructed in 1958 and consists of reinforced concrete columns, diaphragms and 500mm deep deck slab (Figure 3). The structure comprises six piers and concrete abutments. Piers 1 and 6 comprise 5 columns each and have pinned connections to the deck and piers 2 – 5 have 6 columns each and are cast integrally with the deck.

The waterway being crossed is a wide stream which fluctuates at different times of the year. This waterway has abundant vegetation, weed and some debris which may hinder the flow.

The columns, crossheads and abutments appear to be generally in good condition although typical hairline to medium transverse and longitudinal cracking has developed in several locations. Abrasion of the concrete due to water wash was evident at the base of all columns.

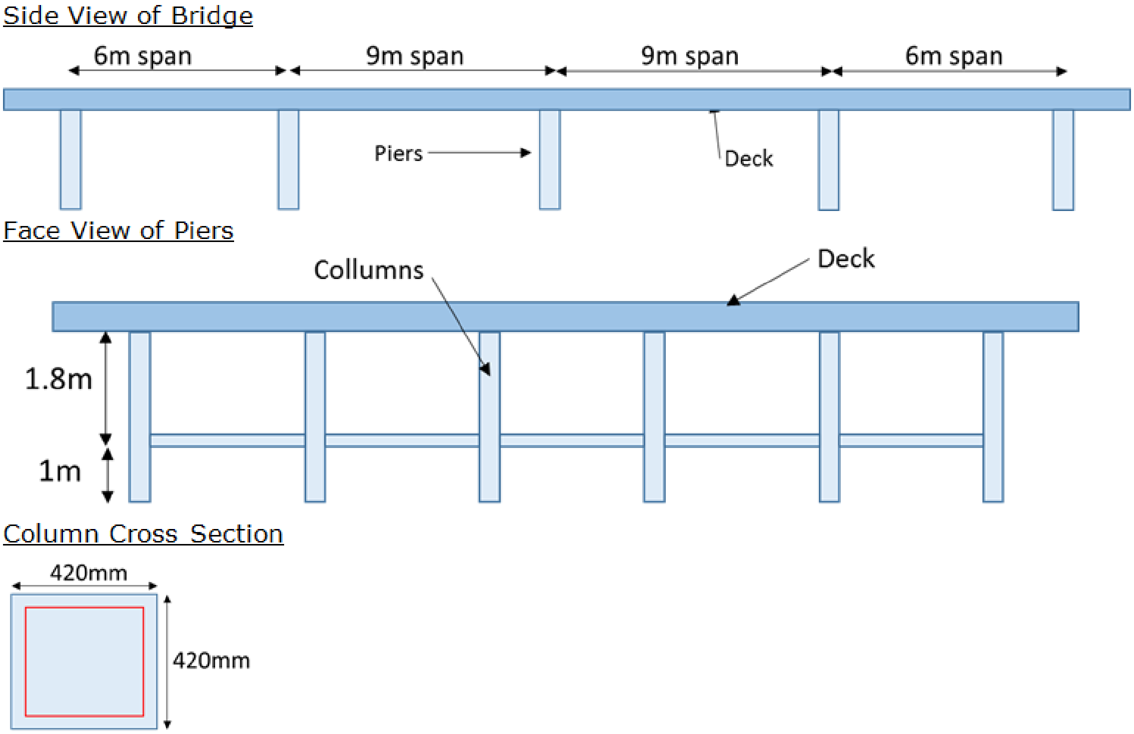


Figure 4: Dimensions of SN5577

5. Analysis

5.1. Deck slabs and deck units

Table 1 shows the depth of the isotherm 500 as well as the concrete reduction coefficient based on the fire exposure time. The temperature in the reinforcement bars and their corresponding yield strength and residual yield strength reduction factors are given in Table 2 for concrete deck slabs.

Table 1: Depth of 500°C isotherm, and concrete reduction coefficient, K_c values.

Depth of T500		K_c (at depth from exposed surface)			
time	mm	50mm	100mm	150mm	200mm
30	10	0.88	1	1	1
60	21	0.64	0.975	1	1
90	29	0.43	0.92	1	1
120	36	0.3	0.825	0.99	1
180	49	0.15	0.64	0.95	1

Table 2: Temperature of reinforcement and associated yield strength reduction factor(r), and residual yield strength reduction factor ($r_{residual}$).

Temperature at 30mm (reinforcement)			
time	T(°C)	r	$r_{residual}$
30	230	1	1
60	395	0.649	1
90	495	0.436	1
120	570	0.277	0.93
180	680	0.043	0.82

Table 3 shows the bending strength and the stiffness reduction factors for during and after the extreme heat on the concrete slab.

Table 3: Reduction factors for bending strength (Mu factor) and member stiffness (stiffness factor) of SN5577's reinforced concrete deck slab.

		Mid span			Above Pier			
			Mu factor			Mu factor		
	B (mm)	d(mm)	During Fire	After Fire	d(mm)	During and After Fire	$K_{c,mean}$	stiffness factor
T(30)	610	270	1.000	1.000	260	0.963	0.951	0.803
T(60)	599	270	0.650	1.000	249	0.922	0.926	0.667
T(90)	591	270	0.438	1.000	241	0.892	0.910	0.581
T(120)	584	270	0.278	0.930	234	0.866	0.897	0.516
T(180)	571	270	0.043	0.821	221	0.818	0.884	0.422

5.2. Columns

The depth of the Isotherm 500 and the corresponding concrete strength reduction coefficient in columns are given in Table 4. Tables 5 illustrates bending strength reduction factors, compression capacity reduction factor and the stiffness reduction factor for during and after the fire exposure on columns.

Table 4: Depth of 500°C isotherm at and concrete reduction coefficient, K_c values.

Position of T500				kc			
time	Minimum (mm)	Maximum (mm)	Average (mm)	50mm	100mm	150mm	200mm
30	10	22	16	0.88	1	1	1
60	22	39	30.5	0.64	0.975	1	1
90	32	50	41	0.43	0.92	1	1
120	40	61	50.5	0.3	0.825	0.99	1
180	50	70	60	0.15	0.64	0.95	1

Table 5: Reduction factors for member bending strength (Mu factor), member compression capacity (N factor) and member stiffness (stiffness factor), as well as effective length and radius of gyration ratio of SN5577's reinforced concrete columns.

				Mu factor				N Factor			
	B(mm)	D(mm)	d(mm)	During Fire	After Fire	radius of gyration	Le/r	During Fire	After Fire	k	stiffness factor
T(0)	420	420	380	1	1	121.8	14.8	1	1	1	1
T(30)	388	388	364	0.957	0.957	112.5	16.0	0.881	0.881	0.898	0.587
T(60)	359	359	349.5	0.721	0.918	104.1	17.3	0.738	0.782	0.87	0.404
T(90)	338	338	339	0.476	0.889	98.0	18.4	0.620	0.715	0.86	0.310
T(120)	319	319	329.5	0.292	0.827	92.5	19.5	0.523	0.649	0.855	0.243

6. Results

The following table (Table 6) shows the estimated damages to the deck and columns of the case study bridge in fire exposure durations of 30, 60, 90 and 120 minutes. Rehabilitation or replacement actions are also suggested based on the estimated damage on the components.

Table 6: Damage and repair requirements

Exposure Time	Deck Units	Columns
30 minutes	500°C isotherm 10mm deep + cracking. Post fire yield strength of reinforcement is unaffected. Repairing of damaged concrete required.	500°C isotherm 16mm deep + cracking. Post fire yield strength of reinforcement is unaffected. Repairing of damaged concrete required.
60 minutes	500°C isotherm 21mm deep + cracking. Post fire yield strength of reinforcement is unaffected. Repairing of damaged concrete required.	500°C isotherm 30.5mm deep + cracking. Post fire yield strength of reinforcement is unaffected. Repairing of damaged concrete required.
90 minutes	Ruined concrete (500°C Isotherm) has reached reinforcement. (30mm) Post fire yield strength of reinforcement is unaffected. Repairing of damaged concrete required.	500°C Isotherm is average of 10.5mm past reinforcement. (40mm) Post fire yield strength of reinforcement is unaffected. Repairing of damaged concrete required.
120 minutes	500°C Isotherm is 6mm past reinforcement. Post fire yield strength of reinforcement is reduced by 7% Repairing of damaged concrete required.	500C Isotherm is average of 20mm past reinforcement. Post fire yield strength of reinforcement is reduced by 4%. Replacement of the columns required.

6.1. Risk of failure of Bridges

Based on the structural capacity reductions calculated in Section 5, failure risks of the components have been suggested in Table 7.

Table 7: Relevant values for failure condition 1: During fire under dead load

Exposure Time	Deck Units	Columns
30 minutes	Stiffness has dropped by close to 11%. No risk of failure.	Moment capacity has dropped by 4%, compression capacity has dropped by 12%, and stiffness has dropped by 41%. No risk of failure.
60 minutes	Sagging moment capacity has dropped by 35%, and stiffness by 20%. Failure unlikely since the bridge will only be supporting the deadload. Small amount of extra damage from deflection likely.	Moment capacity has dropped by 28%, compression capacity has dropped by 26%, and stiffness has dropped by 60%. Failure unlikely since the bridge will only be supporting the deadload.
90 minutes	Sagging moment capacity has dropped by 56%, and stiffness by 25%. Failure unlikely. Extra damage from deflection likely.	Moment capacity has dropped by 52%, compression capacity has dropped by 38%, and stiffness has dropped by 69%. Buckling Failure possible.
120 minutes	Sagging moment capacity has dropped by 72%, and stiffness by 29%. Flexural Failure possible. Extra damage from deflection likely.	Moment capacity has dropped by 71%, compression capacity has dropped by 48%, and stiffness has dropped by 76%. Buckling or compression Failure possible.

7. Conclusions

The paper explored extreme fire impacts on concrete bridges and presented a methodology to estimate the extent of damages on concrete structures. Isotherm 500 method has been utilized to analyze a case study bridge in Victoria due to effects of extreme heat. The extent of fire damage and resulting strength reduction in the bridge deck and columns have been investigated during and after the fire. Rehabilitation or replacement actions as well as failure probability estimations have been presented. Following conclusions can be made from the outcome of the analysis of the case study:

- Columns were significnatly at a higher risk than the slab due to their exposure to fire on all sides. Also, the duration of exposure would be higher for the columns as well in a real situation. If the exposure was limited to 90 minutes, the bridge could be repaired to its pre-disaster capacity
- If the duraiton of exposure is over 120 minutes, all the columns of the bridge would require full replacement. The columns have a high risk of failure under fire as well, which may lead to a need for full replacement of thebridge.

  Whilst the analysis was limited to one bridge, the generic process can be adopted for other bridges of the network to ascertain the risk of damage under Bush Fire. Critical bridges in high risk regions can be hardened to ensure that failure doesn’t occur under common exposure scenarios.

References

ABCB (2014). National Construction Code Series: 2014, Australian Building Codes Board,

ACI (2007). "216.1-07: Code requirements for determining fire resistance of concrete and masonry construction assemblies." Farmington Hills (Michigan): American Concrete Institute.

AS (2014). "AS 1530.4:2014 - Methods for fire tests on building materials, components and structures - Fire-resistance tests for elements of construction ". Australian Standards.

ASTANEH-ASL, A., NOBLE, C., SON, J., WEMHOFF, A., THOMAS, M. & MCMICHAEL, L. "Fire protection of steel bridges and the case of the MacArthur Maze fire collapse." Proc. of the 2009 ASCE Technical Council on Lifeline Earthquake Engineering Conference (TCLEE09), 2009.

ASTM (2014). "E119-14 - Standard Test Methods for Fire Tests of Building Construction and Materials." American Society for Testing and Materials.

BELOW, D. & KAMARA, M. 2008. Fire and Concrete Structures. Structures Congress 2008.

BS (1985). "Structural Use of concretePart 2: Code of practice for special circumstances (BS 8110-2: 1985)." Britis Standards.

Clark, T., Woodley, R., De Halas, D., 1962. Gas-Graphite Systems, in “Nuclear Graphite”. In: Nightingale, R. (Ed.). Academic Press,

Deal, B., Grove, A., 1965. General Relationship for the Thermal Oxidation of Silicon. Journal of Applied Physics 36, 37–70.

Deep-Burn Project: Annual Report for 2009, Idaho National Laboratory, Sept. 2009.

EN, B. (2004). "1-2: 2004 Eurocode 2: Design of concrete structures-Part 1-2: General rules-Structural fire design." European Standards, London.

Fachinger, J., 2006. Behavior of HTR Fuel Elements in Aquatic Phases of Repository Host Rock Formations. Nuclear Engineering & Design 236, 54.

Fachinger, J., den Exter, M., Grambow, B., Holgerson, S., Landesmann, C., Titov, M., Podruhzina, T., 2004. Behavior of spent HTR fuel elements in aquatic phases of repository host rock formations, 2nd International Topical Meeting on High Temperature Reactor Technology. Beijing, China, paper #B08.

KODUR, V. (2014). "Properties of Concrete at Elevated Temperatures." ISRN Civil Engineering, 2014.

LI, M., QIAN, C., WANG, H., YOU, Y. & SUN, W. (2003). "Mechanical properties of high-strength concrete after fire." Guisuanyan Xuebao(Journal of the Chinese Ceramic Society)(China), 31, 1116-1120.

NBC (2010). National Building Code of Canada, National Research Council of Canada.,

New York, pp. 387.

NFC (2010). National Fire Code of Canada, Canadian Commission on Building and Fire Codes, National Research Council of Canada.,

PHAN, L. T., MCALLISTER, T. P., GROSS, J. L. & HURLEY, M. J. (2010). Best practice guidelines for structural fire resistance design of concrete and steel buildings, National Institute of Standards and Technology,

PURKISS, J. A. (2007). Fire safety engineering design of structures, CRC Press

Disaster Risk Management of Cultural Heritage
The Rocks, Sydney, Australia

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Abstract

Although built heritage contributes to the structure, grain and character of our cities, it is rarely considered in emergency planning. Yet cultural heritage connects people to their past, provides comfort in the present and a firm foundation for rebuilding the future. Focusing on The Rocks, this paper examines the importance of cultural heritage to the life of Sydney, its economy and cultural identity. It analyses the vulnerabilities and disaster risks to the built fabric and heritage values of The Rocks and identifies the potential losses to the community. It explores mitigation and disaster response strategies for the precinct and highlights the need for inclusion of cultural heritage in emergency planning for Sydney.

Keywords: built cultural heritage, disaster mitigation strategies, disaster risk management planning, Sydney

1. Introduction

For most cities the layout, structure, grain and fabric of the city have been built up over many years. It is these multiple layers of built heritage that define the character and identity of our cities. It forms the environment in which we live out our daily lives and contributes to our sense of place. Yet, very little thought is given to the impact of disaster on cultural heritage and the resulting impact of its loss on the people who have inhabited and grown attached to it.

Our built heritage is closely linked to our cultural identity. In a disaster situation heritage is as susceptible to destruction as housing, businesses, basic services and infrastructure. In a conflict situation it is often the target of destruction, as we have recently seen in Syria and Iraq. Yet our emergency plans rarely consider the need for its protection. When a disaster occurs the emergency response focuses on saving lives, not heritage. Following a rapid assessment of the damage, the sense of urgency for cleaning up and moving on often results in much more than just the debris being swept away. In order to make room for rebuilding, the remains of our built heritage are also removed without proper consideration of their value to the community. Yet cultural heritage is what connects people to their past, provides security and comfort in the present and provides a firm foundation on which to rebuild the future. The loss of built heritage, including landmarks, cultural icons and whole streetscapes, to earthquakes in Newcastle, Christchurch and Kathmandu has been greatly mourned by the local communities [1, 2].

Focusing on The Rocks, an historic urban precinct in Sydney, Australia's oldest city, this paper highlights the potential losses to the community that may result from disaster. By examining the cultural heritage values of the Rocks and the vulnerabilities of its built heritage to various hazards, disaster risk management planning to mitigate the risks and promote a heritage rich recovery is discussed. The importance of collaboration between the Sydney Harbour Foreshore Authority (SHFA), who manage the site on behalf of the NSW State Government, the City of Sydney, the local community, business owners, emergency services and heritage specialists is also considered.

2. Case study: The Rocks, Sydney

2.1 Physical context

The Rocks is located on a rugged point on the edge of Sydney Harbour, at the foot of the Sydney Habour Bridge and overlooking Circular Quay and the Sydney Opera House. It lies within the buffer zone of the Sydney Opera House World Heritage site, and inversely, the Opera House, the Harbour Bridge and the harbour all form part of the buffer zone of The Rocks (Figure 1).

The Rocks was named for the geological foundations on which it was established. The sandstone bedrock onto, into and out of which the new settlement was constructed still dominates the urban landscape. Despite several attempts to rename the area, it remains 'The Rocks'.

Figure 1: Location Plan showing the Rocks Precinct (yellow) on the edge of Sydney Harbour, its buffer zone (circle) and heritage sites referred to in this paper (red).

2.2 Historic context

The Rocks is the site of first white settlement in Australia, although for our Aboriginal people it is regarded as the place of invasion. It is the place where, in 1788, convicts were first put ashore onto the rocky outcrops at the edge of Sydney Cove to establish the new British colony of New South Wales [3]. It was a penal colony without walls and the convicts became active contributors to the creation and success of the settlement that has since become the thriving City of Sydney.

In the early years of settlement, The Rocks was the economic centre of the new colony. As the principal port, it was the place of trade as well as the place of arrival for new immigrants. Gradually, small wattle and daub cottages replaced the original tents, and in turn were replaced by more substantial terrace houses, shops, hotels, port facilities and warehouses. Following an outbreak of Bubonic Plague in 1900, the whole area was resumed by the NSW Government in order to raze the unsanitary housing that had developed there and to extend the commercial and port facilities. Although many houses were demolished for larger scale development, including the construction of the Sydney Harbour Bridge (1925-1932), examples of all building types and stages of development still survive within the historic precinct. In the 1970s, when major redevelopment and modernization was again proposed, The Rocks became one of the first places in Australia where Australians recognized and fought to save their built heritage through a series of public protests and Green Bans. Thus, The Rocks has survived and is now an area much loved by Sydney siders.

2.3 Social and economic context

With over 14 million visits per year [4], The Rocks is a thriving tourist destination for both local and international visitors. Linking two of Sydney’s cultural icons, the Sydney Opera House and the Sydney Harbour Bridge, the area contains many restaurants, hotels, retail outlets, offices, street markets, art galleries and museums (Figures 10 and 11). The area also contains public housing accommodating both elderly and disabled residents. Although the cargo ships that previously docked at The Rocks have now been relocated to Port Botany, the place still overlooks the busy ferry wharves of Circular Quay and provides port facilities for large cruise ships during the summer months (Figures 2 and 3).

The Rocks is a place where the people of Sydney go to celebrate as well as to enjoy catching up with friends over a drink or a meal. It provides a stage for special events such as ‘Vivid’ and a viewing platform for the crowds who come to watch the fireworks over the harbour on New Year’s Eve and Australia Day. The Rocks is alive, 24 hours a day, 7 days a week and 365 days a year.

2.4 Heritage values

When undertaking disaster risk management planning for places of cultural heritage significance, it is important to understand the values attached to the places. Unless these values are clearly identified and understood, it is difficult to know what the potential losses might be and what needs protecting. Heritage sites have economic value, but they also have historic, aesthetic, social, spiritual, research and educational values [5].

Figure 2: View looking southeast over the roofs of Campbell's Stores (centre) at the northern end of The Rocks, the overseas passenger terminal, the ferry wharves of Circular Quay and the city beyond. The chimney of the former power station stands high above The Rocks precinct (right).

Figure 3: View looking north along George Street, The Rocks, towards the Sydney Harbour Bridge, the Sydney Opera House and the harbour. The archaeological remains of the first Government dockyards survive under First Fleet Park (right) and the Museum of Contemporary Art (centre).

The Rocks has many values. It has historic value as the site of first white settlement in Australia and as the place of invasion. Thus it is of National significance to the people of Australia. In addition, the precinct encapsulates the history of Sydney as it retains examples of all types and stages of development from the first convict settlement to the contemporary city, providing a rich backdrop to the activities that occur within it. The sandstone materiality of the site, the complex and chaotic pattern of streets and narrow laneways that respond to its rugged terrain, the richly layered streetscapes with their variety of building types and the views over the busy working harbour to the Sydney Opera House and the Sydney Harbour Bridge give The Rocks exceptional aesthetic and architectural value (Figure 3). As a tourist destination, the place has high economic value. And as a place of celebration and contemporary social activity, The Rocks has a very high social value to the people of Sydney. All these values are embodied in the built heritage and setting of the precinct and need to be protected.

2.5 Built heritage attributes

The Rocks contains many buildings and sites listed as heritage items on the NSW State Heritage Register (SHR) and the Sydney Local Environmental Plan 2012 [6]. Outstanding examples include:

- Cadman's Cottage, built as coxswain's barracks in 1816, the oldest surviving building in The Rocks (Figure 4).
- Unwin's Store, a terrace of five shop tenement houses, built in the 1840s to service sailors and new immigrants (Figure 5).
- Campbell's Stores, built during the 1850s, adjacent to the first private wharf in the city and the only surviving nineteenth century warehouse group in the precinct (Figure 6).
- The Argyle Cut, carved by the convicts through the sandstone ridge to provide access to the neighbouring residential area of Millers Point (Figure 7).
- The sandstone sea wall, constructed from the rock removed from the Argyle Cut to contain land reclaimed to extend the deep water port facilities of the city (Figure 6).
- The archaeological remains of the first government dockyard, located below First Fleet Park and the Museum of Contemporary Art (the former Maritime Services Board building) (Figures 3 and10).
- The narrow lanes and stairways providing the vertical connections between the streets running north-south along the contours of the headland (Figures 8 and 9).

3. Disaster risk management planning

3.1 Hazards

The most likely hazard to impact The Rocks is a severe weather event (a regular occurrence in Sydney), but other hazards include earthquake (Sydney is located in a moderate earthquake zone [7]), rising sea levels (high tide already reaches the foot of Campbell's Stores at least ten times per year [8, 9]) and tsunami (from earthquakes off New Zealand's west coast [10]).

Figure 4: Cadman's Cottage, built in 1816, is the oldest surviving building in The Rocks.

Figure 5: Unwin's Stores, a terrace of five stone shop tenement houses, built in the 1840s.

Figure 6: Campbell's Stores, built during the 1850s, is the last nineteenth century warehouse group in the precinct. The sandstone sea wall was built using stone cut from the Argyle Cut.

Figure 7: The Argyle Cut, carved by the convicts through the sandstone ridge to provide access to Millers Point beyond.

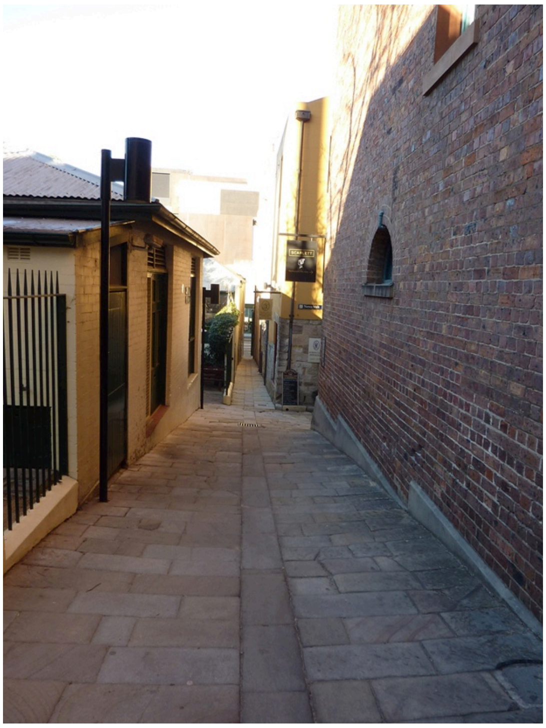

Figure 8: Suez Canal, a narrow pedestrian lane linking Harrington and George Streets.

Figure 9: Argyle Steps linking Argyle Street to Cumberland Street above the Argyle Cut.

Figure 10: The archaeological remains of the first government dockyard are located below the Museum of Contemporary Art.

Figure 11: Food markets in Argyle Street, the principal street linking the eastern and western sides of the headland.

Fires, gas explosions, drunken riots (due to the large crowds and many pubs located within the precinct) and terrorism (targeting Sydney Harbour Bridge) may also be added to this list. This paper focuses on two hazards: severe hailstorm and earthquake.

Severe hailstorms accompanied by lightning strikes, torrential rain and gale force winds, often result in flash floods, fallen trees, twisted power lines and smashed roofs. The damage bill from the Sydney hailstorm of 1999 was in excess of $1.7 billion, making it the most costly disaster in Australian history to that time [11]. Climate data shows that winds can gust up to 150km per hour and rainfall at Observatory Hill has fallen in excess of 600mm in a 24-hour period on at least three occasions in the last 150 years (1861, 1950 and 1990) [12]. The 2014 State of the Climate report predicts that extreme rain events will become more intense in the future [13].

Although there have been no major earthquakes within the Sydney Basin in recent history, hundreds of smaller quakes have been recorded [14] and significant quakes (magnitude 5.6) have occurred around the edges of the basin at Penrith (1899), Bowral, Robertson and Picton (1961 and 1973) and Newcastle (1989) [15]. This last event caused significant loss of life and damage to the built heritage of Newcastle. The lack of available data, due to our short settlement history, makes it difficult to estimate the likelihood of larger quakes within the Sydney Basin. However, recent studies indicate that they should be anticipated, especially considering the fault zones traversing the city [16].

3.2 Vulnerabilities, sensitivities and risks to heritage values

So what are the likely losses from these events? When considering storms, the slate roofs in The Rocks are highly vulnerable to large hail damage, the tall chimneys and towers to lightning strike and the below ground basements and sunken areas to flooding. Campbell's Stores, Unwin's Stores and Cadman's Cottage are all at risk of flooding. For Campbell's Stores the risk of damage is increased by its location on low lying reclaimed land that is also vulnerable to storm surge, particularly at high tide, and its location adjacent to a floodway. Cadman's cottage is at high risk due to its location in a flood storage area [17]. The poor condition of some buildings in the precinct, lack of maintenance of gutters and drains and poor management practices of tenants compound the risks to the heritage fabric [18].

Many of the buildings in The Rocks are highly vulnerable to earthquake due to their unreinforced block masonry construction. Although some of the buildings have been strengthened in recent years when conservation works have been carried out, many have not and are at risk of collapse. Of particular concern are the tall power station chimney that stands high above the precinct (Figure 2) and buildings, such as Campbell's Stores, that are in very poor condition. If the sea wall collapses, the risks to archaeological sites located in the foreshore area and the buildings located on the reclaimed land will be increased. The narrow laneways and stairways that connect the low ground to the high are likely to be blocked by fallen debris, and combined with the impenetrable high rock faces and other barriers that surround the precinct, access for emergency services and evacuation from the area will be extremely limited. If the elevated roadways and railway that enclose the area collapse, all access and egress points will be blocked (Figure 12).

Although most buildings in The Rocks have been upgraded to meet modern building codes, including provision of fire separation, compartmentalization, fire exits and a suite of fire warning and suppression systems, in the event of an earthquake, many of these measures are likely to fail. Broken water pipes will prevent activation of sprinklers and hydrants, and failure of masonry walls will compromise fire barriers between buildings. Adding to the risk is the rupture of gas pipes, damage to electrical wiring and disturbance of cooking facilities in the many kitchens located throughout the precinct. Cadman's Cottage is particularly vulnerable due to its timber-shingled roof surrounded by trees. Also at risk are the collections stored within the buildings (historical records, archives, artworks and artefacts).

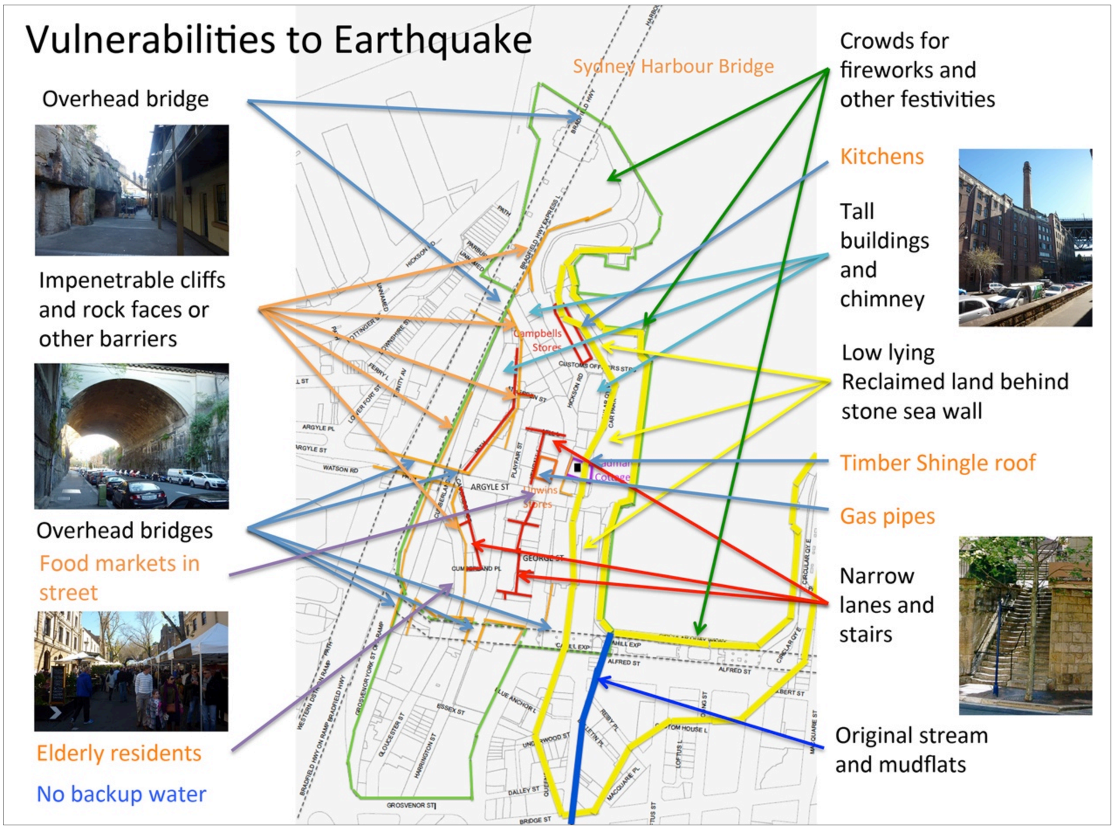

Figure 12: Vulnerabilities and sensitivities of the Rocks and its built heritage to earthquake hazards (Basel plan from SHFA, overlay by C. Forbes).

In most cases the losses to the heritage fabric of The Rocks due to storm damage, though costly to repair, should generally be recoverable. In the case of an earthquake and its accompanying fires, however, the destruction will be far more extensive, resulting in a much greater loss of heritage fabric and values, and The Rocks' whole sense of place. The loss of the historic buildings will totally change the character of the precinct and the aesthetic and architectural qualities of its streetscapes. This in turn will have a great impact on the economic and social values of the precinct, as it will no longer attract visitors. It will also impact the educational and research values of the precinct due to the loss of tangible evidence of its history and significance to Australia. The resulting impact of the destruction on the morale and identity of the people of Sydney, and even further afield, will be immense and possibly immeasurable.

3.3 Mitigation strategies

Mitigation strategies must be developed to minimise the risks to the built heritage of The Rocks without compromising its heritage values. In order to reduce the risks associated with severe storms, strategies should include installation of lightning protection to chimneys and towers, undertaking essential repairs to ensure buildings are water tight, improving drainage systems and ensuring gutters and drains are well maintained. The most important strategy to reduce earthquake risk would include seismic upgrade of historic structures, including the sea wall, prioritizing those structures that are at greatest risk or pose the greatest danger to their surroundings. To reduce risks associated with earthquake-induced fire, provision of an alternate water supply within or near the precinct and an earthquake resistant hydrant system should be considered.

Development of a disaster risk management plan (DRMP) for the precinct is essential and should be a collaborative process between SHFA, the City of Sydney, police, fire and rescue, water, gas and electricity providers, the local community and business owners, as all parties need to be engaged for its successful adoption and implementation.

3.4 Emergency response, recovery and reconstruction

In Australia the disaster response can be swift, with all debris, including the physical remains of our cultural and built heritage, being cleared away promptly to make room for reconstruction and a fresh start. The resulting disconnection between the people and the place that was once familiar and important to them adds to the grieving and sense of loss. To minimise the loss, it is essential that experienced heritage professionals are involved as soon as possible after the initial emergency response. Specially trained damage assessment and artefacts rescue teams, comprising structural engineers, conservation architects, builders and archaeologists, all with heritage expertise and experience, must secure the affected sites and undertake rapid assessments of the damage. Their tasks would also include retrieving and storing artefacts, collecting the rubble from the streets and storing it for future restoration of the buildings, investigating causes of building failure and establishing priorities for repair and reconstruction. Detailed records, including inventories, surveys, photographic records and measured drawings of the historic buildings (gathered prior to the disaster) will be extremely important to successful reconstruction. During the medium term recovery and long-term reconstruction phases, emphasis will need to be on finding ways to 'build back better' using sustainable and resilient solutions that support and don't compromise the heritage values of the precinct.

4. Where to from here?

The DRMP for The Rocks is only conceptual at this stage and requires considerable input from all stakeholders, including the City of Sydney, which is responsible for emergency coordination, as well as planning and development controls during the reconstruction phase, and the NSW State Government, which, as owner of most properties within the precinct, would have considerable input into planning and funding the recovery.

But the DRMP for The Rocks, or any other heritage site, cannot operate in isolation. Cultural heritage must be recognized and integrated into local, regional and state Emergency Plans, including the various sub-plans for the different types of disaster [19, 20]. Unless this occurs, the focus on other priorities will always override the retention and conservation of our built heritage.

It must also be recognized that, unlike The Rocks, most of our built heritage is not owned by government, but instead resides in the private sector. Thus, strategies must be developed for reducing the risks to cultural heritage in this sector, possibly through education, legislation and public-private partnerships. Even though government may be responsible for infrastructure, property owners are responsible for the management, care and protection of their properties, including heritage sites.

5. Conclusion

The heritage of our cities has value, not just in the present or in the past, but also for the future. It embodies our history, our identity and our sense of place. Thus it should be protected, even in times of disaster. With appropriate planning and mitigation measures in place, we can protect our cultural heritage and ensure that it continues to be passed on to future generations.

References

[1] Gates, C. (2014) Cathedral Poll: People want to be Heard. *The Press*, New Zealand: press.co.nz, 31 October 2014, (available online http://www.stuff.co.nz/the-press/news/10682740/Cathedral-poll-People-want-to-be-heard [accessed on 14/11/2014])

[2] Beenish, A. (2015) Before and After: Earthquake Destroys Kathmandu’s Centuries-Old Landmarks. *Thinkprogress*, April 26 2015, (available online http://thinkprogress.org/world/2015/04/26/3651327/nepal-earthquake/ [accessed 26/4/2015])

[3] Sydney Harbour Foreshore Authority (2010) *The Rocks Heritage Management Plan*. Volume 1, NSW: Sydney Harbour Foreshore Authority, April 2010, (available online https://www.shfa.nsw.gov.au/content/library/documents/0B9628D6-B745-73FA-E1F20F992872ED23.pdf [accessed on 10/7/2014]).

[4] Sydney Harbour Foreshore Authority (2014) *Visitor Snapshot: The Rocks, July 2013 to June 2014*, NSW: Sydney Harbour Foreshore Authority (available online http://www.shfa.nsw.gov.au/content/library/documents/40CD4E62-5056-A83C-FCA66728CBD43C28.pdf [accessed on 11/3/2015]).

[5] Australia ICOMOS (2013) *The Burra Charter, The Australia ICOMOS Charter for Places of Cultural Significance*. Burwood: Australia ICOMOS (available online . http://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf [accessed 10/7/2014]).

[6] NSW Heritage Division. *NSW State Heritage Register*. Parramatta:.NSW Government Office of Environment and Heritage (available online http://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx [accessed 11/3/2015]).

[7] Casus Calamitus Consulting (2013) An Earthquake in Sydney: could it happen here? *Disaster Risk Management*, 6 November 2013 (available online http://casuscalamitas.com/2013/11/06/an-earthquake-in-sydney-could-it-happen-here/ [accessed 10/7/2014]).

[8] Watson, P.J. (2010) Sydney Harbour Sea Level Rise Design Parameters. Draft report prepared by the NSW Department of Environment, Climate Change and Water; April 2010.

[9] Design 5 Architects (2008) Campbell's Stores: Investigations of Potential Causes of Ground Floor Rising Damp and Recommendations for Remedial Works. Report prepared for Sydney Harbour Foreshore Authority; 12 June 2008.

[10] Cardno (NSW/ACT) (2013) NSW Tsunami Inundation Modeling and Risk Assessment. Report prepared for NSW State Emergency Service and Office of Environment and Heritage; August 2013.

[11] Bureau of Meteorology (nd) *Summary of Significant Severe Thunderstorm Events in NSW 1990/2000*, Australian Government Bureau of Meteorology (available online www.bom.gov.au/nsw/sevwx/9000summ.shtml, [accessed 10/7/2014]).

[12] Bureau of Meteorology (2014) Monthly Climate Statistics from 'Sydney (Observatory Hill)' commenced 1858, Australian Government Bureau of Meteorology (available online www.bom.gov.au/nsw/sevwx/9000summ.shtml, [accessed 10/9/2014]).

[13] CSIRO and Bureau of Meteorology (2014) *State of the Climate*. Third biennial report for the Commonwealth of Australia, Canberra (available online http://www.bom.gov.au/state-of-the-climate/documents/state-of-the-climate-2014_low-res.pdf?ref=bottom [accessed 24/3/2015]).

[14] Geoscience Australia (2009) Potential geologic sources of seismic hazard in the Sydney Basin, Proceedings volume of a one day workshop, Editor: Clark, D. *Record* 2009/11, GeoCat # 65991. Canberra: Department of Energy, Resources and Tourism (available online http://www.ga.gov.au/metadata-gateway/metadata/record/65991/ [accessed 10/7/2014]).

[15] Denham D. (1992) Earthquake attack in the Sydney Basin: what is the risk? *Exploration Geophysics* 23(4), Canberra: CSIRO, 579–587 (available online http://www.publish.csiro.au/paper/EG992579.htm [accessed 20/3/2015]).

[16] Smith, D. (2005) Revealed: Sydney's Crack-up. *Sydney Morning Herald*, 22 October 2005 (available online http://www.smh.com.au/news/national/sydney-youre-a-real-crackup/2005/10/21/1129775959891.html [accessed 31/10/2014]).

[17] BMT WBM (2014) City Area Catchment Flood Study. Draft report prepared for City of Sydney, March 2014 (available online http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0005/201947/140505_EC_ITEM06_ATTACHMENTB3.pdf [accessed 7/7/2014]).

[18] Design 5 Architects (2008) Campbell's Stores: Investigations of Potential Causes of Ground Floor Rising Damp and Recommendations for Remedial Works. Report prepared for Sydney Harbour Foreshore Authority, 12 June 2008.

[19] State Emergency Management Committee. 2012. *New South Wales State Emergency Management Plan*. Sydney: Ministry for Police and Emergency Services; December 2012 (available online http://www.emergency.nsw.gov.au/media/1621.pdf [accessed 7/7/2014]).

[20] State Emergency Management Committee. 2005. *Sydney CBD Emergency Sub-Plan*. NSW State Emergency Management Committee; 8 December 2005 (available online http://www.emergency.nsw.gov.au/media/332.pdf [accessed 7/7/2014]).

A Case Study of Capacity Building: Embedding Sustainable Development Principles and Practices at the University of Wales, Trinity Saint David

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Abstract

The concept of sustainable development is increasingly being used as a philosophical framework and planning tool for better decision making, with the aim of creating more benefit with less resource. Importantly it is a vehicle for capacity building and building resilience for a 'sustainable' future. In this paper the results of a university-wide initiative to embed sustainability across all aspects of university life is discussed, from campus initiatives to pedagogy developments as well as student-led initiatives. Students are entering a World characterised by rapid change, uncertainty and risk, which will affect them throughout their professional and personal lives. Students therefore need a suitable environment to develop appropriate skills and knowledge, so that when they do leave university they are equipped to face the future with confidence.

Keywords: Capacity Building, Embedding, Regional, Sustainable Development, University.

1. Introduction

The University of Wales Trinity Saint David (UWTSD) is a new university with an historic past. UWTSD was formed on 18 November 2010 through the merger of the University of Wales Lampeter and Trinity University College Carmarthen, under Lampeter's Royal Charter of 1828. On the 1 August 2013, Swansea Metropolitan University became part of UWTSD. The University's Royal Charter is the oldest in Wales and England after the universities of Oxford and Cambridge. In 2011 HRH the Prince of Wales became its Royal Patron.

The UWTSD Group includes Coleg Sir Gâr and Coleg Ceredigion as part of a dual sector (HE and FE) group structure comprising further education colleges and the university. The UWTSD Group has over 25, 000 learners across 17 campuses in rural and city locations. UWTSD aims to deliver clear, tangible benefits for learners, employers, industry and communities by offering a vocational approach from entry level to post-doctoral research. The Group will be further strengthened with the merger of University of Wales into UWTSD in due course (UWTSD, 2015).

The University's main campuses are situated in various locations in and around Swansea's city centre as well as in the rural towns of Lampeter and Carmarthen in South West Wales. The Wales International Academy of Voice is located in Cardiff and in addition the University has a Business School in London for international students. UWTSD has a clear national profile, with many of its staff and students speaking the Welsh language and there are opportunities for students to undertake their studies through the medium of Welsh. Indeed the University's strong presence in South West Wales alongside its dual sector delivery makes it an important voice in the region. Many students are locals, living and working in the region. They also intend to live and work in the region on completion of their studies. Indeed their contribution to the local region, its economy, environment and culture are readily identifiable (UWTSD, 2015).

As a newly formed institution that has placed itself at the heart of a region, the university has an integral role to play in building capacity and importantly building resilience for a sustainable future for South West Wales. In this paper the results of a university-wide initiative to embed sustainability across all aspects of university life is discussed, from campus initiatives to pedagogy developments as well as student-led initiatives. This is timely with the recent introduction of the Well-being of Future Generations (Wales) Act 2015, the first of its kind in the World, where the well-being of future generations will be considered at the heart of government decision making. Going forward there will be a requirement for public bodies to make sure that when making decisions they take into account the impact they could have on people living their lives in Wales in the future. It will expect them to work together better, to involve people reflecting the diversity of our communities, to look to the long term as well as focusing on now and to take action to try and stop problems getting worse, or even stop them happening in the first place (Welsh Government, 2015). The university is therefore well placed to not only meet the requirements of this act but also to support others to do so through its learning, teaching and research activities.

2. Embedding sustainability

2.1 Strategic level

Transformation, adaptability and flexibility are familiar words to organisations working in times of merger. Indeed as a newly formed institution experiencing widespread organisational change, the University has had to make a number of key decisions in shaping the new university. This has brought about many opportunities, one of which has been to place sustainability at the core of its strategic planning, embedding sustainability within its core operations and culture. The core values of the University as outlined in its Strategic Plan: 2013 to 2017 are as follows:

1. *Collaboration*: Through the establishment of a range of strategic relationships at regional, national and international level. Such networks will have the potential to inspire

learners, staff and partners to create exciting new learning futures.

2. *Inclusivity*: Through putting learners first and championing lifelong learning without barriers; and supporting students from all backgrounds and at all stages of their education.
3. *Employability and creativity*: By harnessing the entrepreneurial, research, creative and enterprising skills of its learners, the university will offer educational programmes that allow students to have the best opportunities to gain employment and develop their transferable skills.
4. *Sustainable development*: Through a system-based approach to delivering meaningful and relevant educational pathways, promote learning and social responsibility that supports 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987).
5. *Wales and its distinctiveness*: Through celebrating the distinctive linguistic and cultural assets and heritage of Wales.
6. *The concept of global citizenship*: Through the development of further multi-national activities and opportunities for learners, staff and partners.
7. *Research and its impact on policy*: By ensuring that its research activity and outcomes influence the evidence base of policies developed in Wales and beyond (UWTSD, 2013).

Therefore the University's strategic plan makes the commitment of UWTSD clear, namely to embed sustainability as a core principle across all aspects of the University.

2.2 The Institute of Sustainable Practice, Innovation and Resource Effectiveness (INSPIRE)

The Institute of Sustainable Practice, Innovation and Resource Effectiveness **(**INSPIRE) is a virtual institute which provides a focus for sustainable development activities across the University and the wider UWTSD group including Coleg Sir Gar and Coleg Ceredigion. INSPIRE was established by Jane Davidson, a former Minister for Environment and Sustainability in Wales, in January 2012. In 2013 INSPIRE became a strategic sustainability directorate and a Sustainability Committee, which serves the whole university, was established. INSPIRE's role is to work across academic and support structures to deliver on the University's strategic priorities and embed sustainable development through its learning, teaching, curricula, campus, community and culture.

Through INSPIRE the university aims to:

- Develop curriculum-related delivery to ensure that students are provided with the knowledge, skills and attitudes that will equip them for their future contribution to the economy, community and environment;

- Develop a research and innovation capacity focused on the core strengths of the University;

- Develop its campuses to the highest standards of environmental performance; and
- Contribute to local communities by giving particular regard to issues of sustainable rural and urban communities and the development of South West Wales as a low carbon region.

In this paper a number of initiatives delivered through INSPIRE will be discussed, with a particular focus on teaching and learning.

2.3 Faculty level

The University recognises ‘Education for Sustainable Development and Global Citizenship’ (ESDGC) holistically, whilst deliberately and consciously acknowledging the need for a balance between society, economy and environment to contribute towards individual and community wellbeing, a reduction in environmental impacts and consequently a more resilient future.

The University’s intention is to ensure that it embeds of a framework for ESDGC in a way that delivers, where the emphasis is not merely on the content of the modules and programmes of study offered but on the entire learning and teaching experience. Indeed, the University’s agreed Learning, Teaching and Enhancement (LTE) Strategy includes ‘sustainability conscious learning’ to enable students to have a clear understanding of the impacts of their future actions on the physical, social and economic environments (INSPIRE, 2015).

This commitment to strategically introduce ESDGC through its teaching and learning offering is recorded in Faculty Sustainability Plans, which were introduced in 2013 and provide a mechanism for annual reporting on faculty level ESDGC through the University Sustainability Committee. Each University faculty is required the produce a plan, to a common template, outlining how they are working to embed ESDGC within subject disciplines as well as identifying cross curricular opportunities. The plans also reflect environmental commitments.

Each faculty plan is required to provide a summary of the key ethos and pedagogical approach of the faculty and how the faculty as a whole intends to take the sustainability commitment forward, including arrangements for plan delivery and reporting structure; e.g. area/activity, sustainability element and faculty wide and interdisciplinary approaches and concepts.

Specifically the faculty makes commitments in relation to:

- Sustainability: working within environmental limits;
- Sustainability: how the faculty teaches;
- Sustainability: what the faculty teaches;
- Sustainability and research and development activity;
- Sustainability, the Faculty and the wider community; and
- Sustainability: competitive advantage.

Faculty Plans demonstrate the link between faculties and the University's strategic agenda on sustainability. The documents are available on the INSPIRE web page and can be used publicly to demonstrate the University's practical application of its commitment to sustainability (Davidson, 2014).

2.4 Framework Approach

Academics are encouraged to work within existing frameworks when developing new programmes and updating existing programmes. As part of the validation and revalidation of teaching programmes, course directors are required to provide a sustainability statement, demonstrating their pedagogical approach and how sustainability has been embedded in the programme, its modules, their learning outcomes and assessment. As part of the validation process, all programme validation documentation is reviewed by the academic lead for INSPIRE to ensure consistency with the University's sustainability commitments. This is a very valuable process and is proving to be a useful intervention point with which to shape curriculum in relation to ESDGC.

Academics have been encouraged to use UNESCO's five pedagogic principles to support the development of ESDGC curricula. These are as follows:

1) *Futures thinking:* engages people in imagining preferred visions for the future. It involves the exploration of assumptions and of meaningful understandings and interpretations of sustainable development. This process of envisioning futures leads people to take ownership and responsibility for more sustainable futures.

2) *Critical and creative thinking*: enables people to explore new ways of thinking and acting, make informed decisions and create alternatives to present choices. It involves reflecting on how people interrelate with one other, understanding cultural differences and creating alternative ways to live together.

3) *Participation and participatory learning*: The engagement of people is needed to build sustainable futures collectively. Engaging diverse stakeholders and communities is essential, as they value and include differing knowledge systems and perspectives. The process of participation is also important for creating ownership and empowerment.

4) *Thinking systemically*: is essential to sustainable development, as piecemeal approaches have proved not to work - instead resolving one issue while creating other problems. Sustainable development requires approaches, which go beyond analysis in terms of 'problem-solving' and/or 'cause-effect'.

5) *Partnerships:* a motivating force towards change. They empower people and groups to take action, to take part in decision-making processes and to build capacity for sustainable

development. Intercultural and multi-sectoral partnerships in particular are often highlighted as critical in Education for Sustainability approaches (UNESCO, 2002).

In addition the university recognises the Higher Education Academy (HEA)'s Future Fit Framework (Stirling, 2012); and the HEA's Quality Assurance Agency for Higher Education (QAA) guidance, 'Education for Sustainable Development Guidance' (2014), which was formally adopted by the University in March 2015 as the framework for ESDGC curriculum design, delivery and review within the University. Educators are encouraged to use it as a framework, within their own disciplinary context, rather than as a prescription of a curriculum or pedagogic approach.

In the first instance, the university made a commitment that 15% of the total student experience for each undergraduate would include ESDGC (Davidson, 2014). In order to monitor and evaluate progress towards this target, a review of all degree programmes was undertaken in 2014 to ascertain where ESDGC was part of the learning and teaching experience. In this initial review, only core and compulsory modules on each programme were reviewed. A methodology developed by Bristol University (Willmore, *in press*) was utilised and details of this can be found on the INSPIRE website.

The results of the curriculum audit exceeded expectation at the time, showing for example that 93% of modules in Teacher Education contained teaching and learning on ESDGC. Other faculties with high scores included Business (77%), Architecture, Computing and Engineering (67%), Art and Design (58%), and Social Sciences (51%). The lower scores were recorded as 39% by Performance and 29% by Humanities (Davidson, 2014). This approach produced a quantitative assessment of the progress the University has made to embed sustainability within its curriculum but it did not provided an understanding on the pedagogic approaches being applied by individual educators.

2.5 The Educator

So far this paper has reported on an approach to embedding ESDGC where academics/educators must conform to a centrally mandated, systematic, whole-of institution policy at a strategic and faculty level. However previous research has demonstrated that cultural change in organisations is most effectively managed as a process of learning through *dialogue* and *praxis*, grounded in systems thinking (Senge, 1990).

It is also necessary to recognise that educational change occurs through cultural changes in the way academics work within their disciplinary expertise, interact across interdisciplinary boundaries, and negotiate the forms, purposes and pedagogies through which knowledge and learning experiences are prepared for, and experienced by students (Fullan, 1999). The importance of developing the educators' knowledge, skills and attributes in ESDGC pedagogy cannot be overlooked.

A contextual appreciation of the pedagogy within individual faculties is required. It is necessary to comprehend how ESDGC is understood, implemented and informed by professional industry bodies, organisations and potential employer groups, and the day-to-day operations of academics so that they had the ability to complete the work and feel validated (Hayles and Holdsworth, 2008).

Early on a sustainability skills survey was conducted to develop an evidence base of existing expertise, experience and interest in sustainability across the institution. The results from the survey that have been published indicate a significant potential within the institution to take the sustainability agenda forwards. 78% expressed an interest in ESDGC whist 49% documented experiences of working on ESDGC already (Davidson, 2014). However this process was not used to identify what support academics might need to further develop their skills sets. To this end a number of initiatives are starting to be put in place with the appointment of an academic lead in 2015.

Each faculty has one or more sustainability link contacts, observers on the University Sustainability Committee, who act as a liaison for their faculty and meet with the academic lead of INSPIRE to discuss issues arising and identify the support and training needed at an individual, group and faculty level.

In addition an annual ESDGC conference has been launched. The conference is open to all academics within the university, and gives an opportunity write and present a paper on teaching and learning experiences, showcasing best practice from across the university's campuses, faculties and disciplines. This is seen as an opportunity for academic staff to exchange experiences and ideas, find commonalities and form alliances with staff from elsewhere in the University. All academics are welcome to attend the event and learn from the experiences of others. The first conference takes place in June 2015. Written papers will be submitted after the conference and peer reviewed in due course. A special publication of the University's teaching journal will be published in late 2015. A best paper prize will be awarded, with support to attend an international conference. Indeed, authors will be encouraged to publish ESDGC work outside of the university.

It is early days with this part of the embedding process, but it is intended that more initiatives will be put in place to support academics and educators as they develop ESDGC pedagogies.

2.6 Student Initiatives

2.6.1 National Union of Students (NUS) 'Green Impact' programme

A number of student initiatives have also been put in place. In 2013 the Students' Union and the University jointly signed up to the NUS 'Green Impact' programme, an environmental accreditation programme, which brings staff and students together within their wider communities to enable and showcase positive changes in environmental practice and to make simple, tangible and potentially powerful changes in behaviour and policy documented via an online workbook.

2.6.2 INSPIRE student internship opportunities

To incentivise students to participate in the sustainability agenda, new internship opportunities were set up as a reward scheme in partnership with the Students' Union for students prepared to make 'One Planet Living' commitments. Nine annual internships positions were created, starting in 2013; three students on each of the University's principle campuses. They were tasked with working on Fair-trade, Green Impact and Sustainability Exchange programmes.

- *Fair-trade interns*: promote Fair-trade and develop the University's commitment to Fair-trade activity, through organising and hosting events and boosting student involvement.
- *Green Impact interns*: have more of an operational and organisational focus, playing an active role in making the University more sustainable through the delivery of the 'green impact' programme; and
- *Sustainability Exchange interns*: promote and organise opportunities for staff and students to share ideas, news and views on sustainability issues within the University and the wider community.

Interns are expected to work both independently and in teams, meeting regularly with INSPIRE staff, a nominated Students' Union representative and each other. All interns are encouraged to be dynamic, creative and to forge links with the student body and relevant external groups and organisations.

2.6.3 Employability Award

The University introduced an Employability Award in 2013, again in partnership with the Students' Union. The link between the sustainability and employability agenda is made explicit in the student attribute requirements, namely:

- Active Citizenship: able to appreciate the importance of environmental, social and political contexts to their studies;

- Creative Problem Solving: able to think creatively, holistically, and systemically and make critical judgements on issues;

- Teamwork: able to work collaboratively and work in interdisciplinary teams;

- Learning and Personal Development: able to develop a high level of self-reflection at a personal and professional level; and

- Communication: able to understand, critically evaluate, adopt thoughtfully and communicate sustainability values (Davidson, 2014).

3. A Sustainable Campus

Campus sustainability, and in particular environmental sustainability, is usually the first thing university’s tackle, as good energy and environmental management systems (EMS) contribute towards the efficient and effective use of resources. It is undeniable that addressing environmental challenges is key to building a more resilient and sustainable future. The university needs to be an exemplar of best practice as students expect to see in ‘practice’, what the academics ‘preach’.

The University has recognised that environmental issues are fundamental to the future health and wellbeing of all those involved within the institution, the wider community and society as a whole, and accepted its responsibility to demonstrate leadership in sustainability and build resilience through innovation and enhancement of sustainable solutions to environmental concerns.

To this end, the University produced an institutional action plan, ‘Towards Living within our Environmental Limits’ (UWTSD, 2012), which details the University's immediate priorities and longer-term plans for addressing environmental challenges. Areas covered included EMS, the roles and responsibilities of the members of the institution, carbon management, procurement, buildings and information technology, waste management, travel and transport, and student / staff engagement.

A review undertaken in 2014 recognised that UWTSD is at the beginning of its journey relative to many other UK universities as a result of the recent mergers and the challenges of dispersed campuses. However, the review commended the work of INSPIRE in relation to outreach and the work done to make staff and students more aware of environmental issues. Indeed, a number of initiatives have been put in place. For example, the University Council adopted the ‘University’s Carbon Management Plan’ in July 2014 (UWTSD, 2014). The policy considers both the need for environmental management systems and behaviour change programmes. Many meetings involving staff from different campuses now take place via the video conferencing suits, Lync or Skype, which has reduced the amount of travel between campuses significantly.

4. Conclusions

Sustainable development is about making better decisions using long-term values. It is about thinking about the impacts of today’s actions on future generations and learning to live within environmental limits. It is about balancing social, environmental and economic needs in a way that does not compromise future generations. It is about building capacity now for a more resilient future.

In this paper the results of a university-wide initiative to embed sustainability across all aspects of university life is discussed, from campus initiatives to pedagogy developments as well as student-led initiatives. It provides evidence that it is possible to embed sustainability within an institution at a time of organisational renewal. Indeed, as a direct result of the work lead by

INSPIRE, UWTSD was presented with the first Guardian award for the most sustainable higher education institution in the UK in 2013 and has featured as an exemplar of best practice in the independent Higher Education Academy evaluations of the outcome of the Green Academy work in 2012 and 2014. In 2015 the university was presented with a first class degree from the People and Planet University League Tables, coming 8th in the UK and 1st in Wales (INSPIRE, 2015).

Previous research has shown that unless:

1) A culture of value or priority is given to sustainability;
2) There is organisational and resource support for staff; and
3) There is training for academic staff; instigating such a change during organisational renewal will not succeed (Cowell *et al.*, 1998).

In this instance *priority* has been given to embedding sustainability, *organisational and resource support* have been introduced at a strategic and policy level, and *training for academic staff* is starting to filter through with INSPIRE recognised by academics within the university as a resource.

Students are entering a World characterised by rapid change, uncertainty and risk, which will affect them throughout their professional and personal lives. Students therefore need a suitable environment to develop appropriate skills and knowledge, so that when they do leave university they are equipped to face the future with confidence.

By using INSPIRE as a sustainability hub, the UWTSD's aim is to *inspire* individuals and develop ethical graduates and practitioners who can make a difference in society. Through work-based learning, research and knowledge transfer networks, the University aims to play a pivotal role in the promotion of social justice, economic renewal and the development of social and cultural capital in South West Wales, building capacity and resilience for a region.

References

[1] Cowell, S.J., Hogson, S.B. and Clift, R. (1998). Teamwork for environmental excellence in a university context. Moxen, J. and Strachan, P. A. (1998). *Managing Green Teams.* Greenleaf Publishing, Broom Hall, pp131-144.

[2] Davidson, J. (2014). *Sustainability Strategy 2014*. Available online at: www.uwtsd.ac.uk/.../strategies.../Sustainability--Strategy--Approved-by-Council-10-7-14.pdf [Accessed 19.05.15].

[3] Fullan, M. (1999). *Change Forces: The sequel*. Falmer Press, London.

[4] Hayles, C. S. and Holdsworth, S. E. (2008). Curriculum Change for Sustainability. *Journal of education in the Built Environment* (JEBE), Vol 3 (1), 25-48

[5] INSPIRE (2015). About INSPIRE. Available online at: http://www.uwtsd.ac.uk/inspire/about-inspire/ [accessed 19.05.15].

[6] Senge, P. (1990). *The Fifth Discipline: The art and practice of the learning organization*, Random House, New York.

[7] Sterling, S (2012). *The Future Fit Framework – An introductory guide to teaching and learning for sustainability in HE,* The Higher Education Academy**.** Available online at: https://www.heacademy.ac.uk/node/3573 [accessed 20.05.15].

[8] UNESCO (2002). *Teaching and Learning for a Sustainable Future*. Available online at: www.unesco.org/education/tlsf [accessed: 20.05.15].

[9] UWTSD (2012). *Living within environmental limits*. Available online at http://www.uwtsd.ac.uk/inspire/inspire-activity/living-within-our-environmental-limits/ [accessed: 19.05.15].

[10] UWTSD (2013). *University of Wales: Trinity Saint David Strategic Plan: 2013 to 2017*. Available online at: www.uwtsd.ac.uk/media/uwtsd-website/content-assets/documents/inspire/Strategic-Plan---FINAL-AGREED-version-7-Nov-13.pdf [accessed: 19.05.15].

[11] UWTSD (2014). Carbon Management Plan. Available online at: http://www.uwtsd.ac.uk/about/strategies-and-policies/ [accessed: 19.05.15].

[12] UWTSD (2015). *About University of Wales: Trinity Saint David*. Available online at: http://www.uwtsd.ac.uk/about/ [accessed: 19.05.15].

[13] Welsh Government (2015). *Future Generations Bill.* Available online at: http://gov.wales/topics/people-and-communities/people/future-generations-bill/?lang=en [accessed 19.05.15].

[14] Willmore, CJ, Tweddell, HM & Tierney, A.E. P. (in press). 'Measuring Education for Sustainable Development: experiences from the University of Bristol'. *International Journal of Sustainability in Higher Education*, Vol 17.

[15] World Commission on Environment and Development (1987). *Our Common Future*, Oxford University Press: New York.

Housing and resilience: Case studies from the Cook Islands

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Abstract

The Pacific Islands is widely known as being highly vulnerable to climate change impacts. In addition to long-term impacts such as sea level rise, current impacts such as tropical cyclones wreak havoc and the housing sector is often most severely affected. There is therefore a critical need for assessing the resilience of housing in the region. In response to that need, an evaluation tool for assessing housing resilience was developed. The analytical framework of the tool consists of five main factors - Inputs, Output, Result, Impacts & Effects, and External Factors – and the tool was tested in the Cook Islands. Two housing case studies implemented or and/or facilitated by Australia-based agencies on two different island locations were examined: On Aitutaki, it was a reconstruction project built after Cyclone Pat in 2010; in Mangaia, it was a program for strengthening roofing against cyclones. It was found that in different ways both the projects had improved the resilience of the beneficiary communities. However a number of challenges were also evident in meeting the wider needs of the beneficiaries and long-term sustainability. The sustainability of these interventions, and indeed that of the islands facing severe resource constraints and rapid demographic and environmental change, posed serious questions. The study allowed confirming the importance of the evaluation tool in the global context of climate change and consequent widespread disaster occurrence, and the devastating impact on the housing sector. In that respect, while there are obvious implications for other Pacific islands, the findings of the study offer wider global lessons for the multiplicity of agencies engaged in housing reconstruction, disaster risk reduction and development.

Keywords: Cook Islands, Cyclones, Evaluation tool, Housing, Resilience.

1. Background

Housing is usually the most valuable asset for many people and experiences widespread devastation in disasters. Loss of housing exposes people to the weather – rain, snow, heat, etc – thus compounding the impacts of the disaster and often affecting communities over a long term. Therefore the need for housing that is resilient, to safeguard people from such disaster impacts. However, commonly, the need for disaster-resilient housing assumes significance, tragically, after a disaster. Most guidelines and initiatives for safer housing have arisen after major disasters (for example, ERRA 2006; NHDA 2005) and in many post-disaster recovery programs maximum resources and priority is allocated to shelter and infrastructure reconstruction compared to other sectors (Lang 2008). Thus during reconstruction there is the opportunity to understand and thereby address and overcome the underlying vulnerabilities that had previously prevented building resilient housing, and the risks that threaten the durability and sustainability of housing. Building housing back to a standard that is less vulnerable to future hazards can contribute to reduced disaster risks in the long term. Reconstructed or rehabilitated housing built with avoidance of future risk in mind will prove more resilient and sustainable.

This paper is concerned with the importance of housing resilience in the face of increasingly intense and frequent disasters linked to climate change, and the potential for post-disaster reconstruction to enable resilience. It is derived from a research project entitled *Scoping study: shelter and disaster risk reduction in the Asia-Pacific region* (Charlesworth and Ahmed 2012) undertaken for the Australian Shelter Reference Group (SRG). A key outcome of the study was the development of an evaluation tool encompassing a range of physical and social dimensions for understanding and assessing housing resilience. The tool consisted of three main sequential stages – Pre-Assessment, Assessment and Consolidation – with each stage including a set of guided activities (see Fig. 1). An Analytical Framework consisting of five main factors – Inputs, Output, Result, Impacts & Effects, and External Factors – established through a literature review, was adopted in the evaluation tool (see Table 1).

The tool was tested in actual housing projects in two countries in the Asia-Pacific region – the Cook Islands and Sri Lanka. While the evaluation tool and the Sri Lankan case studies have been discussed elsewhere (Ahmed and Charlesworth 2014; Ahmed and Charlesworth 2015), this paper focuses on the case studies in the Cook Islands, highlighting the opportunities and challenges in the Pacific, a region highly vulnerable to climate change.

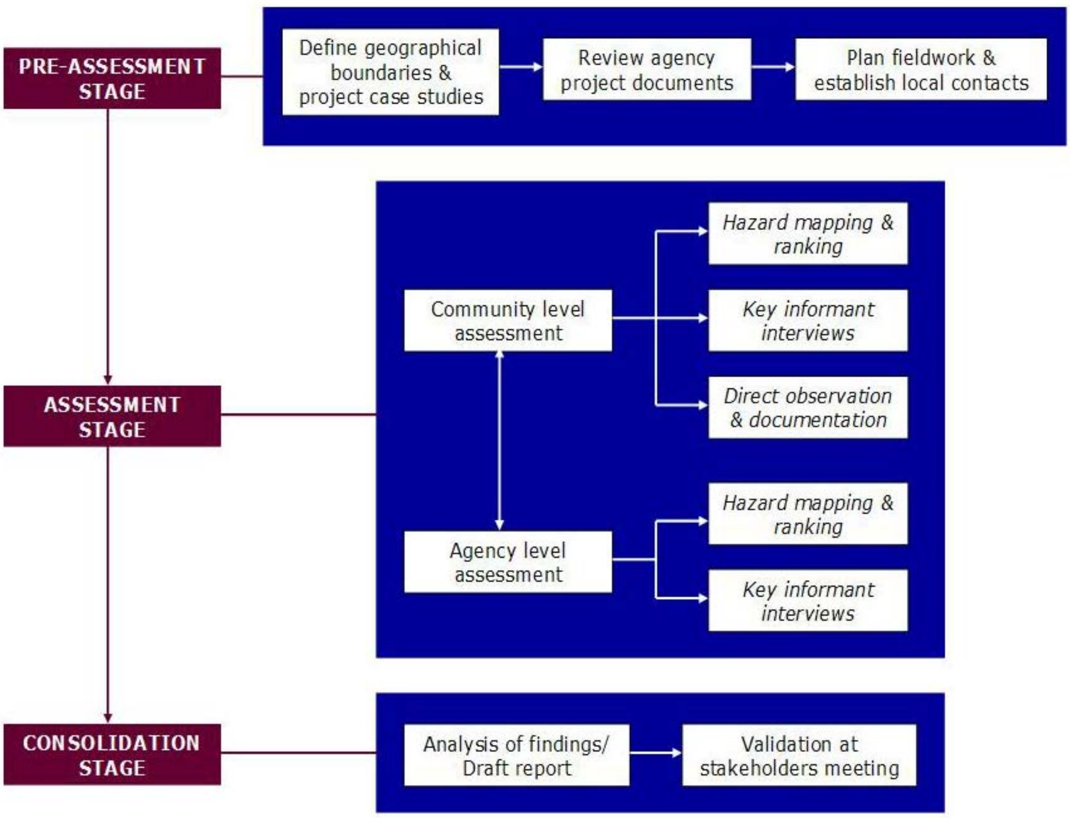

Figure 1: Stages and activities of the evaluation tool

Table 1. Analytical framework of the evaluation tool (adapted from Lizarralde 2002).

Factors	Definition	Aspects	Key questions
a) Inputs	Human, material and financial resources required to incorporate resilience in shelter	Efficiency	• Were the local and external resources optimised (cost-effectiveness)? • Was the community specifically engaged in design/construction? • Was there a dedicated skills transfer/training component?
b) Output	Articulation of resilience options before applying it	Results	• Were the resilience options realised?
		Timing	• Were they available at the right time?
		Quality	• Are the resilience options 'good' in the local context?
c) Result	Direct consequence for the beneficiary of applying the resilience options	Pertinence	• Were the resilience options available to the most vulnerable people?
		Acceptability	• Did the local community use the resilience options? • Were they pre-determined/required, or optional? • Were they replicated outside the project? • Are they easy to maintain?
d) Impacts & Effects	Indirect or later consequences for the beneficiary of using resilience options (or the situation originating from the project)	Strategy	• Did the resilience options correspond to the needs of the community?
		Scope	• What proportion of vulnerable people was covered?
		Ultimate objective	• Did the project reduce the disaster risks of the community? • Do the community/ households feel a greater sense of security?
e) External Factors	Factors beyond the control of the implementing agency.	External aspects	• How did the context and environment affect the results of the project?

2. Disasters and housing in the Cook Islands

Countries in the Pacific region are among the most vulnerable in the world to climate change impacts, presenting tremendous challenges to the housing sector (World Bank and SOPAC 2009; World Bank 2013). In addition to exposure to coastal hazards because of the islands' locations, vulnerability is compounded by low socio-economic development throughout the region. A number of disasters affect Pacific Island countries, among which cyclones are by far the most significant; among all the hazards, an estimated 50% risk is posed by cyclones (World Bank 2013).

Out of twenty countries in the world that experience the highest disaster losses, eight are Pacific island countries including the Cook Islands (World Bank 2013). The group of small islands comprising the Cook Islands is highly exposed to cyclones. Part of a long history of cyclones, Cyclone Pat hit Aitutaki Island in February 2010 with a wind speed of nearly 200 kilometres per hour and caused extensive devastation. Out of 762 buildings on the island, 388 were damaged or destroyed and 90% of housing was impacted. Most of the damage was evident in the roof structure (MOIP 2010). All the islands of the Cook Islands, such as Mangaia Island, are at risk. A number of cyclones battered Mangaia in 2005, including the most devastating Cyclone Meena. Islanders were aware of the risk and had a local practice of tying down metal sheet roofs during the cyclone season (January-April).

3. Basis of selection of case studies

Two case study housing projects in the Cook Islands were selected through extensive consultation with SRG member agencies. The projects were led by Australia-based members of the SRG, which offered their projects for test assessments using the evaluation tool. One of the projects was a housing reconstruction project on Aitutaki island implemented after Cyclone Pat, designed and led by Emergency Architects Australia (EEA). The other was a housing disaster risk reduction (DRR) project led by Partner Housing Australasia (PHA) in Mangaia island. Both the projects incorporated disaster resilience features and hence were considered suitable for assessment to understand the extent resilience had been achieved. The projects were however different in scope and nature, and therefore allowed gaining a broader insight.

4. Case study 1: Housing reconstruction, Emergency Architects Australia (EAA)

This project was funded by the New Zealand government through NZAID. Post-cyclone damage-and-needs assessment was undertaken by the Cook Islands Ministry of Infrastructure & Planning (MOIP), Rarotonga, in partnership with the Aitutaki Island Council. Key decision-making and guidance was provided by a Recovery Committee consisting of key government agencies in Rarotonga. However, the local level implementation and management was conducted by the island council. The design of the new housing was prepared by EAA, with periodic supervision provided by an EAA architect. Thus the project relied on a range of stakeholders, which had a bearing on its effectiveness.

4.1. Key housing features

There were four categories in the post-cyclone housing reconstruction program. Cat 1 and Cat 2 consisted of repairing minor structural and other damages; Cat 3 involved building a new roof over houses that had lost their

Figure 2: A 2-bedroom house in the Aitutaki

roofs, but were otherwise undamaged; and Cat 4 consisted of constructing new houses to replace completely destroyed houses. The study focused largely on Cat 4 housing. Firstly Cat 1 and 2 were implemented, followed by Cat 3 and finally Cat 4 over one year (July 2010 – July 2011).

Two house designs were built: 1-bedroom type for households with less than 5 residents and 2-bedroom type for larger households. 66 houses were built, out of which 33 were of the 1-bedroom type and 33 of the 2-bedroom type. The cost of the 1-bedroom type was NZ$26,000 and the 2-bedroom type NZ$34,000 including labour costs.

4.2. Main findings

4.2.1. Inputs: Resources for incorporating resilience

Beneficiary selection was based on assessment by MOIP, with support from the Island Council. The Rarotonga-based Recovery Committee ruled that only households that were living in the houses during the cyclone would be eligible for reconstruction support, even if they were tenants; thus absentee landlords were not compensated. Households that were poor and vulnerable, but whose houses were not damaged or destroyed did not receive reconstruction support. This led to various grievances.

There was minimal or no consultation with beneficiaries. After the designs were done, they were shown to the affected communities and most of them accepted the designs in order to be able to get free houses. During construction, some households made changes, for which they had to bear any extra costs incurred. The houses were expected to be painted and floor finishes (tiles, linoleum, etc) to be provided later by the beneficiaries, which some of them had done or were in the process of doing with their own funds.

4.2.2. Output: Articulation of resilience options

The Cat 4 houses were built to resist future cyclones. Some of the main resilience features included: strong foundations with heavily reinforced footings (6 rebars of 20mm diameter), reinforced concrete block posts (4 rebars of 16mm diameter with stirrups of 10mm @ 300mm spacing), double wall plates (6”x2” each), strong timber rafters (8”x2” instead of the commonly used 4”x2” or 6”x2”), purlins (4”x2” instead of the usual 3”x2”) and wall studs (6”x2”), metal straps to connect roof framing members, thick corrugated iron (CI) roofing sheets (0.45mm) screwed onto the frame and a roof pitch more than 30^{o} to prevent lift-off by wind. The main focus was on building a strong roof, the element most affected by cyclones. The wet areas – bathroom and kitchen - had external walls of concrete block to prevent quick deterioration and requiring less maintenance, adding to the resilience of the house.

All interview respondents agreed that the houses were strong and would withstand future cyclones. Indeed, some of them mentioned that they were “over-designed”. Most respondents agreed that the construction quality and materials were good, and adequate supervision was provided. However in some houses finishing was reported deficient with gaps in the ceiling, window louvres not matching in colour and other such shortcomings.

All the sites were compacted to prevent settlement and adequate infrastructure and services were provided. Although flooding was generally not common, localised water-logging occurred due to low elevation of some of the sites. In such instances, some households paid the extra cost of increasing the plinth height by one layer of concrete block during the construction process.

4.2.3. Result: Direct consequences of application of resilience options

It was not clear to what extent the resilience features included in the project were being replicated locally. In one house where an extension had been added, it was found that some features such as connecting straps were used, largely because one of the household members was a construction worker and involved in the shelter reconstruction where he learnt the strengthening technique. On the other hand, in a new house being built, it was reported that there were hardly any resilience features. Houses more than 15 square metres required a building permit and to follow wind-resistant building codes. However the codes had not been upgraded to the wind speed level of Cyclone Pat, and also enforcement in implementation by Island Council building inspectors was found to be lacking.
In general, most commodities in the Cook Islands were imported from New Zealand, as were the building materials and products used in the reconstruction program. This made the commodities expensive and there was also an embodied energy cost due to transport. Therefore any repair, maintenance or extension of the houses would require imported and hence expensive materials, not available locally.

There were unanimous reports that the houses were too small. The 1-bedroom type had a small bedroom of 2.65 x 2.85 metres and in the 2-bedroom type, bedrooms were smaller - 2.65 x 2.65 metres. Large extended households were common and alternative arrangements had to be made, such as sleeping outside in makeshift structures or in the living room. Nonetheless the houses were designed for ease of extension, having exposed rafters under the eaves to which new roof frames could be attached. Many households were found to have built extensions or planning to. However it was uncertain if the extensions would be as resilient to cyclones as the original house; only a shallow roof pitch could be maintained in the extended parts, and also it seemed unlikely that most households would be willing to spend money on and have access to products and skilled workers to apply resilient building techniques.

A number of households mentioned that they did not like having the bathroom inside the house, especially next to the kitchen. Some of them had arranged during construction to avoid building the bathroom inside, some had moved the kitchen to an extended structure at the back and most were planning to build extensions and move the bathroom and kitchen. Firstly, this pertained to the local culture. Secondly, because of the small house sizes, not having a bathroom and/or kitchen inside allowed more space inside the house; for example, one household with 11 residents was found to have converted the area originally allocated for a kitchen into a small bedroom.

4.2.4. Impacts & Effects: Indirect/Later consequences of application of resilience options

In the earlier stages (Cat 1 and 2) building teams were brought in from Rarotonga, but subsequently 18 local builder teams were engaged and local construction workers employed and trained on the job. Even workers who built their own house were paid, hence contributing to the local economy. It was not clear to what extent local builders and workers were trained in building resilient houses, though there was some evidence of that, for example in the new extension to a house mentioned above, where some resilience features were applied.

The new houses provided a sense of security to the beneficiaries and they felt that they were better protected from future cyclones. Even in Cat 1, 2 and 3, repairs and roof replacements were reported to be of high standard and had therefore contributed to the disaster resilience of the wider community on the island.

4.2.5. External Factors: Beyond control of implementing agency

Because the project was managed and implemented largely by MOIP from Rarotonga, although in partnership with the Aitutaki Island Council, the local people did not feel entirely empowered. The design of houses and decision-making process was external and the locals felt left out. The Island Council office did not even have a set of the design drawings. In this sense, the project was somewhat top-down. The Mayor of Aitutaki at that time was unpopular in his own village (Amuri) and it was alleged that he intentionally overlooked people who deserved a new house, even though some of them needy and vulnerable.

5. Case study 2: Disaster risk reduction (DRR) of housing, Partner Housing Australasia (PHA)

This project was funded and designed by PHA in partnership with the Australian Red Cross. The Cook Islands Red Cross was the local partner and the project was implemented through the Mangaia Red Cross Chapter. The project consisted of implementing a system of tying down metal sheet roofing to prevent displacement by storms and cyclones. It started in July 2012 in one of the three villages – Tamarua – in Mangaia Island. All of the 30 occupied houses in the village were planned to be strengthened, and there were plans to subsequently extend the project to the other two villages (Oneroa and Ivirua), thereby building resilience throughout the island.

5.1. Key housing features

Recognition of the cyclone risk led to this DRR project. Based on the local practice of tying down metal sheet roofs, a more systematic approach to roof anchoring was being implemented. Households were provided good quality nylon (polypropylene) ropes (12mm diameter) to tie down roofs to anchor points.

Figure 3: A house with the roof anchoring system.

The terrain being rocky, where strong and deeply embedded rocks were available on site, the anchors consisted of galvanised iron ‘eyebolts’ (with a threaded end 25mm long) fixed into the rocks. A hole was first drilled into the rock and the pointed and threaded end of the eyebolt then placed in the hole, which was then filled with fast-setting adhesive cement. The ‘eye’ or ring protruding from the rock could then be used for tying the rope holding the roofing sheet in place. Where suitable rocks were not present on site, a reinforced concrete footing having a base of 450 x 450 x 400mm with a cylindrical shaft (100mm diameter, 600mm high) was used as the anchor. A 12mm diameter steel rebar was curved and attached to the base reinforcement, acting as reinforcement for the shaft and the curved end protruding from the top of the shaft to serve as a ring to tie ropes.

5.2. Main findings

5.2.1. Inputs: Resources for incorporating resilience

There was significant migration of young people from Mangaia to the capital, Rarotonga, and New Zealand for employment opportunities. Tamarua village was found particularly vulnerable in a Vulnerability & Capacity Assessment in 2011 by the Red Cross because of the high prevalence of elderly-headed households and few able-bodied persons. Only 30 houses were occupied in the village and the owners of most other houses had migrated. The village was also somewhat isolated from the main part of the island. Therefore it was chosen to begin the DRR roof anchoring project here.

A representative from Red Cross, Rarotonga visited the village together with Island Councillors, and community meetings were held in a local church. The project was introduced to the community and reportedly all of them agreed that it was a good idea.

The cost of roof anchoring for each house was roughly NZ$200 including labour. Some of the beneficiaries helped the construction workers, or provided them lunch or snacks, and in some cases supplied materials such as old chains or shackles as an alternative to the eyebolts or curved rebars. An engineer from PHA trained a local builder and a construction worker. After gaining experience, the trained builder was expected to train and supervise workers in subsequent stages of the project when implemented in the other villages.

5.2.2. Output: Articulation of resilience options

This was the first time this type of resilience feature was applied on this island. Although there was a tradition of tying down roofs, the ropes were tied to trees or nearby heavy objects. If the tree was uprooted in a storm, it could fall and damage the house. Thus the new roof anchoring system could be expected to contribute better to resilience.

The materials provided through the project and the construction was reported to be of good quality. However progress was slow as only two workers were involved. Additionally not having good transport affected their work as the village was somewhat remote and about a 40-

minute drive from the main village; there was no public transport on the island and roads were not paved, making transport of materials a critical issue.

5.2.3. Result: Direct consequences of application of resilience options

Nylon ropes being used in the project were more durable than ropes made of organic materials. However they would deteriorate in the sun within a few years, if left on the roof. Therefore households had been instructed to use them only in the cyclone season and store them inside the house during the rest of the year. Fixing and tying the ropes is a laborious task and it was not clear how household without able-bodied persons would be able to manage. Nonetheless there was a tradition of mutual help within the island communities and the elderly people would possibly be able to get some help from other community members.

The galvanised eyebolts were weather-resistant, but the curved steel rebars will rust and weaken by corrosion in the salty atmosphere. There was no provision in the project for coating them with corrosion-resistant paint or a greasy substance. The roof anchoring was expected to resist up to Category 3 cyclones (118-159 kilometres/hour wind speed) evidence of which can only be found after an actual cyclone.

5.2.4. Impacts & Effects: Indirect/Later consequences of application of resilience options

This was a small-scale project and hence only a couple of local construction workers were trained. Nonetheless over the long-term this could be expected to build further capacity with the support of these trained workers. However, as typical of the Cook Islands, all the building materials had to be brought from New Zealand or elsewhere. This might be a barrier to extensive replication and long-term maintenance.

The project addressed a key vulnerable part of the house. Although the whole structure was not strengthened and only a part of the roof was made secure, it still improved the resilience of houses to some extent. As one interview respondent commented: “It’s better than nothing.”

5.2.5. External Factors: Beyond control of implementing agency

Reliance on imported building materials and outside suppliers led to some uncertainty. For example, it proved difficult to get timely delivery of the eyebolts causing delay to the project. Subsequently the anchor design was modified, replacing the originally planned eyebolts with the curved rebar design. Materials such as steel rebars and cement were imported, but more easily available in local markets, especially in Rarotonga, compared to unusual products such as eyebolts.

6. Overview of findings

In the EAA-led project in Aitutaki, the quality of construction and building materials were of high standard, and the houses incorporated resilience features to resist cyclones, the main hazard there. However, houses being small required extensions for large households, often built

without professional support. It is uncertain if such extensions would be as resilient as the original house, in which case the occupants and household belongings would be vulnerable to future cyclones.
In the PHA-led project in Mangaia, the system of roof anchoring introduced in the project provided better resilience to cyclones, addressing a key vulnerable part of the house. Although the whole structure was not strengthened and only a part of the roof was made secure, it still improved the resilience of houses to some extent. However, reliance on imported materials might affect sustainability and long-term resilience.

Thus both the projects were found to have reduced disaster risk to varying levels, and had contributed to their respective beneficiaries' resilience. By reducing vulnerability, they had led to an improvement of previous living conditions. However, despite the overall positive findings some challenges became evident when testing the housing evaluation tool, especially with regard to the **Result** factor concerning housing design issues. The one-size-fits-all approach followed in the Aitutaki project, given the diversity of beneficiary households, resulted in the obvious problem of lack of space for large households and too much space for small ones. Other challenges as noted above, such as the lack of acceptance of indoor toilets, mismatch of colours of window louvers and gaps in ceilings were due to the bearing of the **Inputs** factor on the **Result**: Although the houses were designed and built professionally, there was no community consultation and participation in those processes, hence the challenges arose. The Mangaia project also indicated weakness in the **Result**, where there was no specific strategy for managing the labour-intensive roof-anchoring system in a community with a significant proportion of elderly residents.

The other factor that was found to have played a problematic role was **External Factors**. The lack of ownership by local authorities in Aitutaki because of the externally driven implementation, and in Mangaia, the reliance on imported building products, both undermined the long-term sustainability of the projects and the well-intentioned efforts of the implementing agencies.

7. Conclusion

The evaluation tool was designed to capture a wide range of issues relating to housing and disaster resilience. Because it is comprehensive, it allows examining different types of projects, as indicated from the two different case studies from the Cook Islands. Not all the issues included in the tool would be relevant for all projects, and some issues might be more important according to specific projects. To prove relevant to organisations, it would need to be adapted to the particular context and project while adhering to its structure and processes. The advantage of being comprehensive, as found in the field, is that it provided a menu of issues that allowed selecting those most relevant to the project being studied.

The evaluation tool that allowed arriving at the above findings and conclusion has been found productive in a variety of contexts and projects and would therefore serve as a useful resource for agencies interested in evaluating whether and how resilience has been achieved in their housing projects. It is being recommended that such evaluations using purpose-built tools should be a standard procedure, given the widespread and global occurrence of disasters, their devastating impact on the housing sector and the multiplicity of housing reconstruction and DRR projects by humanitarian agencies.

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References

Ahmed, I. and Charlesworth, E., 2015. An Evaluation Framework for Assessing Resilience of Post-Disaster Housing. Journal of Disaster Resilience in the Built Environment, DOI: 10.1108/IJDRBE-11-2013-0042.

Ahmed, I. and Charlesworth, E., 2014. Housing and Resilience: Case Studies from Sri Lanka *in "Recovery from the Indian Ocean Tsunami: A Ten-Year Journey"*. In: Shaw, R. (Ed.) Springer, Tokyo, pp. 417-434.

Charlesworth, E. and Ahmed, I., (2012) Scoping Study: Shelter and Disaster Risk Reduction in the Asia-Pacific Region. http://harbureau.org/downloads/Shelter-DRR-Final-Report.pdf (accessed March 2014).

ERRA, 2006. Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement Sand Mortar in Earthquake Affected Areas. ERRA (Earthquake Reconstruction & Rehabilitation Authority), Pakistan.

Lang, H., 2008. Community Housing in Post Disaster Area on Nias islands, Indonesia: Responding to Community Needs. Proceedings of the 4th International i-Rec Conference, University of Canterbury, Christchurch.

Lizarralde, G., 2002. Organizational Design, Performance and Evaluation of Post-Disaster Reconstruction Projects. Proceedings of the conference on Improving Post-Disaster Reconstruction in Developing Countries, Université de Montréal, Montreal.

MOIP, 2010. Cyclone Pat Initial Assessment Report: Aitutaki Building Damages. MOIP (Ministry of Infrastructure & Planning), Rarotonga.

NHDA (National Housing Development Authority), 2005. Guidelines for Housing Development in Coastal Sri Lanka. Ministry of Housing and Construction, Colombo.

World Bank, 2013. Acting on Climate Change & Disaster Risk for the Pacific. World Bank, Washington D.C.

World Bank and SOPAC, 2009. Preparedness, Planning, and Prevention: Assessment of National and Regional Efforts to Reduce Natural Disaster and Climate Change Risks in the Pacific. World Bank, Washington D.C.

A systems approach to managing human resources in disaster recovery projects

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Abstract

Lack of construction resources and capacity has always presented difficult challenges to the construction industry following a major disaster. In the case of the Canterbury earthquakes that took place in 2010 and 2011 in Christchurch, New Zealand, a number of factors combined to influence the post-disaster recovery environments and increase the demands for better approaches to managing human resources for reconstruction projects. By using a systems approach, this study identified the dynamics that have changed construction companies' resourcing behaviours in relation to the employment demand and supply in the Canterbury recovery. Research findings show that the limited technical capability available nationally, lack of motivation among new entrants, combined with high turnover rate, had accounted for socially produced skills shortages in Christchurch. This shortage was further compounded by factors such as the shortage of temporary accommodation, time lags of training and a lack of information about reconstruction workloads from the recovery agencies. The study suggests that the design of policy instruments in managing human resources in Christchurch should be informed by a detailed understanding of the dynamics that mediate between policy objectives and outcomes over time. A systems approach should be applied to increase the efficiencies in resource management in the continued reconstruction.

Keywords: Systems dynamics, Human resources, Disaster reconstruction, Construction firms, Christchurch

1. Introduction

The gradual shift in modern concept of 'building resilience' that has occurred over the past decade is having far-reaching implications for the construction industry who plays a pivotal role in disaster risk reduction and carrying out the post-disaster reconstruction tasks. In many countries, disaster recovery projects are given equal or even more priority over other development projects. Compared to conventional construction projects, disaster recovery construction projects are seen as requiring different management and delivery systems [1, 2]. In particular, disaster recovery construction projects following a large disaster tend to have resource challenges [3, 4] and capability issues [5].

When the Darfield earthquake struck Christchurch in 2010, the New Zealand construction industry was going through a recessional period of low activity caused by the 2008 global financial crisis. Many construction businesses had managed to come from the bust of economic cycle and aiming for a reviving opportunity in post-earthquake reconstruction [6]. Nevertheless, the shortage of skills is a recurrent problem in the New Zealand construction industry [7, 8]. And there was a limited pool of professionals in the country who had the experience of seismic assessment and design. The Canterbury region subsequently suffered a sequence of aftershocks. The earthquake of magnitude 6.3 on 22 February 2011 was the most severe, taking the lives of 185 people and causing buildings to collapse, further damage to infrastructure and widespread liquefaction [9]. High pressures of skills needs in undertaking the reconstruction following the earthquake events raised questions concerning how these skills needs can be met given the limited resource pool in New Zealand construction sector [10].

A number of factors such as the change of the building standards [11], insurance pay-out [12] and the decisions made by the Immigration New Zealand on Canterbury Skills Shortage List[1], combined to influence the post-disaster recovery environments and increase the demands for better approaches to managing human resources for reconstruction projects. By using a systems approach, this study aims to identify the dynamics that have changed construction companies' resourcing behaviours in relation to the employment demand and supply in the Canterbury recovery. The study was undertaken longitudinally with 15 construction organizations over an extended period. Research findings from this study is hoped to provide insights into future disaster response with respect to addressing the problem of rebuilding capability.

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[1] The Canterbury Skills Shortage List (CSSL) highlights occupations in shortage that are needed during the rebuild in Canterbury region (area of South Island), and facilitates the grant of temporary work visas for those occupations. For more information, see http://www.dol.govt.nz/immigration/knowledgebase/item/4551

2. The construction industry skills shortage

Having a skilled, well-trained and productive workforce has always been central to the construction sector's growth and success [13-15]. The literature reveals a number of factors which have impinged upon the construction skills problem (See Table 1).

Table 1: Contributing factors that shape the skills problem in the construction industry

Category	**Contributing factors**
1) Contextual factors	• Workforce aging and demographic downturn • Reduced numbers of young people entering the construction sector • Technological changes • A lack of investment in skills development
2) Structural factors	• Absence of human resource management strategies at a project level • A lack of partnership between sector employers and training bodies • Low levels of training • Increased casual self-employment and sub-contracting • Rigidity of skills divisions
3) Inherent factors in the construction industry	• Poor image of the industry • Poor perception of pay and workplace conditions • Working practices • Cyclical labour demand • Fragmented, transient and heterogeneous workforce structure • Fragmentation between training provision and employment

Context-specific factors included such as workforce aging and demographic downturn [13, 16], reduced numbers of young people entering the construction sector [17, 18], technological changes [19, 20] and a lack of investment in skills development [21]. Structural factors causing construction skills shortfall included the absence of human resource management strategies at a project level [22], a lack of partnership between sector employers and training bodies [23, 24], low levels of training [7, 25], increased casual self-employment and sub-contracting [26, 27] and the rigidity of skills divisions [28].

Adding to the list are factors in relation to the very nature of construction industry, including the poor image of the industry [29, 30], especially regarding the pay and workplace conditions [31]; working practices [32]; cyclical labour demand [33, 34] and often fragmented, transient and heterogeneous workforce structure [35, 36]. Above all, Dainty et al. found that fragmentation that flows from the structure of training provision and employment is likely to narrow the industry's skills base and reduce innovation within the sector [17].

By comparing construction industry concerns 50 years apart, O'Donnell et al. concluded that how to attract and develop apprentices and graduates remained to be a major industry concern [37]. Chan and Dainty [14] suggested that genuine skills improvement requires a sustained effort to understand the practical realities of skills provision at a project level. Lobo and Wilkinson [7] advocated a focus on examining the efficiency of skill level in the existing workforce, rather than quantity of skills. In practice, there has been a shift of emphasis from top-down labour market policy measures towards demand-led skills development systems [35, Dainty et al., 38]. This shift, however, calls for employers and employees to play a more proactive role in formalising the industry's training and employment practices if improved performance and productivity is be achieved [39, 40].

There is a growing awareness of the importance of skills development among construction organisations as a means of improving productivity [35, 41, 42]. Research points towards a direct correlation between skills, productivity and employment. Enhancing labour productivity was proposed by Chan and Dainty [14] as one of the solutions to alleviating the problem of skilled labour shortages in construction. This view, however, emphasised the efficacy of skills utilisation and development, rather than increasing their supply. Other solutions to addressing skills crises have been used in the past, primarily in such areas as training [25, 31], multi-skilling [43], industry promotion [13, 14], employing migrant workers or outsourcing [28], and the development of new technologies and construction techniques [44]. However, as Dainty et al, suggested such measures are difficult to sustain unless backed by a bespoke regional labour market approach [17, 45].

3. Resource issues faced by construction organisations post-earthquake in Christchurch

Past disaster events have shown that in the aftermath of a major disaster where the operational environment is often uncertain, complex and dynamic, the "business as usual" way of managing resources may not be fully applicable [46, 47]. In a post-disaster environment, there is strong pressure to act quickly to get back to normal [48]. Under the pressure of limited time, the need to replace lost housing, building and infrastructure facilities often generates a demand surge for labour [49, 50].

According to Dainty et al. [51], workforce planning models need to take account of a wide range of factors determining both labour supply and demand. However, the complexity of the post-earthquake situation has rendered accurate forecasting of skills needs extremely difficult. Variations in the size, speed and scope of reconstruction had a marked effect on the employment practice which further influenced skills demand [52]. In the case of New Zealand, despite a relatively brief hiatus created by the global financial crisis, significant skills shortages have re-emerged from the earthquakes. The construction sector has moved from bust to boom and the employment situation in construction has dramatically changed [53].

Construction organisations, largely being labour-intensive, are more influenced by human resource effects. Following the 2010/11 earthquakes, construction organisations in Christchurch experienced major resource shortages for both post-quake damage emergency response and reconstruction stages [54]. Ongoing aftershocks caused structural and land inspection professionals to be constantly diverted from existing jobs to new damage [55, 56]. A questionnaire survey commissioned by the Resilient Organisations between October 2011 and January 2012 revealed that resource pressures experienced by the construction organisations in Canterbury region were primarily from human resources associated with structural, architectural and land issues. And the three most frequently reported ‘problematic’ human resources were: structural engineers, geotechnical engineers, and draughtsperson [54].

A follow-up survey in 2013 showed that as the reconstruction progressed, many construction organisations started encountering difficulty in finding suitable project management expertise such as site engineers, project managers and quantity surveyors [57]. Some engineering consultancies have reported ongoing issues with sourcing workers of high skill levels [53]. Since the September 2010 earthquake, young engineers and mature project management skills from Europe continue to be the largest inbound demographic group involved with the rebuild in Christchurch [56, 58]. At the same time, there has been an inflationary impact which flows through to higher property rents, and makes attracting tradespeople from other parts of New Zealand harder [59].

Against this backdrop, this research attempts to investigate the dynamic factors that influence the resourcing behaviours of construction organisations operating on post-earthquake projects in Christchurch. By capturing perspectives from construction organisations, this study provides an understanding of how companies are responding to a looming skills and labour shortage for the Canterbury rebuild and how their resourcing approaches might affect the environment where they operate. The research methods used, the findings from this research along with a discussion are presented in the remaining sections. This paper concludes by reflecting on the implications of research findings for future studies.

4. Research Methods

4.1 Case study method

A case study method was adopted for this research due to its theory-building nature [60, 61]. As proposed by Yin [62], the case study design develops an empirical approach to research of a contemporary phenomenon within its own context. Longitudinal case studies of construction organisations can provide insights into how hiring strategies across the construction industry and their strategies for workforce development will change as the landscape of Christchurch changes. The selection of case study organizations was based on criteria such as: the type of organization, size2, business characteristics, and involvement in the earthquake recovery process.

The key strategy used for selecting the sample was that all organisations would come from a spectrum of areas of the New Zealand construction industry. The case study sample was selected from the New Zealand Construction Industry Council (NZCIC) membership database. Sample organisations were all based and operated in Christchurch and registered with regional industry bodies under the umbrella of NZCIC. In December 2012, 15 case study organisations were selected to participate in the research. The chosen case studies collectively provided a reasonable overview of current experience with regard to the resourcing of skills for building activities [57].

In April 2014, the researchers conducted a second series of case studies with previously selected organisations. The focus of the second case studies was to examine the dynamics that influence their experiences of resourcing in Canterbury and changed business strategies since. Of 15 organisations, 10 participated in the second case studies. The reasons for the other 5 organisations not being able to participate included unavailability at the time of the case studies and absence from Christchurch operations. 3 additional organisations took part in the case studies. A total of 16 interviews were undertaken across 13 organisations in Christchurch in April 2014 (See Table 2).

Table 2: Description of organisations used for case study data collection

Types of construction organisations	Characteristics
2 Engineering consultancies	1 large size and 1 medium size (E1 and E2)
7 Contractors/builders	3 large civil contractors, 2 subcontractors, 1 home builder, 1 large construction company (C1-C7)
2 Building supplies companies	2 large concrete product manufacturers (M1 and M2)
2 Project Management Offices	Horizontal infrastructure rebuild & EQC's residential repairs (P1 and P2)

The research design and data collection methods complied with the requirements of the Human Ethics Committee of the University of Auckland (Reference number 7520). The interview records within case studies were recorded, transcribed, coded, and further analysed using NVivo 9 qualitative data analysis software. NVivo 9 coding comparison of queries allowed for similar

[2] The size of the organization was pre-defined in the survey in terms of the number of employees. A large organization has more than 100 employees; a medium sized organization has more than 50 but less than 100 employees; a small organization has 50 or fewer employees; and a micro-sized organization has less than 10 employees.

comments and suggestions being synthesised under common themes. A case study report that relates to individual organisations was sent back to interviewees for data validation.

4.2 Qualitative systems dynamics

System dynamics is a method to enhance learning in complex systems [63, p4]. Based on the findings from the interviews, further analysis was conducted by using causal loop diagrams to describe the dynamics and how they have influenced the behaviours of case study construction organisations in resourcing for disaster recovery. This paper only reports the qualitative system dynamics, often referred to as system thinking. The quantitative system dynamics which is based on quantified simulation will be reported in future published works.

The System Dynamic modelling approach was first introduced by Jay Forrest [64]. It offers a rigorous method for the description, exploration and analysis of complex organisational system comprised of organisational elements and the environmental influence. In the security world, systems thinking is a powerful tool for analysing and interpreting risks, and for developing control or intervention options [65]. While systems methods are not yet widely used in disaster management, experience in related disciplines, such as earthquake mitigation decision making [66] and planning for disaster recovery [67], indicates that they will be an increasingly useful tool for addressing complex issues in the aftermath of a large disaster.

We approached the analysis with the intent of exploring the critical dynamics of organisational resourcing process following the Canterbury earthquakes. By aggregating the findings from the case studies, the issues and processes that were relevant across a range of case study organisations can be identified. Those dynamics and how they have influenced the resourcing behaviours of case study organisations are presented in the causal loop by using Vensim modelling technique. In the following section, the generalised thematic findings will be presented and discussed, with illustration of dynamics identified in case studies.

5. Results and Discussion

5.1 Changed business operational model

Case studies in April 2014 show that there is a general trend for the workforce that were involved in the Canterbury earthquake reconstruction to move away from disaster recovery projects, as shown in Figure 1. In particular, the medium to large-sized infrastructure contractors were experiencing some human resourcing pressure as they have lost expertise to the new subdivision sectors. Case study organisations reported a renewed interest in moving back to their business-as-usual market, driven by the development of new subdivisions in Canterbury and New Zealand Government's housing and transport commitments.

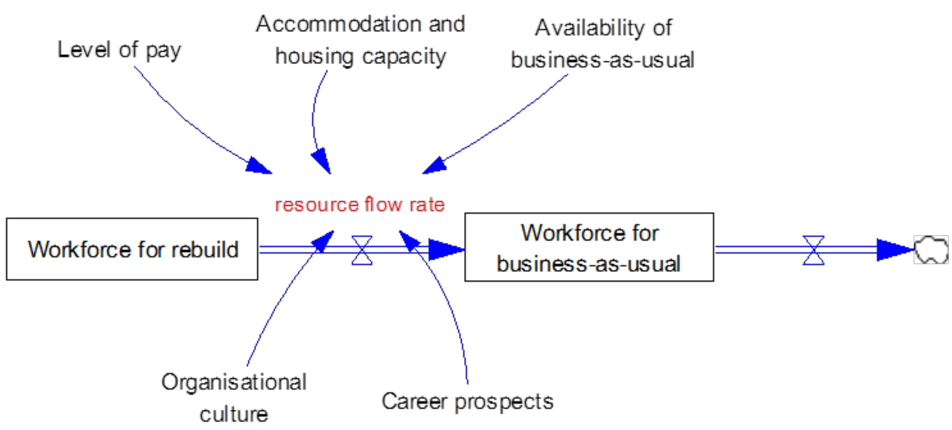

Figure 1: Dynamic factors that influence workforce flows between sectors

Lifestyle and cost factors are the dominant determinants of workforce migration patterns [68]. Such labour demographic-related factors play a major role in a workforce's decision-making and changing directions of resource flows [35, 36]. Case study organisations reported that the phenomenon of moving away from reconstruction to other sectors was most prominent among those who entered the reconstruction sector following the earthquakes, including overseas immigrants and those entrant people from outside Canterbury. Anecdotally, it appears that some new entrants tended to pursue better career opportunities in other places with their Christchurch reconstruction experience. This tendency, however, will likely be moderated somewhat by rebuild-related organisations providing needed support with organisational culture and certainty of career development playing a central role [59].

Small-to-medium sized businesses have seen work levels in non-reconstruction sectors rise over 2013 and were optimistic about development prospects in buildings and infrastructure industry. Large engineering and construction companies, however, remained to be focused on the reconstruction projects, in the meantime, dealing with high rate of staff turnover and the challenge of staff retention. As reported by interviewee C6,

> *'This year (2014), we start seeing a significant resource pinch on our external subcontractors. For instance, we sent 100 invitations for tender, only a third got back to us as those subcontractors are busy and their resources got tied up. It will be difficult for us to find compliant tenders and keep us competitive.'*

General changes in the demand landscape for different sectors of reconstruction and new developments were also affecting business operational behaviours. For example, as shown in Figure 1, the change in demand and higher rates in other places meant that those who established local operations in Christchurch and secured reconstruction projects following the earthquakes had now moved back to housing and building markets in Auckland or Wellington. As one interviewee E2 put it,

> '*As the Auckland market picks up whereas the Christchurch market raised but not super busy, some of those companies had pulled out their presence from Christchurch as they can survive now in other markets.*'

This finding bears resemblance to the situation following the 2009 Victorian 'Black Saturday' bushfires [69] and the situation in Queensland' flood-affected areas in Australia [70]. Comerio [71] stressed that with prospects of economic development and growth pressures in other areas, the impact of their competing demands for construction skills should not be underestimated. Some case study organisations were concerned that escalating accommodation costs may discourage some construction workers from outside Christchurch. Case study organisations highlighted the importance of Government's investment in temporary housing for additional out-of-town workers as a strategy to retain these resources for the reconstruction projects.

5.2 Shifted focus from recruitment to retention and up-skilling

The skills issue in terms of resource quality is one of the most reported problems – so to a certain extent was viewed by small-to-medium-sized organisations as their top concern. This is not surprising as Mahamid [72] argued that a lack of labour experience is among the top-five factors negatively affecting construction business performance. A range of terms, such as 'lack of competency', 'lack of experience', 'low level of skill', 'absence of work ethics' and 'incorrect work attitude', were used by studied employers as a reason, in part, to explain their reluctance to recruit young workforce which does not seem to have a sufficient skills set for work elements of the reconstruction. A continuing low unemployment rate (3.2 per cent for the December quarter of 2013) in Christchurch will make sourcing appropriate labour more difficult [73]. This is an issue that may become more prominent once more construction works get underway.

Prolonged lead time from planning for forward work programmes to their eventualisation was another key resourcing barrier identified by case study organisations. This is also intertwined with an inconsistent work flow issue. For construction businesses, there is added instability and uncertainty in planning, particularly human resources which causes waste and increased costs [74]. According to Hua [75], firms are more likely to invest in physical assets if they expect demand to remain high and long-term economic conditions to be good. If the economic prospects are unfavourable, they tend to be conservative about their investment due to potential fiscal risks.

Some interviewees noted that slow reconstruction of commercial buildings was capping the rate of the cash flow and the rate and number of people coming in. This is in line with the findings of Ng et al. [76] which emphasised that private construction investment is more sensitive to general economic conditions, creating uncertainty in the future levels of construction workloads. Contractors and suppliers also reported some of their spare capacity was a result of the inconsistent workflows, affecting their workforce demand. One contractor C2 in the infrastructure rebuild sector shared its particular concern:

> *'In 2014, we are particularly concerned that the new subdivisions as a result of the earthquakes and the vertical rebuild will be sucking a lot of our subcontractors. What's gonna happen next might be they are going to suck our own staff, our engineers and project managers.'*

Case studies opened up a discussion about a focus in 2014 for skills retention and up-skilling. Strategies already implemented included changing from annual to quarterly reviews, touching base on a regular basis, increasing the focus on staff development and staying competitive in the market in terms of pay rates. It appears that the high turnover rate among newly recruited workforce undermines the skills retention and in-house up-skilling strategies adopted by case study organisations. As one interviewee (C4) highlighted:

> *'Finding the right people who are willing, able and motivated has been problematic. The more frustrating is you take on new people and spend a lot of time and money training them up. Once they have gained that experience, they move to another company. This is certainly not good for apprenticeship with fewer companies willing to invest in youth training.'*

This is not supervising given that the New Zealand construction industry has a labour turnover rate of over 20 per cent on average [77]. It in turn increases recruitment and training costs. With the higher turnover rate, construction business owners will need to secure key people who maintain the core competency of the business [26, 27]. The need to effectively 'self-insure' for human resource loss, and escalating competing demand from the business-as-usual sectors, will potentially lead some businesses to rethink their resourcing strategies.

5.3 Changing dynamics and relative nature of hiring

Some construction businesses of small-to-medium size indicated that it may be uneconomic to hire wage workers, partly due to quick turnover and some of the work ethics issues of their recruits. This is similar to the findings in the European construction sectors, which lead to the increased sub-contracting [24]. One studied organisation C5 reported that they had to re-assessed their business development strategies and opted to re-structure the company by using sub-contractors to reduce operational costs. The interviewee acknowledged that this change of staffing approach had increased its revenue in terms of improved productivity and work efficiency.

As mentioned above, the change in business resourcing behaviour brought about by staffing experience through a rapid growth cycle post-earthquake will in turn affect the in-take of new staff and buy-in of industry training programmes. If a growing number of construction businesses choose to cancel or reduce the pipeline of their recruitment, it is less likely that a skilled workforce will be delivered to Christchurch in the long term. Figure 2 shows that three critical dynamics – staff turnover rate, competency of hired workforce and business operational capacity – play out together to have an impact on company's ability to work efficiently. The more difficulties a company finds in achieving work efficiency, the lower the productivity [78, 79]. This will in turn make hiring less desirable and less affordable, causing more businesses not to hire.

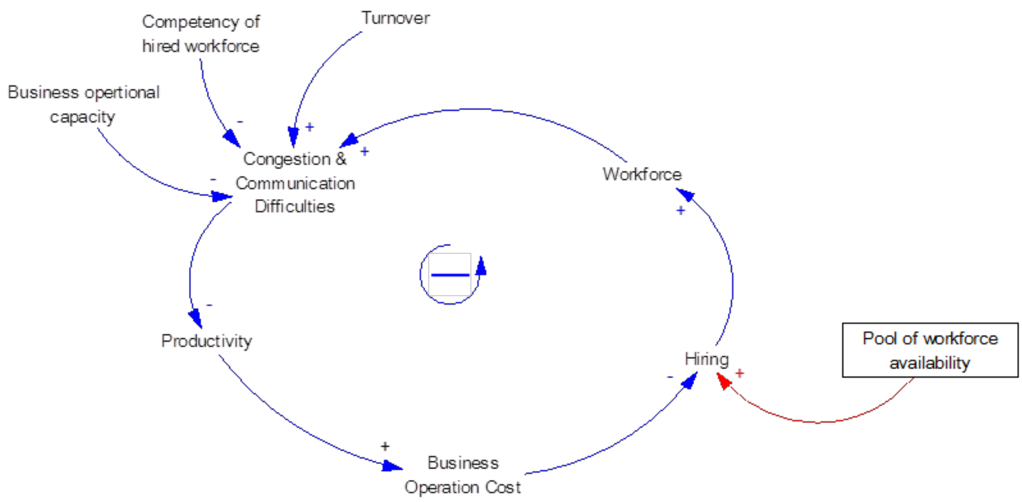

Figure 2: Changing business dynamics and relative nature of hiring

As mentioned earlier, the issues of rapid turnover and lack of competency are particularly found among the youth workforce. The implications from the dynamic model in Figure 2 are that the trend of recruitment is now moving to more temporary contracts on short-to-medium terms. However, there are economic and social consequences of the industry labour market in not delivering the supply of workforce at a rate to meet the required demand by employers [23, 80, 81]. In the meantime, construction organisations were understandably concerned about the risks of overcapacity in Christchurch. In particular, the risk of influx of a less experienced labour force and questions over the training buy-in from the industry were of concern.

6. Conclusion

The nature of reconstruction following a large disaster is often fraught with uncertainties, leading to pronounced fluctuations in its demand [50]. By using a systems approach, this study identified the dynamics that have changed construction companies' resourcing behaviours in relation to the employment demand and supply in the Canterbury recovery from 2010/11 earthquakes. In particular, the limited engineering and project management capability available nationally, lack of motivation among new entrants, combined with high turnover rate, had accounted for socially produced skills shortages in Christchurch. This shortage was further compounded by factors such as the shortage of temporary accommodation, time lags of training and a lack of information about reconstruction workloads from the recovery agencies.

It is difficult to separate pre-existing contributing factors that influence construction skills problems from those of the effects of reconstruction demands. Comerio suggested that disasters do not completely change pre-disaster economic conditions; instead they simply magnify trends or conditions in place before disaster strikes [82]. As shown in this research, the Canterbury earthquakes and the reconstruction demand had brought about fluctuations in the economic cycle. However, the pre-event issues such as the high staff turnover rate, competency of hired workforce, organisational culture and company retention ability still played a dominant role impinging upon the practice of human resource management of construction organisations in disaster recovery projects.

The dynamic models developed in this research provide visual directions for decision makers and construction organisations to implement supporting measures for improved capacity and capability for ongoing reconstruction. The study offers an improved understanding of disaster effects on the construction skills needs and of changes in the skills requirements post-event, enabling better future industry preparedness for a similar event. It is suggested that the design of policy instruments in managing human resources in Christchurch should be informed by a continued investigation of the dynamics that mediate between policy objectives and outcomes over time.

More than that, the study makes the case for a new approach to looking at resourcing problems following a major disaster. Those methods that are based on neoclassical economics and deal mostly with the larger economy tend to consider resource availability as a consequential result of market processes. The systems approach used in this research demonstrates that for enhancing the reconstruction capability in complex post-disaster settings, an organisational perspective should be considered in the decision making, which explains both internal resourcing dynamics and the linkages between construction organisations and the wider recovery environment.

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References

[1] Zuo, K. and S. Wilkinson (2008), *Supply chain and material procurement for post disaster construction: the Boxing Day Tsunami reconstruction experience in Aceh, Indonesia*, in *CIB W89 International Conference on Building Education and Research BEAR 2008*: Heritance Kandalama, Sri Lanka.

[2] Marurier, J.L., J. Rotimi, and S. Wilkinson (2006), *A comparison between routine construction and post-disaster reconstruction with case studies from New Zealand*, in *22nd ARCOM Conference on Current Advances in Construction Management Research*: Birmingham, UK.

[3] Chang, Y., S. Wilkinson, E. Seville, and R. Potangaroa (2012), *Changes in resource need for post-disaster reconstruction: a longitudinal study in China.* Building Research and Information, **40**(3): p. 327-336.

[4] Chang, Y., S. Wilkinson, R. Potangaroa, and E. Seville (2010), *Resourcing challenges for post-disaster housing reconstruction: A comparative analysis.* Building Research and Information, **38**(3): p. 247-264.

[5] Crawford, L., C. Langston, and B. Bajracharya (2012), *Building capability for disaster resilience*, in *28th Annual Conference of Association of Researchers in Construction Management (ARCOM), September 2012*. the Institute of Sustainable Development and Architecture, Bond University: Edinburgh, Scotland.

[6] PWC (2011), *Valuing the role of construction in the New Zealand economy: A report to the Construction Strategy Group*. PricewaterhouseCoopers (PWC): Auckland.

[7] Lobo, Y.B. and S. Wilkinson (2008), *New approaches to solving the skills shortages in the New Zealand construction industry.* Engineering, Construction and Architectural Management, **15**(1): p. 42-53.

[8] Wilkinson, S. (2001), *An analysis of the problems faced by project management companies managing construction projects*. Engineering, Construction and Architectural Management, **8**(3): p. 160-170.

[9] GNS Science (2011), *The Canterbury Earthquake sequence and implications for seismic design levels*, in *GNS Science Consultancy Report 2011/183, July 2011*, T.H. Webb, Editor. GNS Science: Wellington.

[10] Wilkinson, S. and A. Boiser (2011), *Where are the skills coming from?* Build, **126**(October/November): p. 42-43.

[11] Wilkinson, S. and Y. Chang (2011), *Hasty Code changes may slow recovery.* Build Magazine of BRANZ, **June/July**: p. 14.

[12] King, A., D. Middleton, C. Brown, D. Johnson, and S. Johal (2014), *Insurance: Its role in recovery from the 2010-2011 Canterbury Earthquake Sequence.* Earthquake Spectra, **30**(1): p. 475-491.

[13] Agapiou, A., A.D.F. Price, and R. McCaffer (1995), *Planning future construction skill requirements: understanding labour resource issues.* Construction Management and Economics, **13**(2): p. 149-161.

[14] Chan, P.W. and A.R.J. Dainty (2007), *Resolving the UK construction skills crisis: A critical perspective on the research and policy agenda.* Construction Management and Economics, **25**(4): p. 375-386.

[15] Construction Skills (2005), *Construction Skills Network 2012-2016: Blueprint for UK Construction Skills 2012-2016*. Construction Skills Network: London.

[16] Haig, R. (Year), *Age trends in the New Zealand and Australian trades workforce 1991-2001*. in *the 11th Conference Labour, employment and work in New Zealand*. 2004. Industrial Relations Centre, Victoria Management School, University of Wellington.

[17] Dainty, A.R., S.G. Ison, and D.S. Root (2004), *Bridging the skills gap: a regionally driven strategy for resolving the construction labour market crisis.* Engineering, Construction and Architectural Management, **11**(4): p. 275-283.

[18] Loosemore, M., A.R.J. Dainty, and H. Lingard (2003), *Human Resource Management in Construction Projects: Strategic and Operational Approaches*. London & New York: Spon Press.

[19] Kikwasi, G.J. (2011), *An evaluation of construction skills in Tanzania.* Engineering, Construction and Architectural Management, **18**(2): p. 127-139.

[20] Hwang, B.-G. and W.J. Ng (2013), *Project management knowledge and skills for green construction: Overcoming challenges.* International Journal of Project Management, **31**(2): p. 272-284.

[21] Naylor, G., A. Morgan, and A. Raiden (Year), *Does construction skills policy reflect local needs for skills investment?* in *24th ARCOM Conference, 1-3 September*. 2008. Cardiff, UK: Association of Researchers in Construction Management (ARCOM).

[22] Srour, I.M., C.T. Haas, and D.P. Morton (2006), *Linear programming approach to optimize strategic investment in the construction workforce.* Journal of Construction Engineering and Management, **132**(11): p. 1158-1166.

[23] Morgan, A., A. Raiden, and G. Naylor (2008), *Unlocking the potential to influence government skills policy: A case study of the UK construction industry.* International Journal of Training and Development, **12**(4): p. 238-252.

[24] Clarke, L. and G. Herrmann (2007), *Skill shortages, recruitment and retention in the house building sector.* Personnel Review, **36**(4): p. 509-527.

[25] Clarke, L. (2006), *Valuing labour.* Building Research and Information, **34**(3): p. 246-256.

[26] Forde, C. and R. MacKenzie (2007), *Getting the mix right? The use of labour market contract alternatives in the UK construction.* Personnel Review, **36**(4): p. 549-563.

[27] Forde, C., R. MacKenzie, and A. Robinson (2009), *Built on shifting sands: Changes in employers' use of contingent labour in the UK construction sector.* Journal of Industrial Relations, **51**(5): p. 653-667.

[28] McGrath-Champ, S., S. Rosewarne, and Y. Rittau (2011), *From one skill shortage to the next: The Australian construction industry and geographies of a global labour market.* Journal of Industrial Relations, **53**(4): p. 467-485.

[29] Fellows, R., D. Langford, R. Newcombe, and S. Urry (2001), *Construction Management in Practice, 2nd Edition*. London: Blackwell Science.

[30] Gould, E. and N.E. Joyce (2000), *Construction Project Management*. Harlow: Pearson Prentice Hall.

[31] Clarke, L. and C. Wall (1998), *A Blueprint for Change: Construction Skills Training in Britain*. Bristol: The Policy Press

[32] Khatib, J.M. and M. Mahoney (2005), *Can the skills shortage in the UK construction industry be reversed? - A South Yorkshire perspective.* Building Engineer, **80**(10): p. 36-44.

[33] Green, E., A. and D. Owen (2003), *Skills shortages: Local perspectives from England.* Regional Studies, **37**(2): p. 123-134.

[34] Ejohwomu, O.A., D.G. Proverbs, and P. Olomolaiye (Year), *The UK construction industry: A review of black country skills demand*. in *23rd Annual ARCOM Conference, 3-5 September*. 2007. Belfast, UK: Association of Researchers in Construction Management (ARCOM).

[35] Moehler, R.C., P.W. Chan, and D. Greenwood (Year), *The inter-organisational influences on construction skills development in the UK*. in *24th Annual ARCOM Conference, 1-3 September 2008*. 2008. Cardiff, UK: Association of Researchers in Construction Management.

[36] Wilkinson, A., S. Johnstone, and K. Townsend (2012), *Editorial: Changing patterns of human resource management in construction.* Construction Management and Economics, **30**(7): p. 507-512.

[37] O'Donnell, H., T. Karallis, and E. Sandelands (2008), *Reflecting on the skills agenda: A construction industry perspective.* Education + Training, **50**(1): p. 59-63.

[38] Dainty, A.R.J., I. Grugulis, and D. Langford (2007), *Guest Editorial: Understanding construction employment: the need for a fresh research agenda.* Personnel Review, **36**(4): p. 501-508.

[39] Gann, D. and P. Senker (1998), *Construction skills training for the next millennium.* Construction Management and Economics, **16**(5): p. 569-580.

[40] Dainty, A. and D. Edwards (2003), *The UK building education recruitment crisis: A call for action.* Construction Management and Economics, **21**(7): p. 767-775.

[41] Dainty, A.R.J., S. Green, and B. Bagihole (2007), *People and Culture in Construction: A Reader*. Abingdon: Taylor & Francis.

[42] Dainty, A.R.J. and M. Loosemore (2012), *Human Resource Management in Construction*. London: Taylor & Francis.

[43] Burleson, R.C., C.T. Haas, R.L. Tucker, and A. Stanley (1998), *Multiskilled labor utilization strategies in construction.* Journal of Construction Engineering and Management, **124**(6): p. 480-489.

[44] MacKenzie, S., A.R. Kilpatrick, and A. Akintoye (2000), *UK construction skills shortage response strategies and an analysis of industry perceptions.* Construction Management and Economics, **18**(7): p. 853-862.

[45] Dainty, A., S.G. Ison, and D.S. Root (2005), *Averting the construction skills crisis: A regional approach.* Local Economy, **20**(1): p. 79-89.

[46] Soderlund, J. (2002), *Building theories of project management: Past research, questions for the future.* International Journal of Project Management, **22**(3): p. 183-191.

[47] Shenhar, A. and D. Dvir (2008), *Project management research: The challenge and opportunity.* Engineering Management Review, IEEE, **36**(2): p. 112-121.

[48] Johnson, L.A. and R.B. Olshansky (2013), *The road to recovery: Governing post-disaster reconstruction.* Lincoln Institute of Land Policy, **July 2013**: p. 14-21.

[49] Olsen, A.H. and K.A. Porter (2013), *Storm surge to demand surge: Exploratory study of hurricanes, labor wages, and material prices.* Natural Hazards Review (ASCE), **14**(4): p. 247-257.

[50] Chang, Y., S. Wilkinson, R. Potangaroa, and E. Seville (2012), *Managing resources in disaster recovery projects.* Engineering, Construction and Architectural Management, **19**(5): p. 557-580.

[51] Dainty, A.R.J., S.G. Ison, and G.H. Briscoe (2005), *The construction labour market skills crisis: the perspective of small-medium-sized firms.* Construction Management and Economics, **23**(4): p. 387-398.

[52] Chang-Richards, Y., S. Wilkinson, and E. Seville (2012), *Resourcing of the Canterbury rebuild: Changes and emerging themes*, in *June 2012*. The University of Auckland, BRANZ and Resilient Organisations: Auckland.

[53] MBIE (2012), *A Changing Landscape: Recruitment Challenges Following the Canterbury Earthquakes, Evidence from the Canterbury Employers Survey* Labour and Immigration Research Centre, the Ministry of Business, Innovation and Employment (MBIE): Wellington.

[54] Chang, Y. and S. Wilkinson (2012), *Preliminary results from the Resource Availability for Christchurch Earthquake Reconstruction (RACER) survey*, in *January 2012*. Resilient Organisations.

[55] Chang, Y., S. Wilkinson, R. Potangaroa, and E. Seville (2012), *Analysis of resource availability for post-earthquake reconstruction in Christchurch, New Zealand*, in *The 8th annual International Conference of the International Institute for Infrastructure, Renewal and Reconstruction (IIIRR), 24-26 August*: Kumamoto, Japan.

[56] Stevenson, J.R., Y. Chang-Richards, D. Conradson, S. Wilkinson, J. Vargo, E. Seville, and D. Brunsdon (2014), *Organizational networks and recovery following the Canterbury earthquakes.* Earthquake Spectra, **30**(1): p. 555-575.

[57] Chang-Richards, Y., S. Wilkinson, E. Seville, and D. Brunsdon (2013), *Resourcing of the Canterbury rebuild: Case studies of construction organisations*. The University of Auckland, BRANZ, Resilient Organisations: Auckland.

[58] MBIE (2013), *The New Zealand Sectors Report 2013 Featured sector: Construction*. Ministry of Business, Innovation & Employment (MBIE): Wellington.

[59] AECOM (2013), *Infrastructure and building construction survey sentiment.*

[60] Eisenhart, K.M. (1989), *Building theories from case study research.* Academy of Management Review, **14**(4): p. 532-550.

[61] Yin, R.K. (2003), *Case Study Research: Design and Methods, 3rd Edition*. Thousand Oaks, CA, USA: Sage.

[62] Yin, R. (1984), *Case study research*. Beverly Hills, California, USA: Sage Publications.

[63] Sterman, J.D. (2000), *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston: Irwin McGraw-Hill.

[64] Forrester, J.W. (1961), *Industrial Dynamics*. Cambridge, MA: MIT Press.

[65] Helm, P. (2009), *A systems approach to security management.* Tephra, **22**(July): p. 64-70.

[66] Robards, K.J. (2001), *Earthquake Mitigation Decision Making in Local Government: An Application of System Dynamics Modeling*, in *Graduate School of Arts and Sciences* Washington University: St. Louis, Missouri. p. 255.

[67] Comfort, L.K., N. Oh, and G. Ertan (2009), *The dynamics of disaster recovery: Resilience and entropy in hurricane response systems 2005-2008.* Public Organization Review, **9**: p. 309-323.

[68] Blair, J.P. and R. Premus (1993),*Location Theory*, in *Theories of Local and Economic Development: Perspectives from Across the Disciplines*, R.D. Bingham and R. Mier, Editors. Sage Newbury Park, California.

[69] Chang-Richards, Y., S. Wilkinson, R. Potangaroa, and E. Seville (2013), *Resource challenges for housing reconstruction: A longitudinal study of the Australian bushfires.* Disaster Prevention and Management, **22**(2): p. 172-181.

[70] Queensland Reconstruction Authority (2011), *Resources for Reconstruction, September 2011*, in *Discussion Paper No 1*. Queensland Government: Brisbane.

[71] Comerio, M.C. (1993), *Housing repair and reconstruction after Loma Prieta* National Information Service for Earthquake Engineering (nisee).

[72] Mahamid, I. (2013), *Contractors perspective toward factors affecting labor productivity in building construction.* Engineering, Construction and Architectural Management, **20**(5): p. 446-460.

[73] CDC (2014), *The Canterbury Report*. The Canterbury Development Corporation (CDC),: Christchurch.

[74] Allan, N., Y. Yin, and E. Scheepbouwer (2008), *A study into the cyclical performance of the New Zealand Construction Industry*. New Zealand Centre for Advanced Engineering (CAENZ): Christchurch.

[75] Hua, G.B. (2012), *Modeling sectoral construction demand and its relationship with economic indicators.* International Journal of Construction Education and Research, **8**(3): p. 223-240.

[76] Ng, S.T., R.Y.C. Fan, and J.M.W. Wong (2011), *An economic model for forecasting private construction investment in Hong Kong.* Construction Management and Economics, **29**(5): p. 519-534.

[77] CIPD (2007), *Annual survey report 2007*. Chartered Institute of Personnel Directors (CIPD): London.

[78] Chan, P.W. and A. Kaka (2007), *Productivity improvements: Understand the workforce perceptions of productivity first.* Personnel Review, **36**(4): p. 564-584.

[79] Allan, N. and Y. Yin (2010), *Enhancing SME Labour Productivity in the New Zealand Horizontal Infrastructure Construction Sector*. New Zealand Centre for Advanced Engineering (CAENZ): Christchurch.

[80] Lerman, R. (2005), *What role should career-focused education and training play?*, in *The Urban Institute Conference on Workforce Policies for the Next Decade and Beyond, November 2011*: Washington, D.C.

[81] BCITO (2013), *Older workers in the construction industry*, in *BCITO Researcher, 11/1/2013*. The Building and Construction Industry Training Organisation (BCITO): Wellington.

[82] Comerio, M.C. (1998), *Disaster Hits Home: New Policy for Urban Housing Recovery*. Berkeley and Los Angeles, California: University of California Press.

The Australian Natural Disaster Resilience Index

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Abstract

Australia's recently adopted National Strategy for Disaster Resilience recognizes four characteristics of disaster resilient communities: 1) they function well while under stress 2) they adapt successfully 3) they are self-reliant and 4) they have strong social capacity. However important questions are raised. How would progress towards the development of resilient communities be assessed? What are the specific priorities needed to improve resilience for various communities? How should investments to develop disaster resilience be evaluated and reported? This project will develop an Australian Natural Disaster Resilience Index as a tool for assessing, evaluating and reporting resilience to natural hazards in Australia.

1. Introduction

Natural hazard management policy directions in Australia – and indeed internationally – are increasingly being aligned to ideas of resilience. There are many definitions of resilience in relation to natural hazards within a contested academic discourse (Klein et al., 2003; Wisner et al., 2004; Boin et al., 2010; Tierney, 2014). Broadly speaking, resilience to natural hazards is the ability of individuals and communities to cope with disturbances or changes and to maintain adaptive behaviour (Maguire and Cartwright, 2008). Building resilience to natural hazards requires the capacity to cope with the event and its aftermath, as well as the capacity to learn about hazard risks, change behaviour, transform institutions and adapt to a changing environment (Maguire and Cartwright, 2008). The shift from a risk-based approach to managing natural hazards towards ideas of disaster resilience reflects the uncertainty associated with predicting the location and impacts of natural hazard events, the inevitability of natural hazard events, and the uncertainty of future natural hazard risks in a changing climate and population.

The emergency management community sits at the forefront of operationalizing ideas of disaster resilience. Australia's *National Strategy for Disaster Resilience* champions a resilience based approach to the challenges posed by natural hazards. Emergency management and other government agencies involved in hazard management are also adopting principles of natural hazard resilience in policies, strategic planning and community engagement (e.g. Queensland Reconstruction Authority, 2012). It is in light of the need to operationalize the concept of disaster resilience that we are developing the Australian Natural Disaster Resilience Index.

The index is a tool for assessing the resilience of communities to natural hazards at a large scale. It is designed specifically to assess resilience to natural hazards – not derived for another purpose then modified to suit a resilience focus. The assessment inputs in several ways to macro-level policy, strategic planning, community planning and community engagement activities at National, State and local government levels. First, it is a snapshot of the current state of natural hazard resilience at a national scale. Second, it is a layer of information for use in strategic policy development and planning. Third, it provides a benchmark against which to assess future change in resilience to natural hazards. Understanding resilience strengths and weaknesses will help communities, governments and organizations to build the capacities needed for living with natural hazards.

There are two principal approaches to assessing disaster resilience using an index. Bottom-up approaches are locally based and locally driven and are qualitative self-assessments of disaster resilience (Committee on Measures of Community Resilience, 2015). Bottom-up approaches survey individuals or communities using a scorecard consisting of indicators of disaster resilience such as preparation, exposure to specific hazards, community resources and communication (e.g. Arbon, 2014). In contrast, top-down approaches are often intended for use at broad scales by an oversight body (Committee on Measures of Community Resilience, 2015) and use secondary spatial sources such as census data to quantitatively derive indicators that describe the inherent characteristics of a community that contribute to disaster resilience (Cutter et al., 2010). It is important to align the approach used with the purpose of the resilience assessment because bottom-up and top-down approaches both have a point of spatial or conceptual limitation beyond which conclusions about resilience are no longer valid. A framework that outlines the philosophical underpinnings of a project, linked to the mechanisms used to collect and interpret data, can help to scope and define relevant assessment approaches. A framework is an important tool for a resilience assessment because it defines the boundaries - the why, what and how - around the evidence that we use to derive our assessment of natural hazard resilience.

2. Our approach to disaster resilience

There are two prominent schools of thought about the influence of natural hazards in human societies. One school of thought derives from a vulnerability perspective where distributional inequalities in physical, social, economic and environmental factors influence the susceptibility of people to harm and the ability of people to respond to hazards factors (Cutter et al. 2003; Birkmann, 2006). The second school of thought derives from a resilience perspective where people are learning to live with a changing, unpredictable and uncertain environment. Human societies interact with their environment and the environment influences human societies within a social-ecological system, of which natural hazards are a part. In this school of thought, resilience is the capacity of a community to cope with disturbances or changes and to maintain adaptive behaviours (Maguire and Cartwright, 2008). Important in this view of resilience is the notion of adaptation, where adaptation and transformation can be proactive for future events, or reactive in response to an event that has already occurred (Handmer and Dovers, 1996; Engle, 2011). Learning from experience and a focus on review and adjustment helps to build resilience to future events.

The Australian Natural Disaster Resilience Index project views resilience as a process linking a set of capacities to a positive trajectory of functioning and adaptation after a disturbance (sensu Norris et al., 2008). The definition of natural hazard resilience that we adopt for the Australian Natural Disaster Resilience Index is:

> *Resilience is the capacity of communities to prepare for, absorb and recover from natural hazard events and to learn, adapt and transform in ways that enhance these capacities in the face of future events.*

Implicit in this definition are three important elements of the index. First, we are concerned with capacities – or potential – for resilience, not the actual realization of resilience in a particular hazard event (Norris et al., 2008). However, information about the realization of resilience can be used to validate potential resilience and refine the index components. Second, learning, adaptation and transformation are vital to resilience because they provide a strategic feedback loop back to the capacities of preparation, coping and recovery (Berkes, 2007; O'Neill and Handmer, 2012). Learning, adaptation and transformation are also mechanisms for adjusting responses and behaviour and provide flexibility for facing an uncertain, unpredictable future (Berkes, 2007). Flexibility is an important element of disaster resilience because natural hazard events will continue to occur, but we do not know where, when, or of what magnitude these events will be.

Third, we also use the term natural hazard events rather than natural disasters because with appropriate preparation, natural hazard events can occur but not result in natural disasters (Annan, 2003). However, the terms natural hazards and natural disasters are sometimes used interchangeably to mean any natural hazard event – floods, fires, storms, tsunami, cyclones and so forth – that potentially disrupt and cause loss in society. Natural disaster is also a preferable term for communicating with the general public.

The Australian Natural Disaster Resilience Index will assess resilience based on two sets of capacities – coping capacity and adaptive capacity:

- Coping capacity enables people or organizations to use available resources and abilities to face adverse consequences that could lead to a disaster (sensu UNISDR, 2009). In a practical sense, coping capacity relates to the factors influencing the ability of a community to prepare for, absorb and recover from a natural hazard event.
- Adaptive capacity is the ability of a system to modify or change its characteristics or behaviour to cope with actual or anticipated stresses (Folke et al., 2002). Adaptive capacity entails the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem solving and balance power among interest groups

(Folke et al., 2002). In a practical sense, adaptive capacity relates to the factors that enable adjustment of responses and behaviours through learning, adaptation and transformation.

Together, these coping and adaptive capacities form the core of our assessment of resilience to natural hazards (Figure 1). Coping capacity and adaptive capacity help to answer the question 'How able is a community to prepare for, respond to and recover from a natural hazard event and return to a satisfactorily functioning state in a timely manner, and to strategically learn and adapt to improve its resilience to future natural hazard events?'

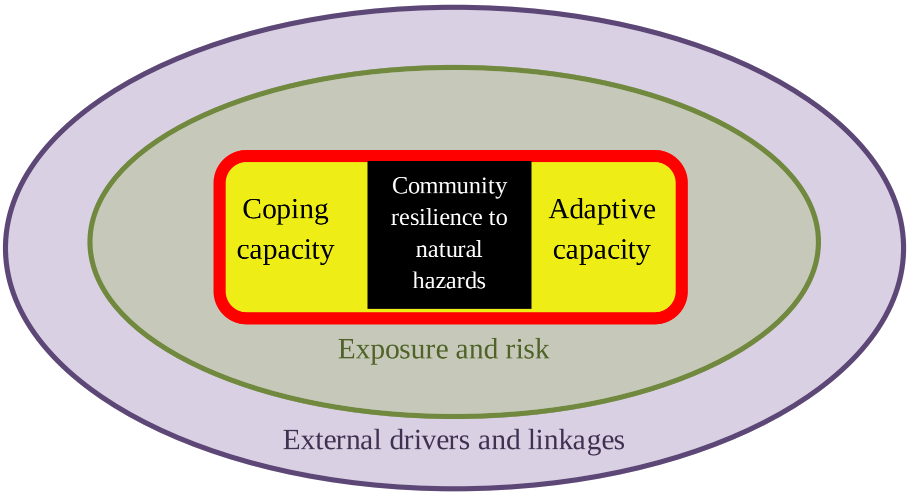

Figure 1. Conceptual model of the Australian Natural Disaster Resilience Index. Factors bordered by the red box are the two sets of capacities that form the index – coping capacity and adaptive capacity. Exposure and risk, and external drivers and linkages are contextual factors that influence disaster resilience but are not included in the index.

The conceptual model also reveals how coping and adaptive capacity are not independent of two important contextual factors. The first of these contextual factors is risk and exposure (Figure 1). Risk expresses the probability and potential loss from natural hazards. Risk assessment is the process of identifying, analysing, evaluating and treating the risks of natural hazard events. Aligned to risk is the concept of exposure. Exposure is the spectrum of natural hazards that occur at different geographical locations and at different magnitudes. We have deliberately excluded risk and exposure from the assessment of resilience to natural hazards.

This is a potential point of contention arising from our approach – how can we assess resilience to natural hazards without knowing what risks we need to be resilient to in different parts of Australia, how likely we are to face them, and what losses might occur? We intend for the Australian Natural Disaster Resilience Index to be able to be overlain with risk maps developed as part of risk assessment and planning (although this overlay step is not part of this project). An all-hazards setting also requires that the assessment considers multiple natural hazards. Not all types of natural hazards occur in all locations in Australia, but the index will assume that the capacities that enable community resilience to one type of natural hazard also enable resilience to other types of natural hazards.

The second contextual factor that influences capacities of resilience is external drivers and linkages (Figure 1). External drivers and linkages include Commonwealth, State and regional policies or legislation in areas such as emergency management, regional development, natural resource management, critical infrastructure and land use planning. External drivers and linkages also encompass broad conditions that influence the characteristics of communities, such as demographic and economic trends.

It is also important to define what we mean by the term community. A community can be seen as sharing a common place or location (Jenkins, 2013). A community can also be seen as sharing a common interest, or a common attachment (Jenkins, 2013). In this project we take the first view of community – that is, a community shares a common location. This view is further moderated by the finest resolution at which we are collecting data –Statistical Area Level 2 area in the Australian Bureau of Statistics census data.

3. An Index to Assess Disaster Resilience in Australia

Assessment refers to a qualitative or quantitative process of evaluating the status of some phenomenon of interest. Assessments can be conducted for different purposes including: 1) to gauge or audit the state of a system at one point in time or over time; 2) to assess whether regulated performance criteria have been exceeded; 3) to detect impacts; and, 4) to assess responses to mitigation or restoration (Downes et al., 2002). We take assessment to mean gauging or auditing the state of disaster resilience in a system at one point in time. Resilience to natural hazards can be assessed using indicators of the components of resilience - in this case coping and adaptive capacities – and combined to form an index. An index is a way of summarizing and reporting complex relational measurements about a particular issue. An index should capture change and respond directionally according to the behaviour of the system (Burton, 2015). As such, an index can be arrayed along a continuum of good to poor condition. The status of an index along the continuum can be used as a baseline against which to measure change through time, or change following intervention or treatment.

There are several well-known top-down indexes used in the field of natural hazard assessment. The work of Susan Cutter and her US colleagues began in the 1980s as an index of vulnerability to natural hazards (Cutter et al. 1993), but has evolved further into an index of disaster resilience (Cutter et al., 2008; Cutter et al. 2010). The European emBRACE project reviewed the concepts of resilience and indicators of resilience (Birkmann 2006) and applied these in several case studies of European natural hazard events. Sherrieb et al (2010) assessed capabilities for community resilience in the US Gulf States using a set of resilience indicators. The World Risk Index (Alliance Development Works, 2014) assesses the comparative vulnerability of individual countries to natural hazards using an index approach. We reviewed these (and other) indices and their conceptual bases and concluded that we could not directly adopt an existing top-down, large scale approach to assess disaster resilience in Australia, for several reasons. First, these indices have been developed overseas under different hazard, socio-economic, governance and policy circumstances to Australia.

Second, none of the indices were designed to explicitly assess disaster resilience in the way that we conceptualize it – being a set of coping and adaptive capacities. For example, the need for adaptive and flexible organizations has been proposed as an important factor in disaster resilience, but this is often not included in existing indices. However, we do not by any means ignore the important body of assessment research that has come before and there is much overlap in concept, approach and methods between the Australian Natural Disaster Resilience Index and existing indices. We draw on the philosophical underpinnings and methods of assessment of these existing indexes and incorporate them into our assessment of Australian disaster resilience.

There is also an important difference between an index and indicators. An index conveys the overall status of the issue at hand. It can be reported as one number, or more commonly, as sets of numbers related to themes. These themes should be related to the purpose of the index as described by the underlying philosophical approach – in this case, resilience. Indicators are variables that are used to 'indicate', or measure, the status of the theme. Resilience is not always a directly observable phenomenon, particularly in a top-down, large scale approach (Tate, 2012) and proxies can be used to convey an indicator when the relationship between the proxy and the phenomenon of interest is known. In addition, disaster resilience is influenced by many factors, often with complex interactions. Thus, a robust index requires careful design of component indicators. The structural design of an index can be deductive, hierarchical or inductive. The choice of structure depends largely on the formulation of the conceptual framework but the type of structure used can affect the robustness of individual indicators and the overall index (Tate, 2012).

We have used a hierarchical structure for the Australian Natural Disaster Resilience Index (Figure 2). A hierarchical structure allows levels with similar concepts, processes and spatial/temporal organization to emerge. Lower levels can be summarized into higher levels, and higher levels constrain the elements of levels sitting within it. The first level in our hierarchy is made up of the adaptive capacities and coping capacities that make up our conceptual premise of disaster resilience. The second level in our hierarchy is made up of themes that convey the components of adaptive capacity and coping capacity. The third level is comprised of indicator sets that measure the status of a theme. It is possible that one indicator is relevant across different themes or capacities.

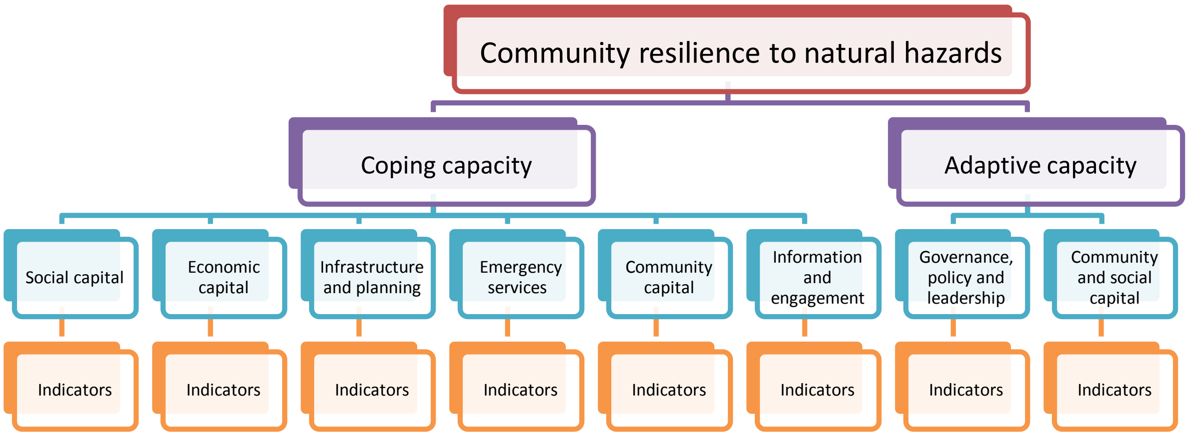

Figure 2. The hierarchical structure of the Australian Natural Disaster Resilience Index. Indicator themes (blue boxes) and component indicators (orange boxes) are outlined in Section 3.1 and 3.2.

3.1 Indicator themes

Themes divide coping capacity and adaptive capacity into its sub-components. Themes are the factors – related to coping capacity or adaptive capacity – that contributes to community resilience to natural hazards. Themes have a basis in the literature: some with empirical evidence of the relationship between the theme and resilience, and others that conceptualize this relationship but with little empirical testing.

Coping capacity is comprised of six themes that encapsulate the factors influencing the resources and abilities that communities have to prepare for, absorb and recover from natural hazard events Adaptive capacity is comprised of two themes that encapsulate the factors that enable institutional and social learning, flexibility and problem solving. The relationships between the theme and natural hazard resilience are established through the literature, where quantitative and qualitative studies explain the resilience responses of communities. Gathering the evidence for the relationship between a theme, or component indicator, is an important part of the study.

3.2 Indicators

Indicators provide the data for a theme – together the indicators measure the status of the theme. Many indicators have a basis in the literature and have demonstrated relationships with aspects of natural hazards or disasters. For example, there is a documented relationship between income, housing type and gender and the ability to prepare for and respond to natural hazard events (Morrow, 1999). Selecting indicators is both an art and a science. The indicators used to measure the status of the theme can be selected using a set of criteria that increase confidence in the associations between an indicator and disaster resilience (Winderl, 2014). While there will always be trade-offs between indicator specificity, data availability, cost effectiveness and sensitivity (Winderl, 2014) the selection of indicators can be guided by criteria that help to bound large sets of potential indicators. The criteria used to guide the selection of indicators are outlined in Table 3. These criteria will guide the selection of indicators for the Australian Disaster Resilience Index. Several criteria will be more prominent in guiding this selection. First, the data used for the indicator needs to have a whole of nation geographic coverage (Criteria 3, 4 and 6) such as from census data, policy documents or economic data. Second, there will be statistical challenges or requirements that may require us to modify the indicators included in each theme (Criteria 5). Third, the indicator needs to be supported by evidence of how it contributes to resilience and how it behaves along a continuum of low to high resilience, including any verification of the indicator in independent studies (Criteria 1, 2 and 5).

Table 3. Generalized criteria for indicator selection. Compiled from Brown (2009), Bene (2013) and Winderl (2014).

Criteria for indicator selection	Requirements
1. The indicator reflects a justifiable element of natural hazard resilience	• The relationship between the indicator and natural hazard resilience has been verified in the academic/professional literature
2. The indicator can track change and variability in natural hazard resilience	• Change in the indicator can be determined and associated with change in resilience spatially and temporally
3. The indicator is relevant to the scale(s) of assessment	• The indicator aligns with the scale at which the assessment is undertaken. There may be a requirement for an indicator to remain valid across scales (e.g. local to national).
4. The indicator is measurable and readily interpretable	• The indicator is specific and precisely defined. • The indicator is quantifiable and spatially referenced • The indicator is easy to define, understand and communicate
5. The measurement method for the indicator is robust	• Measurement is reliable (and verifiable) and representative of reality • Measurement occurs regularly enough for the purpose • Measurement is methodologically sound
6. The indicator is achievable – data are available, accessible and cost effective	• Data are available at the required scales across most of the study area • Data are readily available from secondary sources • Data can be accessed within the cost and resource framework

A literature review revealed many indicators that have been used to assess disaster vulnerability or resilience in top-down, large scale approaches (e.g. Cutter et al. 2003, Cutter et al. 2010, Sherrieb et al. 2010, Birkmann et al., 2012, Frazier et al., 2013, Orencio and Fujii, 2013). These indicators describe factors influencing disaster resilience, including economic capital, social capital, dwelling type, dwelling tenure, family structure, health and well-being, infrastructure, institutions and demographics. We used these indicators as a basis for identifying potential indicators for the Australian Disaster Resilience Index. Most of the published indicators are aligned with the coping capacity part of the conceptual model (Figure 1). This arises largely from the conceptual approaches that have been used in the aforementioned large scale assessments, where resilience is viewed as the capacities of communities to absorb and moderate the impacts of natural hazards (e.g. Cutter et al. 2010, Sherrieb et al. 2010). The idea of adaptive capacity and the agency of societies to transform and learn in the face of natural hazards is a newer conception in large scale assessment, although it has been a core theme of the theoretical literature on disaster resilience (Engle, 2011). Deriving indicators of adaptive capacity in relation to natural hazards is even rarer. For example, Cutter et al. (2010) did not attempt to include adaptive capacity indicators, despite adaptive capacity being part of the BRIC Model (Cutter et al., 2008). However, much attention has been paid to the assessment of adaptive capacity in the climate change literature (Engle, 2011; IPCC, 2012). We will explore the climate change adaptation approach as the basis for deriving adaptive capacity indicators, refining to suit the definition associated with natural hazard adaptation. The generalized process for indicator selection, literature review and index calculation is given in Figure 3. Sitting alongside the selection of indicators will be a process of determining the relationship between the indicator and resilience. There can be a positive or negative relationship between an indicator and natural hazard resilience. For example, families with a large number of dependents often do not have the financial resources to prepare for natural hazard events (Cutter et al. 2003) and renters also may not be able to make modifications to premises that may confer resilience (Morrow, 1999). Quantitative and qualitative studies will be reviewed to extract evidence for the relationship between the indicator and resilience. Both peer-reviewed and grey literature will be considered, as will Australian and international studies. A data set will be established and meta-analysis techniques used to set the relationship between an indicator and resilience, with confidence bounds. This will determine the directionality of the indicator along a continuum of high to low resilience.

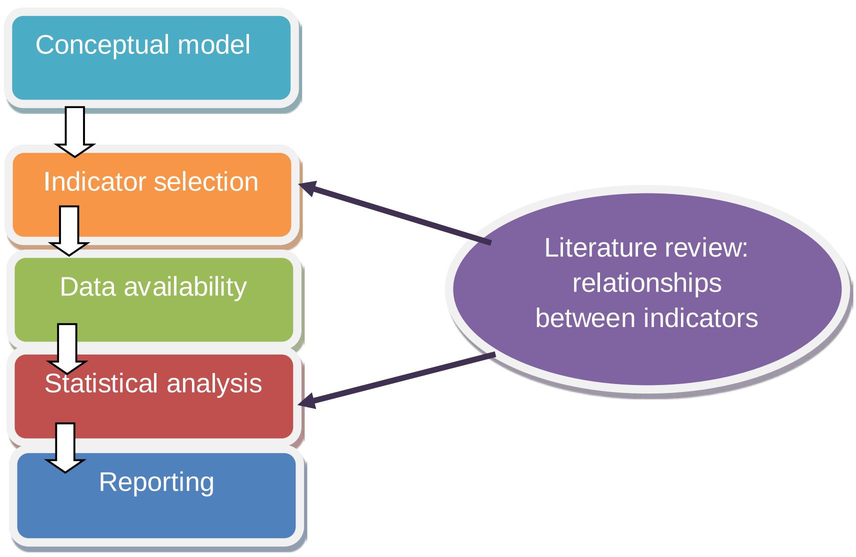

Figure 3. The generalised process for deriving the Australian Natural Disaster Resilience Index.

Index calculation is the process of bringing together the indicators to form an index. There is much debate in the literature about the derivation of an index from component indicators, and the relationship between an index and reality (Tate, 2012; Burton, 2015). Deductive and hierarchical designs tend to use additive models of index derivation.

Weighting may be applied to emphasise some indicators with greater contribution to resilience, although weighting strongly influence index sensitivity (Tate, 2012). Inductive designs (e.g. Cutter et al. 2003) use factor analysis to extract factors describing the relative contribution of indicators to overall variation. Factor analysis is sensitive to the choice of indicator set (Tate 2012). Recent symposia suggest that index designs are leaning towards deductive designs that use simple but robust additive models, because these facilitate more meaningful communication of index results. We will explore the outcomes of these two types of approaches on the results of the index. Validation against reality is an element of index design that is developing, because the opportunities for validating assessments of resilience against real events are rare (but see Burton, 2015 for an exception). The extensive literature review supporting each indicator will help to link smaller-scale, hazard-specific observations of the factors thought to influence resilience with the larger-scale index outputs.

4. What will the Australian Natural Disaster Resilience Index look like?

The Australian Natural Disaster Resilience Index is a spatial representation of the current state of disaster resilience across Australia. It will be composed of multiple levels of information that can be reported separately – an overall index, themes and indicators. Information will be conveyed primarily as maps that are colour coded along a continuum of high to low resilience status (see Figure 4 for an example). The index will cover Australia. This means that each point on a map will have a corresponding set of information about natural hazard resilience. Where possible the resolution at which we calculate indicators is the Statistical Areas Level 2 (SA2) division of the Australian Bureau of Statistics (ABS). For data that are not available at this level we will then move up in resolution to the Statistical Areas Level 3 (SA3) division of the ABS. Some indicators may also need to be derived at the Local Government Area level, or even at the regional or state level. Part of our work in the data collection phase of the project will be to examine the sensitivity and comparability of data collected at different scales. The index and indicators will be drawn together as a State of Disaster Resilience Report. This document will interpret resilience at multiple levels and highlight hotspots of high and low elements of natural hazard resilience.

We also intend for the Australian Natural Disaster Resilience Index to be used as a layer of information in the preparation, prevention and recovery spheres. These activities might include policy development, strategy development, risk assessment and management, land use planning, community engagement and organizational planning and prioritization. Spatially explicit capture of data (i.e. in a Geographical Information System) will facilitate seamless integration with other types of information and mapping. These spatial data layers will be a product of the project. However, the relationship between risk and resilience is not necessarily linear and further research will be required to associate the index to risk assessment tools. It is also important to note that the Australian Natural Disaster Resilience Index is not information that supports operational decision making during response to an incident.

In any top-down large-scale assessment such as the Australian Natural Disaster Resilience Index there will be limitations on the currency and application of the findings. Broad national data sets such as the 2011 Australian census will be 7 years old when the index is released in 2017/18. The next Australian census is scheduled for 2016 but it can take several years for some variables to be validated and released by the Australian Bureau of Statistics. There is also a ceiling spatial resolution at which the disaster resilience index can be applied. For example, the index will explain variation in resilience at the smallest resolution of SA2 level of the 2011 Australian census, and some variables may be collected at a broader resolution.

Some community planning and engagement activities might ideally like to have finer scale information related to household preparedness activity or street level neighbourliness. This type of data is not collected in the index and indeed, requires a bottom-up survey approach that is outside the scope of this project. Rural, remote and indigenous communities may also experience resilience differently to urban and regional communities. The social influences on rural and remote communities may need to be accounted for in deriving indicator variables and this will be part of the analysis process.

The Australian Natural Disaster Resilience Index also has great benefits. It will provide a tool to assist the move from disaster risk reduction towards a sustainable future of natural hazard resilience (Committee on Measures of Disaster Resilience, 2015). There are many challenges in operationalizing resilience (Klein et al., 2003), particularly through a resilience index. However, the idea of disaster resilience is here to stay (Norris et al. 2008). The Australian Natural Disaster Resilience Index will be advantageous in many ways and support National and State strategic interests in natural hazard management. The index will provide a benchmark of national-level disaster resilience against which future changes can be assessed. It will evaluate hot-spots of high or low disaster resilience in Australia, and identify areas of strength in coping and adaptive capacity. It can also support various policy development initiatives such as the Australian Natural Disaster Resilience Strategy, and potentially help to embed disaster resilience into policy and legislation. It can also be used as a layer in risk assessment that overlays the socially based influences on disaster resilience.

References

Akama, Y., Chaplin, S. and Fairbrother, P. 2014. Role of social networks in community preparedness for bushfire. International Journal of Disaster Resilience in the Built Environment, 5: 277-291.

Aldrich, D. 2012. Building resilience: Social capital in post-disaster recovery. The University of Chicago Press: Chicago.

Alliance Development Works. 2014. World Risk Report, 2014. United Nations University, Institute for Environment and Human Security, Bonn, Germany.

Annan, K. 2003. United Nations Secretary-General's message for the International Day for Disaster Reduction. United Nations, New York. Available from: http://www.un.org/sg/statements/?nid=551

Arbon, P. 2014. Developing a model and tool to measure community disaster resilience. Australian Journal of Emergency Management, 29: 12-16.

Bene, C. 2013. Towards a quantifiable measure of resilience. IDS Working Paper Number 434. Institute of Development Studies, Brighton, UK.

Berkes, F. 2007. Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. Natural Hazards, 41: 283-295.

Bird, D., King, D., Haynes, K., Box, P., Okada, T. and Nairn, K. 2013. Impact of the 2010-2011 floods and the factors that inhibit and enable household adaptation strategies. National Climate Change Adaptation Research Facility, Gold Coast, Queensland.

Birkmann, J. 2006. Measuring vulnerability to promote disaster-resilient societies: conceptual frameworks and definitions. In: Birkmann, J. (Editor). Measuring vulnerability to natural hazards: towards disaster resilient societies. Pages 9-54. United Nations University Press: Tokyo.

Birkmann, J. et al. 2012. Systematization of different concepts, quality criteria and indicators. Working Paper 1.2, Embrace. United Nations University, Institute for Environment and Human Security, Germany.

Boin, A., Comfort, L.K. and Demchak, C.C. 2010. The rise of resilience. In: Comfort, L.K., Boin, A. and Demchak, C.C. (Editors) Designing Resilience: Preparing for extreme events. University of Pittsburgh Press, Pittsburgh, PA. Pages 1-12.

Boin, A. 2010. Designing resilience: Leadership challenges in complex administrative systems. In: Comfort, L.K., Boin, A. and Demchak, C.C. (Editors) Designing Resilience: Preparing for extreme events. University of Pittsburgh Press, Pittsburgh, PA. Pages 129-142.

Brown, D. 2009. Good practice guidelines for indicator development and reporting. Contributed paper: Third World Forum on Statistics, Knowledge and Policy. 27-30 October 2009, Busan, Korea.

Burton, C.G. 2015. A Validation of Metrics for Community Resilience to Natural Hazards and Disasters Using the Recovery from Hurricane Katrina as a Case Study. Annals of the Association of American Geographers, 105: 67-86.

Committee on Measures of Community Resilience. 2015. Developing a framework for measuring community resilience: summary of a workshop. The National Academies Press, Washington DC.

Crompton, R.P., McAneny, J., Chen, K., Pielke, R.A. and Haynes, K. 2010. Influence of location, population and climate on building damage and fatalities due to Australian bushfire: 1925-2009. Weather, Climate and Society, 2: 300-310.

Cutter, S.L., Boruff, B.J. and Shirley, W.L. 2003. Social vulnerability to environmental hazards. Social Science Quarterly, 84: 242-261.

Cutter, S.L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. and Webb, J. 2008. A place-based model for understanding community resilience to natural disasters. Global Environmental Change, 18: 598-606.

Cutter, S.L., Burton, C.G., and Emrich, C.T. 2010. Disaster resilience indicators for benchmarking baseline conditions. Journal of Homeland Security and Emergency Management, 7: Issue 1, Article 51. DOI: 10.2202/1547-7355.1732

Downes, B.J., Barmuta, L.A., Fairweather, P.G., Faith, D.P., Keough, M.J., Lake, P.S., Mapstone, B.D. and Quinn, J.P. 2002. Monitoring Ecological Impacts: Concepts and Practice in Flowing Waters. Cambridge University Press: Cambridge.

[EMA] Emergency Management Australia. 2013. National Strategy for Disaster Resilience Community Engagement Framework. Handbook Number 6, Attorney General’s Department, Canberra.

Engle, N.L. 2011. Adaptive capacity and its assessment. Global Environmental Change, 21: 647-656.

Folke C., J. Colding, and F. Berkes. 2002. Building resilience for adaptive capacity in social-ecological systems. In: Berkes F., J. Colding, and C. Folke (Editors). Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge, UK.

Frazier, T.G., Thompson, C.M., Dezzani, R.J. and Butsick, D. 2013. Spatial and temporal quantification of resilience at the community scale. Applied Geography, 42: 95-107.

Goldstein, B.E. (Editor). 2012. Collaborative resilience: moving through crisis to opportunity. The MIT Press: Cambridge, Massachusetts.

Handmer, J.W. and Dovers, S.R. 1996. A typology of resilience: Rethinking institutions for sustainable development. Industrial and Environmental Crisis Quarterly, 9: 482-511.
Handmer, J. and Dovers, S. 2013. Handbook of disaster policies and institutions. Routledge: Abingdon, UK.

[IPCC] Intergovernmental Panel on Climate Change. 2012. Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Jenkins, P. 2013. The nature of human communities. In: Thomas, D.S.K., Phillips, B.D., Lovekamp, W.E. and Fothergill, A. (Editors). Social Vulnerability to Disasters. Pages 397-413. CRC Press: Boca Raton, FL.

Kaufman, S. 2012. Complex systems, anticipation and collaborative planning for resilience. In: Goldstein, B.E. (Editor). Collaborative resilience: moving through crisis to opportunity. The MIT Press: Cambridge, Massachusetts. Pages 61-98.

King, D. 2008. Reducing hazard vulnerability through local government engagement and action. Natural Hazards, 47: 497-508.

Klein, R.J.T., Nicholls, R.J. and Thomalla, F. 2003. Resilience to natural hazards: How useful is this concept? Environmental Hazards, 5: 35-45.

Maguire, B. and Cartwright, S. 2008. Assessing a community's capacity to manage change: A resilience approach to social assessment. Australian Government, Bureau of Rural Sciences, Canberra.

Morrow, B.H. 1999. Identifying and mapping community vulnerability. Disasters, 23: 1-18.

Norris, F.H., Stevens, S.P., Pfefferbaum, B., Wyche, K.F. and Pfefferbaum, R.L. 2008. Community resilience as a metaphor, theory, set of capacities and strategy for disaster readiness. American Journal of Community Psychology, 41: 127-150.

Orencio, P.M. and Fujii, M. 2013. A localized disaster-resilience index to assess coastal communities based on an analytic hierarchy process (AHP). International Journal of Disaster Risk Reduction, 3: 62-75.

O'Neill, S.J. and Handmer, J. 2012. Responding to bushfire risk: the need for transformative adaptation. Environmental Research Letters, 7, online. doi: 10.1088/1748-9326/7/1/014018.

Queensland Reconstruction Authority. 2012. Planning for stronger, more resilient floodplains. Part 2: Measures to support floodplain management in future planning schemes. Queensland Government, Brisbane.

[UNISDR] United Nations International Strategy for Disaster Reduction. 2009. UNISDR terminology on disaster risk reduction. UNISDR, Switzerland.

Sherrieb, K., Norris, F.H. and Galea, S. 2010. Measuring capabilities for community resilience. Social Indicator Research, 99: 227-247.

Smith, G. 2009. Planning for sustainable and disaster resilient communities. In: Pine, C. (Editor). Natural Hazards Analysis. Taylor and Francis: Boca Raton, FL. pp. 221-247.

Tate, E. 2012. Social vulnerability indices: a comparative assessment using uncertainty and sensitivity analysis. Natural Hazards, 63: 325-347.

Thomas, D.S.K., Phillips, B.D., Lovekamp, W.E., and Fothergill, A. (Editors). 2013. Social Vulnerability to Disasters. CRC Press: Boca Raton, FL.

Tierney, K. 2014. The social roots of risk. Stanford University Press, California.

Winderl, T. 2014. Disaster resilience measurements. Stocktaking of ongoing efforts in developing systems for measuring resilience. United Nations Development Programme.

Wisner, B., Blaikie, P., Cannon, T. and Davis, I. 2004. At risk: Natural hazards, people's vulnerability and disasters. Routledge, London.

Urban heat island effect in Asian metropolitan centres – Tokyo and Singapore

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Abstract

Urban Heat Island effect is a climatological phenomenon that occurs due to a concentration of reflective surfaces and a lack of vegetation. It tends to exacerbate heat wave events in urban environments as it increases heat absorption during the day and increases the re-emission of heat at night time. In this study, two metropolitan cities – Singapore and Tokyo have been explored for UHI effect experience and how proactive measures, such as monitoring and revising landuse planning are mitigating the impact. Qualitative and quantitative data has been used to analyze the effect, as well as the effectiveness of mitigation measures.

Keywords: Urban Heat Island (UHI) effect; Tokyo; Singapore; Mitigation; Risk.

1. Background

Events such as the 2003 European heat wave and the 1995 Chicago heat wave events are well known examples of disasters caused by UHI effect. Many large metropolitan cities around the world are at risk of heat wave events, especially major cities located on coastal areas. An estimated three billion people living in urban areas around the world are directly exposed to the problem, which will be increased significantly in the near future [1]. Heat waves and random weather patterns are expected to become more frequent and more intense in the context of climate change. In contrast to other hazards, heat waves are foreseeable and deaths are in turn preventable. A period with more than three consecutive days of maximum temperatures at or above 32°C is considered to be a heat wave event [2]; [3]. The UHI effect physically elevates temperatures in large urbanized regions relative to rural areas at their peripheries [4]; [5]; [6]. UHI effect is a climatological phenomenon that occurs due to a concentration of reflective surfaces and a lack of vegetation that results in exacerbation of heat wave events in urban environments. It increases heat absorption during the day and therefore, increases the re-emission of heat at night time. This effect is expected to increase in rapidly growing metropolitan regions McPherson 1994 in Stone and Rodgers [6], especially in the context of micro climate change. Figure 1 demonstrates the phenomenon.

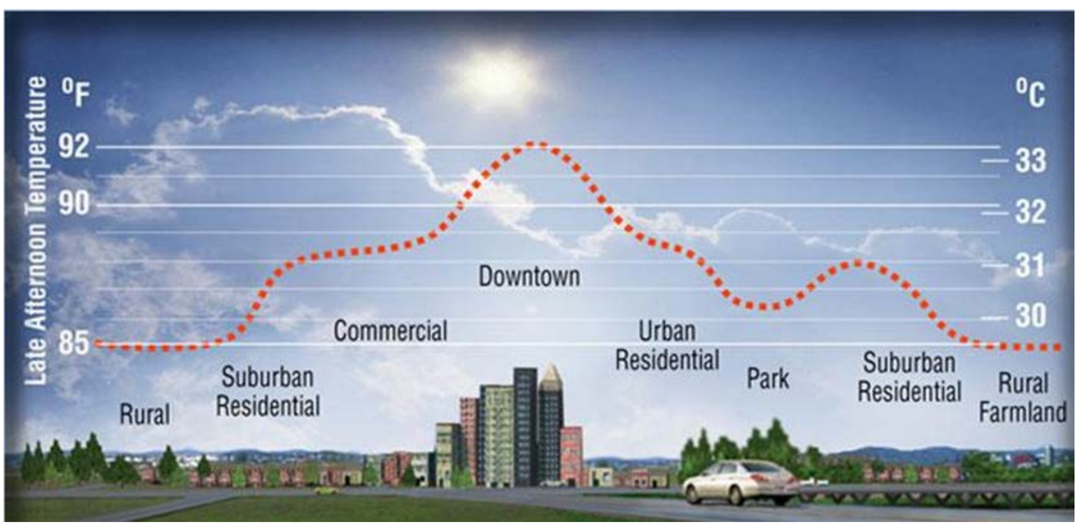

Figure 1: The Urban Heat Island Effect (http://heatisland.lbl.gov/).

1.1 Causes of Urban Heat Island Effect

Some of the main causes of the UHI are greenhouse gas emissions, gradual loss of urban forest cover, the impermeability and low albedo of materials, thermal properties of materials, urban morphology, the size of the cities, and the anthropogenic heat. The Urban environment, human vulnerability, and geographic location play vital role in determining the impact of heat [7]. Well known examples are the 1995 Chicago heat wave during which more than 700 deaths were identified as being heat related [8] and the 2003 European heat wave that caused an total excess of 70,000 deaths in 16 countries [9]. A tolerance to heat varies within each population. Vulnerability to heat waves is greater for children, pregnant women, older adults and people with chronic health conditions [10]. Tolerance also varies according to the time of the year, its duration and intensity, the frequency of heat wave events and the number of heat waves during a period of time [4]; [7]. When heat wave events occur earlier in the summer they have a greater impact on human mortality because the heat stress on the body will be greater due to a lack of acclimation. Heat stress directly impacts morbidity by increasing the risk of heat cramps, heat exhaustion, and non-fatal heat strokes. People may be subject to dehydration, heat fatigue, and a reduced ability to cool down their body. Heat stress exacerbates some medical conditions and can also increase the risks of death from cardiovascular disease, cerebrovascular accidents and vascular lesions, respiratory diseases and even increase susceptibility to infectious diseases [8]; [4].

2. UHI in large metropolitan centres

In this study, we have selected two large and popular metropolitan cities - Tokyo and Singapore – to study the phenomenon of UHI effect and its mitigation measures. The two cities are located along coastlines and experience significant man-made alterations of the urban surface [11]. Singapore is a low-latitude city where air conditioning load can be significant all year round, and Tokyo's development frenzy brings substantial influx of anthropogenic heat in central parts of the city contributing to the UHI [12]. The two cities have been discussed in detail in subsequent sections.

2.1 Tokyo

Tokyo is one of the largest urban cities in the world, with a population of approximately 30 million people where rapid progress in industrialization and urbanization has resulted in the concentration of economic growth and social functions in the urban areas [13]. Its geographic location (Figure 2), by the Pacific Ocean, and geomorphological features such as mountains make it unique for certain weather patterns. The daily mean temperature has risen by 3°C in 100 years in Tokyo (see Figure 3 and Table 1) during the 20th century. Approximately 2 degrees Celsius out of the 3 degrees Celsius increase is attributed to the UHI effect, making this overall increase in temperature the largest of any other major city in the world. The climate in Tokyo has recently been altered to include abnormal weather events for the area, such as "guerilla downpours". These rare events of torrential and unpredictable rains are becoming more frequent in Tokyo, sometimes resulting in death [14].

Over the last few decades, the UHI has intensified rather quickly, mainly due to an increase in released anthropogenic heat, as well as changes in surface materials. Japan's mean annual surface temperature has been rising at a rate of approximately 1.14ºC per century, comparable to the global mean surface temperature which is rising at a rate of approximately 0.69ºC per century. Annual average temperatures were observed from stations within Japan, and resulted in a more pronounced long-term trend at the urban observation stations versus the rural observation stations [15]. The above long-term trends are not as prominent in summer, compared to autumn, winter, and spring seasons.

Statistical data exists suggesting that long-term average annual temperature trends are more prominent in Tokyo, than from 15 rural stations surrounding Tokyo. The differences in the trends, strongly suggests the influence of urbanization on the average temperatures of Tokyo, contributing to the UHI [15]. Figure 4 displays a comparison between Tokyo and 15 rural station long-term average annual temperature trends. The temperature trends from Tokyo are observably higher than those from the rural stations. The local circulation found here typically affects the UHI during the day in warm seasons when the sea breeze front carries warm temperatures and due to temperature distribution during the nighttime.

Figure 2: Tokyo's geographic location by the Pacific Ocean (worldtravel.com).

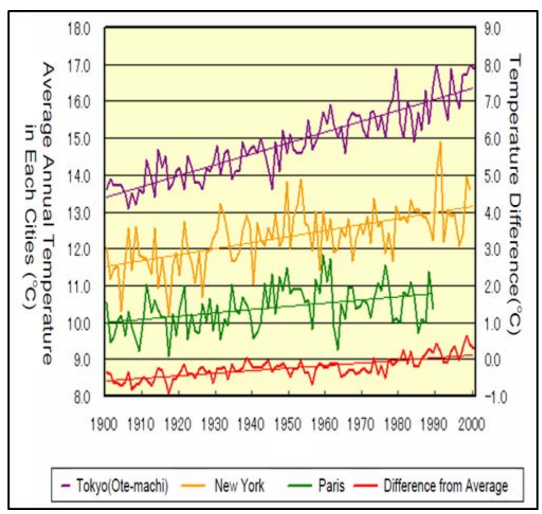

Figure 3: Comparison of temperature difference for big cities (Hanaki [17]); JMA [15]).

Table 1: Comparison of average temperatures in major cities of Japan from JMA [15].

City	Rise by 100 years (°C)		
	Average Temperature		
	Annual	January	August
Sapporo	+2.3	+3.0	+1.5
Sendai	+2.3	+3.5	+0.6
Tokyo	+3.0	+3.8	+2.6
Nagoya	+2.6	+3.6	+1.9
Kyoto	+2.5	+3.2	+2.3
Fukuoka	+2.5	+1.9	+2.1
Average of Big Cities	+2.5	+3.2	+1.8
Average of Middle and Small Cities	+1.0	+1.0	+1.0

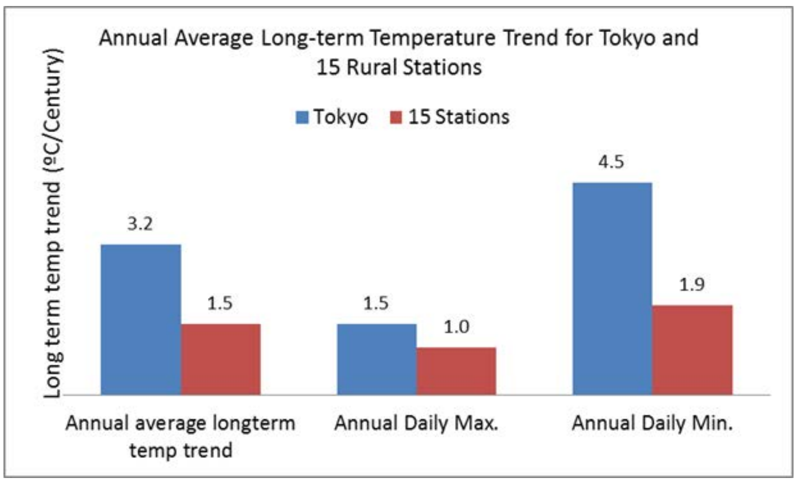

Figure 4: The annual average long-term temperature trend for Tokyo and 15 rural stations. Data includes annual average, annual daily maximum and annual daily minimum temperature trends (based on data in JMA [15]).

In Tokyo, during the summer, shortwave radiation is strong and the influence of anthropogenic heat is small. However, in the winter the shortwave radiation is weaker but the influence of anthropogenic heat is larger (Figure 5). Near surface air temperature is strongly affected by land coverage, during the heating stage when the anthropogenic heat in central Tokyo can exceed 400 W/m^2 in daytime and the maximum value has been recorded as 1590 W/m^2 in winter [12]. This information is based on observed peaks of high temperature around areas with the largest anthropogenic heat fluxes. The annual number of days with temperatures of 35ºC and above, are predicted to increase, while the annual number of days with temperatures reaching below zero degrees Celsius has decreased [15].

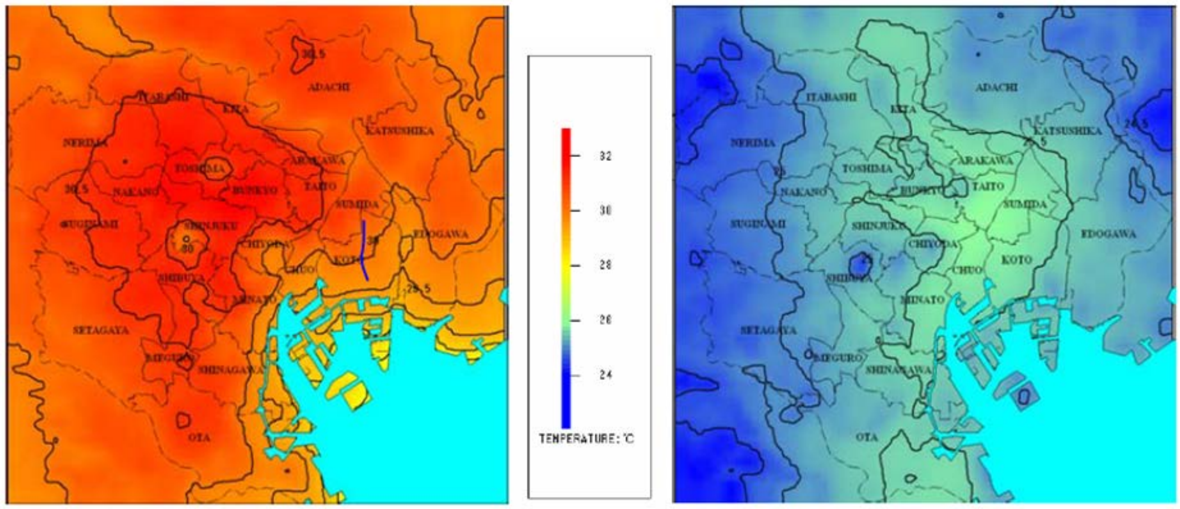

Figure 5: Distribution of temperature in Tokyo at 2pm (left) and 6am (right). The simulation is based on fine summer days with weak winds [17].

2.2 Singapore

Singapore is highly urbanized and densely populated with a population of 5.4 million people, according to the World Bank [18], and is considered the 4th largest per capita energy consumer in the world [19]. The Heat Island intensity in Singapore is about 4.5°C. The geographic location of the country and a dense built-up area make it vulnerable to UHI effect (Figures 6-8). The northern part experiences lower temperatures while the southern developments have higher temperatures, especially in the Central Business District (CBD) area.

Chow and Roth [20] traveled throughout Singapore and measured the temperature at the identified stations used in Figure 9 in order to measure UHI intensity, measured as the temperature difference between the urban area and its rural surroundings. They used following markers to describe landuse type:

- COM: the commercial area contains a weather station located at the centre of the commercial and shopping area of Orchard Road;
- CBD: this weather station is located in the financial/CBD area near the southernmost tip of Singapore. It is surrounded by skyscrapers of z >150 m (where z= height above ground);

- HDB: located in a government-built housing development board, it is characterized high-rise flats of z = 35-40 m and is located approximately 1.5 km from the coast;
- RES: a low-rise housing area consisting of 2-3 story, privately owned terrace houses, located approximately 1.5 km from the coast;
- RUR: a less developed area consisting of a mix of secondary tropical rainforest, agricultural land, and military training grounds located in northwest of Singapore.

Figure 6: Singapore's geographic location (www.ephotopix.com).

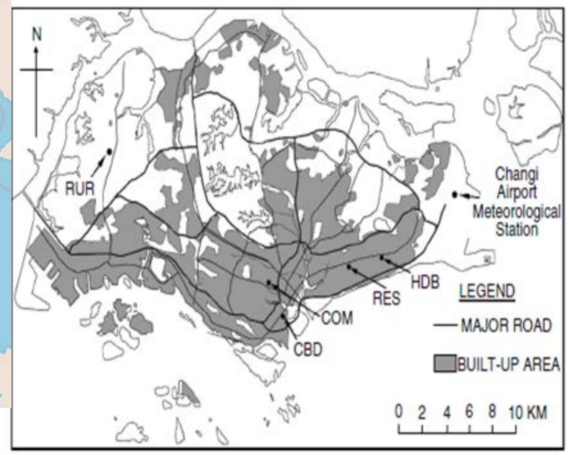

Figure 7: Built-up area (gray shaded) in 2002. The black dots indicate the observation locations [20].

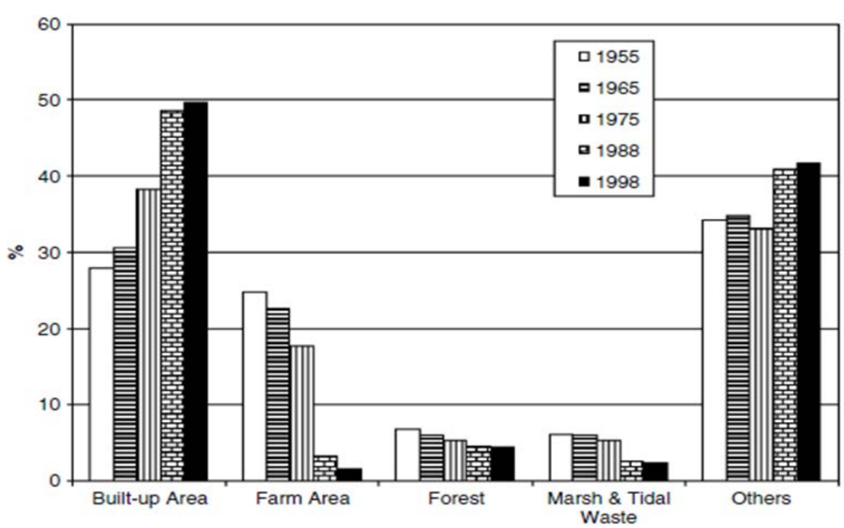

Figure 8: Landuse in Singapore during 1955-1988. 'Others' includes reservoirs, open spaces, public gardens, cemeteries, military establishments, and unused land [20].

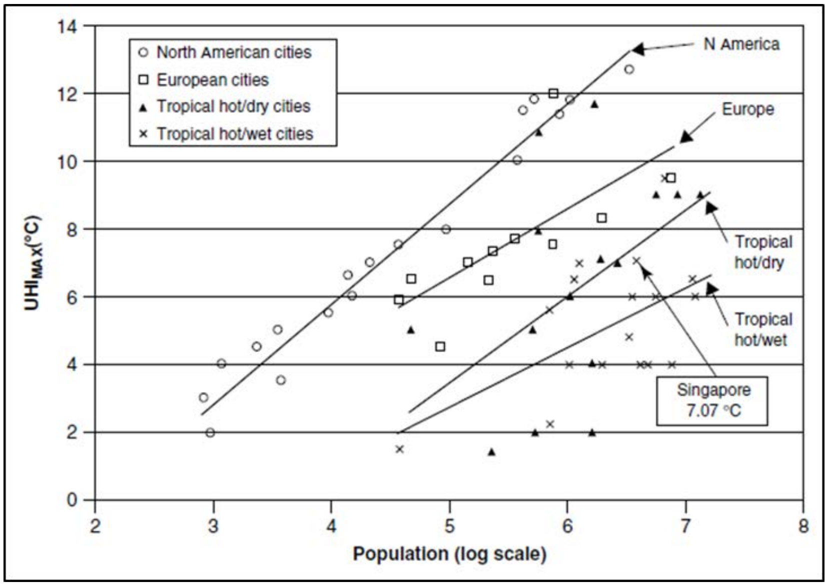

Figure 9: UHI$_{MAX}$ plotted against city population. Different symbols are used for cities in different climate zones. Solid lines are the corresponding regression lines [20].

Mean UHI intensities are highest at COM at about 3 hours after sunset. The mean UHI at HDB are consistently lower during night time. The UHI for CBD and RES are generally similar both in intensity and in timing of the peak at midnight (Figure 10).

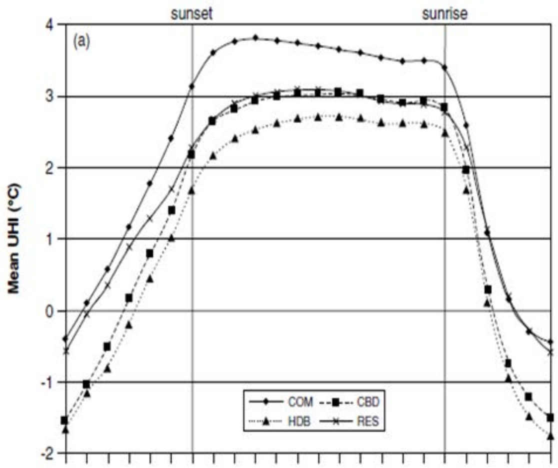

Figure 10: Diurnal variation for all days and meteorological conditions between March 2003 and March 2004 of mean hourly UHI intensity at urban stations [20].

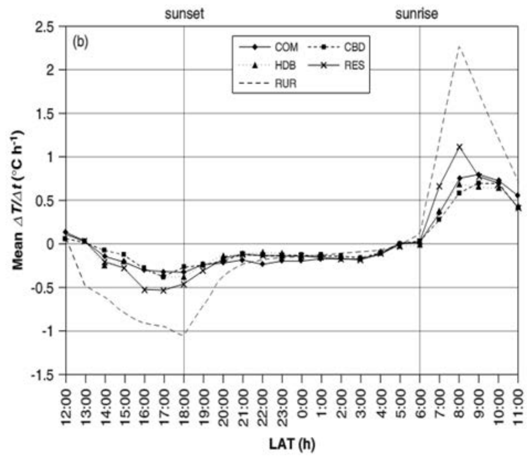

Figure 11: Warming/Cooling rates (ΔT/Δt) at urban and rural stations [20].

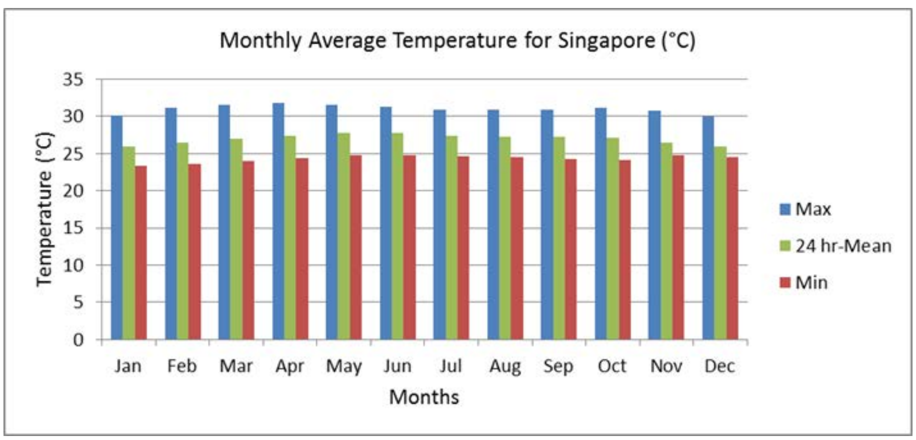

Figure 12: Climate Station Means within an 80 year period (1929-1941; 1948-2014) converted into a bar graph (data from http://www.nea.gov.sg/weather-climate/climate-information/weather-statistics).

The possible causes for the temperature increase in Singapore include, lack of ventilation due to building-street layout and orientation in street canyons, dark coloured façades (Figure 13), the type of material used in construction (Figure 14), the impact of heat rejection from the air conditioning systems [21]; [22], and anthropogenic heat. The increased temperature and the presence of air pollutants result in the formation of smog, which not only has a negative effect on reducing UHI, but also jeopardizes human health [23]. An increase in energy use is also a result of UHI because it leads to greater use of air conditioners, directly affecting buildings' energy consumption.

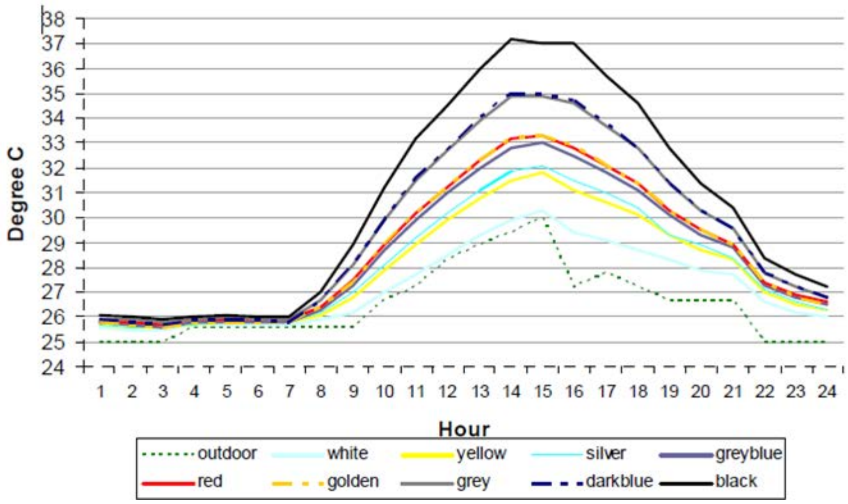

Figure 13: Effect of façade colour on surface temperature [21].

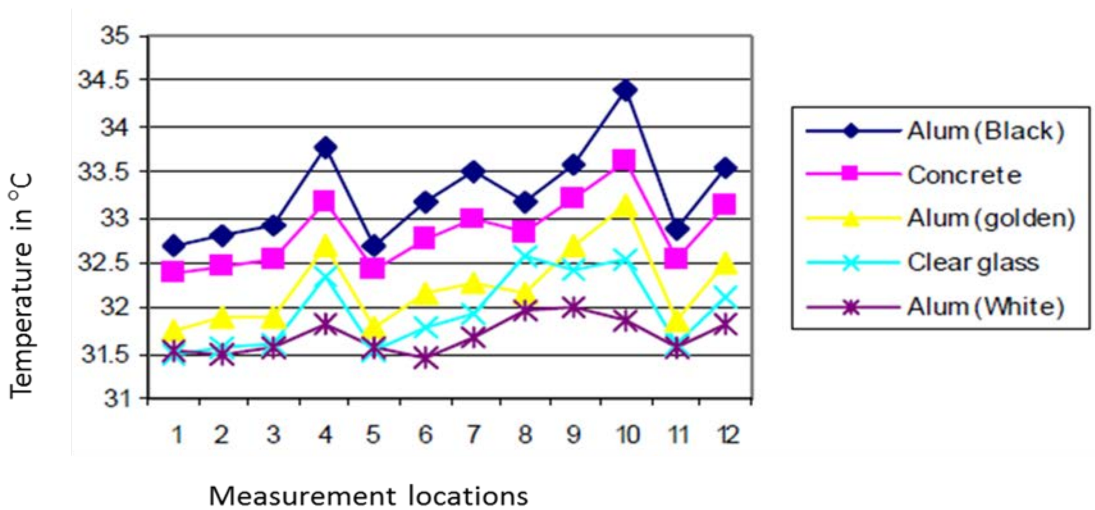

Figure 14: Effect of material on temperature [21].

3. UHI Mitigation Efforts

3.1 Mitigation efforts in Tokyo

A three year program to promote regulatory reform to address UHI effect in Japan was brought into action in March 2002 by a joint partnership of local and central governments, businesses, and residents. The framework emphasizes on a need for long term monitoring of the UHI and review of new scientific knowledge and technologies, and outlines basic policies and concrete measures to be implemented. A four pillar approach is proposed that accounts for reduction of anthropogenic heat emission, improvement of urban surface, urban structure, and lifestyle. Detailed policies have been developed to achieve the following:

- Improve efficiency of energy consumption
- Diffuse High energy efficient houses/buildings, environment friendly housing, utilizing ESCO (Energy Service Company), encourage use of new energy
- Use of low emission vehicles
- Tree-planting in both public and private housing/buildings
- Urban parks and green spaces
- Research urban heat emission treatment system
- Utilize sunshine, rainwater, and air heat energy

In 2004, Japan's Ministry of the Environment considered the UHI as a form of heat air pollution and designed the Three-Year Program for Promoting Regulatory Reform [24]. It was determined that urbanization was one of the main causes for the serious environmental issue of UHI. Existing UHI-related measures at the time included:

- Urban Regeneration Project (2001)
- Fundamental Plan for the Environment of Tokyo (2002)
- Ground Design for Infrastructure for the Urban Environment in the Tokyo Metropolitan Area (2004)

In 2005, Tokyo Metropolitan Government (TMG) prepared guidelines for Heat Island Countermeasures, including a heat environment map, countermeasures by municipalities, and countermeasures to be implemented in the private and public sectors. Monitoring systems are usually the first step if the mitigation effort is directed towards early warning. These systems are based on high density temperature data. For monitoring purposes, the interaction between UHI effect and local heat circulation in Tokyo is shown in Table 1 where Tokyo's summer average temperature rise is the highest among major Japanese cities [25].

The TMG also established the Committee to Promote Cool-roof to explore and promote greening rooftops and the use of thermal barrier coating. Studies on surface temperatures in green areas versus surface temperatures on concrete surfaces were also conducted by JFS [14] and Inoue [26]. Research findings reported that in mid-summer when concrete area temperatures rose to 55˚C, the green areas were much lower in temperature at approximately 30˚C. As a result, both national and local governments have offered reductions in property taxes and subsidies in order to promote green rooftops and green areas.

Another significant and effective measure to mitigate the UHI is based on Japan’s unique geography and geomorphology that allow for the utilization of ‘wind paths’ along a river. Since Japan is located on an oceanic coast, wind paths funnel in cool air blowing onshore via river channels. This would lower the daytime urban temperatures and aid in dispersing air pollution as the cooler air currents and cleaner sea winds enter urban areas. Additionally, urban planning professionals are considering orienting buildings located along a major river channel at a 45˚ angle to the river allowing wind to channel between the buildings and into the urban area [27].

3.2 Mitigation efforts in Singapore

In the 1960s, Singapore adopted a ‘Garden City’ approach to urban development, which had a focus on preserving current green space and increasing the amount of green space in the city. Singapore's 50 year plan for urban development outlined in the New Concept Plan 2001 works towards making the city greener by using land space more effectively by doing the following:

- Doubling the amount of green space from 2500 ha to 4500 ha;
- Preserving rustic areas in their natural state;
- Expanding the park connector network to link parks with town centres, sports complexes and homes (Fernandez [28]; Thundiyil [29]).

Historical analysis of long term climatic data of Singapore indicates the rise in temperature to be associated with the landuse, as the well planted areas experience lower temperatures. Singapore’s CBD area is a network of street canyons in which the asphalt road surfaces contribute to a significant temperature rise. However, it is noteworthy that high rise towers counter this rise in temperature by enhancing the airflow inside the canyons. According to the available scientific data, when the wind flows parallel to the high rises, velocity increases by up to 90% and the temperature gets reduced by up to up to 1°C. For perpendicular wind flow, velocity can increase up to 10 times and the temperature can reduce by 1.1°C. High-rise towers enhance higher air flow at the lower level which in turn leads to a decrease in temperature. The velocity and increased air flow also help to reduce the heat emitted from air conditioning units, which is a factor consuming the largest amount of energy [30]; [19]. Table 2 provides range of reduction in temperatures, humidity, and heat flux in Singapore.

Other heat contributing factors involve the material and the colour of the façade within street canyons due to their low albedo. In Singapore, the effects of UHI are considered to be best addressed by introducing high albedo materials and colours for façades. Rooftops gardens and green areas in the built environment are found to be significantly effective. They appear to reduce ambient temperature by up to 4°C as well as lower the heat transfer into the rooms below [23]; [21] quite substantially. Greenery allows for the filter of carbon dioxide and other toxins. Increased foliage also balances the release of anthropogenic heat [31]. The implementation of rooftop gardens above carparks also helps to reduce UHI. Rooftop gardens help to mitigate UHI effect by reducing air temperature by as much as 4°C; providing insulation to buildings, hence potential energy savings from air conditioning; and improving air quality [29].

Table 2: Measured reductions in temperature caused by rooftop gardens on building's [21].

Thermal parameter		**Range of reduction**
Surface temperature of roof		0-31.0°C
Ambient temperature	At 300mm heights	0-4.2°C
	At 1000mm heights	0-1.5°C
Relative humidity		-23.5%-0%
Solar radiation (at 300mm heights)		4.2-124.6W/m^2
Mean radiant temperature		0-4.6°C
Globe temperature		0-4.1°C
Heat flux transferred through surface		0.6-15.4 W/m^2
Total heat gain over a day		395.0-466.3 KJ/m^2

The mindfulness regarding reducing UHI has led to the adoption of UHI mitigation strategies and incentives for stakeholders. For instance, the Changi General Hospital grows vegetables on the hospital's roof, and uses them to feed patients and cut the cost of the hospital's energy bill by $800,000 [32]; [33] With a focus on beautification of the city, competitions are held to see which HDB resident has the best looking skyrise garden, bringing awareness to the importance and extended role of urban greenery [29]. Public awareness and education of UHI will promote future apartment buildings and buildings scheduled for renovation to be designed with green roofs and additional green space. Singapore is also implementing a congestion pricing system that charges a fee for vehicles to enter a certain zone in the city. This measure is supposed to reduce the trapping of pollutants within street canyons [34], thus, acting as a means of helping to encourage healthy greenery and air quality in Singapore.

4. Conclusions

UHI effect is a built environment's characteristic, and it is possible to reduce heat storage through modification of the built environment. A comprehensive account of Urban Heat Island phenomenon has been presented in this study. Examples of Tokyo and Singapore, two popular and large urban centres, are used to explain main reasons of UHI effect as well as mitigation practices and policies to reduce its impact on communities. In Tokyo, UHI effect is more prominent in winters than in summer season due to the weak sea breeze as well as weak shortwave radiation during winter. Anthropogenic heat in central Tokyo can go up to 1590 W/m^2 in winter. Mitigation measures and policies in Tokyo include, monitoring systems, reduction of anthropogenic heat emission, better urban surface and structure, efficient use of energy, and making use of natural resources, such as sunshine and rain water. Additionally, steps are being taken towards developing urban parks and green spaces and partnering with all levels of governments, businesses, and communities. As a matter of fact, discussions regarding reducing the impact of UHI are always ongoing in research and industry circles in Japan in order to combine technological and natural measures in the best possible manner.

In Singapore, the canyon radiative geometry contributes to the decrease in long wave radiation loss from within the street canyon due to the complex exchange between buildings and the screening of the skyline. The thermal properties of building materials, the anthropogenic heat released from combustion of fuels, and the reduced turbulent transfer of heat from within streets are all contributing factors to UHI. Extensive research has been conducted on how UHI may be connected with numerous factors, such as the extent of urban sprawl, the colour of the façade, and the temperature variation at sunrise and sunset around different landuse, including commercial, high-rise residential, low-rise residential, and undeveloped rural areas.

Based on the understanding of how UHI effect works and varies in different areas, both, Singapore and Tokyo have successfully adopted and implemented effective mitigation measures. Among most common ones are, using high albedo building material and promoting green roofs and green spaces.

References

[1] Rizwan, A.M., Dennis, L.Y.C., Liu, C. (2008) A review on the generation, determination and mitigation of Urban Heat Island, J Environmental Sciences, 20(1): 120-128.

[2] Health Canada (2011a) Adapting to extreme heat events: guidelines for assessing health vulnerability http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/climat/adapt/adapt-eng.pdf [Accessed November 12, 2012].

[3] Health Canada (2011b) Communicating the health risks of extreme heat events: toolkit for public health and emergency management officials http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/climat/heat-chaleur/heat-chaleur-eng.pdf [Accessed December 1, 2013].

[4] Smoyer-Tomic, K.E., Kuhn, R. and Hudson, A. (2003) Heat wave hazards: an overview of heat wave impacts in Canada, Natural Hazards, 28(2-3): 463-485.

[5] Giguère, M. (2009) Literature review of Urban Heat Island mitigation strategies, Direction de la santé environnementale et de la toxicologie, Institut national de santé publique du Québec http://www.inspq.qc.ca/pdf/publications/1513_UrbanHeatIslandMitigationStrategies.pdf [Accessed May 10, 2013].

[6] Stone J.B., Rodgers, M.O. (2001) Urban form and thermal efficiency: how the design of cities influences the Urban Heat Island effect, J. American Planning Association, 67(2): 186-198.

[7] Wilhelmi, O.V., Purvis, K.L., Harriss, R.C. (2004) Designing a geospatial information infrastructure for mitigation of heat wave hazards in urban areas, Natural Hazards Review, 5(3): 147-158.

[8] Klinenberg, E. (2002) Heat wave: A social autopsy of disaster in Chicago, The University of Chicago Press. p305.

[9] Robine, J.M., Cheung, S.L.K., Le Roy, S., Van Oyen, H., Griffiths, C., Michel, J.P., and Herrmann, F.R. (2008) Death toll exceeded 70,000 in Europe during the summer of 2003, Biologies, 331:171-178.

[10] Sandink, D. (2013) Reducing heat-wave risk through active and passive measures, Municipal World, 123 (4): 17.

[11] Lansberg, H.E. (1981). The urban climate, International Geophysics Series, Academic Press, Volume 28, p255.

[12] Ichinose, T., Shimodozono, K., Hanaki, K. (1999) Impact of anthropogenic heat on urban climate in Tokyo, Atmospheric Environment, 33(24-25): 3897-3909.

[13] Saitoh, T.S., Simada, T., Hoshi, H. (1996) Modeling and simulation of the Tokyo Urban Heat Island, Atmospheric Environment, 30(20): 3431-3442.

[14] JFS (2008) Efforts in Japan to mitigate the Urban Heat Island effect, Japan for Sustainability Newsletter, 73: 1-5.

[15] JMA (2013) Climate Change Monitoring Report, Chapter 2, Japan Meteorological Agency. http://www.jma.go.jp/jma/en/NMHS/indexe_ccmr.html [Accessed December 29, 2014].

[16] Hanaki, K. (2008) Urban Environmental Management and Technology, Springer Science & Business Media, p250.

[17] JME (2004) Outline of the policy framework to reduce urban heat island effects. The Inter-Ministry Coordination Committee to Mitigate Urban Heat Island. Japan. https://www.env.go.jp/en/air/heat/heatisland.pdf [Accessed December 29, 2014].

[18] World Bank (2014) Population total http://data.worldbank.org/indicator/SP.POP.TOTL [Retrieved December 24, 2014].
[19] Nathan, D. (1999a) Is Singapore using too much energy? The Strait Times (Singapore). September 18,1999.
[20] Chow, W. and Roth M. (2006) Temporal Dynamics of the Urban Heat Island of Singapore. International Journal of Climatology. 25: 2243-2260.
[21] Priyadarsini, R.,Hien, W.N. (2009) Causes of Urban Heat Island in Singapore: An investigation using computational fluid dynamics (CFD). PLEA2009-26th Conference on Passive and Low Energy Architecture, Quebec City, Canada, June 22-24, 2009.
[22] Hien, W.N. (2014a) A study of Urban Heat Island in Singapore, School of Design and Environment, National University of Singapore. http://www.sde.nus.edu.sg/rsh/SDE_rsh_highlights_B01.html [Accessed December 23, 2014].
[23] Hien, W.N. (2014b) Urban Heat Island effect: sinking the heat, Innovation Magazine, 3(2). http://www.innovationmagazine.com/innovation/volumes/v3n2/free/coverstory2.shtml
[24] Masuda, Y., Takahashi, N., Ojima, T. (2009) Development of urban environmental infrastructure, The seventh International Conference on Urban Climate, 29 June - 3 July 2009, Yokohama, Japan.
[25] Yamato, H., Takahashi, H., Mikami, T. (2009) New urban heat island monitoring system in Tokyo metropolis, The seventh International Conference on Urban Climate, 29 June-3 July 2009, Yokohama, Japan.
[26] Inoue, K. (2011) Energy efficient activities on residences and buildings – cool roof paints in Japan, Ministry of Economy, Trade and Industry (METI) Japan.
[27] Yamamoto, Y. (2006) Measures to mitigate Urban Heat Islands, Quarterly Review, 18: 65-83.
[28] Fernandez, W. (2001) Singapore in 50 years ---thriving, world class and very green. The Straits Times (Singapore). July 21, 2001.
[29] Thundiyil, K. (2003) Rising temperatures and expanding megacities: Improving air quality in Mexico City through urban heat island mitigation. MIT Thesis, Master in City Planning. http://hdl.handle.net/1721.1/29946 [Accessed Feb 03, 2015].
[30] Hien, W.N. (2004) A study of Urban Heat Island (UHI) in Singapore. http://www.bca.gov.sg/ResearchInnovation/others/UHI _2004-001_ rev.pdf [Accessed December 23, 2014].
[31] Priyadarsini, R., Hien, W.N., David, C.K.W. (2008) Microclimatic modeling of the urban thermal environment of Singapore to mitigate Urban Heat Island, Solar Energy, 82(8), 727-745.
[32] Greenroofs (2015) Changi General Hospital, www.greenroofs.com [Accessed Feb 11, 2015].
[33] Nathan, D. (1999b) Hospital's garden feeds patients and cuts bills, The Straits Times (Singapore), May 28, 1999.
[34] Zhou, Y., Levy, J.I. (2008) The impact of urban street canyons on population exposure to traffic-related primary pollutants, Atmospheric Environment, 42(13): 3087– 3098.

Utilizing disaster risk information to develop local resilience in Manadalay City, Myanmar

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Abstract

Due to recent economic and political changes in Myanmar, the country is experiencing increased migration, urbanization, and development in urban areas at a pace unseen before in the country's history. Development, both formally and informally takes place, often without robust and well thought out urban land use plans, strategic visioning, and building codes at the local level. This leaves many urban areas more susceptible to hazards such as fires, flooding, storm surges, cyclones, and earthquakes; leading to increased disaster risk. As urbanization continues across the country, there is a greater need to integrate Disaster Risk Information (DRI) into the planning process to ensure that both a city's assets and its residents are protected from multiple hazards and disasters. The goal of this paper is to outline and discuss a project to integrate disaster risk information into the urban land use planning process in Myanmar using Mandalay City as a pilot site to inform about the realities of mainstreaming disaster risk planning. The project involved a series of steps including developing a situational analysis, formation of a building database updated with relevant disaster risk information, and a national level steering committee established to finalize national guidelines aimed to provide local government agencies with a process on how they can identify opportunities to make risk-sensitive land use decisions in the future.

Key Words: Disaster Risk Information (DRI), Urban Land Use Planning, Local Level Resilience, Mainstreaming Disaster Risk Planning

1. Introduction

Myanmar is expected to experience increased migration, urbanization, and development in urban areas throughout the country. The pace at which this is projected to take place has not been experienced in Myanmar's history (World Bank 2015). The expansion of urban areas will undoubtedly increase the exposure of municipal assets to the various hazards that affect the country including fires, flooding, storm surges, cyclones, and earthquakes. The increased density associated with urban activities also places a higher financial cost and loss of lives when hazards affect urbanized areas and can also trigger additional technological hazards such as fires (Vasta, 2005). In order to reduce damage to life and property, there is a need to increase understanding through risk assessments relating to the effect of hazards on current buildings and communities, along with future development and risk-sensitive land use planning has been identified as one of the most cost effective ways to reduce risk in rapidly expanding cities throughout the developing world (UNISDR, 2012). Today, it has been shown that effective land use planning practice involves not only assess risk, but also manage and update data in the future are associated with best practices relating to disaster risk management (Colenbrander et. al 2013, ADB 2013, UN-Habitat 2012). As development takes place, the government of Myanmar will need to improve local level planning capacity to effectively manage this process. Utilizing information developed from risk assessments is a critical step towards informing the land use planning process in urban areas throughout the country.

The Asian Disaster Preparedness Center (ADPC) developed a process for addressing these issues in a project entitled *Integrating Disaster Risk Information into Urban Land Use Planning in Myanmar*.

The project not only aimed to produce guidelines for municipalities across Myanmar to improve these processes, but also strives to explore how technologies like Geographical Information Systems (GIS) can be used as an effective management tool while developing comprehensive databases comprised of disaster information. In order to provide a framework and practical application of the guidelines, Mandalay City was chosen as a pilot site to provide context and insight about the realities of integrating disaster risk information into the urban land use planning process. The paper presents the overall process of the study, the current situation in the country in terms of city development with reference to the city of Mandalay, prevailing hazards and projected disaster risk for the city and the way out for integrating Disaster Risk Information into the development process in the future.

2. Brief History on Mandalay City

The city of Mandalay is located on a flat plain and was established as the royal capital dating back to 1221. The city has developed in the shape of grid iron pattern with the royal palace as the center constructed 1857, divided into four section designating them according to cardinal direction into 144 “Pyas” (blocks) based on the turrets on the city walls and 16 “Blocks” of the Palace. Complete with a moat and walls, the palace was at the heart of development in the city. Following with a layout from an earlier period, streets ran out from the city center (the palace) along axis that were divided into wards which housed residences. Evidence of the past building practices can be seen today, as wooden monasteries and residences still exist in some form throughout the city and utilize wood and bamboo as the primary construction materials (Phyo et. al 2013). The city’s population is expected to experience a large increase, with a projected population of over 3 million by 2040 (DHSHD, 2013). Already considered the cultural and economic capital of north and central Myanmar, this population growth and development will be fueled by both domestic and international investment based the city’s strategic location as a major trade hub between India, China, and Southeast Asia. The city’s rich history can still be seen with the multiple historic sites located both within the city and surrounding areas and tourism is also expected to increase with additional investment (ADB, 2014). In 2011, the Government of Myanmar has taken initiative for a 30 years perspective plan for guiding the city for sustainable future direction.

3. Methodology

With a mandate to develop a comprehensive and sustainable Disaster Risk Reduction (DRR) enhanced land use planning process, ADPC followed several steps to achieve the project goal that were developed from recent experience from a variety of sources (ADPC 2013, Shah and Ranghieri 2012, Trohanis et. al 2009). Sustainability and mainstreaming of DRR into land use planning has been ensured through involvement of Local Government agencies during implementation of the project. The following paragraphs describe the steps followed throughout the duration of the project.

Formation of a Technical Working Group – A Technical Working Group (TWG), with the leadership of the Department of Human Settlement and Housing Development under the Ministry of Construction of the Government of Myanmar, was formed to guide the overall activities of the project. The major tasks of the TWG were to approve the outline of the overall activities, approve and guide the activities and documents developed under the project and to assist the technical team in conducting research. Since the TWG is represented by a number of government representatives, the sustainability of DRR integration will be ensured in future land use planning initiatives at sub-national and local levels of Myanmar.

Situational Analysis – The second step of the process was to understand the current land use planning process in the country. This step involved a literary desk review, field visits, and interviews with officials at the national and local levels in Myanmar. The Situational Analysis provided an overall context and established a baseline for the next steps of the project. During this step, the study team was able to gain an understanding on national- and local-level (Mandalay City) urban land use planning processes, current projects being developed such as the National Building Code, the capacity of city departments in Mandalay City related to GIS and disaster risk reduction, and greater insight regarding the hazards experienced in Mandalay City.

Capacity Building Initiative – A number of hands-on training sessions were initiated with participants from various government departments to develop the capacity on physical feature survey, database development, GIS mapping, Disaster Risk Reduction, land use and city planning.

Development of an Urban Database – This step involved the process to develop an urban database. The database development includes demarcation of base maps with field measurements and attribute information survey, as well as updating information collected from various departments and urban area mapping in a GIS platform. Hazard information and related datasets were collected from various local agencies and sources.

Developing Guidelines for Risk-sensitive Land-use Plans – Based on the situational analysis and consultation with relevant agencies, a guideline for an integration of Disaster Risk Information into land-use planning process has been developed. This guideline will help formulate risk-sensitive land-use plans with the provisions of Disaster Risk Reduction initiatives.

4. Disasters and Mandalay City

Compared to rural areas, the impact of disasters can affect urban areas in many different ways. Much depends on the type of disaster and the scale, but because urban areas are typically associated with economic growth and development, local, regional, and even global supply chains can be disrupted if businesses are not allowed to function normally as a result of a disaster event. Infrastructure used in cities is often in high concentration and a disaster affecting roads, public transit, electricity, telecommunication, and water/sanitation could greatly reduce the ability of a city to return to its normal functions for weeks, months, or even years (Shaw, 2009).

Mandalay City faces a multitude of disasters. A recent study on the risk (in terms of possible damage) from earthquake scenarios for Mandalay City (ADPC, 2012) has shown that the city would experience extensive damage to its critical infrastructure like roads, hospitals, educational facilities, and water pipelines from large earthquakes of 7.0 and 8.0 magnitude along different fault lines near the city, notably in the western section of the city. Recently an earthquake, registering a 6.8 magnitude, struck Sagaing and Mandalay regions on 11 November 2012. The earthquake damaged 400 houses, 65 schools, and 100 religious buildings. About 22 townships were affected across Sagaing and Mandalay Regions with Singu and Thabeikkyin townships in Mandalay region and Kyaukmyaung sub-township in Sagaing region were most affected (OCHA, 2012).

In terms of flood hazards, Mandalay City suffered from heavy flooding in 2010 after water levels in Aungpinlay, Aung Tharyar, Thamankone and New Yadanabon townships reached up to 1.8 meters after the highest amount of rainfall experienced in six decades period (RRD, 2013). Floodwater that flows into Mandalay City could come from a variety of sources including riverine flooding, external water from surrounding highland regions, diversion due to development in natural floodplains, and leakages in aging infrastructure.

Additionally, urban fire has caused problems to Mandalay City in the past. According to recent data, fires have affected both commercial and residential districts. There were about 1,685 fire incident records during 2004 to 2013 when about 7,040 building got damaged affecting 24,000 people with the economic losses estimated at 4.4 million USD (RRD, 2013). Figure 1 provides a view of the impact of fire hazard in Mandalay Division from 2004 to 2013.

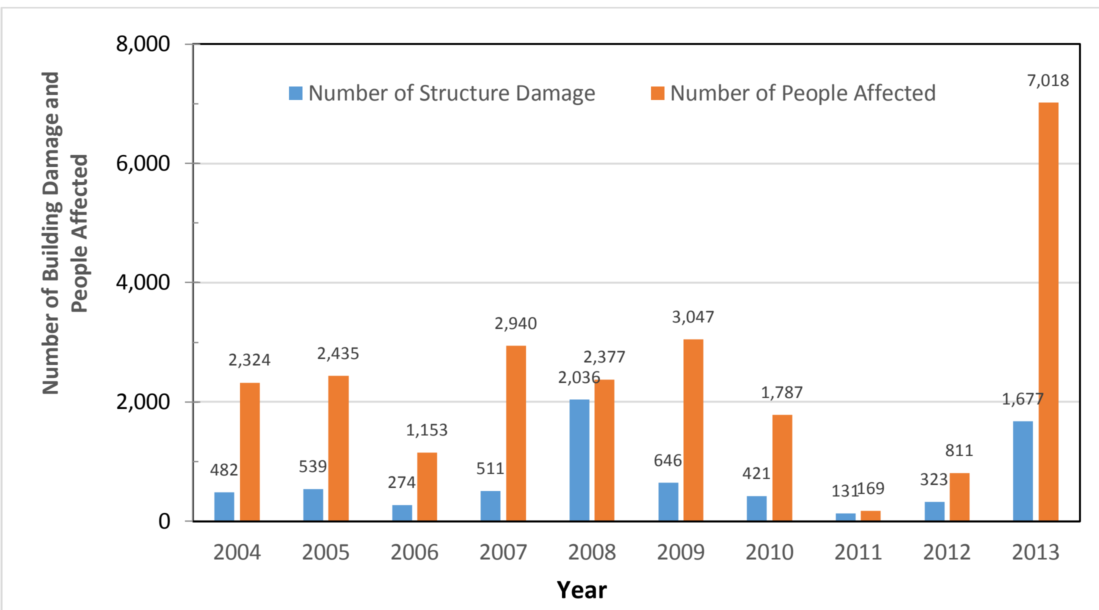

Figure 1: Impact of Fire Hazard in Mandalay Division during 2004-2013 (source: Relief and Resettlement Department, RRD)

5. Current land-use planning process of Mandalay City

Mandalay City Development Committee (MCDC) is a government agency overseeing land use planning, city development, and disaster preparedness within Mandalay City, but currently there is not a well-established land use planning process outside of land development and building construction. The planning process for land development and building construction in Mandalay City follows the same guidelines provided for all city development committees in the country. The City Planning and Land Management Department (PLMD) at the MCDC issues land titles. The permission is typically granted based on the designated use filed by the applicant during the process. Once a land title is obtained, MCDC issues building permits within Mandalay City. Building construction permission is issued based on the application by the individual or firm.

5.1 Identified gaps in the existing process

While disaster risk reduction procedures are beginning to be discussed in Mandalay City, they are not comprehensive and there are still various gaps identified during the review period. Currently, there exists a building code with respect to seismic loading requirements but it is only for structures over 4 stories, which represent a small fraction of buildings in Mandalay City, leaving most residential buildings throughout the city with no measures to withstand the impact of an earthquake. Additionally, hazard maps that do exist are only available in a hard-copy format and only with limited historic data (ADB, 2014). New scientifically-produced hazard maps need to be developed using GIS that not only account for earthquake, flood, and fire, but also consider the multi-hazard aspect.

5.2 Why is disaster risk information important?

Disaster risk information can be divided into 3 distinct groups: (1) hazard inventory data, (2) environmental factors, and (3) triggering factors (van Westen, 2010). These information are important to be considered for mitigation planning for any urban area. Hazard assessment and damage estimation provides guidelines for decision makers to ensure DRR inclusive development plans. Hazard inventory data is by far the most important, as it should give insight into the distribution of past hazardous phenomena, their types, mechanisms, causal factors, frequency of occurrence, intensities and the damage that has been caused. The environmental factors are a collection of data layers that are expected to have an effect on the occurrence of the hazardous phenomena, and can be utilized as causal factors in the prediction of future events.

6. Linking DRR and land-use planning in Mandalay City

A DRR-enhanced land use plan can ensure sustainable development for the city of Mandalay. Risk sensitive land use planning has been well documented as a cost-effective response to reducing disaster risk in urban areas across the globe when compared to hard infrastructure implementation (Timothy and Early, 2008). Recent seismic events in Mandalay can often prove to be beneficial in terms of implementing future plans and while there are some criticisms for any regulatory policy, namely as it relates to effective monitoring and implementation, land use planning is still likely to be most effective when implemented after disaster events have taken place because of their importance is typically well documented in the local context (Burby, 1998). While the current land use planning process of Mandalay City does not consider Disaster Risk Information, initiatives were taken to enhance the capacity of the existing government departments for effective management of disaster information across a variety of levels and amongst different sectors. One component of this is to utilize GIS for its spatial analysis capacities through map creation, which could potentially be linked online to a public database complete with information about city infrastructure, buildings, communities and how they interact with hazards. This would provide a framework within which future land use and development planning are coordinated with risk mitigation in Mandalay City (Revi, 2008).

6.1 Process of database development for Mandalay City

One of the major challenges in the city planning process is the availability of required information and datasets. This lack of required information is common for cities in developing countries and Mandalay city is no exception. There is existing information and maps within the city government, but they are not comprehensive and are not arranged in a systematic way. Realizing this fact, the project team initiated a process for developing comprehensive database for Chan Aye Tharsan Township (one out of seven townships in Mandalay) as pilot for conducting detail survey on database development with all basic information like road, open spaces, natural features like water bodies & hills and detail database of about 24,000 buildings. Detail building inventory includes structure type, use, age, visible physical conditions etc. The database development process includes the use of satellite images, field survey, attribute information collection and use of GIS as a tool for mapping and data analysis.

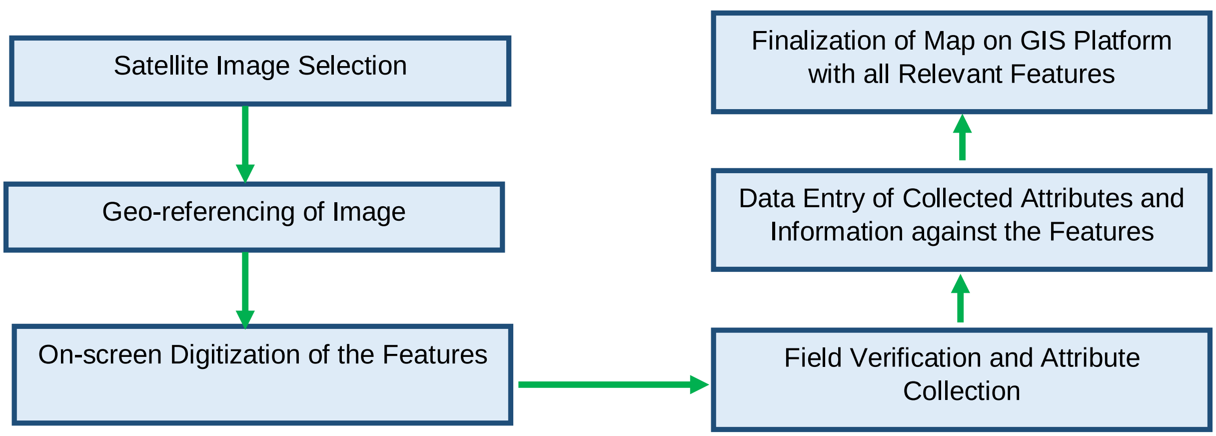

Figure 2: Flow Chart of the Process for Database Development for the City of Mandalay

Apart from the field data collection, a number of information particularly on disaster damage and hazard events were also collected from secondary sources. Table-1 lists details the various departments and organizations that provided data related to specific hazards experienced in Mandalay City. Hazard information has been linked with the spatial dataset to be utilized for Hazard Mapping and Disaster Risk Assessment.

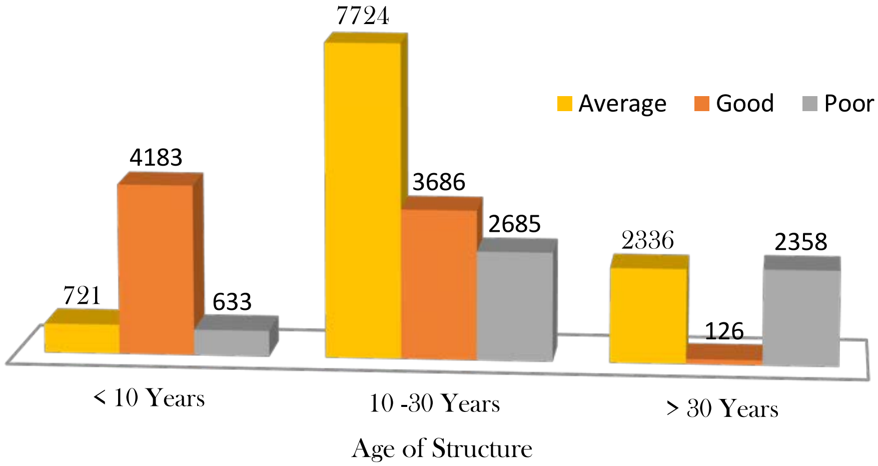

Figure 3: Structural Age and Visible Physical Condition in Chan Aye Tharsan Township, Mandalay (Source: survey data, February to April 2014)

Table:1 List of Prevailing Hazard Related Information for City of Mandalay

Hazard Type	**Data Needed**	**Sources**
Fire	*Historic Fire Events*	Fire Brigade; MCDC; General Administrative Department
	Road Network	
	Water Hydrant	
	Water Body Location	
	Medical Facilities	
Flood	*River System*	Meteorology and Hydrology Department; Relief and Resettlement Department; General Administrative Department; MIMU
	Elevation Data	
	Past Flood Events	
	Flood Intensity	
	Return Period	
Earthquake	*Seismic zone data*	Meteorology and Hydrology Department; Relief and Resettlement Department; Myanmar Earth Society; Myanmar Engineering Society; General Administrative Department; Ministry of Health; MIMU
	Fault Lines	
	Vulnerable Structures	
	Liquefaction/subsidence	
	Earthquake Magnitude	
	Past Seismic Events	
	Medical Facilities	

While developing the database, all related government agencies including Mandalay City Development Committee (MCDC), Department of Human Settlements and Housing Development (DHSHD), and Relief and Resettlement Department (RRD) were involved in the process. Mandalay Technological University also facilitated the database development process, which will retain the idea and develop capacity of future professionals.

6.2 Using the database to inform planning decisions

Following the development of the database from the pilot township, government officials continue to work with Mandalay Technological University to scale this process and expand the database to the other 6 townships in Mandalay City. While the database provides a basis to address risk in the city, land use planning procedures themselves are needed to be changed in order to effectively use the urban risk database to inform risk sensitive land use planning decisions. During the handover ceremony of the guidelines document in September 2014, the government of Myanmar undertook the first step of this process by acknowledging the need to integrate risk sensitive planning guidelines into Mandalay City as a model for their national land use planning and development process. This policy-level support of risk sensitive land use planning, when followed through, will ensure that urban development is informed using the most up to date disaster risk assessments.

The comprehensive dataset and spatial information will substantially contribute to mitigate disaster and to reduce risk in the future. The set of information will be utilized for hazard, vulnerability and risk assessments for the city of Mandalay which will help city managers for (1) identifying suitable areas for future development: Hazard Assessment result will identify areas to be prone of respective hazards. This will guide to avoid high risk areas for intensive development (2) Decision for land registration, land consolidation and land reallocation (3) Density control for the risk prone areas of the developed areas (4) Readjustment of the existing Zones in the developed areas. (5) Implementation of building code.

The city of Mandalay is susceptible to a number of natural disasters like earthquake, flood and urban fire. These are the results of noncompliance in land use planning implementation by the city administration. High density core city areas with mixed land use increasing the risk of urban fire. The city is growing to the directions which are prone to the effect of earthquake liquefaction effect. The current trend of city development increasing disaster risk more crucially in all considerations. Figure 4.0 shows number of buildings on the western part of Mandalay is likely to suffer more due to an effect of earthquake. This is due to the fact of city development on relatively soft soil in marshy areas.

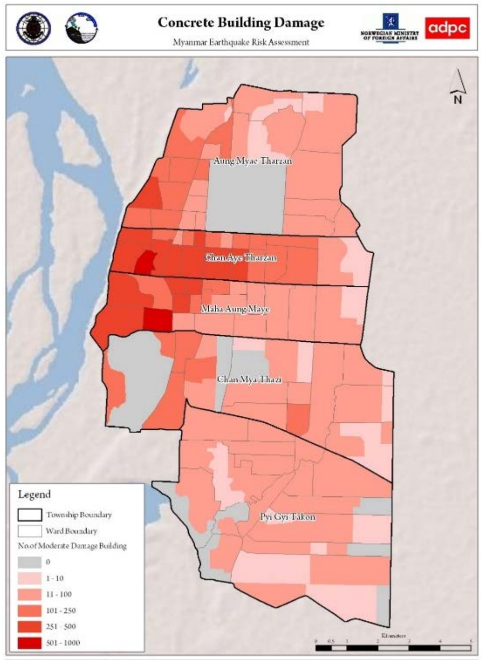

Figure 4: Number of Concrete Buildings Likely to Suffer More Damage in the City of Mandalay due to a likely earthquake effect from Sagaing fault. Legend denotes the range of building numbers to be damaged (Source: Earthquake Risk Assessment for Mandalay City)

The probable risk of natural hazards for the city of Mandalay are severe and needs timely attention. The Mandalay City Development Concept Plan Vision 2040 by the Ministry of Construction of the Union of Myanmar is underway and has set guidelines for future development of the city on different visions. This is a policy document to guide the city in the future spatial development and although the national government has acknowledged the need to incorporate risk sensitive guidelines into their national process, disaster risk information has not been incorporated in policy documents for Mandalay or other master plans such as the Proposed Housing Development Plan 2040 for Greater Yangon (Ministry of Construction 2012). In order to guide the city towards a sustainable future, it requires disaster risk information incorporated into the City Development Concept Plan. In order to integrate new hazard information into city development plans and master plans, additional multi hazard risk assessments are required to be conducted by the relevant agencies from the city which are to be facilitated by the experiences from the local knowledge to ensure community level resiliency. Having now implemented pilot projects in this regard, Mandalay has laid the foundation to begin this comprehensive approach to reducing disaster risk through land use planning.

7. Conclusion

In terms of disaster preparedness, efficient urban land management and land use planning can reduce disaster risk avoiding risk prone areas for development. It requires comprehensive datasets and information for such important decision making process. As Mandalay City and other areas throughout

Myanmar continue to grow in land size and population, buildings, infrastructure, livelihoods, and communities will be exposed to hazards. Having an updated urban disaster database in Mandalay City expands the capacity to perform disaster assessments at the local level and will allow decision makers to implement land use plans and building codes that are applicable to the conditions on the ground. This is a critical step in the process of developing comprehensive land use plans based on disaster risk information. As the city of Mandalay continues to urbanize, a comprehensive land use plans is needed and the urban database complete with disaster risk information is a major step forward in disaster risk reduction work in Myanmar.

8. References

ADB – Asian Development Bank (2013), "Investing in Resilience: Ensuring a disaster resistant future". Manila, Philippines

ADB - Asian Development Bank (2014), *"Towards a Green Mandalay: Study for a Strategic Development Plan for Mandalay"*, Draft Final Report. Manila, Philippines.

ADPC – Asian Disaster Preparedness Center (2012), *"Earthquake Risk Assessment of Mandalay City"*. Bangkok, Thailand.

ADPC – Asian Disaster Preparedness Center and Urban Development Directorate (UDD), Government of the People's Republic of Bangladesh (2013), "*Guidelines for Mainstreaming Disaster Risk Reduction into Land Use Planning for Upazilas and Municipalities in Bangladesh*. Bangkok, Thailand

Burby, R.J. (1998) Natural Hazards and Land Use. In: Burby, R. (ed.) "*Cooperating with Nature. Confronting Natural Hazards with Land-Use Planning for Sustainable Communities"*. Washington, D.C. USA, John Henry Press.

Colenbrander, Darryl, Penny Price, Gregg Oelofse and Sakhile Tsotsobe (2013). *"A Coastal Adaptation Strategy for the City of Cape Town: An Ecosystem-based Management Approach Towards Risk Reduction"*. Taken from: The Role of Ecosystems in Disaster Risk Reduction; 164-190. United Nations University, Tokyo Japan.

Department of Human Settlement and Housing Development, Ministry of Construction Republic of the Union of Myanmar (2013), "*Preparation of Mandalay Urban Development Concept Plan*". Nay Pyi Taw, Myanmar

Revi, A. (2008), *"Climate Change Risk: An Adaptation and Mitigation Agenda for Indian Cities"*, Environment and Urbanization, Vol. 20, no. 1, 207-229.

Ministry of Construction, Republic of the Union of Myanmar (2012), "*Proposed Housing Development Plan 2040 for Greater Yangon"*. Nay Pyi Taw, Myanmar.

OCHA – United Nations Office for the Coordination Humanitarian Affairs (2012) "*Sagaing/Mandalay Earthquake Situation Report No. 3*", Geneva, Switzerland.

RRD – Relief and Resettlement Department (2013), "*Residential Hazard Data for Townships in Mandalay (2004-2013)*". Nay Pyi Taw, Myanmar

RRD – Relief and Resettlement Department (2014), *"Residential Hazard Data for Townships in Mandalay: 2014 Update"*.. Nay Pyi Taw, Myanmar

Timothy S., and B.J. Earl (2008) "*The Proof of the Planning is in the Platting: An Evaluation of. Florida's Hurricane Exposure Mitigation Planning Mandate"*. Journal of American Planning Association 74(3):349 – 370.

Trohanis, Zoe, Fatima Shah, and Federica Ranghieri (2009). "*Building Climate and Disaster Resilience into City Planning and Management Processes"*. Fifth Urban Research Symposium: 2009. Marseille, France.

Shah, Fatima and Federica Ranghieri (2012). "A Workbook on Planning for Urban Resilience in the Face of Disasters: Adapting Experience from Vietnam Cities to Other Cities. Washington D.C.

Shaw, R. (2009), *"Climate Disaster Resilience: Focus on Coastal Urban Cities in Asia"*, IEDM - International Environment and Disaster Management Laboratory.

Republic of the Union of Myanmar (2009), *"Hazard Profile of Myanmar"*. Nay Pyi Taw, Myanmar.

Republic of the Union of Myanmar (2012), "*National Land Use Policy"*. Nay Pyi Taw, Myanmar.

van Westen, C. J. (2010), *"Remote Sensing and GIS for Natural Hazards Assessment and Disaster Risk Management"*, Faculty of Geo-information Science and Earth Observation, University of Twente; 10-16.

UN-Habitat – United Nations Human Settlements Programme (2012), Urban Planning for City Leaders. Nairobi, Kenya.

UNISDR – United Nations International Strategy for Disaster Reduction (2012), "*Making Cities Resilient Report: 2012*"; 53, New York, USA.

Vasta, K.S. (2005) *"Home for Almost Half the World"*. In T. Jeggle (ed.), *Know Risk.* Geneva: United Nations International Strategy for Disaster Reduction, pp. 282-285.

World Bank (2015), "*East Asia's Changing Urban Landscape: Measuring a Decade of Spatial Growth"*; 106-109. Washington D.C., USA.

‘Humanitarian' or; 'Resilient Architecture’ for vulnerable communities?

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Abstract

Besides their singular urban and cultural realities, in regard to rebuilding and development programs the rapidly growing cities of the Portuguese Speaking Countries Community (CPLP) seem to deal with similar challenges. Despite Portuguese alignment with international guides to reduce vulnerability and building communities' resilience to natural hazards, little attention has been paid to these issues within the bilateral framework for cooperation.

This paper focuses a reframing of the architectural practice developed in humanitarian context; it tries to bridge the specific gaps between architects, humanitarians and developers working within vulnerable communities. Ultimately, it aims at applying this knowledge to the CPLP.

Embracing the action research method it uses the data collected from and progress with the field work done by the project Sustainable Urban Renewal: Energy Efficient Building for Africa (SURE Africa) and Portuguese-based-NGO Building 4Humanity.

Adopting a trans-disciplinary approach, it incorporates ‘humanitarian architecture' with resilience and social innovation features such as the emphasis on connecting people, resources and ideas, eco-efficiency, empowerment and communities' engagement in design. To improve the dialogue between ‘humanitarians', ‘designers' and householders, research explores translational tools, namely mapping, web-based platforms for co-design and tools for building resilience.

The analysis undertaken suggests that trans-disciplinary, interdisciplinary and intercultural dialogue play a crucial role in the process of informing and assisting local leaders and households to (re) build on community assets and internal capacities, introducing ‘eco' and energy efficiency solutions without mischaracterizing traditional settlements and vernacular architectural knowledge and caring about previous lifestyles and livelihoods.

Keywords: humanitarian architecture, resilience, social innovation, eco-efficiency, Africa

1. Introduction

State members of the Portuguese Speaking Countries Community (CPLP) such as S.Tomé e Principe, Cabo Verde, Guiné-Bissau, Angola and Mozambique, Brazil and Timor-East seem to deal with similar shortages and risky circumstances when it comes to informal settlements, which are characteristically present in the peripheral and sometimes even central areas of their major and rapidly growing cities. In these slum areas the relationship between disasters and development is of much greater magnitude due to the high vulnerability of people and houses. [1]

Corresponding to the impact of disasters, conflicts and extremely poverty issues, NGO's present in the field are mostly specialised in emergency response, and just a few of them have been dedicated to (re) building employing a long-term developmental perspective. As a result of that, there is a significant lack of planning, design and enduring action, notably in vulnerable areas, such as the informal settlements. Thus, besides the need for urgent humanitarian aid, acting in favour of sustainable urbanism and architecture for informal settlement is necessary. By reducing disaster's risks, promoting better building, retrofit, and rebuilding, it is possible to achieve a more substantial social impact.

Within the scope of analysis, synthesis and learning from local traditional and innovative attempted solutions, the current research will be looking selected experiences on low-income housing and recovery. Ultimately, the aim is to apply lessons to the Portuguese-speaking countries community (CPLP), especially in Africa and in general in the global south, where Portuguese actually is the most spoken language. Particular attention will be given to the concept of incremental housing, which has proven to be effective throughout decades of slum upgrading operations based on self-help or aid-self help building.

2. Objectives/Methodology/Scope

Research should contribute to a better understanding of a few crucial points when comes to deal with several affected communities:

- (1) Which is the role-played by architects and architecture in the post-disaster, namely in the aftermath, in the developmental phase and also in between the two phases?

(2) How many people are interested in the subject, what are the short and long terms architectural impacts, to what extent it matters, and, ultimately, does it really make a difference?

(3) What examples may confirm architectural impacts and the actual role played by designers working near humanitarians and low-income housing developers such as local communities, NGO's, and municipalities?

(4) How to involve the communities in design and building meaningful processes and how useful are classical tools, such as incremental housing, and social & ecological innovative tools, such as community-building, experiential learning, gender issues and creative thinking?

- (5) How to educate, enable, empower and technically support people for disaster risk reduction and launch, in a community driven & oriented basis, design and building recovery, and developmental processes?

A first working hypothesis was that the more sustainable and resilient accomplishments occur when architects undertake a creative but also supporting role. A second hypothesis was that the dissemination of incremental housing design among householders, builders ad self-builders may respond to both emergency and long-term needs, allowing for effective urban form and building type controlled massive reconstruction and upgrading.

Summing up, the research goals are as following:

- (1) Questioning the place occupied by architectural design practice and the role played by architects on rebuilding recovery processes addressed to very severely affected communities in the context of humanitarian aid (post-disaster rebuilding) and low-income housing (development contexts).
- (2) Building up translation tools between humanitarians and architects, exploring common conceptual vocabulary, web-based digital mapping, computer aid design and interactive systems for re-generating building types.
- (3) Incorporating the subject of humanitarian architecture into the architectural graduation curricula and outlining a post-graduate proposal with a focus on the CPLP geography.
- (4) Although focused on how to better plan, design and rebuild in disaster-prone and informal settlement areas, investigation must also address education at different levels, ranging from children (formal and informal education for disaster risk reduction) to adults (long life learning), to students of university (particularly those enrolled in architectural, urban design or urban planning graduations).
- (5) Bringing into the discussion of theory and practice of architecture, features and tools used in social innovation, towards a sustainable and trans-disciplinary architectural approach to be applied in the context of disaster and development.
- (6) Making a contribution to the strengthening of cooperation amongst Portuguese-speaking countries in the areas of post-disaster rebuilding, disaster risk reduction, post-recovery assessment, informal settlement upgrading.

In terms of methods, the investigation undertakes the challenge of facing the theatre of humanitarian and developmental operations. Moreover, it brings together in humanitarian projects and surveys experts coming from different areas and with a diverse background, while working and alongside and within communities. Learning on the field, drawing near the residents and researching by project and by doing, designing and building in a local-resources-basis, requires a close relation with stakeholders. In a small scale and low

profile NGO this relation with local communities may progress through remote communication; in the beginning, indirectly, via humanitarians on the field; afterwards, directly, thanks to internet technologies and social networks. Precisely, these interfaces of communication will be addressed in next stage through a web community-driven mapping collaborative tool for architectural models simulations. This technology is supposed to anticipate scenarios for rebuilding and incremental housing and risk reduction measures, while supporting the monitoring and assessment of long-term impacts of on-field actions. [2]
Keeping the focus on the Portuguese-speaking developing countries geography, research deals with an encompassing framework concerning (1) theory and practice, (2) planning and building, (3) the social and the environmental, (4) the ethical and the educational, (5) innovation and traditional knowledge.
The in-situ observation, interviewing and surveying embraces a genuine exchange and intercultural dialogue with residents; digital mapping and computer aid design tools assist and tries to advance this interaction while pursuing communities members empowerment on recovery, urban upgrading and housing issues. An action & research laboratory will be attempted by crossing information with on-going projects and research for African countries by Portuguese-based NGO Building 4Humanity Design and Reconstructing Communities Association and also follow steps of the joint international project leaded by a Portuguese University, focusing on local building types and energy efficiency, the SURE Africa [3].

Leading with these trends through a interdisciplinary approach, joining architects, sociologists, psychologists, economists, engineers, ecologists, social service technicians and spiritual leaders, both practitioners and researchers, B4H tries to develop the concept of social innovation architecture. With this new approach B4H seeks to investigate participation models that strengthen the social and cultural component of sustainability of each of the operations in the field, assuming that ongoing social, economic and cultural transformations require a reconfiguration of the relationship between residents, technicians, institutions and administrations. [4]

Additionally, B4H started the process of empowerment of men and women to acquire greater levels of expertise in green construction or repair of buildings. In the developing of this task B4H is benefiting from the work developed in SURE-Africa project a European joint-venture project focused on the improvement of energy efficiency of vernacular houses leaded by the Higher Technical Institute (IST, Portugal) [3]. This project received contributions of the University of Cambridge (UK) and the University of Lund (Sweden) and was carried out in the field for three years within the involvement of local architecture schools such as the Agostinho Neto State University in Angola, and local communities. Energy and ventilation performance where checked by measurements of comfort levels in the interior of buildings and users' comfort perceptions testimonies [5]. Both analogical and digital methods were used, namely questionnaires and Ecotec software, a 3D building analysis and simulation program that integrate lighting, energy and environmental studies in order to visualize and increase sustainable design solutions [6].

Figure 1. Vernacular houses in Guiné-Bissau usually built with rammed earth or adobe walls and straw fiber roofs (above), recently replaced by zinc (below). Credits: The authors

Figure 2. A composed covering of zinc and straw, combining the durability and waterproofing properties of the zinc (above) with the insulation qualities of the straw (below) is the best practice recommended for tropical conditions. Credits: The authors

3. Discussion

In the 21st century, new developments in technology, notably in GIS, the consolidation of the environmental university programs and reshaping of geography and mathematic sciences enabled the incorporation of scholars from these areas, concomitantly contributing to widen the scope of post-disaster research. Thus, the new studies addressed risk and economic issues [7], social and cultural impacts, livelihoods, gender issues, minorities, social and cultural impacts, as well as in-depth investigations on participation models [8]. Additionally, in a gradually way, acquired importance the subject of the informal settlement, the place where came to live the majority of the most vulnerable people. Although covering an increasingly wide range of areas, it is noteworthy in recent studies, the lesser attention paid to architectural issues within the humanitarian context. As such, there is little evidence of Architecture exposure to other fields of research, just a few signs of trans-disciplinary investigations [9]. It is necessary to go back many decades to find an integration of architecture to services, infrastructures, economics and social dimensions, like the one proposed by the site and services projects (SSP, conducted by the World Bank in the seventies). [10]. In this matter, it is noteworthy the current interest in the trans-disciplinary concept of incremental housing, successfully implemented by Alejandro Aravena and Elemental group, in Chile [11]. This concept, both in research and practice, can be seen, at a certain extent, as a revision of the SSP. [12]. Recently, this concept has been approached by cutting-edge research focused on computer aid design-based automation software, with the goal of optimising mass housing design and (re) construction [13].

In the Portuguese-speaking countries arena, the inter-cooperation on urban research gave rise to studies that addressed peripheral non-infrastructured areas issues, highlighting social concerns and the right to the city, in Lefebvre terms. [14]. Singular cases in African countries, addressing thermic comfort and building performance of local houses through specific software simulation, showed the potential of cultural landscape and building type concepts in design thinking and within the field work of NGO's near communities [15]. In addition, these examples, by emphasizing local cultural idiosyncrasies thorough rituals and architecture revealed that build meet people needs, in Paul Oliver meaning, involves, at the same level, to meet physical, cultural and spiritual needs [16].

In accordance with the chief objective of enhancing lifestyles and livelihoods research tries to bridge architecture with other disciplines presents on the field of disaster recovery and development [17]. It argues that an architecture embedded in a trans-disciplinary approach is more likely to foster communities' participatory action, sustainability issues, and, ultimately, is more suitable to pursue a desired dynamic of social change. [18]

Fig. 1 The *humanitarian architecture* approach: a local-based multilevel, intercultural, trans-disciplinary and dialectic process that requires social innovation tools and involves diverse partners and members of the communities whose aspirations, ultimately, it will try to meet.

Additionally, innovative tools such as web collaborative digital community mapping tools and open source mobile applications for engaging community members in the process of DRR, recovery, resettlement and slum upgrading, might also be of great interest whenever they are assumed by local groups as part of their social agenda. This widened conceptual and instrumental lexicon is supposed to pervade architectural discourse and practice, thus contributing to filling the gaps between theory and practice, between humanitarians' immediate focus and designers' developmental visions. Ultimately, this upgrade of humanitarian architecture [19] fits the purpose of building translation tools for the necessary inter-sectorial dialogue among professionals.

The dialogue between researchers and professionals from the field may benefit from acknowledging of a common ground of interest. To this end, the research champions that social innovation might be this common ground from where to built up, possibly in a more consensual and fertile way, this dialogue between humanitarians and designers.

At this point, it is important to bear in mind that a trans-disciplinary approach must not overlap to the nature of the discipline of Architecture. In a rapidly and increasingly urbanised world, the role to be played by architects should never be underestimated if a consistent 'humanitarian architecture' is to be accomplished. To go beyond disciplinary boundaries and let related disciplines permeate architecture; to accomplish a trans-disciplinary approach is required. Rather than mitigating architectural identity and running the risk of turning it into a syncretistic field of knowledge, which it is not the case, this approach point to the full spectrum of architecture's possibilities.

4. Results

Both literature analysis and under progress operations of NGO Building 4Humanity point to the best methods of informing local leaders and households to rebuild and incrementally expand their houses, without mischaracterising traditional settlements and vernacular architectural knowledge and caring about previous lifestyles and livelihoods.

Also, from the interaction with stakeholders, it has emerged that the most resilient achievements occur when architects work as ‘cultivators’ and ‘facilitators’. In this sense, these on-going experiences corroborated literature, specifically, case studies that advocate that in the humanitarian field, to filling the gaps between theory and practice a new conceptual and instrumental lexical should infuse architectural discourse.

Initial results suggest, therefore, that a new commitment, a real shift in architectural practice within the humanitarian context is necessary to allow on-going innovative practice and thinking permeate architecture. Instead of undermining its credibility or diminishing its field of intervention, this cross-disciplinary interaction, tend to consolidate architecture as a broader body of knowledge to where high kinds of knowledge converge to and amalgamate. But what will be the profile of this new humanitarian architecture?

Case studies reflecting on direct action-planning and building field experiences, whether in disaster or development context, provide valuable clues to devise a set of principles for a humanitarian and sustainable practice: (1) Prioritising local cultures, knowledge and resources; (2) paying attention to minorities, (3) investigating urban & architectural design and building strategies and also participation models that strengthen the social and cultural component of sustainability and community resilience, (4) incorporating into ‘humanitarian' architecture intercultural and interdisciplinary dialogue, (5) integrate to practice digital and analogical tools for social innovation, (6) bring in findings of ground-breaking research and mainstream disruptive practices that attempts, not necessarily prioritized in this order, assertive concepts such as (i) system building type, (ii) incremental housing (iii) community resilience (iv) disaster risk reduction (v) women participation and leadership, (vi) cultural landscape preservation and valorisation (vii) cultural and social assets, (viii) well-being and quality of life.

The incorporation of digital mapping into the communities' participation process as a strategy of inclusive citizenship and the delivery of GIS mapping and 3D simulation tools to be spread and patent registered will constitute one of the innovative elements and final outcomes of the research. This effort, still in progress, has been supported from its initial stage by ESRI-Portugal, the national supplier of ESRI-International solutions the world leader producers of GIS Technology with relevant experience on the area of disaster management, technical support, training, and product design. This partnership is supposed to generate, in the next three years, two different products, one non-profit, other commercial. The first is an online open source mapping application to be easily accessible to stakeholders through mobile technology. The second, a more sophisticated solution combining GIS mapping and 3D simulation tool, provide assistance to technician and developers from the private sector. Both solutions are supposed to expand the possibilities of transferring knowledge and data collection among Portuguese-speaking countries. These tools matter since they can contribute to improving practice and hence, influence housing policy.

The main finding of the SURE project confirmed the importance of design and communicating according to the dominant self-construction techniques. It also highlighted the relevance of meeting basic comfort needs using passives strategies. Final outcomes suggest energy conservation through passive building design as a proven equivalent to renewable energy power generation, emphasizing net demand reduction rather than production, an approach considered more compatible with traditional lifestyles and to the social-economic conditions of the majority of the population [3]. Otherwise, people will not be able to build the proposed solutions and will prompt to acquire and install air conditioning (if they can afford it). These cultural and social contexts suggest new ways of communication, addressing both native idiosyncrasies and knowledge, privileging hand drawing and local sources as, for example, oral tradition.

5. Conclusions

In Africa, the degradation of urban buildings, a housing deficit combined with a massive influx of poor rural people, unplanned urban growth and low comfort levels inside buildings, strongly impacting climatic agents such as high levels of solar radiation and air humidity, and torrential rainfall, challenge builders and architects to find sustainable ways of providing security, comfort, and economic satisfaction for the final building users. Raw materials, ancient techniques, such as earth walls, straw covered roofs, optimized orientation and natural ventilation are still available and may be potentiated by joint projects of academics, humanitarian associations and local communities that address empowerment of residents. Following the steps done in the field and strengthening SURE-Africa achievements in laboratory, B4H will identify and deeper characterize housing building types, analyse their comfort performances but also their cultural framework, and create an interdisciplinary approach, before propose strategies for sustainable design.

This shift in the current architectural practice into a definitive humanitarian architecture means to move from the dominant design-centred approach to drawing near social innovation issues regarding local housing recovery and development trough: (1) community oriented design of a local resources-based architecture or just enabling, perhaps capacitating stakeholders, community-driven design, (2) urban cost-efficient and socially equal infra-structure lay-out, (3) land design subdivision towards open, green public and community spaces and private secure tenure, (4) local empowerment on building techniques, (5) assistance, facilitation, cultivation in self-help and aid self-help building. (6) Attention to correlative themes such as community involvement, land rights, local governance articulation, social business, minorities and gender [19].

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References

[1] UNISDR. Retrieved from http://www.unisdr.org/partners/countries/prt, accessed May, 3rd, 2015

[2] George, G. and Goethert, R., Chavez , R., (2011), Self-help and incremental housing El Salvador: likely directions for future policy. SIGUS research / MIT with the Fundación salvadoreña de vivienda minima (Fundasal),

http://web.mit.edu/incrementalhousing/articlesPhotographs/pdfs/El%20Sal%20FINAL%20REPORT-5%20OCT%2711.pdf, accessed May, 2, 2015

[3] Correia Guedes, M. et al (2011) Arquitectura Sustentável na Guiné Bissau, Manual de Boas Prática, Lisboa:CPLP

[4] UN-HABITAT (2009), Planning Sustainable Cities: Global Report on Human Settlements. United Nations Human Settlements Programme

[5] Kazimee, B.A. (2008) Learning from vernacular architecture: sustainability and cultural conformity, in Eco-Architecture II Harmonisation between Architecture and Nature Ed.: G. Broadbent, University of Portsmouth, UK and C.A. Brebbia, Wessex Institute of Technology, UK

[6] Lauber, W., 2005. Tropical Architecture: Sustainable and Humane Building in Africa, Latin America and South-East Asia. New York: Prestel Publishing.

[7] Simão, A., Denshamd, P.J., Haklaye, M. (2009). Web-based GIS for collaborative planning and public participation: An application to the strategic planning of wind farm sites. In Journal of Environmental Management, Volume 90, Issue 6, May, Pages 2027–2040. Available at http://www.sciencedirect.com/science/article/pii/S0301479708001254, acessed on May, 1, 2015

[8] Lizarralde, G., Johnson, C. and Davidson, C. (2010). Rebuilding after Disasters. In: Rebuilding after Disasters, From Emergency to Sustainability. Oxon: Spon Press. /

[9] Hamdi, N. (2014). The Spacemaker's Guide to Big Change. Design and Improvisation in Development Practice. Oxon: Routledge.

[9] Doucet, I and Janssens, N. (Eds.) (2001), Transdisciplinary Knowledge Production in Architecture and Urbanism, Towards Hybrid Modes of Inquiry Series: Urban and Landscape Perspectives, Vol. 11, XVI

[10] Caminos, H. and Goethert, R. (1978) Urbanization Primer: Project Assessment, Site Analysis, Design Criteria for Site and Services or Similar Dwelling Environments in Developing Areas: with a documentary collection of photographs on urbanization, MIT Press.

[11] Greene, M. and Rojas, E. (2008) Incremental construction: a strategy to facilitate access to housing, Environment and Urbanization, 20: 89

[12] Goethert, R, (1985). "Sites and Services." In "3rd World." edited by: Nabeel Hamdi and E. Robbins. Architectural Review, pp 28-31.

[13] Duarte, J.P. (2001), Customizing mass housing : a discursive grammar for Siza's Malagueira houses Docotral thesis presented to the MIT, acessed at http://hdl.handle.net/1721.1/8189

[14] Raposo, I., Salvador, C., (2007). Há diferença, ali é cidade, aqui é subúrbio. Urbanidade dos bairros, tipo e estratégias de habitação em Luanda e Maputo. in Oppenheimer, J. e Raposo,I., Subúrbios de Luanda e Maputo, Colecção Tempos e Espaços Africanos, Edições Colibri, Lisboa 2007, pp. 105-138

[16] Raport, A. (1969). House Form and Culture, Prentice Hall

Raport, A. (2006). Vernacular Design as a Model System, in Vernacular Architecture in the Twenty-First Century: Theory Education and Practice, ed. by L. Asquith and M. Vellinga, London: Taylor and Francis,

[17] Sanderson, D., (2009). Integrating development and disaster management concepts to reduce vulnerability in low income urban settlement (Ph.D. by published works). Oxford Brookes University

[18] Zetter, R. and Watson, G. B. (edited), (2006). Designing Sustainable Cities in the Developing World. Hampshire: Ashgate Publishing Limited.

[19] Charlesworth, E.(2014). Humanitarian Architecture: 15 Stories of Architects Working After Disaster. Oxon: Routledge.

[20] Mitlin, D. and Patel, S. (2010) Gender Issues and Slum/Shack Dweller Federations. In Chant, S. (ed.) The International Handbook on Gender and Poverty, Cheltenham: Edward Edgar Publishing

Revitalizing Home Sales in the Current Challenging Economic Environment

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Abstract

Over the past decade, the homebuilding market trend has fluctuated immensely. Indeed, the U.S. housing market has experienced all time highs and severe declines between 2004 and 2010. Due to the radical declines in the market, fewer potential homebuyers exist today than in years past. The present study aims to analyze customer needs prior to the housing bubble in order to address future needs in the post "boom years." A survey was conducted to determine how a company can adapt to accommodate changes in home-buyer needs relative to a shifting market, as well as securing home sales in a growing competitive market. The survey factored in present-day factors inhibiting home purchases, homebuilder obstacles, as well as the evolution of homebuyers' needs. Both potential homebuyers and homebuilders received the survey in order to determine where the disconnect lies between present-day buyer needs and what the builders are offering. Ultimately, the present study aimed to eliminate disconnect and create an opportunity where both homebuilders and homebuyers can benefit. Results from the study were compiled for strategic analyses. The findings indicated important implications tied to the shift in customer preference and ultimately, increased sales.
Keywords: homebuilding, homebuyers, home sales, housing bubble, fluctuating market

1. Background

Over the past decade the homebuilding market trend has fluctuated from all time highs to all time lows. The purpose of this study is to focus on customers and homebuilders and determine what has changed in the brief amount of time prior to the shift in the homebuilding market. This study will focus on customers and what the consumer requires in the post "boom years". It will also discuss what has changed since then and what is required from customers now and in the future. Research will be conducted to determine what a company can do to adapt itself to accommodate these potential homebuyers and what it will take to create a sale and get customers into a new home. Many factors will be investigated such as what is keeping potential buyers from purchasing and what are they requiring in a home now compared to past requirements.

Discovering what dynamics have changed over the past few years from homebuyers, as well as homebuilders, perspectives will shed light on any disconnects. Surveys were sent to both homebuyers and homebuilders and a comparison was determined between what the customer requires versus what the homebuilder thinks the customer requires. By doing this, an opportunity was created where both homebuilders and homebuyers could benefit and sales can now return to the residential homebuilding market. The purpose of this study was to discover what disconnects exist between homebuilders and homebuyers and what builders can do in order to revitalize homes sales in the current challenging economic environment. By achieving these answers, sales will be created and these sales will in turn propel the housing sector out of the current economic downturn.

1.1 Industry Background

In the past decade the housing market in the United States has declined significantly. As housing statistics were at all time highs in the early part of the decade, this trend started to peak in early 2006. As housing numbers began to decline in late 2006 and in 2007 we were still in a downfall as of 2011(Standard and Poor's, 2011). The Case-Shiller index provides constant quality home prices indices for the United States. These indices are updated quarterly and consist of single-family home priced indices for the nine U.S census divisions. On December 30, 2008 the largest price drop in U.S. History was reported by Case-Shiller (Standard and Poor's, 2011). These drastic changes in the housing market led to what industry insiders called the "housing bubble bust" and a chain reaction in the housing market ensued.

An unprecedented bubble in U.S. housing prices began to inflate in the first quarter of 1998 and then popped in the second quarter of 2006 (Saxton, 2011). Increased foreclosures were on the rise as of 2008 and these effects were felt in the homebuilding sector, real estate, home supply and retail outlets (Bonney, 2011). Over the past few years, home prices have continued to decrease which has led to even more foreclosures. In addition, new bank lending regulations have begun to come in effect as a direct result of prior unacceptable lending practices. These new regulations have led to even more difficult situations for potential homebuyers as well as homebuilders.

With such a decline in the housing market it is evident that fewer potential homebuyers exist today than in years past. While homes were selling at an all time high in 2004-2006 the downturn has drastically changed the market. This study will determine how an established mainstream residential homebuilder can do to adapt to the existing market to create sales.

1.2 Overview of Methodology

Surveys were administered to a database of previous potential homebuyers who have "shopped" a model home with a mainstream homebuilder over the past year as well as homebuyers who have purchased within the past year. Multiple homebuilders also received a survey pertaining to what they are offering current buyers and what they think current buyers are requiring in today's fragile market place.

Surveys were sent to both parties by multiple methods including email, fax, stamped mail with return postage, and hand delivery with retrieval. The first party considered was the potential homebuyer. Surveys for the potential homebuyer consisted of twelve items and focused on general questions that pertained to the home shopping experience and determining factors in the purchasing process. Surveys were also sent to multiple home builders in Wake County, NC and surrounding areas via email, faxing, stamped mail with return postage, and hand delivery with retrieval. Items included on the homebuilding survey focused on issues such as recent buyers' interest and challenging obstacles in selling new homes. An emphasis was placed on buyer requirements for homes sold over the past year. The compilation of these surveys determined what the current home buyer is requiring in the existing market versus the "boom years" and what a main stream residential home builder can do to acquire a sale.

2. Literature Review

2.1 Customer Needs Prior to the Housing Bubble

Over the past decade there were multiple factors that contributed to inflated housing numbers. One of the major factors was simplistic loan requirements that allowed homebuyers to finance one hundred percent of a standard mortgage with no money down. This process allowed many homebuyers the ability to afford a home outside of what they could afford. Over these years the estimated size of a new home averaged well over 2400 square foot and had a median sales price of $244,000. Homes in this period consisted of “McMansions” that were developed on large lots in ideal locations. These homes consisted of over sized master suites, gourmet kitchens and outdoor amenities. Often the homebuyer was increasing the size of their new home from their existing home and moving into more upscale modern neighborhoods and communities.

These communities offered more diverse architectural designs, neighborhood diversity, and high quality design standards. As the market continued to grow with no end in sight, these luxuries started to become a standard with many homebuilders and a majority of business models were changed to a “more is better” mentality. During the first part of the decade as land prices were low and lending practices were weary many builders were able to capitalize on the conditions and create compelling homes and communities that catered to the modern day homebuyer. This is no longer the case as many homebuilders are no longer in business due to this practice and many are struggling to stay in business in the current economic conditions.

2.2 Customer Needs Post Housing Bubble

As the housing bubble began to burst in the middle of the decade the needs of homebuyers seem to be changing dramatically and it is the responsibility of the homebuilder to recognize this change. Over the past five years median home sale prices have decreased from an average in 2004 of $244,000 to $169,000 in 2011(Emrath, 2011). This has also led to a decrease in the average square foot size from 2700 square foot in 2004 to 2300 square foot in 2011 (Emrath, 2011). The evidence of a changing homebuyer is very compelling. Today, homebuyers are typically Generation Y buyers and they want something completely different than in previous years as well as previous generations. No longer do they want what their parents or grandparents had. Many are more focused on the neighborhood itself than the large master suite or kitchen upgrades.

A study of Generation Y buyers has discovered that many do not want a traditional home and that they require a living space that is open and able to become customized to these ever-changing living styles. They also care more about the environment and the carbon footprint than their home is producing. Many are interested in green construction and prefer to buy with a homebuilder who will offer energy efficient homes that focus on Home Energy Ratings (HERs) with a sustainable design. Bill Freeman, a contractor in Essex, Connecticut has focused the adaptation of his home building business to focus on sustainable design and in the process has created record new home sales in a down housing market. Mr. Freeman was able to utilize building practices such as solar thermal energy, photovoltaic options and geothermal heating and cooling.

Other practices such as eliminating batt and blown insulation and installing open cell expanding foam insulation has also decreased his energy loss significantly. Also, other measures are taken such as Low E high performance windows, water heaters without tanks, and Energy Star- rated appliances. It is estimated with all of these systems in effect the home will see an average saving of $4000 a year in utility cost compared to a conventionally built home of similar size (Freeman, 2010). Numbers such as these are what potential homebuyers and Generation Y buyers are focused on in the new and future housing market. Homebuilders are going to have to operate at a new scale in the current economy to compete for these potential buyers.

Old thought process and ways of doing business are over and a new, fresh, innovative, and sleek business model needs to emerge. New cultures will need to be developed in existing home building companies. Those who are willing to sacrifice the time and effort will succeed with their efforts. Those who do not adapt and stick with the mantra that the economy will eventually "come back around" will be lost in the change and will fall to the wayside when the economy does recover. Their sales will continue to suffer due to the incorrect product that they are trying to sell that sold previously and they will no longer progress forward in the industry.

2.3 Homebuilder Obstacles

Over the past five years homebuilders have faced many obstacles in the construction and selling of new homes. Existing home sales decreased as foreclosures were on the increase. As homeowners from the housing boom could no longer afford their new homes, mortgages started to become delinquent and the mortgage crisis was born. This led to more stringent lending practices and left homebuilders struggling to create sales with products in a high price point with customers who could only afford to purchase in a lower price point, if at all. As fewer customers were entering the market to purchase new homes, homebuilders had to compete with not only foreclosures but also the idea that many new sales were lost to rent and even remodeling. Another major factor with foreclosures on the rise was that idea that housing values were beginning to lower and a majority of homeowners now lived in a home that currently had a lower value than when they purchased it. Also, many potential home buyers were not able to purchase new homes due to the fact that they could not sell the home they currently lived in part to factors such as the inability to qualify for new loan terms and decreasing home values. All of these factors have contributed to major obstacles for homebuilders.

2.4 Home Builder Adaptations

With fewer potential homebuyers in the market, the increased competition between homebuilders is at an all time high. Many homebuilders started with the simple tactic of price discounting and believed that discounting alone would solve their sales problems. As sales continued to decline many homebuilders decided to "stay the course" and not change any of the characteristics of the company and to remain with the business plans that they had in the years previous to the housing crisis. These builders continued to build homes in a high price point range with the same wide range of luxuries that they had included in there home as normal. Other homebuilders decided to adapt to the current economic down turns and decided to retool and create other product lines in various prices point in order to reach out to a broader portion of the market share. These builders offered downsized homes on quaint lots but offer the same level of quality standards and luxuries, just on a smaller scale. Not only do these homes appeal to another share of the market, they also have lower and more competitive sales pricing.

3. Explanation of Methodology

A set of surveys consisting of two pages each was created for this case study. One survey was sent to potential homebuyers in the market and was titled, "Survey for Potential Home Buyers". This survey consisted of twelve items and was formatted with general questions with spaces left for qualitative responses, general “yes” and “no” questioning, and multiple-choice items. A second survey was created and sent to homebuilders and was titled “Survey for Homebuilders”. This survey consisted of ten items and was formatted with general questioning and multiple-choice items. Spaces were left at each question for comments and surveyors were encouraged to answer all questions to the best of their ability. The survey for potential homebuyers was distributed through a list of over fifty potential buyers, which were obtained from the database of a local residential homebuilder. This list consisted of potential homebuyers that had either shopped a model home or filled out an information card at a model home visit. Surveys for homebuilders were distributed to fifty homebuilders in the Raleigh/Durham and surrounding markets in North Carolina, as well as over a dozen sales agents and real estate professionals. Each sales agent and real estate professional was also sent the “Survey for Potential Home Buyers” and encouraged to distribute it to potential homebuyers that they encounter on a daily basis. Both surveys were confidential and each explained that the purpose was to compile information to understand any disconnects between homebuyers and homebuilders and discover methods to create sales opportunities that will benefit both parties. It was also noted that the surveys were part of a Capstone project in order to obtain a Masters degree in Construction Management.

4. Results and Conclusion

Surveys were sent to fifty homebuilders in multiple markets. Surveys were sent via email, fax, standard mail and hand delivery. Of the 50 surveys a total of 32 surveys were returned complete with standard mail being the most effective method. The following is the percentage of returns by method. Surveys not Returned- 18 of 50 (36%) Standard mail with return postage- 15 of 50 (30%) Email- 8 of 50 (16%) Fax- 5 of 50 (10%) Hand Delivered and Retrieved- 4 of 50 (8%).

In summary, after reviewing all the data from the surveys it appears that the industry as a whole is moving in a different direction. It has been determined that the question of “How can an established mainstream homebuilder adapt to the existing market to create sales?” can be placed into a few categories. As part of the findings on uncovering disconnects between homebuilders and potential homebuyers, the following has been discovered: First, as the focus was placed on homebuilders, it was discovered that many homebuilders did not agree with what the majority of homebuyers want in their home. When questioned about what homebuyers prefer most in a new home, 38% of homebuilder believed that locations and neighborhoods were a major factor, followed by price point at 28%. Interestingly, after surveying the potential homebuyers, they listed price point at 38% followed closely by open spaces/square footage at 32%. Small differences like this between the homebuilder and homebuyer create a disconnect and these differences affect potential sales.

After reviewing both sets of surveys, it is apparent that more of these disconnects do exist. It is also apparent that the industry is shifting and it is beginning with the customer. The new potential homebuyer is not like to homebuyer of years past. Oversized homes full of luxuries are out and smaller homes that are livable with large open spaces are in. Today’s homeowners want a new, smaller, and more affordable product. They are highly educated and are also geared toward environmentally friendly homes that leave a small carbon footprint. In order to meet this requirement, it is going to require many homebuilders to retool their entire business model. Homebuilders who are currently selling in higher price points and waiting for the market to return will not survive this market shift. Companies are going to have to change the entire culture of their company in order to adapt to what the “new” homebuyers requirements are.

By reviewing surveys and studying mainstream homebuilders, it was discovered that companies who followed this idea were able to adapt over the past few years and are successful today due to this strategy. One success story is from a large publicly trades homebuilder who had the business model of large and luxurious homebuilder. Typically, this homebuilder does not do small and inexpensive contracting, but in order to create sales, a new business model was adopted. In order to downsize the existing product and not sacrifice the quality or branding of the product, the company enlisted the help of a third party architectural firm. After spending nine months in a dedicated effort to retool the company and the product, the company was able to unveil two new floor plans early this year starting in the low 200k range. In return they were able to sell 16 of these plans over the first four months of the fiscal year. Overall, the retooled plan is 546 square foot smaller than the existing plan, yet it lives larger because of the spaces people spend more time in are larger and more open which is what the new homebuyer wants. Homeowners are using furniture to define a room rather than walls, which lends itself towards the livable aspect that the new homebuyers now require. If more companies are willing to dedicate the time to retooling their company, they will have a successful story as mentioned. If homebuilders consistently study the market and educate themselves about what the potential homebuyer requires in a new home, they will be able to create sales opportunities and in turn create a successful company.

After studying multiple business models and reviewing both homebuilders and potential homebuyer surveys the following recommendations have been determined. A company with the following aspects will be successful in the existing market as well as the future: First, companies must realize that the customer of the past is gone. The new homebuyer consists of younger buyers that want something different. They are interested in function rather than fancy and prefer to have community ties rather than an oversized floor plan. New homebuyers are also concerned about the carbon footprints of their home so energy efficiency is a factor. Secondly, companies who understand this will need to retool their business model in order to accommodate these potential homebuyers and create sales opportunities. The most important part of this retooling is a process that will require a change in entire “company culture”. The company must sacrifice and dedicate itself to retooling its products. In a market where potential buyers are trendy and require open and livable spaces this includes revamping existing floor plans in order to accommodate the new buyer. Homebuilders need to operate more like high-tech companies and to create a process of innovation. They need to be innovative, capture market knowledge, and adapt better business practices.

One thing to note is that this process cannot be handled as a short cut and must be carried out correctly. A dedicated effort by every member of the company must take place. Often short cuts lead to lost details and failed quality. A company needs to ask itself the following three questions prior to moving forward and dedicating itself to retool to adapt in the market. First, “What do buyers really want in a home?” Secondly, “How will new customers live in their home?” Finally, “How will we as a company build it?” By answering these three questions it will arm them with the proper answers and allow them to build the appropriate home for the market. Other factors discovered from potential homebuyers surveys that were important to buyers were pre and post construction factors. The majority of homebuyers feel that they are neglected in the pre homebuilding and post homebuilder process. It was determined that if a company properly dedicates the time to understand the potential home buyer and develops programs to keep their best interest in mind and both the homebuilder and home buyer will benefit. Ultimately, this program should involve more homebuilder interaction with the homebuyer prior to construction, during construction, and post construction. Other programs such as warranty protocols should be in place and customers should never feel neglected. By taking these extra steps and not only retooling the product, but retooling the customer interactions in my opinion will lead to sales as well as word-of-mouth sales due to exceptional customer service.

Other factors that need to be taken into consideration with the “new” buyer is: how can a builder attract them to their company and neighborhoods? In the past, many homebuilders focused on print advertising in newspapers as well as other methods such as real estate magazines and billboards. Today, the new homebuyer is a very trendy and highly connected individual and homebuilders need to put a large focus of their marketing into technology. Avenues such as Facebook, Twitter and YouTube can be utilized in order to connect with the younger first-time homebuyer demographic. As social media continues to grow at a rapid pace, it is impossible to determine the amount of exposure a company can receive from it. As a company does the right thing consistently, the reputation of the company will begin to grow not only within the community, but also the market place. If a company listens to what the market is requiring and educates themselves about the “new” homebuyer, then sales will be created and both homebuilders and homebuyers will benefit.

5. References

[1] (2010). Automation Market Place 2011: The New Frontier. Retrieved September 25, 2011. Retrieved from www.joc.com

[2] (2010). RC Case Studies: Improving Company Image and Increasing Custom Home Sales. Retrieved on September 3, 2011. Retrieved from www.conachmarketing.com

[3] (2011). RC Case Studies: Sustainable Building. Retrieved September 6, 2011. Retrieved from www.calrecycle.ca.gov

[4] (2011). New and Single Family Home Prices in U.S., Retrieved on October 2, 2011. Retrieved from www.nahb.com

[5] (2011). Home Builder Confidence Still Flagging. *Portland Business Journal*. Retrieved on October 5th, 2011. Retrieved from www.bizjournals.com

[6] (2011). New and Existing Home Sales in U.S. 2011. Retrieved September 15, 2011. Retrieved from www.nahb.com

[7] (2011). Speak Out: Real Estate and Development. *Baltimore Business Journal*. Retrieved on November 3, 2011. Retrieved from www.bizjournals.com

[8] Bashford, H. Implications of Even Flow Production Methodology for U.S. Housing Industry. Retrieved on December 1, 2011. Retrieved from Journal *of Construction Engineering and Management*, *Volume 129, Issue 3,* pp35-38.

[9] Bonney, Joseph. (2011, October 31). *Journal of Commerce Magazine*, Home Is Where the Downturn Is, Retrieved on October 25, 2011, Retrieved from www.joc.com

[10] Burres, Roddie. Builders Adapt to Changed Market, (August 11, 2011), Retrieved on November 9, 2011, Retrieved from www.thestate.com

[11] Crowe, David. (2011, September 2). Eye On The Economy: Weighed Down by Dismal Economic News, Housing Showing Mixed Results, Retrieved on December 2, 2011, Retrieved from www. nahb.com

[12] Crowe, David. (2011 September 16). Eye On The Economy: Economic Recovery

Unfolding at a Disappointing Rate, Retrieved on December 2, 2001, Retrieved from www.nahb.com

[13] Emrath, Paul. (2011 November 4). NAHB Survey Finds Single Family Home Construction Costs and Profits Down in 2011. Retreived on December 1, 2011. Retrieved from www.nahb.com

[14] Holzer, Robin. (2011, September 9). Complete Streets and Livable Centers: Why Location Matters, Retrieved on October 22, 2011, Retrieved from www.collegepublishing.com

[15] Klein, Ezra. (2011, November 16). The Washington Post, The Whys and Wherefores of Americans Moving Less, Retrieved on October 23, 2011, Retrieved from www.builderpulse.com

[16] Kredich, Nate. (2010, September). Greening the Residential Sector, Retrieved on November 13, 2011, Retrieved from www.usgbc.org

[17] Lewis, Kimberly. (2011, September). Generation Green: Redefining Our Future, Retrieved on September 30, 2011, Retrieved from www.usgbc.org

[18] Nasiripour, Shahien. (2011, October). Financial Times. The Cause and Effects of the Housing Crisis and Falling Prices, Retrieved on November 1, 2011

[19] Nevalis, Mary. (2011, November 15). Builder Confidence Rises Three Points in November: Reaches 16 Month High, Retrieved on November 20, 2011, Retrieved from www.housingzone.com

[20] Post, Kevin. (2011, October 7). Hard-hit Homebuilders Adapt to Survive In Down Market, Retrieved on September 23, 2011, Retrieved from www.pressofatlanticcity.com

[21] Pyable, Mike. (2011, August). Live-Work Housing That's More Livable-and Workable, Retrieved on October 1, 2011, Retrieved from www.builderonline.com

[22] Shah, Rawn. (2011). To Crack the Code on Who's Not Buying, Understand Who's Buying. Forbes Magazine, November Issue, pp 14-18

[23] Saxon, Jim. (2008, June). The U.S. Housing Bubble and the Global Financial Crisis: Vulnerabilities of the Alternative Financial System, Retrieved on December 1, 2011, Retrieved from www.house.gov

[24] Sweet, Jonathon. (2011, November 16). Build Fax Index Shows Record September for Remodeling, Retrieved on November 16, 2011, Retrieved from www.housingzone.com

Sharing responsibility at community level: social resilience and local connections

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Abstract

The Community Connections research involved a survey sent to all ratepayers in the Blue Mountains. Over 1100 surveys were completed and returned. Findings indicate that in some areas 'shared responsibility' has an impact on community resilience as vulnerable community members, who may lack the resources to protect themselves, need to be taken into account. Vulnerable community members can include the aged, financially disadvantaged, single parent families, households without a car, people living alone and people with chronic illnesses, as many of these people lack connections to assist them in emergencies.
Responsibility for appropriately identifying and assisting the vulnerable in a crisis situation falls on communities. Community organisations are recognised in the National Strategy for Disaster Resilience (2011) and are seen as sharing responsibility for disaster resilience. This sector however, is not often invited to the table of disaster committees and bodies. In particular, community organisations could play a part in strengthening community resilience through their work with the most vulnerable members of the community. This paper explores the implications of the survey results for the Blue Mountains.

Keywords: Community resilience, neighbourhood, vulnerabilities, Neighbourhood Centres, social participation

1. Background

1.1 Community Connections Project

Community Connections was a project partnership between Charles Sturt University, local non-government organisations and the local council. The focus of the research was vulnerable community members, examined within the context of social support and social networks as an aspect of community resilience. The aged, that is, those over 65 years, are not all equally vulnerable. Some have extended networks and support available to them and may not require assistance with many tasks until over 75 or even 85 years. Younger people with a chronic condition and those living alone can also lack connections and require assistance.

The Blue Mountains experienced disaster in the form of bushfires as recently as 2013 and the impact on the most vulnerable members of the community and the community as a whole, as it manages the vulnerable in disaster, requires exploration. There is a growing population of ageing people in the region with a projected increase in the proportion of those over 65 years from the current 15.7% to 22.2% in 2026 (ABS 2011 Census).

1.2 Community Resilience

Community resilience refers to the ability of a community to deal with and rebound after a disaster or challenge. The definition Norris et al. [1] is based on an adaptive model of reliance: ‘a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance’ (130). They describe a set of networked adaptive capacities from which community resilience emerges. The four primary sets of networked resources identified are: Economic Development, Social Capital, Information and Communication, and Community Competence.

Maclean et al. [2] defines social resilience as “the way in which individuals, communities and societies adapt, transform, and potentially become stronger when faced with environmental, social, economic or political challenges” (from Cuthill et al. [3]). The six attributes Maclean et al. (2014) outline as building and enhancing social resilience are knowledge, skills and learning; community networks; people-place connections; community infrastructure; diverse and innovative economy, and engaged governance.

The connection between social capital and community networks has been considered in studies suggesting that the beneficial properties of social capital can be attributed to the social networks of individuals (Poortinga [4]; Subramanian et al. [5]). People with higher levels of trust as well as people with higher levels of civic participation were more likely to report good or very good health, than people with lower levels of social trust and civic participation (Poortinga [4]).

Social capital is made up of community participation and social cohesion created through participation (Berry et al. [6]. Social capital is mobilised in communities as a result of disasters and can be related to community resilience, suggesting that where there are high levels of social capital there will also be high levels of community resilience. An obvious example of the mobilisation of social capital is the high level of volunteer involvement in fire and emergency services who are engaged in disasters.

Participation is central to social cohesion and has a number of forms including civic participation and informal social connection. These dimensions of social capital are important in the response of households to disaster, and the capacity of households to manage in times of emergency. This is dependent on the extent to which people are embedded in social networks, through social participation, that are able to support them and/or to support one another.

Social capital has been shown to be related to health outcomes in sometimes complex ways [4]. Individuals can have varied access to social capital and can be effected in different ways. More trusting, socially active individuals benefit more from social capital. By engaging with the community through social participation individuals have more access to social capital. Social capital can have detrimental effects on some by exclusion through discrimination or inability to engage in social participation due to age, illness or disability.

The relationship between social capital and disaster resilience has been explored in Aldrich [7]. Aldrich argues that existing social capital is the most important resource to mobilise after a disaster, though social capital may exclude some groups and individuals who are not integrated into social networks or connected to social supports. Areas where social support is strong recover more effectively while areas with fewer social resources will struggle to recover.

In order to gauge the community engagement of people of different ages, health status and living circumstances, a survey was constructed based on central aspects of social capital. Social participation was measured in a series of questions on involvement in volunteer activities, local associations, providing assistance to others and sharing meals with others. Informal social connection was considered through questions on frequency of engagement with family, friends, neighbours and others. A group of questions on perceptions of neighbourhood as friendly, clean and tidy, safe, with support available and neighbours who help each other, were used to measure social cohesion.

2. Survey Method

The survey was sent to all rate payers with the council rates notice. The City of Blue Mountains consists of a population of 78,691, living in 33,348 dwellings scattered across 25 separate hamlets, within a 75 kilometre stretch.

The survey consisted of five groups of questions. The first set were demographic questions including postcode, age, indigenous or non-indigenous, living arrangements and fluency in English. A single question on whether respondents had a chronic illness or disability was used to gauge limitations related to health. The second set of questions was concerned with social participation adapted from social capital surveys developed for the US Social Capital Benchmark Survey (reported in Putnam [8]) and included questions about participation in associations, volunteering, going out and sharing meals with friends. The third section consisted of one question regarding who was most likely to provide help if needed, e.g. a neighbor, family or friend. The fourth section asked respondents about their local area connections – how often they see family, friends and neighbours, and others who may be regarded as weak ties – such as people talked to whilst shopping. Social cohesion was the focus of questions in the fifth section concerned with how people feel about their neighbourhood and their connection to it, how supported, safe and helped they felt was indicated on a five point scale. These questions were based on the Living in Australia study HILDA Self Questionnaire [9].

3. Results

The survey was completed and returned by 1103 respondents from across all 12 postcodes within the local government area. After data cleaning 1072 remained for analysis. The statistical analysis software program SPSS was used to generate upper level summary statistics by demographic group (for example, age, gender, living arrangements). These results were tested against 2011 Census data to check whether the sample was representative of the Blue Mountains population. Weightings for gender and age were added to reflect the population described in the 2011 Census. The analysis can be seen as indicating trends for age groups and chronic illness/disability in relation to need for assistance and connections within the community. The full results can be found in Redshaw and Ingham [10].

Social participation was measured by levels of civic engagement. Attending festivals and community events was engaged in by the majority of respondents, as was sharing a meal with friends at least once a month. Just over half the survey respondents said they volunteered, which is more than double the 23 per cent indicated in the 2011 census. Involvement in some kind of association was also reasonably high, at 70 per cent.

Most people see family weekly (37 per cent), monthly (30 per cent) or daily (20 per cent) and 4.3 per cent said they never see family. The majority of respondents see friends on a weekly basis with only 1.6 per cent saying never. Most attend social events weekly (44 per cent) or monthly (40 per cent) with 5.7 per cent saying never. Most (49%) talk with people in the street on a weekly basis, though 3.2 per cent never. The majority (52%) chat with people while shopping on a weekly basis, with 7 per cent saying never.

Social cohesion was based on a group of questions in the survey related to how the neighbourhood is perceived. The highest scoring questions were related to feeling safe and the neighbourhood being perceived as clean, tidy and friendly. The lowest rating was attributed to support availability, followed by neighbours helping each other. Most (70%) survey respondents and interview participants considered their neighbourhood to be friendly and, regardless of age, the majority (80%) felt safe. On feeling connected 52% gave a positive response, on neighbours helping each other 48% gave a positive response and on support is available 35% gave positive responses.

3.1 Age

Survey results confirm that people over 65 years are more likely to require assistance with daily tasks, though not all are vulnerable. Many have good connections and family involvement. There were some differences, based on age, as to who would provide help – people aged between 40 and 65 years, and those over 75 years, are more likely to be helped by family while, interestingly, people aged 65 to 75 years are more likely to receive help from neighbours.

Differences related to age were evident in how often people saw neighbours, family and friends. People over 65 years were more likely to see family weekly or monthly, while younger people were more likely to see family daily. Not surprisingly, we found that people over 75 years tend to go to social events less frequently than younger age groups. For many, family live out of the area sometimes more than 100kms away.

People older than 65 years appear to make more effort socially. Most people talk in the street either daily or weekly, but people over 65 years are more likely to talk daily. Talking daily increases with age. Some in the over 65 year age groups are more vulnerable due to chronic illness and social isolation and are less connected.

3.2 Chronic condition

The proportion of survey respondents who indicated they had a chronic illness or disability was 19 per cent. Analysis clearly showed that people with a chronic condition are more likely to require help. Results demonstrated that people over 65 years made a more conscious effort to socialise, perhaps making up for the deficit of less contact with existing friends and family, while those with a chronic condition found it more difficult to socialise.

Having a chronic condition appears to affect the likelihood of neighbours being considered a source of assistance. For those over 65 years with a chronic condition, neighbours were not considered a high source of assistance. Focus groups with people with chronic conditions indicated that relationships with neighbours are more difficult for them.

Regardless of age, people with a chronic condition attend social gatherings less frequently. People under 65 years with a chronic condition tend to chat with people while shopping less frequently and are less likely to report a strong feeling of connection to their community or a strong feeling that neighbours help. People with a chronic condition felt less safe than their healthy peers.

3.3 Living alone

In the Blue Mountains 25.6 per cent of households are lone person households and 3,101 are older (over 65 years) lone person households. Most survey respondents lived with someone, primarily a spouse or partner, while 28 per cent lived alone. Those living alone were more likely to feel that there was not enough support available to them. Of people who live alone, those who require assistance are more likely to receive help from neighbours and family if they are over 65 years, and more likely to receive help from friends if they are under 65 years

People younger than 65 years and living alone go to social events slightly more frequently than those who live with others. For people over 65 years, those who live alone are more likely to report never attending social events.

Living alone was significantly correlated to feeling disconnected from the neighbourhood for people over 65 years. In addition, they felt it less likely that support was available to them and were not as likely to consider the neighbourhood as clean and tidy.

3.4 Living alone with a chronic condition

For people with a chronic condition, those living with others are more likely to see friends daily; those who live alone are more likely to see friends monthly.

Of significance, for people living alone with a chronic condition, it was found that they:

- attend social gatherings less frequently
- talk in the street less frequently
- are less likely to talk daily with someone, and are more likely to never talk with someone while shopping
- are less likely to feel connected to the neighbourhood
- are more likely to feel ambivalent about neighbours helping each other out
- are less likely to strongly agree that the neighbourhood is clean and tidy
- are more likely not to feel safe in the neighbourhood.

People with a chronic condition and those who live alone are more likely to feel that no support with daily activities is available.

Table 1: Participation rates by chronic condition, age and live alone

%	**Chronic cond**	**No chronic cond**	**65-75 years**	**0ver 75 years**	**Live alone**
Attend events	65	82	79	63	72
Volunteer	41	55	54	44	46
Go out monthly	61	77	78	65	69
Belong to associations	62	72	74	69	66
Share meal monthly	64	79	77	69	76

Though smaller proportions as shown in Table 1, many of those with a chronic condition, over 65 years and living alone are involved in social participation. Those who are not are more likely to be less connected and more vulnerable. Personal vulnerability through frailty or cognitive deficits can be increased by interaction with social vulnerability (Tuohy & Stephens [11]).

The results indicate some clear differences in social participation, social support and informal social connection for some, and differences in social cohesion. The survey could potentially facilitate the targeting of some of those who are most vulnerable and the characteristics that make them more vulnerable. While many over 65 years or having a chronic condition are able to participate socially and engage with social networks, some are not.

4. Conclusions

It is not only willingness to act that is important in the face of disaster – differences in the capacity and varying abilities of individual and/or households to access resources needs to be taken into account when considering daily resilience and when planning for response and recovery after a disaster. Not all those who are over 65 years, have a chronic condition or live alone are vulnerable. It is a matter of identifying those most under resourced in their lack of community connection and social participation that is most important. Neighbourhood Centres are ideally placed to fulfill this need.

Community resilience relies on social networks and resources that enable communities to manage in times of disaster or emergency. This includes managing those who require assistance in dealing with a disaster and ensuring the most vulnerable are connected into social networks so that they are not left behind. For communities to take responsibility for those who are more vulnerable the engagement of local knowledge and networks is required. Organisations that deal with the most vulnerable, are aware of pockets of disadvantage within the community and those sleeping rough, and can maximise and increase that knowledge and the social participation and support networks for those in need with a little more resourcing. Mobilising social capital at the level of local organisations can increase community resilience.

With increased emphasis on the need for community involvement in shared responsibility and recovery, local organisations who can mobilise volunteers and engagement opportunities are an essential contributor at every stage of the community's planning, response and recovery activities.

5. References

[1] Norris, F. H., S. P. Stevens, B. Pfefferbaum, K. F. Wyche, and Pfefferbaum, R. L. (2008) Community resilience as a metaphor, theory, set of capabilities, and strategy for disaster readiness. *American Journal of Community Psychology*, 41, 127–150.

[2] Maclean K., Cuthill, M., Ross, H. (2014) Six attributes of social resilience. *Journal of Environment Planning and Management* 57(1):144–156, 146.

[3] Cuthill, M., H. Ross, K. Maclean, K. Owens, B. Witt, and C. King. (2008) Reporting social outcomes of development: An analysis of diverse approaches. International Journal of Interdisciplinary Social Science. 3:145–158, 146.

[4] Poortinga, W. (2006) Social relations or social capital? Individual and community health effects of bonding social capital. *Social Science & Medicine* 63, 255–270.

[5] Subramanian, S.V., Kim,D.J., Kawachi,I. (2002) Social trust and self-rated health in US communities: a multi level analysis. *Journal of Urban Health* 79,S21–S34.

[6] Berry, H. L., & Welsh, J. A. (2010). Social capital and health in Australia: An overview from the household, income and labour dynamics in Australia survey. *Social Science & Medicine, 70*(4), 588-596.

[7] Aldrich, Daniel P. (2012) Building resilience: social capital in post-disaster recovery. Chicago, IL: University of Chicago Press.

[8] Putnam, R., Feldstein, L and Cohen D. (2003) *Better Together: Restoring the American Community*. New York: Simon & Schuster.

[9] HILDA Self Questionnaire 14, v1 R08102 - W14DR1, B11, 6.

[10] Redshaw, S., Ingham, V. (2015), Community connections: Vulnerability and Resilience in the Blue Mountains. Bathurst: Charles Sturt University. Available at http://www.bmcc.nsw.gov.au/yourcommunity/communityservices/agedservices/communityconnectionsproject

[11] Tuohy, R. & Stephens, C. (2011) Exploring older adults' personal and social vulnerability in a disaster, *International Journal of Emergency Management*, 8(1), 60-73.

Inter-organisational characteristics of resilience in a post-disaster recovery context

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Abstract

During post-disaster recovery, an infrastructure system may be subject to a number of disturbances originating from several other interdependent infrastructures. These disturbances might result in a series of system failures, thereby having immediate impact on societal living conditions. The inability to detect signs of disturbance from one infrastructure during recovery might cause significant disruptive effects on other infrastructure via the interconnection that exist among them. In such circumstances, it clearly appears that critical infrastructures' interdependencies affect the recovery of each individual infrastructure, as well as those of other interdependent infrastructure systems. This is why infrastructure resilience needs to be improved in function of those interdependencies, particularly during the recovery period to avoid the occurrence of a 'disaster of disaster' scenario. Viewed from this perspective, resilience is achieved through an inter-organisational collaboration between the different organisations involved in the reconstruction of interdependent infrastructure systems. This paper suggests that to some extent, the existing degree of interconnectedness between these infrastructure systems can also be found in their resilience ability during post-disaster recovery. For instance, without a resilient energy system, a large-scale power outage could affect simultaneously all the interdependent infrastructures after a disaster. Thus, breaking down the silos of resilience would be the first step in minimizing the risks of disaster failures from one infrastructure to cascade or escalate to other interconnected systems.

Keywords: Infrastructure resilience, post-disaster recovery, infrastructure interdependency, inter-organisational collaboration

1. Introduction

The recent urbanisation of infrastructure, along with rapid population growth, has significantly exacerbated the risks and impacts of natural disasters, challenged recovery efforts and raised concerns regarding their effectiveness (Amaratunga and Haigh 2011). Although public organisations have seen a number of improvements in the field of risk evaluation and disaster preparedness, the frequency and severity of extreme events seem to keep increasing, mostly in terms of infrastructure damage and financial losses (Michel-Kerjan 2006). These increases can be attributed to a number of major changes including environmental degradation and the increase of dependencies and interdependencies of technical and social systems. For instance, energy and ICT (Information and Communication Technology) systems induce high degree of interdependencies to other critical infrastructures systems such as roads and rails transportation, as they provide services which are crucial to the functioning of these infrastructures at all times (Buldyrev et al. 2010; Dudenhoeffer, Permann and Manic 2006; Michel-Kerjan 2006). The restoration of interconnected networks following a disaster remains an immense challenge, especially in dealing with the complexity of interdependent structures and their emergent behaviours that become apparent when failure of a critical infrastructure induces a cascade of failures of other interdependent structures (Buldyrev et al. 2010). Considering the many issues that can arise from the impact of infrastructure interdependencies on post-disaster recovery efforts, the key to improving infrastructure vulnerability to disasters extends beyond the redesigning of large technical systems, and lies rather in increasing organisational resilience and reliability.

Recovery generally involves the physical reconstruction of critical infrastructures and the restoring of basic services to normalcy (Johansson and Hassel 2010; Kennedy et al. 2008; Lyons 2009). It is worth noting that there is now an international acknowledgement that post-disaster recovery is considered to be part of a cyclical disaster management process, where response and recovery phases succeed to prevention and preparedness phases and vice versa (Queensland Reconstruction Authority 2014). Most activities performed in each of these phases are interrelated and overlap each other. For instance, resilience takes on different connotations when it is considered in each of those phases. It is viewed as the capacity to mitigate and prepare for disasters when considered in the prevention and preparedness phases, as well as the capacity to respond to and recover from the impacts of disasters, when considered in the response and recovery phases (Queensland Reconstruction Authority 2014). Thus, a resilient infrastructure in the recovery context refers to an infrastructure that has the capability to regain the same basic structure and ways of functioning after being damaged, and demonstrates the ability to recover to normalcy once the disaster has passed (Hyogo framework 2005; UNESCAP 2013). In this case, infrastructure systems do not necessarily need to demonstrate the ability to anticipate the risk of potential damage in order to minimize the consequences of disaster, but instead need to demonstrate their capability to recover rapidly from natural disasters (Hollnagel 2014; Westrum 2006).

Norris et al. (2008) noted that some disasters although familiar in nature, are unpredictable as to where or when they will happen (the “known unknown” scenario), but other disasters are new and will not be known until they happen (the “unknown unknown” scenario). According to Wildavsky

(1988), anticipatory strategies produce better results with known issues, whereas resilience strategies produce better results when unknown issues occur. Thus, it is safe to say that anticipating the risk of damage works best when previously experienced disasters (with expected consequences) arise; whereas resilience strategies, particularly during post-disaster recovery, produce better results when disasters with new and/or unknown consequences occur (Allenby and Fink 2005). Nevertheless, experience has demonstrated that the past is not necessarily a predictor of the future. There are interesting examples of reconstruction projects that have broken the trends of their pre-disaster trajectories (Longstaff 2005). For example, the 2010/2011 Queensland floods in Australia were nowhere near what Queensland had experienced in previous years. Damage reached AUD 2.38 billion, exceeding the 1974 cost of damage, which was estimated at AUD 68 million (ADB 2013; Queensland Government 2012; Queensland Reconstruction Authority 2014). The recovery processes were more ambiguous than expected, giving rise to a need for new reforms and different approaches to be adopted in the aftermath of the 2010/2011 floods.

Thus, relying essentially on disaster anticipatory strategies could potentially reduce the ability of an organisation to adapt to unexpected changes and increase the vulnerability of its infrastructure. In conjunction with this, anticipating a disaster and its impact may vainly monopolize investments against dangers that could never take place. Resilience strategies on the other hand, could offer potential for some short-term sacrifices during recovery, in order to provide long-term survival in the future. This paper provides a comprehensive platform in understanding the role that inter-organisational collaboration plays in re-establishing a degree of resilience during post-disaster recovery. The paper argues that the key to improving infrastructure resilience after a disaster extends far beyond the redesigning of large technical systems and is to be found in the management strategies provided through a level of inter-organisational collaborations. Viewed from an interdependency perspective, resilience is considered as an inherent attribute needed to minimize potential (widespread) damage that could occur during the recovery period.

2. The propensity of critical infrastructures to fail due to interdependencies

Critical infrastructure systems such as energy, water (including sanitation), transport and ICT are made of multi-dimensional, highly complex set of technologies, processes, and people, and as such, are very often vulnerable to potential catastrophic failures whether from manmade or natural disasters. Some systems, such as telecommunications and electric power, operate in real-time, meaning that there is no possibility of stockpiling or scheduling demand: the whole system, from end to end, is "on" all the time (Auerswald et al. 2005). Other systems are less subject to the requirements of real-time operations, but even short or unexpected interruptions, for example in local road traffic, can cause major economic and social disruption. This is why Rinaldi, Peerenboom and Kelly (2001) referred to these infrastructures as complex adaptive systems. In the US Patriot Act mentioned by Sullivant (2007, p.538), critical infrastructures are described as physical or virtual assets, so vital that their incapacitation or destruction would have a debilitating impact on national and economic security, as well as public health or safety. (Sullivant; 2007 p.538).

Given the complexity, breadth and depth of critical infrastructures, one can readily observe characteristics that make the issue of protecting and recovering these critical infrastructures practically intractable (Alesch 2005; Buldyrev et al. 2010). For example, electric power systems are complex, semi-redundant networks of power generation, transmission, and distributions facilities relying essentially on technologies that may have been installed several years ago (Alesch 2005; Dudenhoeffer, Permann and Manic 2006; Freeman and Warner 2001; Kröger 2008). Furthermore, many of these critical infrastructures were designed and constructed over several decades with few, if any, security considerations in mind. This is particularly the case of the energy sector. As a result, each of these critical infrastructures faces a clear and present danger of failure by design or due to potential natural disasters. Adding to these challenges are the numerous dangers that arise from the inherent interdependencies that exist among critical infrastructures. For instance, electric power systems depend upon transportation networks to deliver fuel to generation facilities and to provide accessibility to infrastructure operators, recovery crews and the logistics chain during the post-disaster recovery. These same electrical generators often depend upon water systems for cooling purposes. In addition, electric power systems depend heavily upon telecommunication networks to support the Supervisory, Control and Data Acquisition (SCADA) systems that manage power transmission and distribution (Rinaldi, Peerenboom and Kelly 2001). Thus, any unplanned disruption in the operation of these infrastructure systems resulting from natural disasters, may lead to undesirable outcomes when implementing major post-disaster recovery and reconstruction projects.

Parfomak (2008) mentioned that the intrinsic interdependence that exist between large infrastructure systems make them more vulnerable and exposed to natural disasters (Parfomak 2008; Rinaldi, Peerenboom and Kelly 2001; Setola et al. 2009). Many interdependencies that exist between critical infrastructures are very strong, time-sensitive, and essential. Very often the result from this is a brittle “system of systems” that could lead to catastrophic occurrences of failures, which could cascade or escalate across other infrastructures (Dueñas-Osorio and Vemuru 2009; Moteff and Parfomak 2004). In other words, the higher the interdependencies that exist between those systems, the faster the disturbances tend to propagate through interdependent infrastructures. A pointed recent example can be seen in January 2013 where the blackout which occurred in Bundaberg region and across several southeast regions of Queensland in Australia after the severe storms associated with Cyclone Oswald, led to a loss of power for several businesses and homes (Queensland Reconstruction Authority 2014). Moreover, failure in the electrical power infrastructure had serious impacts on other critical infrastructures. For example, the loss of power subsequently led to a loss of water in many communities, as water systems depend heavily on power to operate the pumping systems that deliver water for consumption. The tight couplings within and across infrastructures and the brittleness that can result were clearly evident in the length of time it took to restore power to the affected regions (Queensland Reconstruction Authority 2014). It was also evident that failure isolation was a difficult task within these complex infrastructures, let alone across all other infrastructures at that time. While the January 2013 blackout may not be considered catastrophic from a human perspective, it was clearly catastrophic from an economic perspective and raised issues during the recovery period at the time. The 2013 damage caused approximately AUD 2 billion of additional damage to the roads networks that were still being reconstructed into 2012 (Queensland Reconstruction Authority 2014).

Kendra and Wachtendorf (2003) argued that the propensity of critical infrastructures to fail during post-disaster recovery is not always due to their interdependencies. According to Kendra and Wachtendorf (2003), these infrastructures systems are bound to experience failures or accidents due to the fact that they have a highly centralized decision-making structure within their own individual organisations. In other words, most of the decisions made within their organisations concentrate or focus primarily on issues related to their own infrastructures instead of decentralising or externalising them to other interdependent infrastructure in order to address complex issues that may result from their interdependencies. For instance, the decision of closing a road infrastructure system following a natural disaster could possibly affect rail transportation and electric systems as well. This type of decision could necessitate an increase in traffic on a parallel railway due to larger numbers of individuals and goods travelling by railway instead of using personal vehicle, bus or truck. The increase in rail traffic volume would require more electric power to sustain the traffic flow, which in turn could possibly generate an overload usage of the electrical network and possibly lead to a failure of the latter. Thus, due to interdependency, the decisions made by one organisation can also affect other infrastructures and hinder their recovery and reconstruction efforts. Therefore, instead of using the "divide-and-conquer" approach, LaPorte (2007) emphasised on the need to promote interrelationships among organisations during post-disaster recovery to contribute in the fast and efficient re-building of resilient infrastructures.

Although a large number of infrastructures are situated within private sectors, and they are managed completely or partially by the latter, contemplating infrastructure resilience in an inter-organisational context provides several advantages, including the transfer of knowledge, technology and expertise from both private and public organisations, together with the sharing of information on disaster risk and impacts, as well as research findings and best practices (Hyogo framework 2005).

3. Achieving infrastructure resilience through inter-organisational relationships

Inter-organisational relationships possess different connotations depending on the context and circumstances surrounding the events which bring them together. Across the world, inter-organisational relationships are present to varying degrees in governance, administration, mutuality, norms and organisational autonomy (Iverson 2013). Terms such as 'strategic alliance', 'joint venture', 'public-private partnership', 'coordinated service delivery', and 'community development', have been used in everyday managerial vocabulary to describe inter-organisational relationships. According to Van de Ven, Delbecq and Koenig Jr (1976), this type of relationship occurs when two or more organisations exchange resources in order to attain collective and self-interested goals. To Iverson (2013), collaboration is not to be confused with cooperation, which is a quite an informal type of relationship, or coordination, which is a very formal type of inter-organisational relationship. According to Iverson (2013), the extent of the relationship within collaborative organisations is higher than cooperative and coordinated organisations. Gray (2000, p.7) further argued that inter-organisational relationships are more than simple collaboration between organisations; it is a "process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible". Viewed from this perspective, for the purpose of this study, inter-organisational relationships will be examined as an essential resilience attribute to cope with complex recovery issues that escalate beyond the capacity and capabilities of a single organisation.

Over the last decade or so, authors have sporadically emphasized the need to consider resilience primarily within a single organisation in order to increase the organisation's ability to understand its current issues and situations and thus formulate appropriate responses that reflect these understandings (Lengnick-Hall, Beck and Lengnick-Hall 2011). Hence, the concept of organisational resilience was initially viewed as a unique blend of cognitive properties of an organisation that will allow successful responding and recovering from a disaster (Lengnick-Hall, Beck and Lengnick-Hall 2011). Furthermore, organisations can easily solve design and technical issues that are specific to the infrastructure's units and sub-units of a specific organisation, which would require a high level of involvement and also a high degree of autonomy from the organisation to act and react (Normandin, Therrien and Tanguay 2009; Telford and Cosgrave 2007). In this regard, the concept of organisational resilience also suggests the organisation's capability to plan for, respond to and recover from crises or natural disasters (Whitman et al. 2013).

According to LaPorte (2007), organisations work better alone for relatively well-understood and regular sources of disruption, such as storms or severe weather, as well as for relatively predictable budget requirements, standardized emergency preparedness, response and recovery procedures, and similar issues. For more complex dealings that could generate high risks and treats from natural disasters such as extreme floods, and earthquakes as well as bushfires, this would require organisations to be more flexible in seeking external collaboration and engagement with outsiders (LaPorte 2007). Furthermore, Turner (1976) argued that large scale organisational failures generally result from ignoring outside complaints, difficulties handling multiple sources of information, falling back on habit or ritual and the tendency to minimize danger. In situations where disasters occur, these elements incubate until they become part of the organisational culture, setting the stage for a serious problem to be triggered by an event that in other circumstances might be easily dealt with (Turner 1976). Some organisations attempt to deal with uncertainty by identifying goals and developing plans to achieve them, but in contingent and complex situations, they have a hard time knowing whether they have done enough (Turner 1976).

Researchers such as (Comfort and Kapucu (2006; Kapucu (2006, 2005, 2008; Kapucu, Arslan and Demiroz (2010; Kapucu and Liou (2014), have argued that infrastructure resilience cannot possibly be achieved by a single organisation. Building disaster resilience is the result of collaborative efforts between several parties involved in inter-organisational relationships. These researchers have described inter-organisational relationships as inherent attributes of resilience, which are generally established in function of the context (or environment) to which the collaboration take place, the dependability or reliance of resources between organisations involved, the economic impact generated by the transactions, as well as the contingency or eventually of not having any transaction taking place, and the institutional paradigms that could eventually impact the collaboration between organisations.

According to Normandin, Therrien and Tanguay (2009), inter-organisational relationships do not happen out of nowhere, they generally take place in political and economic context, in a socio-cultural context, as well as depending on the challenges involves. In a political and economic context, the collaboration between organisations is shaped by laws and rules that not only control the exchanges between organisations, but also protect each party involved (Normandin, Therrien and Tanguay 2009). This generally creates a level of trust as well as an extensive bond or proximity between organisations since they all have to comply with the same rules and regulations, especially for their own economic benefits. In a socio-cultural context on the other hand, collaboration between organisations is based on beliefs, values and standards that the organisations share (Normandin, Therrien and Tanguay 2009). In this case, organisations are obliged to remain in relationship to comply with those beliefs, values and standards. However, when depending on the challenges involved, in most cases the complexity of the issues encountered by organisations defines the complexity of the tasks required to be accomplished during recovery (Normandin, Therrien and Tanguay 2009). This will also lead to the development of obliged relationships between organisations. Thus, the broader context from which inter-organisational relationships happen as well as the differences between parties involved play a significant role in enabling those relationships.

Comfort (2007) mentioned that rebuilding infrastructure to a most reliable state after a disaster require concerted efforts to improve governmental response to natural disasters, increase infrastructure resilience, and reduce future threats. This can be achieved by:

a) Studying past failures with particular attention to communication and coordination problems in multi-jurisdictional settings, in order to improve complex inter-organisational system performance.

b) Recognizing that emergency operations are inherently non-linear and dynamic, and are not manageable by traditional rational and linear methods. In that case, this will require creative and effective operations against unpredictable threats.

c) Facilitating the transition to continuous organisational learning by making substantial investments in information technology and organisational reforms to take advantage of new enabled capabilities.

The above mentioned conditions can be measured by three principal indicators: technical measures, organisational measures, and cultural measures. Technical measures include the state of the infrastructures used by the system to respond to disasters, such as communications or transportation (Comfort, 2007). Organisational measures pertain to the degree of organisational adaptability to new and changing situations, style of communications among system participants and character of leadership (Comfort, 2007). Cultural measures include willingness to accept new ideas or new types of action.

Although inter-organisational collaboration could restrain autonomy of organisations in performing freely during recovery, Kapucu, Arslan and Demiroz (2010) mentioned numerous advantages in working as in a collaborative environment including understanding of the threat between a system and its members, sufficient trust among leaders, organisations, and citizens to overcome uncertainty and enable members to accept direction as well as the ability to gain sufficient resources to sustain collective action under varying conditions.

4. Conclusion

As noted earlier, building a degree of resilience to counter a wide range of potential disasters is a complex task requiring a holistic approach, often in the form of partnerships, which involve multiple organisational sectors such as energy, water (including wastewater), transport, and information and communication systems. Inter-organisational resilience in this paper alludes to the concept of infrastructure interdependency as each of the organisations involved in the post-disaster recovery is responsible for critical infrastructures that are constantly exposed to cascading and escalating failures due to their interdependencies with other infrastructures. Although several authors have favoured toward building disaster resilience within their organisation as a unique blend of cognitive properties that will allow successful responding and recovering from a disaster, many however, have recognized the need of inter-organisational collaboration to contribute to a better resilient infrastructure during recovery. This is especially true due to the fact that increasing interdependence among many organisations intensifies the problem of assuring failure-free operations. Although, the tension between maintaining organisational autonomy and independence against promoting collaboration and cooperation between organisations remain a controversy, many public and private sectors nowadays tend to work together during the recovery period. In most cases, disaster management plans and strategies, inter-organisational collaboration have been defined and incorporated at different levels. Thus, the real issue remains in linking resilience in a post-disaster recovery context to inter-organisational goals in order to reduce the impacts of infrastructure interdependencies.

References

ADB. 2013. *Investing in Resilience: Ensuring a Disaster-Resistant Future., Asian Development Bank*. Mandaluyong City, Philippines: Asian Development Bank, 2013. http://www.adb.org/sites/default/files/pub/2013/investing-in-resilience.pdf.

Alesch, Daniel J. 2005. "Complex urban systems and extreme events: toward a theory of disaster recovery." In *Proceedings of the 1st International Conference on Urban Disaster Reduction*, edited, 18-20: Kobe Japan.

Allenby, Brad and Jonathan Fink. 2005. "Toward inherently secure and resilient societies." *Science* 309 (5737): 1034-1036.

Amaratunga, Dilanthi and Richard Haigh. 2011. *Post-disaster Reconstruction of the Built Environment: Rebuilding for resilience*: John Wiley & Sons.

Auerswald, Philip, Lewis M Branscomb, Todd M La Porte and Erwann Michel-Kerjan. 2005. "The challenge of protecting critical infrastructure." *Issues in Science and Technology* 22 (1): 77-80.

Buldyrev, Sergey V., Roni Parshani, Gerald Paul, H. Eugene Stanley and Shlomo Havlin. 2010. "Catastrophic cascade of failures in interdependent networks." *Nature* 464 (7291): 1025-8. http://gateway.library.qut.edu.au/login?url=http://search.proquest.com/docview/204473461?accountid=13380

Comfort, Louise K. 2007. "Crisis management in hindsight: Cognition, communication, coordination, and control." *Public Administration Review* 67 (s1): 189-197.

Comfort, Louise K and Naim Kapucu. 2006. "Inter-organizational coordination in extreme events: The World Trade Center attacks, September 11, 2001." *Natural hazards* 39 (2): 309-327.

Dudenhoeffer, Donald D, May R Permann and Milos Manic. 2006. "CIMS: A framework for infrastructure interdependency modeling and analysis." In *Proceedings of the 38th conference on Winter simulation*, edited, 478-485: Winter Simulation Conference.

Dueñas-Osorio, Leonardo and Srivishnu Mohan Vemuru. 2009. "Cascading failures in complex infrastructure systems." *Structural Safety* 31 (2): 157-167. http://www.sciencedirect.com/science/article/pii/S016747300800057X. doi: http://dx.doi.org/10.1016/j.strusafe.2008.06.007.

Freeman, Paul and Koko Warner. 2001. *Vulnerability of Infrastructure to Climate Variability: How Does This Affect Infrastructure Lending Policies?* : World Bank, Disaster Management Facility, ProVention Consortium.

Gray, Barbara. 2000. "Assessing inter-organizational collaboration: Multiple conceptions and multiple methods." *Perspectives on collaboration*: 243-260.

Hollnagel, Erik. 2014. "Resilience engineering and the built environment." *Building Research & Information* 42 (2): 221-228. doi: 10.1080/09613218.2014.862607.

Hyogo framework. 2005. *Hyogo framework for action 2005–2015: Building the resilience of nations and communities to disasters. World Conference on Disaster Reduction, January, 18–22, Kobe, Hyogo, Japan.*

Iverson, Erik. 2013. "Networked Resilience: Achieving Inter-organizational and Intergovernmental Collaboration, FLETCHER SCHOOL OF LAW AND DIPLOMACY (TUFTS UNIVERSITY).

Johansson, Jonas and Henrik Hassel. 2010. "An approach for modelling interdependent infrastructures in the context of vulnerability analysis." *Reliability Engineering & System Safety* 95 (12): 1335-1344. doi: 10.1016/j.ress.2010.06.010.

Kapucu, Naim. 2005. "Interorganizational coordination in dynamic context: Networks in emergency response management." *Connections* 26 (2): 33-48.

Kapucu, Naim. 2006. "Public-Nonprofit Partnerships for Collective Action in Dynamic Contexts of Emergencies." *Public Administration* 84 (1): 205-220.

Kapucu, Naim. 2008. "Planning for disasters and responding to catastrophes: error of the third type in disaster policy and planning." *International Journal of Public Policy* 3 (5): 313-327.

Kapucu, Naim, Tolga Arslan and Fatih Demiroz. 2010. "Collaborative emergency management and national emergency management network." *Disaster Prevention and Management: An International Journal* 19 (4): 452-468.

Kapucu, Naim and Kuotsai Tom Liou. 2014. "Disasters and Development: Investigating an Integrated Framework." In *Disaster and Development*, edited by Naim Kapucu and Kuotsai Tom Liou, 1-15: Springer International Publishing. http://dx.doi.org/10.1007/978-3-319-04468-2_1. doi: 10.1007/978-3-319-04468-2_1.

Kendra, James M and Tricia Wachtendorf. 2003. "Elements of resilience after the world trade center disaster: reconstituting New York City's Emergency Operations Centre." *Disasters* 27 (1): 37-53.

Kennedy, Jim, Joseph Ashmore, Elizabeth Babister and Ilan Kelman. 2008. "The Meaning of 'Build Back Better': Evidence From Post-Tsunami Aceh and Sri Lanka." *Journal of Contingencies and Crisis Management* 16 (1): 24-36. http://dx.doi.org/10.1111/j.1468-5973.2008.00529.x. doi: 10.1111/j.1468-5973.2008.00529.x.

Kröger, Wolfgang. 2008. "Critical infrastructures at risk: A need for a new conceptual approach and extended analytical tools." *Reliability Engineering & System Safety* 93 (12): 1781-1787. http://www.sciencedirect.com/science/article/pii/S0951832008000744. doi: http://dx.doi.org/10.1016/j.ress.2008.03.005.

LaPorte, Todd R. 2007. "Critical infrastructure in the face of a predatory future: Preparing for untoward surprise." *Journal of Contingencies and Crisis Management* 15 (1): 60-64.

Lengnick-Hall, Cynthia A, Tammy E Beck and Mark L Lengnick-Hall. 2011. "Developing a capacity for organizational resilience through strategic human resource management." *Human Resource Management Review* 21 (3): 243-255.

Longstaff, Patricia H. 2005. "Security, resilience, and communication in unpredictable environments such as terrorism, natural disasters, and complex technology." *Center for Information Policy Research, Harvard University*.

Lyons, Michal. 2009. "Building Back Better: The Large-Scale Impact of Small-Scale Approaches to Reconstruction." *World Development* 37 (2): 385-398. http://www.sciencedirect.com/science/article/pii/S0305750X08001472. doi: http://dx.doi.org/10.1016/j.worlddev.2008.01.006.

Michel-Kerjan, Erwann. 2006. "Vulnérabilité financière face aux «risques à grande échelle»: la parole est à la première industrie au monde.»." In *Annales des Mines*, edited, 14-25.

Moteff, John and Paul Parfomak. 2004. "Critical infrastructure and key assets: definition and identification, edited: DTIC Document.

Normandin, JM, Marie-Christine Therrien and Georges Antoni Tanguay. 2009. "City strength in times of turbulence: strategic resilience indicators." In *Proc. of the Joint Conference on City Futures, Madrid*, edited, 4-6.

Norris, Fran H, Susan P Stevens, Betty Pfefferbaum, Karen F Wyche and Rose L Pfefferbaum. 2008. "Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness." *American journal of community psychology* 41 (1-2): 127-150.

Parfomak, PW. 2008. "Vulnerability of Concentrated Critical Infrastructure: Background and Policy Options. CRS (Congressional Research Service) Report for Congress." *Order Code RL33206*.

Queensland Government. 2012. *Queensland Floods Commission of Inquiry, Final report*. http://www.floodcommission.qld.gov.au/__data/assets/pdf_file/0007/11698/QFCI-Final-Report-March-2012.pdf.

Queensland Reconstruction Authority. 2014. *Monthly Report: February 2014*. 1.0 vols. http://qldreconstruction.org.au/u/lib/cms2/February-2014-Monthly-Report.pdf.

Rinaldi, S. M., J. P. Peerenboom and T. K. Kelly. 2001. "Identifying, understanding, and analyzing critical infrastructure interdependencies." *Control Systems, IEEE* 21 (6): 11-25. http://ieeexplore.ieee.org/ielx5/5488303/20901/00969131.pdf?tp=&arnumber=969131&isnumber=20901. doi: 10.1109/37.969131.

Setola, Roberto, Sandro Bologna, Emiliano Casalicchio and Vincenzo Masucci. 2009. "An Integrated Approach For Simulating Interdependencies." In *Critical Infrastructure Protection II*, edited by Mauricio Papa and Sujeet Shenoi, 229-239: Springer US. http://dx.doi.org/10.1007/978-0-387-88523-0_17. doi: 10.1007/978-0-387-88523-0_17.

Sullivant, John. 2014. "Strategies for Protecting the Telecommunications Sector." *Wiley Handbook of Science and Technology for Homeland Security*.

Telford, John and John Cosgrave. 2007. "The international humanitarian system and the 2004 Indian Ocean earthquake and tsunamis." *Disasters* 31 (1): 1-28. http://dx.doi.org/10.1111/j.1467-7717.2007.00337.x. doi: 10.1111/j.1467-7717.2007.00337.x.

Turner, Barry A. 1976. "The organizational and interorganizational development of disasters." *Administrative Science Quarterly*: 378-397.

UNESCAP. 2013 *Building Resilience to Natural Disasters and Major Economic Crisis., United Nations Economic and Social Comission for Asia and the Pacific*. United Nations, New York.

Van de Ven, Andrew H, Andre L Delbecq and Richard Koenig Jr. 1976. "Determinants of coordination modes within organizations." *American sociological review*: 322-338.

Westrum, Ron. 2006. "A typology of resilience situations." *Resilience Engineering–Concepts and Precepts. Ashgate Publishing Company*: 55-66.

Whitman, Zach R, Hlekiwe Kachali, Derek Roger, John Vargo and Erica Seville. 2013. "Short-form version of the Benchmark Resilience Tool (BRT-53)." *Measuring Business Excellence* 17 (3): 3-14.

Wildavsky, Aaron B. 1988. *Searching for safety*. Vol. 10: Transaction publishers.

URBANISATION and DISASTER RISK in URBAN VILLAGES: CASE STUDY DELHI

Abstract

Most cities in developing countries have only been able to absorb urban growth through the expansion of informal settlements. The location of such settlements in hazard prone areas, the vulnerability of housing and local services and the lack of provision of the infrastructure necessary to reduce hazard and configure urban disaster risk (GAR United Nations, 2009). **In Delhi**, d**ue to accelerating urban sprawl as well as planned urbanization large areas of farmland are transformed into non-agricultural land. In the process some villages become surrounded by urban built up areas and remain the villages within urban area which are named as "urban villages".** Urban villages of Delhi has experienced rapid urbanization both in terms of its population and built mass, with no physical expansion of the 'abadi'(habitation) area. Thus, the settlements have fixed areas but the population is growing day by day increasing the load on the existing facilities. Also the built mass is increasing on fixed land area decreasing the percentage of the open area.

Consequently, urban villages are characterized by high growth rate, high density, over population, unplanned buildings and infrastructure shortage. The rapid physical development is degrading the built environment of these urban villages. The built environment degradation multiplies the actual impacts of hazards and limits an area's ability to absorb those impacts, which in turns decreases the overall resilience to hazard impacts and recovery from disasters (Fernandez et.al.2012). All the districts of Delhi are highly prone to multi hazards like earthquake, flood, fire and industrial accident. Vulnerability to disasters is closely linked with population density and economic resources. The major factors influencing disaster risks are physical, social, economic and environmental vulnerability, matched with the overall capacity to, or reduce the impact of hazards. Considering the context of the characteristics of urban villages, unmanaged risks may lead to disasters.
First the paper examined the impact of urbanization on urban villages in Delhi and highlights the district wise distribution of urban villages. Second the paper examined the hazards and vulnerability of risk in urban villages and analyse the characteristics of urban villages that create disaster risk vulnerability**.**

***Keywords**: Urbanisation, Disaster Risk, Vulnerability and Urban Villages*

1. Introduction

Urban villages are dynamic entity in the process of urbanisation. The word meaning urban is city, town, metropolitan as well as municipality whereas village meaning rural community, hamlet, settlement etc. The two words together with contradictory meaning form the "*urban village*". Urban villages could be defined as a village that has acquired urban character by virtue of loss of primary sector economic activity (*Tyagi, 1982*). The fast growing urbanism and increase in population not only result in the rise of big cities, but also as the cities cross the limit and trespass to organic areas, agricultural lands, gardens and after all the nature, they produce urban villages which are villages which are passing from village to city *(Qasim, 2005)*.These are the villages that are experiencing change from village to city.

In developed countries, urban village usually refers to a well-planned development at the edge of an urban area. In the Dictionary of Human Geography *(Johnston, 1971)*, an urban village is defined as a residential community, in which residents have the same or similar cultural and ethnic identity, often placed in the transition zone. The urban village concept was first developed and promoted by the Urban Villages Group in the late 1980s. The concept was guided by a philosophy and a set of principles which called for well designed, mixed use and sustainable urban areas, with a sense of place and community commitment *(Aldous, 1992)*. The context for the concept was one of increasing concerns with the quality of modern development, especially when compared with older, more traditional areas.

The urban village movement has been influenced by Ebenezer Howard's Garden City ideals. The idea of an urban village is thus a space that could keep the best of both, rural and urban, in a harmonious and symbiotic way. It is one of the more sustainable means of retaining urban ways of living in urban spaces (*Sen, 2013.)* Also known as new urbanism towns and villages, these places are becoming more popular as people have had enough of suburban traffic jams, and the lack of good urbanism. Urban villages are places where everything needed is within walking distance (shops, restaurants, movies, services), including public squares to relax in and meet people (*Kenworthy, 2000*). The idea of an urban village is to see a massive city as a collection of neighbourhoods which are self-sustainable and where people can collectively share and own the neighbourhood while still retaining the sense of being part of the bigger city.

The conception and perception of urban villages are very different in the context of developed and developing countries. Urban growth in developing areas is proceeding in a different cultural and economic background than that of experienced by the developed world. Urbanization in most of these cases is given by the demographic force that is rural to urban migration rather than by dynamic economic and industrial forces as in European and North American countries (*Sen, 2013.)*. Urbanisation in developing countries is marked by large increase in population and has consequences such as sprawl. As a physical phenomenon, urbanisation takes two paths: through expansion of existing urban bodies by engulfing adjoining villages into their territory and through the independent transformation of rural areas into urban areas (*Qadeer, 2004*). Urban villages in Indian cities are urbanized villages that are original villages that have conformed to the urbanization pattern around them and have submitted to the current development paradigm. *(Chatterjee*, *2014)*.

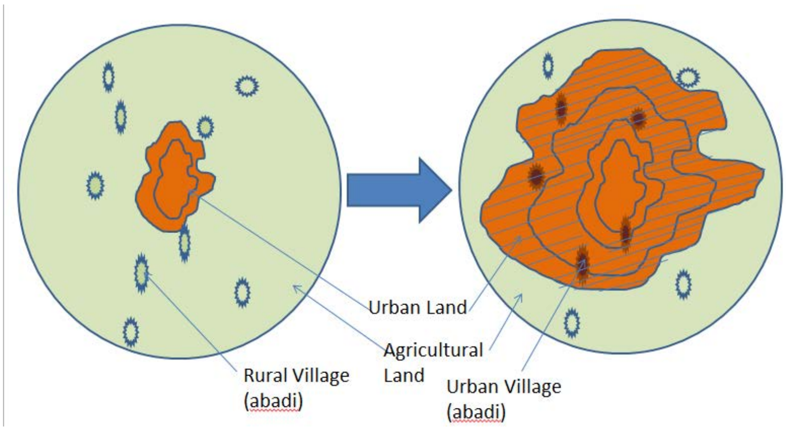


Fig 1: Engulfment of villages in the process of urbanisation
Source: Author

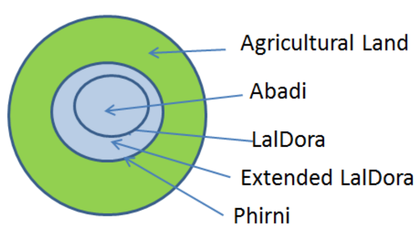


Fig. 2: Structure of an Urban
Source: Author

NOTE: The term '*Lal Dora'* was used for the first time in the year 1908. It is a name classification given to that part of the village 'abadi" (habitation). It is supposed to be used for non-agricultural purpose only. It is that part of the land which was supposed to have been an extension of the village habitation, wherein the villagers used to have their support systems, livestock etc. In olden days, these areas were marked by the revenue department by tying a red thread (*Lal Dora* in Hindi language) around it, to make a boundary and to distinguish it from the agriculture land. (MPD, 2021)

In Delhi villages have been engulfed in the process of urbanisation and rural villages are transformed into urban villages (Fig.1). Urban villages are characterized by mixed land use, compact built form and unplanned buildings (MPD, 2021). These Urban Villages represent an area of transition, a combination of both urban and rural.

According to Hao, (2011) the development path of urban villages involves three phases, namely expansion (more land), densification (higher built-up density through infilling) and intensification (increasing floor space per plot). Facing increasing natural and institutional constraints, this development path is a logical response for the indigenous villagers to exploit the economic potentials of their property. In case of Delhi, the land area of the urban village is not expanding, but the built mass is increasing both horizontally and vertically to accommodate the increasing population in the urban villages. Thus densification and intensification is taking place in a fixed area of land.

First the paper examined the impact of urbanization on urban villages in Delhi and highlights the district wise distribution of urban villages. Second the paper examined the hazards and vulnerability of risk in urban villages and analyse the characteristics of urban villages that create disaster risk vulnerability.

2. Urbanisation of Delhi

The trend of urbanization of villages in Delhi has followed a steady path with a significant increase in the number of urban villages and the process of converting villages to Urban Villages have not stopped. The urbanisation of Delhi dates to the beginning of the 20th Century. In 1901, 52.76% of the total population of Delhi was urban. The urban area in Delhi territory has increased from 22% in 1961 to 75% of the total area in 2011 (Table 1) with the notification of 135 urban villages under clause (a) of section 507 of Delhi Municipal Corporation Act, 1957.

Table 1: Increase in urban area

Year	Urban Area (Sq.km.)	Percentage of Urban Area	Decadal Decrease in Rural Area (Sq. km.)
1961	327	22	-
1971	446.30	30	119
1981	591.91	40	148
1991	685.34	46	93
2001	924.68	62	240
2011	1113.65	75	189

Source: Statistical Abstract of Delhi 2012

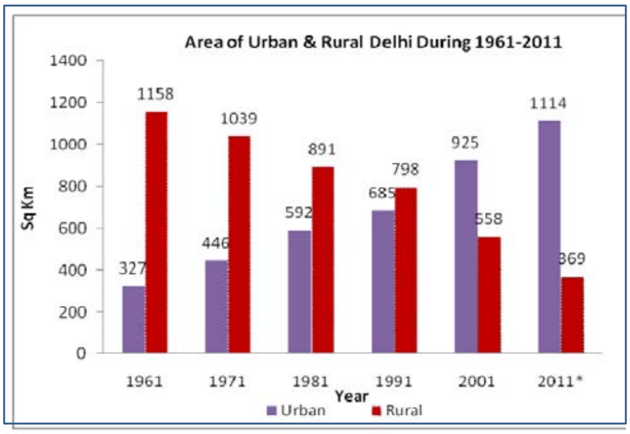


Fig. 3 Area under Rural and Urban Delhi

In 2011 out of the total population of Delhi (16.75 million), around 16.3 million is urban population and 0.5 million is rural population with decrease in rural population by more than 55% during the last decade (Table 2). The urban population of Delhi is 97.5% whereas rural population is 2.5% in 2011. There is an increase of 63% area to accommodate 93% increase in population from 1991-2011.While the total population growth from 2001 to 2011 is 21%, the urban population growth is 27% (Table2) indicating that Delhi has been urbanizing faster than it is growing in the past decade.

Delhi has been experiencing this rapid population growth because of its functional importance and by 2021 its population is expected to be around 23 million (MPD 2021).

The rapid urbanisation of Delhi has resulted in a sharp increase in the density of population. In 1901, the density was 274 persons per sq. km, this increased to 1176 persons per sq. km in 1951 and 9294 persons per sq. km in 2001(Economic survey of Delhi, 2001-2002). In 2011 density of Delhi is 11,297 per sq. km which is higher than national average 382 per sq. km. (Census 2011). Such growth has put tremendous pressure not only on national resources, but has also increased risks of natural disaster. The city is dotted with all kinds of buildings and infrastructural facilities, ranging from very good constructions to extremely poor designs and constructions (Yamin 2012).

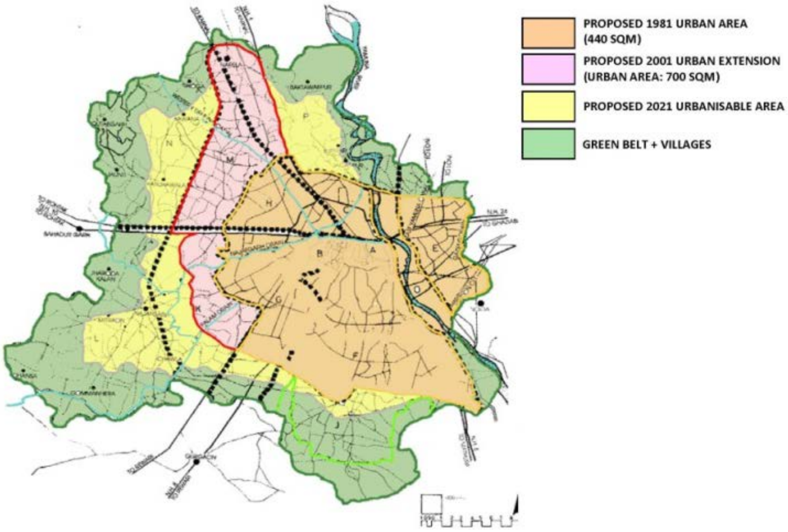


Fig.4 Increasing urban area of Delhi
Source: www.dda.org.in

Table 2: Percentage of Rural and urban population of Delhi

Year	Total Population	Rural Population	Decrease % of Rural population	Urban Population	Decadal urban growth%	Rural Population %	Urban Population %	Area	Density
1991	9,420,644	949,019		8,471,625				1483	
2001	13,850,507	944,727	0.5%	12,905,780	52.5	6.85	93.15	1483	9294
2011	16,753,235	419,319	55%	16,333,916	27%	2.50	97.50	1483	11,297

Source; Census of India

2.1 Urban villages in Delhi

The growth of Delhi had taken place mainly through spatial expansion over last half a century (Hust, 2005). During the making of New Delhi both agricultural and 'abadi' i.e. the residential area was acquired and villagers were compensated and some were rehabilitated in outlying areas. Thus, there were no residual villages within the New Delhi. However, this policy was not followed in post-independence development. Systematic acquisition of agricultural land was postulated in the first Master Plan. While the agricultural land was acquired, the 'abadi' areas were not acquired the 'abadi' areas were circumscribed by a red line and that is how the term 'Lal Dora' came into use.
The 'urban village' lands were classified as 'Lal Dora', in the context of the Master Plans. Land use in the village 'abadi' within the 'Lal Dora' was strictly residential. Urban Delhi grew fast around them while the villages remained within the confines of their 'Lal Doras' (Shrivastava, 2007). Legally Urban Village is defined as: "Any area ceases to exist as rural and is converted into urban

area if it is declared under clause (a) of section 507 of the Delhi Municipal Corporation Act, 1957. The administrative control of Gram panchayat ceases and such villages are included in the urban limit and are known as the "urban village". The legal consequences of urbanization of a village is that the provisions of Master Plan/Zonal plan/relevant Area Development Plan/Building Bye-laws become applicable and the provisions of the Delhi Land Reforms Act ceases to operate as per the provision u/s 1 (2) of the said Act.

But building control regulations were neither prescribed in the Master Plan nor made effective in urban villages (Lal Dora or Extended Lal Dora) under the erroneous but convenient assumption that since such regulations were not applicable in the village 'abadi', the same would also not apply to urban villages as well (Shrivastava, 2007).

In total 25 villages were brought into the urban fold before 1931 (Fig.5) in the subsequent decade 48 villages were included and another 40 were included during 1961-71 to meet the growing urban needs. The 1981 census declared 111 urban villages in the urban limits of Delhi. In 1996 the total number of urban villages stood at 135(CDP, JNNURM, 2006). Non-applicability of building byelaws in these 135 villages results high concentrations of people, uncontrolled growth, poor sanitation and infrastructure.

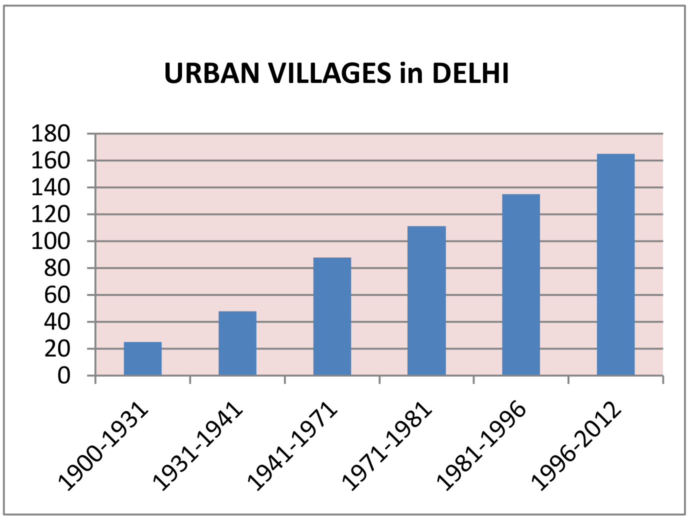


Fig.5 Urban villages in Delhi, Source: CDP, JNNURM,

2.2 District wise growth of Delhi and the urban villages

Out of total 9 district of Delhi, North-West has highest population with 3651261 persons while North-East has the highest density of population i.e. 37346 persons per sq.km (Table3) as per the provisional census population 2011. The highest population of 21.79% is in the North-West district, whereas the lowest 0.80% is in New Delhi district. The city witnessed decrease in population in Central and New Delhi districts during the last decade and these two districts do not have any urban village whereas the population has gone up in all other seven districts. The highest decadal growth has been observed in South-West district with 30.62% (Table 3) rise where the maximum numbers of urban villages were notified in the year 1994 (Table 4), while New Delhi had negative growth of 25.35% as per the provisional results of 2011 Census(Table 3). In 1963 and 1966 after the first master plan in 1961 total of 91 villages were notified out of which 34 were in south district (Table 4).

Table 3: District wise Population data of Delhi

S. No.	District/State	Total Population (in lakhs)		Population in %		Density /Sq. Km.		%Decadal growth rate of Population
		2011	2001	2011	2001	2011	2001	2001-11

1	NCT of Delhi	167.53	138.5	100	100	11297	9340	20.96
2	North West	36.51	28.6	21.79	20.7	8298	6502	27.63
3	North	8.83	7.82	5.27	5.6	14973	13246	13.04
4	North East	22.4	17.68	13.38	12.8	37346	29468	26.73
5	East	17.1	14.64	10.19	10.6	26683	22868	16.68
6	New Delhi	1.34	1.8	0.8	1.3	3820	5117	-25.35
7	Central	5.8	6.5	3.45	4.7	23147	25855	-10.48
8	West	25.31	21.3	15.11	15.4	19625	16503	18.91
9	South West	23	17.55	13.68	12.7	5445	4169	30.62
10	South	27.34	22.67	16.32	16.4	10935	9068	20.59

Source: Statistical abstract of Delhi 2012

2.3 District-Wise distribution of urban villages in Delhi

Distribution of urban villages in the National Capital Territory of Delhi is found in the seven districts out of the nine revenue districts. The table 4 helps to understand the nature of their concentration for the purposes of a comparative study.

There exists the largest concentration of urban villages in the South District. It has 41 urban villages, out of which 34 were notified in 1966, whereas 3 have been notified in 1963 and 4 in 1982. The South west District has the second largest concentration of urban villages with 27 urban villages. Most of the urban villages of south west district were notified in the year 1994, 19 out of 27. Rest villages notified in the year 1963, 1966 and 1982 were 2, 5 and 1 respectively. The West District has a concentration of 18 urban villages, In the West district 9 out of 18 villages were notified in 1966.

Table 4: Urban villages under u/s 507 of Delhi Municipal Corporation Act, 1957

Districts	**Number of Urban villages notified in**				Total urban villages in 2011
	1963	1966	1982	1994	
North west	5	9	10	-	24
North	2	-	2	-	4
North East	-	4	2	-	6
East	1	12	2	-	15
New Delhi	-	-	-	-	--
Central	-	-	-	-	--
West	5	9	3	1	18
South	3	34	4	-	41
South west	2	5	1	19	27
Total	**18**	**73**	**24**	**20**	**135**

Source: http://delhigovt.nic.in/temp/urbanized.asp

The East District has low concentration of urban villages 15 numbers as compared to the South west and South District's. Out of the 15 urban villages 12 were notified in 1966. The North and North East District has least concentration of urban villages. The North district has 4 numbers of urban villages. Out of these 4 urban villages 2 were notified in 1963 and 2 were notified in 1982. In North East District out of 6 urban villages 4 were notified in 1966 where as 2 in 1982. The North West district has a higher concentration of urban villages with 24 numbers.

While analysing the distribution of urban villages' district wise, it is found that 50% of the total urban villages are in south and south west district. Also 50% of the urban villages were notified in 1966 out of which 50% are in South district. These villages which were brought to urban fold during 1970s are at present intensely commercialized, high density settlements beyond the reach of the building bye laws (Mishra, and Singh 1996). Besides this the negligence of the development authority about the very transition process of the 'urbanising villages' leads to formation of another 'urban village' within the urban expansion. They encourage uncontrolled as well as unplanned growth and congestion. The high density built-up area are exerting pressure on the existing infrastructure and facilities resulting in high consumption of resources, disturbing the urban ecology and leading to social insecurity (Begum, 2005).

3. Disaster risk as the product of hazard and vulnerability

Disaster Risk is defined as the product of hazard and vulnerability (R=HxV), or –to put it another way – risk as the probability of an encounter between a specific hazard and an element vulnerable to this is interpreted as the probability of occurrence of loss of life or damage to objects, buildings and the environment as the result of an extreme natural phenomenon with a specific strength or intensity (Kohleret al., 2004).

Hazard and vulnerability must be simultaneously present at the same location to give rise to risk, which then becomes a disaster if the event actually occurs. Vulnerability can only be identified and studied with reference to a concrete hazard.

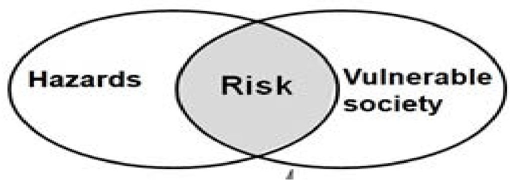


Fig.6 Concept of Risk Source: Author

3.1 Hazards in Delhi

In order to assess the risk probability on to those areas of the state at risk, it is necessary to understand the types of hazard and likelihood of occurrence of hazards.

3.1.1 Seismicity

The entire state of Delhi falls under Seismic Zone IV in the national seismic map. This means the state is adjacent to the high vulnerability area i.e. zone V. The Tectonic activities under the national Capital Territory are shifting swiftly. The increased number of illegal construction practices in the area has been one of the forces behind this (DDMP, 2011). The map (Fig. 7) shows the distribution of urban villages on the different levels of Seismic Hazard Micro zonation Map of NCT, Delhi. About 40% of the urban villages fall in the high and 50% in the medium where as 10% in low hazard of seismic zone.

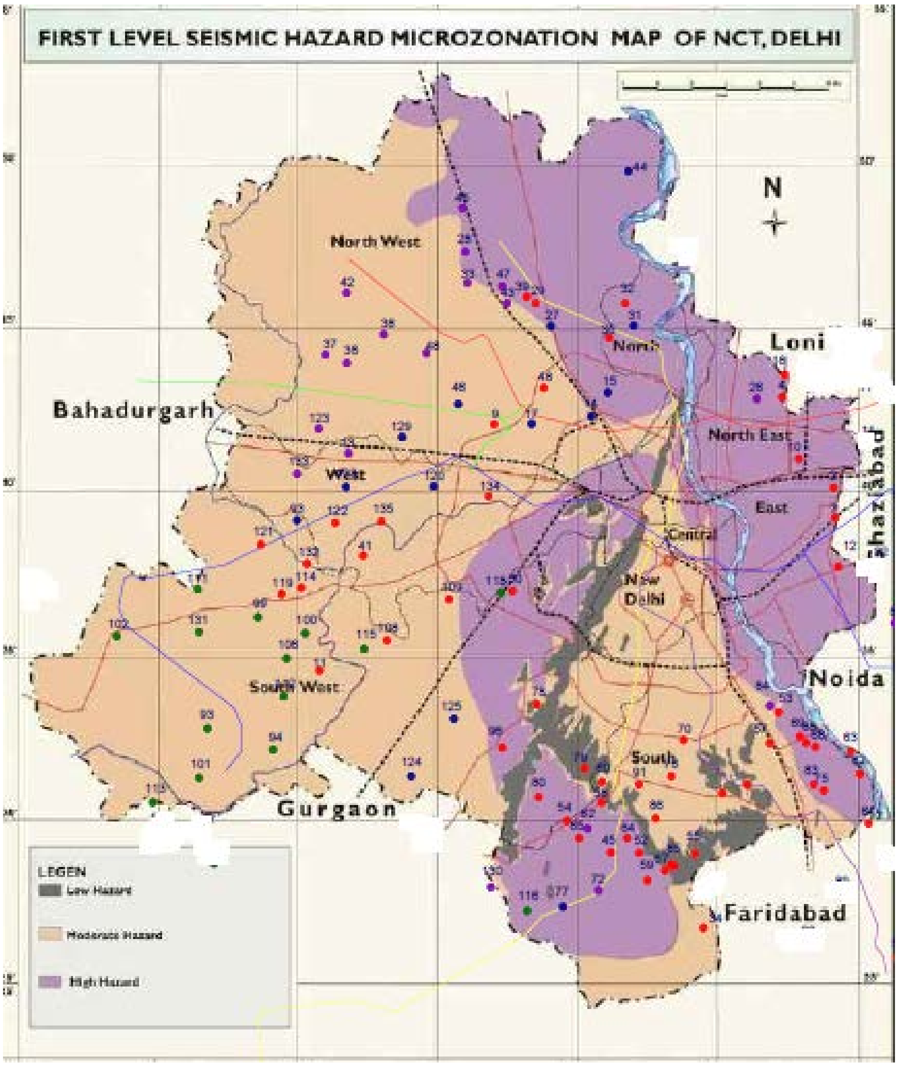


Fig. 7 Distribution of Urban villages on Seismic Hazard Microzonation Map of NCT, Delhi
Source: Seismic Microzonation of NCT Delhi and Author

3.1.2 Floods

Floods in Delhi are not natures wrong doing; it is invariably the irresponsibility of the authorities and those who are totally insensitive of human life blinded by the economics of haves and haves not (*Hazard and Risk Assessment 2011*). The flood zoning pattern of Delhi reveals that the high risk zones are the areas that have earlier been identified as unplanned or poorly planned areas having high population densities and sub-standard housing structures. These include areas of North Delhi, and Trans Yamuna Area (*Hazard and Risk assessment 2011*).Thus the urban villages in North Delhi and Trans Yamuna areas which constitute almost 15% of the urban villages are threatened due to floods

3.1.3 Fire hazards

Fire hazards; include fires due to chemicals, LPG, explosives as well as short circuit of electrical systems. About 70%of fires are estimated to arise from electrical causes, mainly short circuiting and another about 17% due to carelessness (*Hazard and Risk Assessment 2011*). Electric short circuiting results mainly from illegal loose connections, substandard wiring and over loading of the system.

Illegal tapping of electricity from overhead lines through use of loose hooks has been a common sight in urban villages of Delhi (Fig 8).

Fig.8 Illegal tapping of electricity, a common sight in urban villages of Delhi
Source: Author

3.1.4 Industrial Hazards

Industrial accidents may occur as a result of natural phenomena, such as earthquakes, forest fires etc. however; most accidents occur as a result of human activity leading to accidental or deliberate harm. Although there are a number of different definitions of these accidents, the most practical appears to be as follows: any incident connected with an uncontrolled development (such as leak, fire and /or explosion) of an industrial activity involving a serious immediate or delayed hazard to man and / or the environment (*Hazard and Risk Assessment 2011*).

The Master Plan of Delhi, 2021 has notified non-conforming clusters of industrial concentration having more than 70% plots in the cluster with industrial activities for redevelopment, which includes 10 urban villages. These urban villages are: Garhi Peeran, Khyala, Basaidarapur (1963), Nawada (1994) and Hastsal (1966) are in West District. Shalimar Village, Haiderpur and Rithala are in NW (1982), New Mandoli in NE (1982), and Dabri in SW (1994). West district has the maximum number of Urban Villages which have non-conforming industrial activities.

3.1.5 Epidemics

In urban villages, the line of village 'abadi' has not been extended but the increase in population has been phenomenal. In these twin conditions population residing within the Lal-dora has been suffocating. In small houses more than 15 to 20 people and the animals are living together leading to health–hazards and breaking out of disease in the epidemic form. (Gupta, 1986).

Table 5: Risk and Vulnerability levels on the basis of Hazards in Delhi

S.No	Hazard	Districts of maximum risk (in terms of damage and losses-)	Vulnerability
1	Earthquakes	North East, East, Central , North, North West and West Southwest and New Delhi	More than High Moderate to High
2	Floods	North-east, east, North, North west	Moderate to High
3	Wind storms	All districts	Low
4	Epidemics (water borne diseases)	All districts	Medium
5	Road Accidents	All districts	High
6	Fires	All districts	Medium
7	Industrial and Chemical Accidents	All districts	High

Source: Draft- Hazard and Risk Assessment (2011)

Thus all the Districts of Delhi are at risk due to several hazards. Disturbances can be caused due to occurrence of frequent hazards like earthquakes, fires, floods, industrial accidents, road accidents and epidemics (Table 5). Level of risk (high/medium/low) depends upon the various hazards for which any specific area is prone to and/or also on the various physical, social-economic and institutional parameters.

3.2 Vulnerability in Urban Villages

Disaster vulnerability in urban areas arises from a result of a combination of interrelated physical, socio-cultural, economic, and institutional conditions (Gencer, 2013). Risk and the impacts of disasters multiply when population growth is not met with proper land-use planning and appropriate institutional and legislative arrangements (Marjanovicet.al., 2003), and urbanisation is one of the major factors that influence the risk level of a nation (Wisner et al., 2004). Vulnerability and its severity depend on a range of aspects. Vulnerability aspects in Delhi are allocated to the following four categories: physical, environmental, economic and social. The vulnerability indicators defining physical, economic, social and environmental vulnerability in an urban village can be aggregated and combined into an overall vulnerability (Fig. 9).

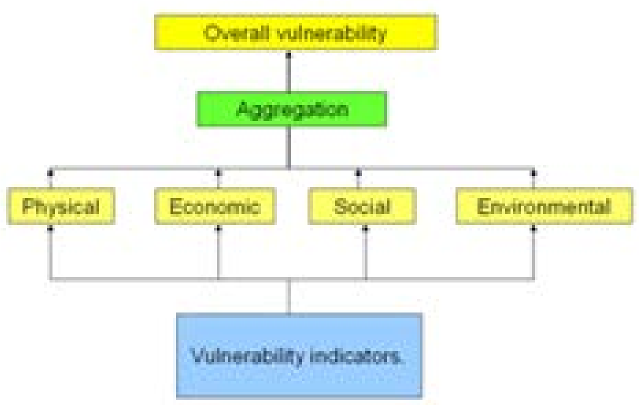
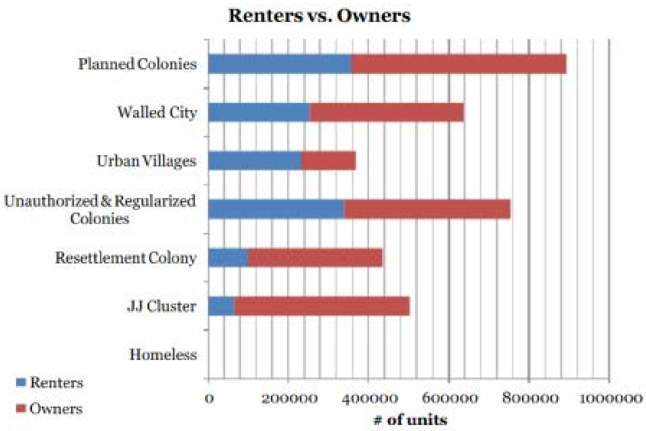


Fig. 9 Overall vulnerability calculation
Source: http://ftp.itc.nl/pub/westen/Multi_ hazard_risk_course

3.2.1 Physical Vulnerability

Urban villages of Delhi has experienced rapid urbanization both in terms of its population and built mass. With no physical expansion of the 'abadi' area as the settlements have fixed areas population is growing day by day increasing the load on the existing facilities. Also the built mass is increasing on fixed land area decreasing the percentage of the open area.
Taking the advantage of 'Lal Dora' status the original population of the villages earned huge profit from land transactions (Deswal, 2007) and found opportunity to build in and around their villages,



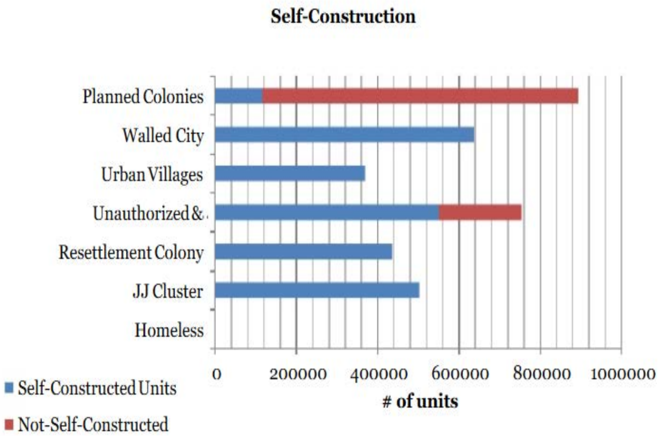


Fig.10 Ownership in different types of housing *Fig.11Self construction in different types of housing Source: Soni, 2014*

An 'urban village' of Delhi represents a process in which a rural settlement is caught in a process of rapid urbanization of a metropolis (Mehra, 2000). While such a settlement suddenly loses the source of its livelihood, it has to adjust to new types of economic activity it has not hitherto been familiar with. Tenancy became one of the major sources of alternative livelihood in these villages. Fig. 10 shows 66% of houses in the urban villages are occupied by the tenants.
Rapid construction and stacking floors over floors, without undertaking any safety measures, is taking place. This is just a way for many land owners to maximize their monetary benefits. High income from tenancy has led to haphazard and mindless construction of buildings (Yamin, 2012). Fig.11 shows 100% buildings in the urban villages are self-constructed. These buildings are of major concern in case of any disaster, as they have poor safety measures and the density of population in urban villages is very high.

3.2.2 Social Vulnerability

According to Anderson and Woodrow (1990) people who have been marginalized in social, economic or political terms are vulnerable to suffering from disasters whereas groups, which are well organized and have high commitment to their members, suffer less during disasters.
In urban villages of Delhi prevails wide range of social standards and social-cultural conflicts because of the different background of the immigrants. The urban villages provide housing to the rural populations who have migrated in search of work in the informal sector (Chatterjee, 2014). These urban villages provide low rent neighbourhood and the immigrants try to adapt their non-

urban institutions. A typical urban village is in constant conflict of traditional values and development happening in the vicinity (Development Plan of GNIDA Expansion). Poor migrants live under the most crowded conditions; they depend on rented accommodation, which they often share with many others to save money. Some households are inclined to rent out a portion of their living space or cattle sheds to tenant (Bentinck, 2000). Such situation in urban villages makes them socially vulnerable.

3.2.3 Economic Vulnerability

A typical family in an Indian urban village thrives by renting multi-storey apartments at prices below those of the surrounding upmarket rental properties. Others operate a variety of businesses from their homes including grocery shops or services such as tailors, barbers, cyber cafes, telephone booths, or they find place in the vast labour pool providing support services such as call centres, taxi drivers, salesmen and so on. (Sharma 2012). Thus, with the shift on the occupation from agricultural base, the economy of the villages has deteriorated. Deprived of farms and fields and cramped within the red-lines, they are economically vulnerable to disaster risk.

3.2.4 Environmental Vulnerability

Urbanization is creating high density, substandard housing, urban poor and environment degradation which result in disasters in hazard-prone urban areas. Disasters are failures of development or result of unsustainable development (Apikul C, 2010). With agricultural fields (that provided the open environment) having been acquired by DDA or grabbed/colonised by market forces driven by skyrocketing land-values, on the one hand and with natural increase in village population on the other, the village ‘abadi’s have become intolerably cramped. It has not been possible to extend even the basic-most civic services like water-supply and sewage-disposal in the narrow twisting streets and haphazard layouts within ‘Lal Dora’ in all the 135 urbanized villages as on date. Most of the dwelling units are inaccessible to ambulances and fire-tenders to attend to emergencies (Shrivastav, 2007).The villages that once had plenty of open spaces, farms and fields full of greenery are now sub-standard, cramped pockets of insanitation making them environmentally vulnerable to disaster.

4. The Conceptual Framework

Disasters are the convergence of hazards and vulnerable conditions (Fernandez et.al.2012) and vulnerable conditions are due to the characteristics of the urban villages. A conceptual framework has been derived to define the characteristics of the urban villages. These characteristics form the indicators defining the physical, social, economic and environmental vulnerability. Hazard being present in the districts of Delhi give rise to risk, which then becomes a disaster if the event actually occurs. Also taking into account the south and southwest district where the maximum number of urban villages occurs may be impacted the most. Capacity and measures of the community needs to be enhanced to protect against the risk.

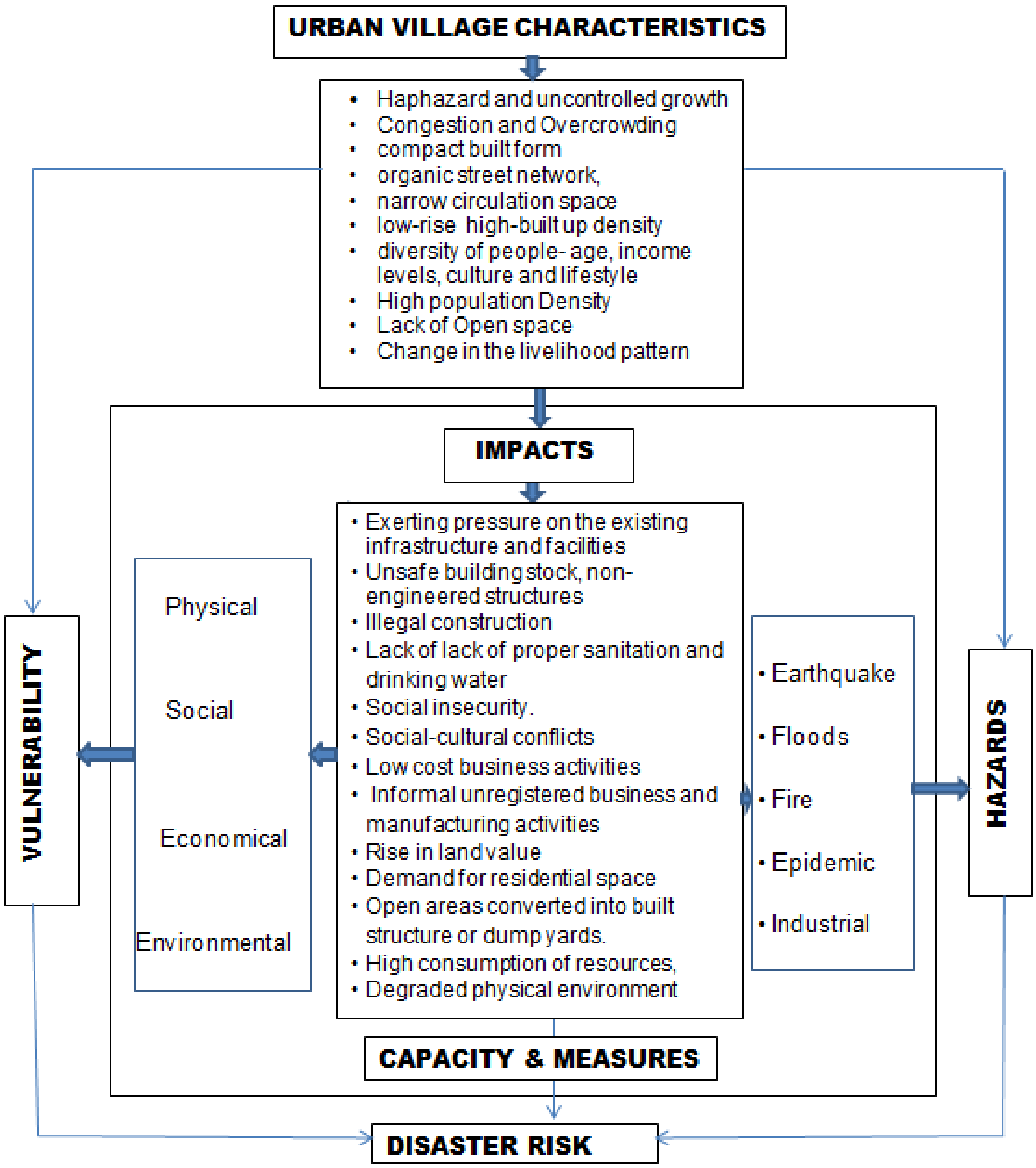


Fig. 12: Conceptual Framework of Vulnerability to Disaster Risk, Source: Author

5. Conclusion

Built environment degradation multiplies the actual impacts of hazards and limits an area's ability to absorb those impacts, which in turns decreases the overall resilience to hazard impacts and recovery from disasters (Fernandez et.al.2012). Vulnerability to disasters is closely linked with population density and economic resources. Urban villages of Delhi are characterised by high growth rate, high density, over population, unplanned buildings and infrastructure shortage. It is concluded that disaster risk is dynamic and increasing rapidly in urban villages. The major factors influencing disaster risks are physical, social, economic and environmental vulnerability, matched with the overall capacity to respond to, or reduce the impact of hazards. Considering the context of the characteristics of urban villages, unmanaged risks may lead to disasters. Thus affect the lives, livelihoods and properties in urban villages. Hence specific interventions for risk mitigation are necessary.

References

- Global assessment Report on Disaster risk reduction, United Nations (2009) Chapter 4. The heart of the matter the underlying risk drivers. (online) Available from http://www.preventionweb.net/english/hyogo/gar/report/documents/GAR_Chapter_4_2009_eng.pdf.(Accessed 22.04.2013)
- Fernandez, R; Sanahuj, H, (2012) Linkages between population dynamics, urbanization processes and disaster risks: a regional vision of Latin America. Available fromwww.unisdr.org/*(Accessed 4.10.2013)*
- Tyagi, V.K. (1982), Urban growth and urban villages: A case study of Delhi. Kalyani Publications, New Delhi.
- Qasim I. Z. (2005) Role of Modern Urban Planning in Urban Village's Development and the Study of their Problems Case Study: Tehran.
- Johnston, R. J. (2009).The dictionary of human geography. Edited by Derek Gregory. Malden, MA: Wiley-Blackwell,
- Aldous, T. (1997) Urban Villages: A Concept for Creating Mixed-use Urban Developments on a Sustainable Scale, second edition, London: Urban Villages Forum.
- Priyadarshini, Sen. 2013, Journey from a City to an Urban Village: A Study on India, Journal of Settlements and Spatial Planning, vol. 4, no. 2 (online) Available from http://jssp.reviste.ubbcluj.ro .(Accessed 26.05.2014)
- Kenworthy J., Techniques Of Urban Sustainability (2000).(online) Available from http://msd.unimelb.edu.au/sites/default/files/docs/Group%202%20-Urban%20Village.pdf. (Accessed18.04.2013)
- Qadeer, M. A. (2004). Urbanisation by Implosion. Habitat International, Vol. 28
- Chatterjee, P. (*2014)*, Urban Villages In Globalized India: Degenerative Growth Processes In Navi Mumbai, A Journal Of Kolkata Centre For Contemporary Studies (online) Available from http://theinclusive.org/ (accessed on 2.02.2015)
- Master plan Delhi 2021, available at www.dda.org.in (accessed on 2.04.2012)
- Hao, P., Geertman, S., Hooimeijer P., &Sliuzas, R. (2011). Measuring the Development Patterns of Urban Villages in Shenzhen. Available fromhttp://www.agile-online.org/ConferencePaper/CDs/agile_2011/ contents/pdf/short papers/ sp59.pdf. (Accessed 11.02.2013)
- Economic survey of Delhi, 2001-2002 available at http://delhi.gov.in/ (accessed on 28.04. 2012)

- Census of India, "Provisional Population Totals," Office of Registrar General of India, Government of India, New Delhi, 1991 2001 and 2011, available at http://censusindia.gov.in/(accessed on 2.04.2012
- Yamin N.(2012) Urban Villages of Delhi at Risk of Natural Disaster, available at http://greenzone.thinktosustain.com (accessed on 25.04. 2012)
- Hust, E. and Mann, M.(2005) Urbanization and Governance in India, Published by Manohar, New Delhi
- Shrivastav, P. (2007) Lal Dora and Extended Lal Dora in Delhi. GOI, Union Ministry of Urban Development. New Delhi: available at http://urbanindia.nic.in/programme/ dd/ Lal Dora.pdf (accessed on 24.04. 2012)
- Delhi Municipal Act, 1957available at: http://www.delhi.gov.in/ (accessed on 4.08. 2012).
- City Development Plan, (2006), JNNURM, Chapter – 5,Land Management & Urban Growth Department of Urban Development, Government of Delhi available at http://ccs.in/delhi-city-development-plan-under-jnnurm(accessed on 25.04. 2012)
- Statistical abstract of Delhi 2012, Government of NCT of Delhi Directorate of economics & statistics, Delhi.
- List of Urbanized Villages in Delhi (2013) available at http://delhigovt.nic.in/temp/urbanized.asp (*Accessed on 28.04.2013).*
- Misra, B. and Singh, H. B. (1996); Development of Villages in Urban Extension: Delhi: Upublished Report by Department of Urban Planning, School of Planning and Architecture, New Delhi, for Delhi Development Authority.
- Begum H. (2005) "Addressing Planning Problems for Territorial Integration of Urban Villages in Delhi: A Case Study of Masoodpur, Jahangirnagar" Planning Review Vol. 3, June, 2005
- Kohler A. (Liu), Jülich S, Bloemertz L (2004), Risk Analysis –a Basis for Disaster Risk Management, available athttp://www2.gtz.de/ dokumente /bib/05-0038.pdf. (accessed on 2.10.2013)
- District Disaster Management Plan, North East Delhi, Office Of The Deputy Commissioner (NE) Delhi -110 093 Available fromhttp://www.delhi.gov.in/*(Accessed 22.09.2014)*
- Shukla K, Prakash R, Singh D., Singh R K, Pandey P., Mandal H. S. and Nayal B. M. S. Seismic Microzonation of NCT Delhi, Earthquake Risk Evaluation Center, India Meteorological Department, New Delhi available at. http://www.civil.iisc.ernet.in/~microzonation/ (accessed on 4.09. 2012)
- *Draft- Hazard and Risk Assessment. Chapter-III. Hazard And Risk Assessment (2011)* availableat http://delhi.gov.in/DoIT/DOIT_DM/risks%20and%20*vulnerability-1.pd* (accessed on 2.04.2012)
- Gupta, R. (1986), Development of urban villages in delhi (1986-2001) City planning wing Delhi Development Authority
- Gencer, Ebru A. (2013) "The Interplay between Urban Development, Vulnerability, and Risk Management, A Case Study of the Istanbul Metropolitan Area" (online) Available from http://www.springer.com *(Accessed 10.4.2014)*
- Marjanovic, P. & Nimpuno, K. (2003). Living with risk: toward effective disaster management training in Africa. (In Kreimer, A., Arnold, M. & Carlin, A., eds. Building safer cities: The future of disaster risk. Washington D.C.: World Bank.)
- Wisner, B., Blaikie, P.M., Cannon, T. & Davis, I. (2004). At risk: natural hazards, people'svulnerability and disasters. 2nd ed. London: Routledge. 0Available fromhttp://www.preventionweb.net/files/670_72351.pdf. *(Accessed 10.4.2014)*
- Vulnerability Assessment, Cees Van Westen, International Institute For Geo-InformatioScience And Earth Observation , Session 5: Available fromhttp://ftp.itc.nl/ pub/westen/ Multi hazard_risk_ course*(Accessed 2.10.2013)*

- Deswal, D, (2007): Almost every family is Crorepati in this village Times of India, New Delhi, 24th July, 2007
- Soni A K, 2014, Housing market and transformation in urban villages Delhi, Unpublished Thesis, Department of Housing, School of Planning, Delhi.
- Mehra, A. K. (2005). 'Urban Villages of Delhi' in Hust, E., and Mann, M., eds., Urbanization and Governance in India, New Delhi, Manohar
- Anderson, M.B.; Woodrow, P.J. (1998). Rising from the ashes: development strategies in times of disaster 2nd ed., Boulder: Lynne Rienner Publishers,
- Development Plan of Greater Noida Industrial Development Authority Expansion.
- Bentinck, J.V. (2000). Unruly urbanisation on Delhi's fringe. (online) Available from https://www.rug.nl/research/portal/files/3140747/c6.pd *(Accessed 20.04.2014)*
- *Sharma*, T. (*2012*) Urban Villages Of The Developed And Developing World (online) Available from http://thisbigcity.net/ *(Accessed 20.02.2015)*
- Apikul C, Risk Assessment in Cities Compiled by, ADPC 2010.Available fromhttp://www.preventionweb.net/files/15047_guidebook02lowres1.pdf. *(Accessed 2.10.2013)*.

A Social Network based framework for assessing risks and vulnerability in built environment

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Abstract

Our built environment comprises large interdependent infrastructure networks. When we add a new piece of infrastructure or a new building into the mix, we rather increase the complexity further in relation operations and management of such infrastructure network. Ensuring appropriate functionality of these networks is absolutely crucial for supporting the community residing within the built environment. Functioning of a society depends on numerous infrastructure functions offered by the range of infrastructure network collectively. If any part of the infrastructure network becomes obsolete due to any external or internal disturbances, the impact will be eventually felt within the community. Whether such an impact is felt at a local level or in entirety, that depends on the degree of dependency of the community on the particular infrastructure network and also the interconnectivity of that network in relation to other network. Thus, in any attempt to address risks and vulnerability within the community, the first step is to map out the interdependent infrastructure network and community dependencies on various functions drawn from individual infrastructure or the network. The multi-level community is highly fragmented especially in a social context. Such fragmentation is characterized by numerous roles that people play within the society. Dependency of every person in the community on the infrastructure functions in their respective business or social roles can be understood by investigating their associations with infrastructure functions and the underlying network structure. Thus, in an attempt to assess the risks and vulnerability, this research aims to develop a new methodology utilizing the social network theory. It has been hypothesized that risk and vulnerability of the community is based on their interactions and social ties within both the community and infrastructure networks structure. Relative impacts of risks of one person or unit on another in relation to community dependency and association of infrastructure need to be visualized before developing the objective risk management strategy. The applicability of the new

SNA based methodology will be demonstrated using an institutional precinct comprising multiple buildings. The findings will add significant new knowledge for managing risks and vulnerability of the community within the built environment context.

Keywords: Infrastructure, risks and resilience, Social Network Analysis

1. Introduction

Our built environment comprises numerous interconnected infrastructure networks (such as water, power, IT) and the functioning of the community relies on the seamless operation of sustained services of these networks. Over past decades, numerous work has been published on the topic of infrastructure related disasters and vulnerability to the community. Recently, the prominence of the research into infrastructure risk and resilience has been highlighted due to number of incidences evident around the world. Referring to the Sept 11 incident or Hurricane Katrina in the US, many agencies are investigating on the solutions for critical infrastructure protections and maintaining sustained operations for supporting the community without disturbances arising from any perturbed situations. As these extreme events revealed significant failures of the readiness or preparedness of the authorities responsible for community support and wellbeing, the effectiveness of the existing practices and underlying approaches are exposed to scrutiny and further considerations. No matter whether it's a man-made disaster or the Act of God, ultimately the community is the most vulnerable part within the society and suffering of the population is inevitable. In any attempt to address the community vulnerability and preparedness for mitigations potentially arising for any extreme events, the community must be clearly understood in relation to their livelihoods and the reliance on the infrastructure systems at large.

Taking into consideration of the community dependencies on these networks and exposure to the risks associated with a specific infrastructure network being inoperative due to a sudden failure, this research develops a Social Network model for investigating the risks and impacts on the community. While the term 'emergency management' encompasses hazards, risks and recovery associated with any event and underlying policies, the focus of this research is not simply on the emergency management per se. The aim of the research is to develop an approach for quantitative assessment of risks and vulnerability among the community in relation to be infrastructure being inoperative due to a sudden failure. The community is an integral part of the built environment and the operation of the built environment is facilitated by a range of highly interconnected infrastructure networks. Thus, in any attempt to understand the community risks and associated vulnerability, the interconnectedness of the infrastructure network and the community interdependencies on the infrastructure services are absolutely crucial for investigation.

2. Background reviews

Although more robust construction in and of itself will not eliminate the consequences of disruptive events, there is widespread recognition that the engineering community has a valuable role to play in finding and promoting rational, balanced solutions to what remains an unbounded threat [3]. There has been considerable research aimed at developing knowledge that will enable the construction of a generation of buildings that are more robust and safer, for example, through reduction of injury inducing blast debris, the development of glazing materials that do not contribute to the explosion-induced projectile hazards and have enhanced security application, as well as the integration of site and structure in a manner that minimises the opportunity for attackers to approach or enter a building While literature review on infrastructure risks, vulnerably and resilience within the built environment context provides enormous results across approaches, methodologies and findings on case studies, there is currently no any single method that measures the quantitative links between the communities with the built environment systems. Bulk of the research focuses on sustainable building and operations of infrastructures with the viewpoints of emergency management due to potential disruptions arising from natural disasters such as Tsunami, Earthquake, Hurricane, Flood etc. In the risk and vulnerability fronts, numerous quantitative and qualitative approaches have been proposed by the researchers and significant body of knowledge has been created around the policy framework especially focusing on the precautionary measures and post-construction initiatives. However, the fact that the operations of the built environment is dynamic in nature and the functioning of the community requires multiple level supports from the highly connected infrastructure systems has not been objectively considered in any of the current attempts. In this research, the proposed model using the social network theory intends to unfold the interlinks between the community and the infrastructure integrating the multifaceted dimension of the built environment in the context of disaster mitigation and building resilience.

The argument that sustainability approach in the context of risks mitigation and resilience is closely coupled with social, cultural and environmental forces has been evident in [9]. However, how the social challenges are objectively considered with other dimensions is not quite discussed. The need for a new conceptual framework for better integration of social forces around the sustainable operation of community is asserted by a number of researchers [7][13]. Quarantelli (1998) suggested a paradigm shift in the disaster research which should focus more on conceptualisation of the social dimensions and appropriate considerations of the community centric needs and requirements. While McEntire (2003) clearly suggested the shift of disaster research from natural disaster and policy framework to more value based workable solutions, how such an approach integrates community with the built environment has not been discussed. Boin and Hart (2006) concluded the causes of vulnerability within the community are highly social in nature and they must be addressed socially in any attempt for building resilience in the society. Some of the social causes highlighted by Boin and Hart (2006) include ethnicity, race, socioeconomic status, gender and age etc. Such realisations eminently identify the need for fundamental research in the area of disaster risks and resilience within the built environment context.

The links and relationships between the disaster and vulnerability and underlying social impacts are appropriately identified in past literatures [3][10]. The need for understanding of the community composition and their intricate dependencies on infrastructure systems has also been realised by some researchers in the risk and resilience context [8]. However, current literature lacks any clear methodology linking the multi-level community and their professional roles and activities that supported by the infrastructure systems within the built environment.

3. Social Network Analysis and its application

The research aims to develop a conceptual model focusing on the social networks of extended stakeholders, their perceptions and interests in relation to critical infrastructure systems and underlying key functions supporting the effective operations associated with their business roles or positions within the selected boundary conditions. No matter how the policy framework is employed in disaster management practice, without understanding the dependencies of the multi-level community on interdependent infrastructure networks within the built environment, a precise solution for managing risks and containing the impacts is not quite possible.

By utilising the Social Network Analysis (SNA), the precise linkages between the multi-level communities with the critical functions of the infrastructure systems can be investigated. While complex mathematical tools are widely used for modelling infrastructure dependencies by many leading researchers [1][4][5], the power of Social Network Analysis (SNA) has not been exhausted in relation to collective representation of the community (such as individuals or organisations), the dyadic ties, their roles, interests and perceptions in relation to their business roles and operations being supported by the critical infrastructure networks. Thus, Social Network Analysis (SNA) has been employed for problem analysis which is based an accurate identification of problems and thoughtful articulation of the current industry situations in view of risks and vulnerability assessments focusing on both community and the infrastructures. The novelty and applicability of the SNA based methodology will be demonstrated using a case study in the following sections. The findings will result in a preliminary reference model that forms the basis for comparison with the real situations in order to identify areas of weaknesses and building the capacity for resilience.

4. Research Methodology

While the assessment of risks and vulnerability of community in relation to the highly dependent critical infrastructure network being inoperative is one of the key research topics across many countries, the current practice seriously lacks any tensible model for assessing the relationships of the community with the infrastructure within our built environment. Addressing this knowledge gap, this research aims to develop a new methodology that takes into consideration of the grassroots level understanding of the stakeholders' composition and their activities being supported by the interdependent infrastructure network systems. Utilising the Social Network Theory, the framework facilities an accurate mapping of the stakeholders with their dependencies on the infrastructure networks focusing on a defined physical boundary condition. Based on the Social Network Models and analysis, quantitative assessment of the stakeholders' dependencies with respect to the infrastructure functions being associated with the respective roles and activities can be performed. Such analysis will then allow assessing the impacts and vulnerability of both stakeholders and the infrastructure networks which will eventually be taken into consideration for building resilience against the failure scenarios.

Figure 1 depicts the principles for assessing infrastructure impacts on stakeholders and building resilience adopted in the current research. While there have been numerous approaches presented in the mainstream literature for identification of stakeholders, there is no any single approach that can be considered superior over others. However, snowball sampling method which is based on the social network of stakeholders is considered to be quite effective especially in the Social Network research. The concept of social network theory has been widely published in sociology based research and it is not the point of discussion in the current manuscript. However, as depicted in Figure 1, following are the brief steps to be followed in the context of current research.

The first step involves a clear definition of the boundary conditions in relation to the study domain where the networks of stakeholders' community and critical functions of the infrastructure systems are required to investigate.

Identification of the stakeholders is then performed based on their roles, activities and affiliations within the organisations. Thus, in the stakeholders' identification process, roles and positions, physical locations and their activities are all necessary to capture. Similarly, critical infrastructure types and underlying critical infrastructure functions are then identified considering the supports provided to the community for seamless operations in their day-to-day business.

In order to assess the meaningful relationship between the stakeholders and the critical infrastructure functions, the stakeholders are then required to respond to a questionnaire and identify their activities and dependencies on infrastructure functions within the organisation. Based on the information received, there are four kinds of relationships can be investigated, namely communication or information exchange, information sharing and propagation, power and influence on one another and frequency and linkages [11].

Relevant mapping between the stakeholders' roles and activities and the infrastructure functions are then developed based on empirical data using Social Network models (SNA) and visualisation of the networks is performed using NetMiner software package. It is worth noting that the there are numerous visualisation software packages are available such as UCINET, NetMiner, R, Pajek, Gephi etc. and all these packages provide more or less the similar functionality.

The SNA models are then investigated based on numerous SNA measures of actors and links which are then used to quantify the relative position, power, influence and linkages of a stakeholder and infrastructure type within their respective networks [4]. In the SNA models, the conceptualisation of the importance or visibility of a node or an actor is usually defined by four major types of centrality namely Degree, Closeness, Betweenness and Eigenvector Centrality. While the degree centrality reflects the activeness of an actor or a node within the network, closeness centrality is the measure of how shortest path to arrive from one node to the next.

Similarly, betweenness centrality the measure of the degree of mediation of information flow from one node to the subsequent nodes. Eigenvalue centrality is the measure of influence of one node on others in terms of strength of relationships with respect to the central actors [6].

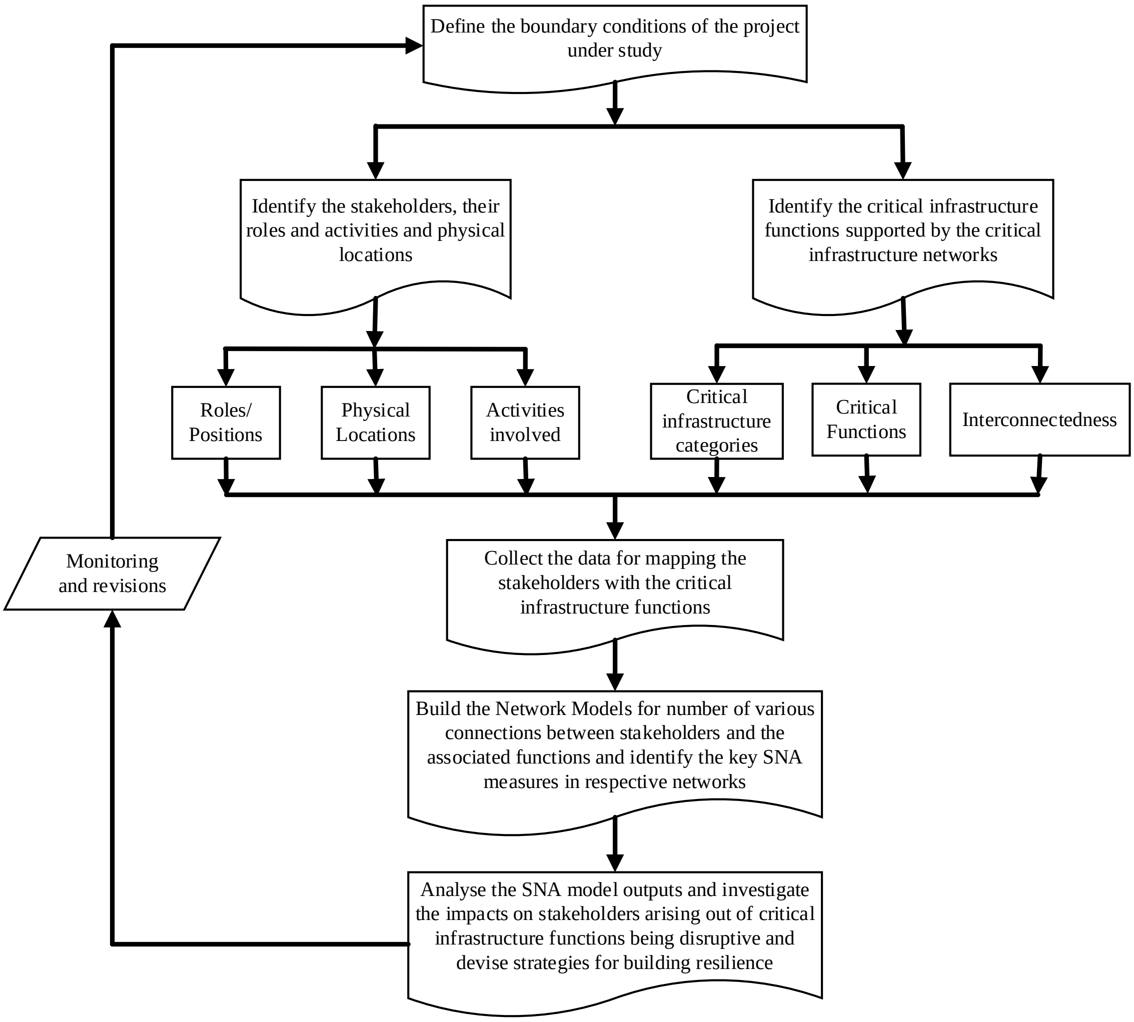

Figure 1. The principles for assessing infrastructure impacts on stakeholders and building resilience

Based on the network measure of three key network models namely stakeholders, critical functions and stakeholders' associated networks, the most and least influential actors will be identified. While the stakeholders and critical functions networks highlight the strengths of respective actors, the propagation or ripple effect due to one stakeholder being affected by a particular infrastructure function on others is not quite clear in these networks. Thus, the analysis of an affiliated network based on stakeholders' associated functions will be required to analyse. Based on the associated network analysis, the impact of one critical infrastructure function being failed upon other stakeholders and functions in the network will be possible to investigate. In order for developing resilience, mitigation measures against the adverse impacts arising out of any potential failure scenarios will be developed. Such mitigation measures and underlying implementation strategy need dynamic monitoring and adjustments for ensuring seamless support and operations within the society.

5. Case study and data collection

Referring to Figure 1 above, the first step towards model development is to identify the boundary conditions on a case project. For this purpose, the scope of the research has been defined focusing on a distinct boundary of a higher education institutional campus in Melbourne, Australia surrounded by four commuters' roads. Within this defined boundary, there are a total of 80 buildings that support the diverse functions within the institution. The users of these buildings (referred as stakeholders) are quite diverse and their dependencies on the functions supported by these buildings and underlying infrastructure systems are highly varied and commensurate by the roles and positions within the organisation. In order to understand the risks and impacts on stakeholders associated with the infrastructure network within the selected project boundary, both the stakeholders and infrastructure functions need to be identified. By identifying the key infrastructure functions and the stakeholders, network maps can be developed based on the empirical data which will then be used for quantifying the stakeholders' associated risks and vulnerability and devising appropriate mitigation strategies.

Based on the analysis of the 80 buildings and users within the institutional organisation, a total of 51 stakeholders under five board community categories have been identified as shown in Table 1. Similarly, a total of 20 critical functions under the six broad categories of critical infrastructure have been identified as depicted in Table 2.

While the analysis of network models requires empirical data from the representative respondents sample from the project site, at the time of developing this manuscript, the data collection process in progress. However, based on the expert judgement of the authors with in-depth understanding of the project in terms of operational environment, a hypothetical dataset was developed by mapping the roles and responsibilities of the stakeholders with the critical infrastructure functions. The dataset was then compiled and analysed using NetMiner Software package. As the purpose of the current manuscript is to demonstrate the unique methodology and extension of scholarly knowledge in the field of risk and resilience, the hypothetical dataset serves the purpose without compromising the novelty of the research presented.

Table 1: Identification of stakeholders in the case project

Community Group	Select an appropriate community category	
S1. Professional staff of the university	S1.1 Security;	S1.6 Libraries staff;
	S1.2 Maintenance;	S1.7 Museum staff, University clubs staff;
	S1.3 Student service staff;	S1.8 Venue management staff;
	S1.4 Yardman, health service staff, Sport facilities and club staff;	S1.9 Client service/ Campus support staff (External ancillary services staff);
	S1.5 Counselling services staff;	S1.10 University student union staff.
S2. Academic and Education Staff	S2.1 Academic staff	S2.6 Research collaborators
	S2.2 Professional staff	S2.7 Session tutors
	S2.3 Post-doctorate student	S2.8 Honorary Academics
	S2.4 Research Higher Education Student	S2.9 Guest lecturer
	S2.5 Research supervisor	S2.10 Visiting Research Scholar
S3. University Student	S3.1 Domestic fulltime student	S3.5 Domestic part-time student
	S3.2 International fulltime student	S3.6 International part-time student
	S3.3 Community Access program (CAP) student	S3.7 Professional master program student
	S3.4 Exchange student	S3.8 Dual degree program student
	S3.1 Domestic fulltime student	S3.5 Domestic part-time student
S4. General Public	S4.1 University alumni	S4.6 Surrounding community
	S.4.2 Visiting company and industry	S4.7 University research partner
	S4.3 Donors	S4.8 External student
	S4.4 External organization	S4.9 External researcher
	S4.5 External clients	S4.10 Past employee
S5. Business Affairs and other Services	S5.1 Financial and banking representative	S5.8 Post office and mailboxes
	S5.2 Academic dress and regalia shop	S5.9 Computer suppliers
	S5.3 Telecommunication provider (company representative services)	S5.10 Cafes, takeaway food and coffee kiosk (canteen)
	S5.4 Store and groceries	S5.11 Pharmacy
	S5.5 University bookshop	S5.12 Cinema and theatre
	S5.6 Hairdresser	S5.13 Travel agency
	S5.7 Newsagent and stationary shop	

Table 2: Identification of the critical infrastructure sectors and critical functions in the case project

Critical Infrastructure (CI) Sector	Critical Function or Products/Services Dependency
C1. Banking and Finance	C11 Insurance, investment and mutual fund companies.
	C12 Financial services (taxation, securities and commodities exchanges).
	C13 Banks (and non-bank) services.
C2. Transportation	C21 Ground access (local roads, trains, highway, transfer centers, bridge, tunnel)
	C22 Marine (waterways systems, ports, sea transportation, shipping, etc)
	C23 Aviation (airports, air traffic control centers and airways services).
	C24 Postal services, couriers and logistics (major distribution centers and services).
C3. Energy	C31 Electricity and power distribution networks, local power supplies
	C32 Oil and natural gas (production, storage and transportation facilities) distribution networks.
C4. Water Supply	C41 Utilities: sanitation, wastewater, rain water and sewer system.
	C42 Basic and potable (drinking) water service, storage facilities.
	C43 Water treatment plants, pipelines, delivery pumping stations, control centers.
C5. Healthcare	C51 Healthcare services and system (internal department, paediatric department, etc).
	C52 Emergency services (First aids, medical service, police, fire brigade and rescue system, etc).
C6. Information Technology and Telecommunications	C61 Telecommunication and digital services infrastructure.
	C62 Internet infrastructure and accessibility, connectivity and speed etc.
	C63 Broadcasting system (TV, radio, Wi-Fi, etc), data center, cyber security and software.
C7. Space	C71 School building, office, laboratory, library space, etc.
	C72 Public space and commercial (parking lot, garden, leisure space, etc).
	C73 Residential (student lodge, graduate house, etc).

6. Data analysis and discussion

As mentioned earlier, the dataset was prepared based on a carefully designed questionnaire survey that comprises four parts. The first part is about respondent's profile that includes respondents' physical location, work or organisational unit and age bracket. These information are necessary for running 'what-if' scenarios in the risk and impact assessment models. The second part of the questionnaire is to identify the respondent's role and position where a total of 51 roles have already been defined under five broad categories based on the in-depth assessment of project organisation. Every respondent is expected to select at least one or possibly more roles as appropriate for his/her job roles within the organisation. The third part of the questionnaire is about the identification of the critical functions out of 20 listed functions under seven broad categories which potentially support performing the job roles of the respondents in their current position within the organisation. A 5-point Likert scale has been used to capture the degree of dependencies of the critical functions for developing necessary valued or weighted networks. The last part of the questionnaire is about the interdependency measure of the respondent's selected critical functions (as selected in third part) with the other critical functions. This measure of associate interdependency matrix is based on the influence or impacts being exerted by their associated functions on others. Based on the collected data in above format, respective network models are built and the key SNA measures such as Degree Centrality, Eigenvector Centrality etc. are analysed.

Table 3 depicts the Eigenvector centrality of stakeholders in the 2-mode Stakeholder vs Critical Function network models. As seen, S13 being the 'Student Services Staff' with an Eigenvector Centrality of 0.313 is one of the most central roles within the organisation. Referring to Table 4, the critical functions C31 and C62 being 'Power services' and 'Internet infrastructure' with the higher Eigenvector Centralities of 0.545 and 0.423 respectively highlight the critically of these functions and underlying infrastructure provisions. These centrality measures are based on the association with the critical functions in the 2 mode network model which signifies the importance of support being provided to the business of the stated organisation by the critical infrastructure networks. By referring to both the Tables 3 and 4, the assessment of the criticality of the stakeholders' business roles and associated physical location such as the building can be ascertained in relation to the support being provided by the particular critical functions within the interdependent infrastructure networks.

Table 3: Eigenvector Centrality of Stakeholders in 2-Mode Network analysis

Stakeholders	Eigenvector Centrality	Stakeholders	Eigenvector Centrality
S11	**0.239**	S37	0.179
S12	0.157	S38	0.149
S13	**0.313**	*S41*	*0.031*
S14	0.129	S42	0.091
S15	0.184	S43	0.044
S16	0.179	S44	0.064
S17	0.060	S45	0.038
S18	**0.191**	S46	0.026
S19	0.091	S47	0.093
S110	0.134	S48	0.033
S21	**0.292**	S49	0.039
S22	0.191	S410	0.011
S23	**0.245**	S51	0.083
S24	0.197	S52	0.083
S25	0.129	S53	0.149
S26	0.139	S54	0.070
S27	**0.220**	S55	0.059
S28	0.050	S56	0.051
S29	0.118	S57	0.099
S210	0.091	S58	0.105
S31	0.131	*S59*	*0.023*
S32	**0.212**	S510	0.107
S33	0.059	S511	0.164
S34	*0.024*	S512	0.123
S35	0.034	**S513**	**0.258**
S36	0.049		

Table 4: Eigenvector Centrality of Critical Functions in 2-Mode Network analysis

Critical Functions	**Eigenvector Centrality**	**Critical Functions**	**Eigenvector Centrality**
C11	0.159	C42	0.142
C12	0.211	*C43*	*0.045*
C13	0.197	C51	0.158
C21	0.165	C52	0.171
C22	*0.008*	**C61**	**0.369**
C23	0.109	**C62**	**0.423**
C24	0.129	C63	0.079
C31	**0.545**	C71	0.271
C32	0.082	C72	0.173
C41	0.156	C73	0.0791

Figure 2 below shows the network map showing the relationship between the stakeholders with the critical infrastructure functions resulted in the 2-mode network analysis. The 2-mode networks, also known as affiliated networks or membership networks represent the involvement of the set of actors with a set of events [14]. Conceptually, the social relationship of the actors is defined in terms of their joint participations in social events or by their common memberships in the organisation.

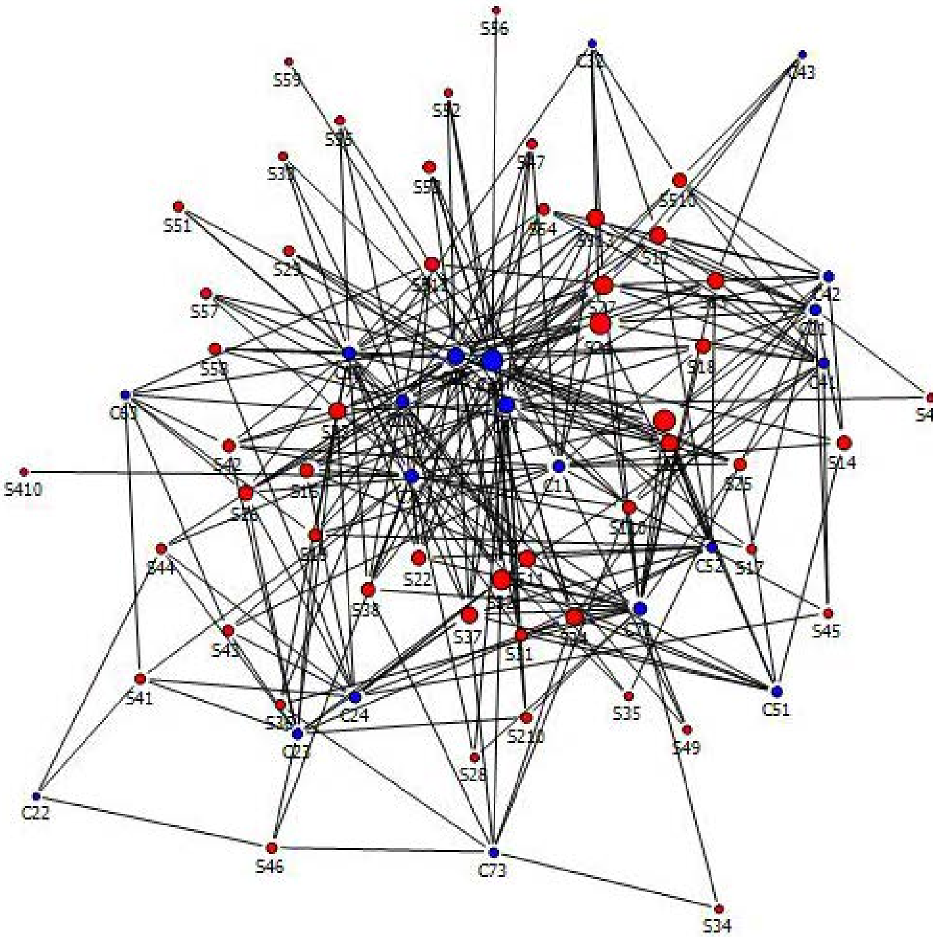

Figure 2. Network Map showing the relationship between the stakeholders with the critical infrastructure functions

As seen in Figure 2, the stakeholders identified in this case project are known to have relevant social interactions or ties based on their shared goals within the organisation and the common support being received from the supporting infrastructure networks. In this affiliated network analysis, the two types of nodes being used are a set of actors which are the 51 stakeholders and the set of events which are the 20 critical infrastructure functions. As the theory of the affiliated or 2-mode network is found in the mainstream literature [6][14], the same has not been discussed in the current manuscript.

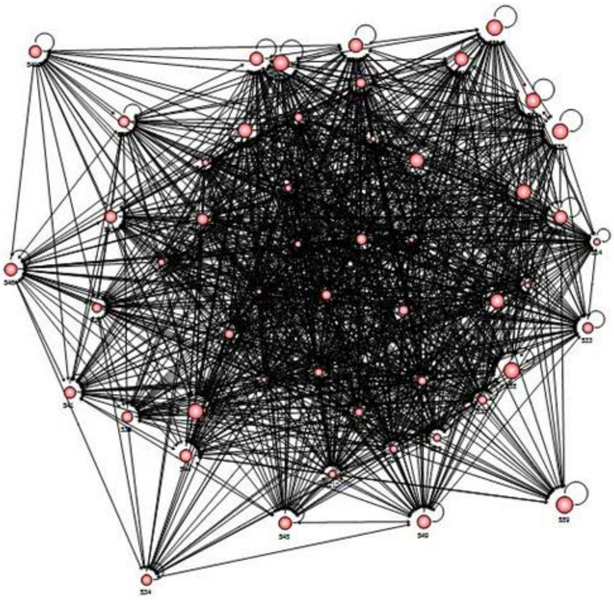

Figure 3. Network map showing the stakeholder to stakeholder interactions in affiliated network

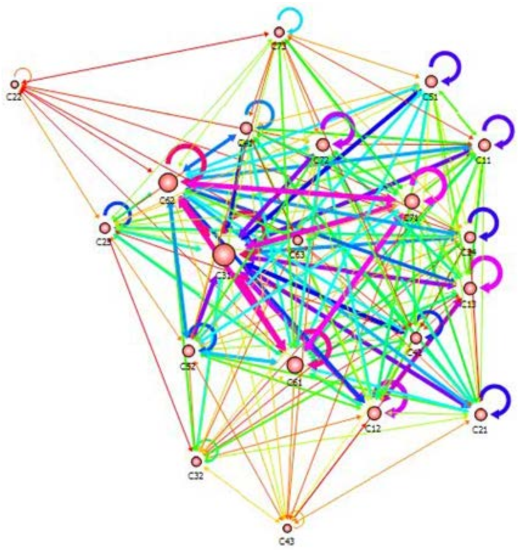

Figure 4. Network map showing the critical functions' interactions in affiliated network

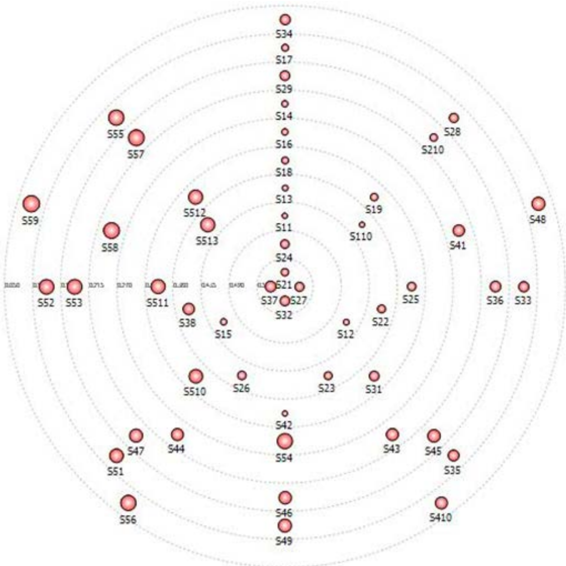

Figure 5. Concentric Map showing the stakeholders' relative position and importance in the affiliated network

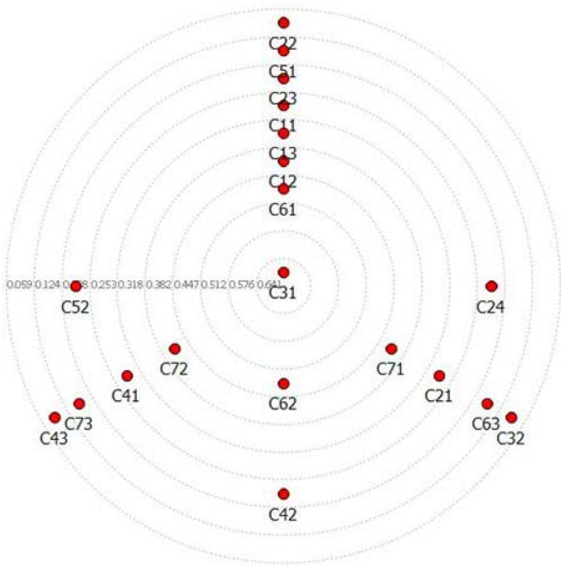

Figure 6. Concentric Map showing the relative positions and importance of the critical functions in the affiliated network

Figures 4 and 5 present the network maps depicting the stakeholder to stakeholder and critical function to critical function interactions in affiliated network respectively. As mentioned earlier, the affiliated network is usually based on actor's interaction with a set of events. Based on such interaction matrix, bipartite matrix can be computed in the NetMiner software package. The brief theory on bipartite analysis as discussed in [6] is presented below:

A Bipartite matrix can be schematically represented as the following:

$$\boldsymbol{X^{A,E}} = \begin{bmatrix} \mathbf{0} & \boldsymbol{A} \\ \boldsymbol{A'} & \mathbf{0} \end{bmatrix}$$

The Co-attendance matrix in the 2-mode dataset

$$\boldsymbol{X^{A} = AA'}$$

The Co-participation matrix in the 2-mode dataset

$$\boldsymbol{X^{E} = A'A}$$

For a symmetric "g x g" co-attendance matrix, $\mathbf{X^A}$, whose non diagonal values are the number of events attended by each pair of actors, the density measure is expressed as:

$$\boldsymbol{D^{A}} = \frac{\sum_{i=1}^{g}\sum_{j=1}^{g} \boldsymbol{X_{ij}^{A}}}{\boldsymbol{g(g-1)/2}} \qquad (\boldsymbol{i < j})$$

For a symmetric "h x h" co-participation matrix, $\mathbf{X^E}$, whose non diagonal values are the number of actors participating in each event, the density measure is expressed as:

$$\boldsymbol{D^{E}} = \frac{\sum_{i=1}^{h}\sum_{j=1}^{h} \boldsymbol{X_{ij}^{E}}}{\boldsymbol{h(h-1)/2}} \qquad (\boldsymbol{i < j})$$

Actors' degree centrality:

$$\boldsymbol{C_D^A(a_i)} = \sum_{i=1}^{g} \boldsymbol{X_{ii}^{A}} \qquad (\boldsymbol{i \neq j})$$

Events' degree centrality:

$$\boldsymbol{C_D^E(e_i)} = \sum_{i=1}^{g} \boldsymbol{X_{ii}^{E}} \qquad (\boldsymbol{i \neq j})$$

Following the bipartite analysis theory, respective 1-mode networks of stakeholder and critical functions have been generated and underlying SNA measures are investigated. Table 3 shows the

Eigenvector Centralities of the Stakeholders' resulted from Bipartite Analysis. As seen, S13 and S21 being the Student Services Staff and Academic Staff with centrality values of 0.360 and 0.245 respectively are found to be most central stakeholders among the 51 identified stakeholders. These two stakeholders are to potentially receive the highest impacts arising out of the critical infrastructure being inoperative due to sudden failures. The relative impacts on the stakeholders can be assessed based on the centrality values which then provide a clear understanding about the risks and vulnerability of the stakeholders associated with the failure scenarios of the critical infrastructure networks. The criticality of the infrastructure types and networks is assessed based on the centrality values of the critical functions resulted in the respective network analysis.

Table 5: Eigenvector Centrality of Stakeholders' resulted from Bipartite Analysis

Stakeholders	Eigenvector Centrality	Stakeholders	Eigenvector Centrality
S11	**0.184**	S37	0.179
S12	**0.179**	S38	0.149
S13	**0.360**	S41	0.031
S14	0.191	S42	0.091
S15	0.091	S43	0.044
S16	0.134	S44	0.064
S17	0.292	S45	0.038
S18	0.191	S46	0.026
S19	**0.245**	S47	0.093
S110	0.197	S48	0.033
S21	**0.329**	S49	0.040
S22	0.139	S410	0.011
S23	**0.220**	S51	0.083
S24	0.050	S52	0.083
S25	0.118	S53	0.149
S26	0.091	S54	0.070
S27	0.131	S55	0.059
S28	0.112	S56	0.051
S29	0.059	S57	0.099
S210	0.024	S58	0.105
S31	0.034	*S59*	0.023
S32	0.049	S510	0.107
S33	0.184	S511	0.164
S34	0.179	S512	0.123
S35	0.060	S513	0.158
S36	0.191		

In order to assess the risks and vulnerability of the stakeholders and critical infrastructure networks, the study of interaction networks facilitated by the social network theory provides a good basis. One of the key advantages of the interaction networks is the ability to assess the propagation effect of one actor being affected on others in the network structure. As the concept of resilience is precisely confined to the containment of risks at the source and reduction of ripple effect downstream, the analysis of interaction networks of stakeholders and the critical functions as demonstrated in this research provides a significant opportunity for containing infrastructure related risks and developing resilience for the community.

7. Conclusions

This research puts forward a new approach for quantifying the risks and impacts and ripple effects on community arising out of interconnected infrastructure networks being inoperative due to any sudden disruptions. A model has been developed for understanding the community dependency on the infrastructure operations, assessing risks and vulnerability and developing resilience in the community in the advent of disruptions. Social Network Analysis has been utilised to investigate the relational linkages between the multilevel community groups or sub-groups and critical infrastructure functions supported by the critical infrastructure networks. It has been demonstrated that the Social Network Analysis (SNA) methodology provides a significant opportunity to address these challenges by mapping out the key actors and their associations with the risk events in any particular context. Based on a pilot study, this research highlighted the applicability of the model that allows visualising the interconnectedness of the risk events associated with the critical infrastructures and the community and assessing impacts on community in the event of any disturbances in the infrastructure networks. Application of model allows understanding the impacts and thereby developing resilience and supporting wellbeing within the vulnerable community.

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References

[1] Almahmoud, E. and Doloi, H. (2013), "Analysis of stakeholders' influence on Construction Processes using Social Network Analysis", Proceedings of the COBRA 2013 (RICS) conference, 10-12 Sept 2013, New Delhi (Best Paper Award).

[2] Boin, A. and Hart, P.T. (2006) The crisis approach, In Rodriguez H., Quarantelli, E.L. and Dynes, R.R., (eds) Handbook of Disaster Research, Springer, New York, pp. 42-54.

[3] Buckle, P. (2005), Disaster: mandated definitions, local knowledge and complexity, in Perry, R.W. and Quarantelli, E.L. (eds), What is a Disaster? New Answers to Old Questions, Xlibris, Philadelphia, PA, pp.1730-200.

[4] Doloi, H. (2012), Assessing stakeholders' influence on social performance of infrastructure projects, Facilities, Vol. 30 (11), pp. 531-550.

[5] Doloi, H. (2014), A framework for supporting planning and development of infrastructure projects from a societal perspective, The 31st International Symposium on Automation and Robotics in Construction and Mining (ISARC2014), July 9-11,2014, Sydney, Australia.

[6] Knoke D. and Yang S. (2008) Social Network Analysis, Second Ed. Sage Publications, CA, USA.

[7] Lagadec, P. (2006) “Crisis Management in the twenty first Century: ‘unthinkable’ events in ‘inconceivable’ contexts” In Rodriguez H., Quarantelli, E.L. and Dynes, R.R., (eds) Handbook of Disaster Research, Springer, New York, pp. 489-507.

[8] McEntire, D.A. (2003), “Searching for a holistic paradigm and policy guide: a proposal for the future emergency management”, International Journal of Emergency Management, Vol.1(3), pp.298-308.

[9] Mileti, D. (1999), Disasters by Design: A Reassessment of Natural Hazards in the United States, Joseph Henry Press, Washington DC.

[10] Poteyava, M., Denver, M, Barsky L.E. and Aguirre, B.E. (2006), Search and Rescue Activities in Disasters, In Rodriguez H., Quarantelli, E.L. and Dynes, R.R., (eds) Handbook of Disaster Research, Springer, New York, pp.200-216.

[11] Prell, C., Hubacek, K and Reed Ma (2006), “Using Stakeholder and Social Network Analysis to support participatory processes”, International Journal of Biodiversity, Science and Management, Vol.2, pp.1-4.

[12] Quarantelli E.L. (1998), “Where we have been and where we might go: putting the elephant together, blowing soap bubbles and having singular insights”, In Quarantelli E.L. (Eds) What is a disaster? Perspectives on the question, Routledge, New York, pp.234-273.

[13] Tierney, K.J. (1999), “Toward a sociology of risk” Sociological Forum,Vol.14(2),pp.215-242.

[14] Wasserman, S. and Faust, K. (1996), Social Network Analysis: Methods and applications, New York, Cambridge University Press.

Early Warning and Early Action redefining the relief, rehabilitation, and reconstruction continuum

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Abstract

This paper questions what constitutes a predicative and preventative early action in Somalia compared to traditional humanitarian responses. Traditional early warning systems in Somalia are considered along with the methodology and results of a pilot early warning early action model. The paper concludes by suggesting that preventative early action brings into question the existing architecture of the aid industry and the links between relief rehabilitation and development. The implications of these findings are considered from a wider policy and practice perspective and recommendations as regards to future directions of early actions in Somalia are deliberated.

Keywords: Somalia, Early Warning, Disaster Management, Drought

1. Early Warning, Early Action failures in Somalia

Recent failures to respond sufficiently early to humanitarian food crisis in the Horn of Africa region by the international community have resulted in significantly preventable deaths and suffering. The crisis in 2011 - with 13 million people affected and up to 250,000 deaths - was the most severe crisis of its kind in 60 years according to the Famine Early Warning Systems Network (FEWSNET, 2013). Darcy, et al. (2012) describes this as a failure both of preventive action and of early relief. These type of actions have been coined Early Warning Early Action (EWEA) with early warning systems being defined by the United Nations International Strategy for Disaster Reduction (2009, p.1) as "The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss." Formal early warning systems are nothing new in the Horn of Africa. Bailey (2013), discussed that the first early warning systems were rolled out across the Sahel and the Horn of Africa in the 1980s noting that since then the capability of famine early warning systems has improved dramatically, yet this has not necessarily delivered a comparable improvement in early action. Drought early warning systems enable a shift from reactive to proactive hazard management and response, and a change of focus from disaster recovery to disaster reduction.

It is clear that droughts and the food insecurity they produce in the Horn of Africa are not 'blips' or temporary trends. Somalia now suffers from chronic, predictable annual droughts and is among the African countries hardest hit by climate change and slow onset disaster (Federal Republic of Somalia, 2013). Compared with its neighbours like Kenya and Ethiopia, Somalia was most affected by the 2011 famine (Bailey, 2012). The 2011 famine was a devastating event that affected much of the Horn of Africa region encompassing Somalia, Ethiopia and Kenya. These three countries all share common climactic attributes yet why was it that the greatest impact of the famine was felt most in Somalia? This paper focuses on the Somalia context where systems failed most dramatically.

This paper suggests that we need to move beyond looking at early relief and consider early action from a preventative and predictive perspective in which case early actions are something done prior to and in the absence of humanitarian conditions rather then something done as a result of humanitarian conditions. Destocking of animals prior to drought and prior to a mass destocking resulting in a surplus of supply on the market can be classified as an early action, whereas water trucking to ensure sufficient water for livestock could be considered and early relief activity. There is no delineation where early action and early relief begins and ends which forces us to re-examine early action across a relief, rehabilitation and development continuum. The International Federation of Red Cross and Red Crescent Societies (2009, p.12) explain that “The fundamental goal of early warning is early and balanced action.” this definition of early warning demonstrates how it must cross numerous phases of development. Yet the humanitarian community is still to come to terms with the 'balanced action' of this definition. Levine, et al. (2011) argues that while early warning has reduced human fatalities over the past 25 years evaluations demonstrate that interventions to save lives and protect livelihoods consistently arrived too late to achieve their intended impact.

This failure of coherent linkages in translating early warning into early action and the cyclical nature of drought exacerbated by conflict in Somalia all lead to a clear need to strengthen the resilience of structures that already exist. Venton, et al. (2012) in a review of cost effectiveness of building resilience to disasters in the Horn of Africa, particularly Ethiopia and Kenya found that divisions between relief and development are artificial. They also recommended that funding mechanisms need to be altered in order to integrate relief and development in a coherent cycle. As explained by (Maxwell, et al., 2014, p.46) “Although the impetus for the discussion about resilience grew out of the late response to the 2011 crisis in the Horn of Africa, elements of the theme has been around for a long time.” Resilience is very much part of the ability to adapt to changes, “In many ways the ability to cope underlines what we mean by resilience in disaster management” (Collins, 2009, p.103). This adaptive capacity is key to dealing with current ongoing and future unknown shocks. Resilience in transformation indicates a capacity of individuals, households and communities to transform according to a changing context and across phases of development. This thinking on resilience fits in well with the concept of a development continuum. This continuum is about linking relief, rehabilitation and longer term development interventions, regardless of the size or character of a disaster (sudden, recurrent or ongoing natural hazards or conflict). This thinking seeks to ensure that humanitarian programming does not undermine development work and that development programming is building on humanitarian knowledge and results (Organization for Economic Cooperation and Development, 2012). This linked up thinking is not a new concept. Buchanan, Smith and Maxwell (1994, p.5), explained that “Considering both micro and macro dimensions, the key to linking relief and development from the development side is to find ways of reducing (a) the frequency and intensity and (b) the impact of shocks, which will in turn reduce the need for emergency relief”. An EWEA model addresses these concerns and in particular in the presence of what has been coined "permanent emergencies" such as in parts of Somalia. The Somalia Resilience Program (SomReP) built an evidence-based case for proactive humanitarian actions based on the above thinking. The presence of permanent emergencies heightened the need to program across the continuum in different ways at the same point in time while complimenting ongoing programming. A successful operationalization of both relief and development programming simultaneously is underpinned by adaptive capacity in an ever changing context. Early Action in the SomReP context is defined as targeted, scalable and contextual actions that reinforce existing coping mechanisms and are guided by principles of no regrets, parsimony and best practice. Early Actions can be scaled up and replicated efficiently to increasing number of households to meet growing severity of a slow onset disaster, and link into humanitarian actions if necessary. Early Actions are contextual in that they are appropriate to local livelihoods, seasonality and social conditions while reinforcing existing coping mechanisms.

This paper details the experience piloting this EWEA model, the recommendations from this pilot while considering from a broader perspective if EWEA forces us to re-examine the Linking Relief, Rehabilitation and Development continuum. The notion of a continuum has created what Audet (2014, p.3) terms a conceptual grey zone between short and long term forms of aid. "Indeed, considering the goals, institutional actors, timeframes, and priorities of disaster relief alongside those of development assistance exposed a ''conceptual grey zone'' between the two forms of aid. That grey zone has since given rise to an array of multifaceted and affiliated concepts and frameworks, including, to mention only a few, ''vulnerability,'' ''capacity,'' ''capability,'' ''risk reduction,'' ''livelihood,'' ''resilience,'' and ''recovery.'' It is this grey area and how in practice we cross this conceptual divide that we consider in this paper. In order to examine this the results of a EWEA pilot in Somalia are drawn upon and the lessons learnt considered from a broader perspective.

2. Early Warning and Early Action in building resilience in Somalia

2.1 Traditional Early Warning in rural Somali communities

A precursor to any discussion on early warning and early action systems in Somalia calls for a review of traditional Somali early warning systems. In Somalia these coping mechanisms have not always received a great deal of attention and while early warning systems such as the Famine Early Warning Systems Network (FEWSNET) have developed over recent years, community based early warning systems in the country have been less than adequately documented, with a focus on processes rather than their impact (Radich and Tekle, 2011). Yet communities in Somalia have a long history of monitoring and coping with drought by using indigenous systems and mechanisms they have developed over time. Traditional early warning systems are not independent mechanisms reserved for crises, but an integral part of local food production and based on the social, environmental, economic and political systems of rural communities (Campbell 1990). Communities that have developed local risk management approaches to slow onset disasters have done so out of necessity and these mechanisms were the sole safety nets in place for many years before the advent of such formal systems.

Pratt (2002) found that in pastoralist Somali communities in North Eastern Kenya, three general principles emerge. Firstly, pastoralists have a historic understanding or calendar of when major rain seasons will arrive, and meteorological changes in temperature, wind and humidity can help determine the probability and quality of these of these rains for each specific season. They use subtle changes in flora and fauna as indicators of temperature and humidity (Pratt, 2002, p.3). Secondly, through their close relationship with livestock, observations of herd behaviour and condition determines much early warning information. An Oxfam report on community level early warning found that pastoral Somali communities from the same region in Kenya identified grunting of camel bulls, mating calls and a jovial mood of the herd were all indications that the coming rain season would be good (Mutua, 2011). Finally, other sources of information used in early warning are drawn from meteorological (clouds, rain, lightning etc.), astronomical (sun, moon, stars), wildlife (migration of birds and animals), and paranormal indicators such as good or bad omens (Pratt, 2002). Community responses to drought are just as varied as these indicators they use to monitor them. In most examples though, in order for early warnings to translate into early action, existing structures need to be in place such as leadership bodies and regular community forums. This is because early actions consist mostly of information gathering, sharing and consultation. It is out of these early actions that other response actions occur and as the severity of a disaster impacts on a community, so do their responses such as migrating further away, 'grain safaris' to distant markets, and community organized slaughter destocking as a last resort. These more severe coping strategies also require the continuation of the original 'early actions', that is the ongoing communication and information sharing within the community to mobilize and agree on these community level coping mechanisms. This continuum is demonstrated in Table 1

Table 1 Traditional community level Early Warning Early Action, Somalia

→ **Continuum of time and *increasing severity* of drought** →		
Community Early Actions	**Community Response Actions**	**Community Coping Mechanisms**
• Information sharing and communication between early warning monitors and leaders • Community meetings for information sharing and decision making • Further information gathering • Prepositioning of community and household resources	• Prioritizing milk supply for young children • Storage of grain in contingency reserves • Preservation of fat, milk, meat and bones for contingency reserves • Planned migration of livestock to different pastures • Collection of fodder /water for vulnerable and weak livestock unable to migrate	• Migration of livestock to areas further afield • Migration of households to different areas • Consumption of wild foods (foraging for fruits and berries) • 'Grain safaris' trading livestock in far off markets for cereals • Slaughter destocking • Destitute families split up among wider family groups
→ Community consultation and information sharing continues →		

Source: extracted from Pratt (2002), Mutua (2011)

Yet early actions are continually changing at the community level due to technological advancements and economic development. For example, access to credit and increased debt is becoming an important coping strategy for Somalis with implications for future livelihoods. Very little has been said about this in the literature on the famine, other than “increased seeking of loans and credit” as a distress coping strategy in Lower Shabelle (FSNAU 2013, p.25). Also, equally important and a facilitator of early action at the community level is the role of the diaspora and other local groups whom Darcy, et al. (2012) explains were in the 2011 famine typically the first responders in drought affected areas. However, traditionally resilient livelihoods and the risk management mechanisms (early warnings and coping strategies) practiced by communities have been continuously eroded due to political and social upheaval during the Siad Barre regime (Ahmed and Herbold, 1999) and the three decades of civil war that followed his downfall (Intergovernmental Authority on Development, 2013). Communities themselves recognise that the traditional seasonal changes are also becoming harder to predict each year due to recurring drought, climate change and increasingly erratic rainfall (Federal Republic of Somalia, 2013).

2.2 Somalia resilience program Early Warning Early Action Approach

One approach to building Early Warning Early Action in Somalia was implemented in 15 districts in Somalia to improve the timeliness and efficacy of humanitarian action in mitigating and addressing slow onset disasters such as drought and the effects of climate change. A contextualized community based disaster risk management approach developed in Somalia by member agency Oxfam, facilitated local communities in the establishment of community level Early Warning Committees (EWCs). These community level committees were trained and supported by agencies to monitor simple early warning indicators and develop contingency plans for fast onset (floods, conflict) and slow onset (drought and climate change) disasters. By linking EW indicators to their contingency plans, EWCs identify when they need to take action and when to advocate to the implementing agency or government for actions beyond their own resources and capacity. EWCs use simple tools to monitor a selection of early warning indicators that support the decision making process and decision making for when to take action. Using a simple pictoral chart EWCs track specific early warning signs such as seasonal rainfall, market prices, animal and pasture conditions and household migration. Agencies also receive these indicators from EWCs to help monitor trends across program areas and inform programming decisions.

A dedicated technical unit worked with partners to identify actions that would be taken should certain thresholds in humanitarian condition be exceeded. The agencies monitor five broad areas including food security, livelihoods, nutrition, health and conflict for early warning signs of slow onset disaster. These thematic bundles are termed 'meta indicators', each being comprised of a number of specific indicators. The triggers for early action occur when shifts in specific indicator severity contribute to a change in the overall severity level of a meta indicator. Data collection for these indicators is a combination of community level data collected through the EWCs, agency collected and secondary data from the consortium's technical partners such as FEWSNET and FSNAU whom manage the wider Famine Early Warning networks. As agencies implement new SomReP grants in each district, a scenario building activity is conducted by project staff to identify the key risks to monitor for early warning, and the activities they would undertake to support communities to respond, mitigate or cope with the early effects of slow onset disasters. These actions take into account the specific livelihoods, environment and market conditions of the area which they are implementing in. A scenario building exercise results in a 'Menu of Actions' for that implementing area - activities the agency would do in the event that the early warning indicators trigger activities. Levine, et al. (2011) referring to a region-wide United States aid project point out that early warning signals must be linked to livelihoods analysis, with a predictive capacity, which in turn are linked to early interventions.

3. Research Methodology

In June and July 2014, SomReP agencies conducted pilot early warning assessments across three regions of Somalia. The scope of this assessment was to test early warning indicators and produce useable information to determine the need for early actions in response to the risk of slow onset disaster with targeted livelihood groups. The pilot assessment examined the usefulness of each early warning indicator collected and the feasibility and importance of each in monitoring early warning at the project level. Three districts were initially chosen for the pilot assessment which provided different conditions, livelihood groups and IPC phases to test the early warning indicators.

3.1 Data collection tools

Documentation provided to enumerators included a guidance note with the methodologies of each survey, and the survey forms which were separated into a household survey and key informant survey. The household survey included the Coping Strategies Index, Household Hunger Score and the Household Dietary Diversity Score survey tools. The key informant survey looked at community level indicators and measured areas of seasonal morbidity, household and livestock migration, local market prices and an experimental conflict indicator. Many of the tools used in the pilot assessment are standardized and well documented questionnaires and surveys. Rather than evaluating the effectiveness of these existing tools, the early warning early action pilot assessment considered the contribution of these used by SomReP agencies to collectively monitor the early warning signs of slow on set disasters.

For SomReP's Early Warning Early Action system, agencies use mobile data tools for fast data collection and a level of basic automated analysis (compilation of graphs with trends, bar charts and pie charts etc). Based on feedback from partners during orientation of the guidance notes the original survey assessment was divided into two separate documents (1) the household level survey, and (2) the community level observation and key informant survey. Community level and Key Informant surveys focused on five areas. Trends of epidemic prone diseases, mid upper arm circumference, school attendance, household migration and conflict and market prices surveys. Each household survey was expected take around 40 to 45 minutes per household. Key informant interviews, and community level observations varied in length of time needed depending on availability of appropriate informants and skills of the enumerator. Community level observations varied depending on the sample size of respondents and size of each village. Drastically less surveys were conducted than planned due to security and access issues for enumerators. The villages in each district were chosen to reflect the different livelihood groups in each of these areas, geo- physical vulnerabilities as well as meeting criteria of having at least 70 households. The selection of these villages were based on the level of access due to high insecurity in the area. Of these villages, two were predominately pastoral communities and three were agro pastoral communities. After field teams had completed their surveys, the raw data collected in paper survey forms was manually inputted into a spreadsheet and checked for errors. Open coding was conducted and data visualized for easy analysis by the pilot team members. Each survey question was directly related to an indicator in the crisis modifier tool. Standard surveys such as the coping strategies index had standardized units of analysis or indexes with established thresholds, while other values were presented in percentages or prices according to the values used in the crisis modifier matrix.

3.2 Limitations of this Research

Lack of historical data in Somalia make comparisons difficult as regards what is a normal year. This lack of historical data posed an important barrier to action in 2010/11 were divisions about what should be done in the face of uncertainty over conditions and whether or not conditions would deteriorate into a humanitarian disaster. In the previous decade Somalia had been seemingly on the brink of catastrophe every year (McDowell, 2014b). The ability to conduct primary research – and what form that field research can take in Somalia is influenced to a large extent by the prevailing security situation. During the main field study period between May and July 2014 an on-going security concern affected the areas where the research was undertaken. This influenced significantly the progress of the field work, the respondent selection as well as the methods eventually utilised to collect the necessary data. These security considerations impacted on the ability to collect household level data in the manner envisaged and numerous compromises had to be made and second-best options embraced.

4. Results

The pilot assessment found that a number of important localized indicators were regularly omitted during their scale up to regional level warning systems or are not captured when they are inputted into traditional food security models which leaves local communities at risk of being overlooked when affected by localized shocks. Traditional food security monitoring tools used in the household level surveys gave strong indications on the level of food access and diversity in the target communities, however many of these indicators are retrospective in that they measure the impact at the household level long after early warning signs have occurred. There was also a negative trade-off between the time and resources needed to conduct the survey and the results produced. The household level survey was the most time and resource intensive survey, requiring transport and other logistical arrangements in order to access household respondents. As highlighted in the previous section it is incredibly difficult in some areas of Somalia to access households regularly in a consistent manner. This in itself raises questions as to the utilization of household level data in terms of frequency and consistency of monitoring early warning indicators. Simply put if access cannot occur in a periodic manner the usefulness of household level measurement is greatly reduced as a component of an overall early warning system.

Further, the traditional food security tools used (coping strategies index, household dietary diversity score and the food consumption score), could be considered outcome level indicators. The inability of households to access food in slow onset disasters is often preceded by poor rain fall, pasture conditions, livestock prices or crop production and the price received by the household for casual labour (households' income and purchasing power), which deteriorate before the household begins employing severe coping strategies. Geo spatial and market price indicators that precede household level food security need to be prioritized and refined to deliver improved early warning information that is useable for communities and humanitarian practitioners. Collecting market data in food security analysis is not new. However, other than seasonal assessments conducted by food security monitoring groups FSNAU and FEWSNET, limited amounts of market data were being collected regularly in districts without the presence of a FSNAU field staff. While most regional markets are currently monitored in Somalia, a large percentage of district level markets remain unmonitored. The various agencies collecting data and operating in these districts run the risk of missing important market trends that develop over time, and the effects of local shocks on the local economy and livelihoods, particularly when only using supplied regional prices for local food security analysis. Results of the pilot show that large disparities in the prices recorded in some cases as high as 34% can occur between local markets and their regional hubs. Regular monitoring at the district level over time is necessary to ensure that practitioners and early warning mechanisms are adequately informed about the local food security context.

Monitoring and responding to Early Warning signs require enumerators and programmers to be trained in new concepts and skills. In Somalia, agencies traditionally participate in humanitarian response to slow onset disaster, however the persistent disconnect between monitoring and corresponding early actions was evident in the pilot phase. Agency staff used early warning data collected to supplement their food security information, however it was not used in a predictive sense for other early actions in program areas. Humanitarian practitioners are not historically well trained in monitoring early warning indicators for drought - a shock which has both high likelihood and high impact on households in Somalia.

Local understanding of markets, seasons and historic context is essential. Keeping the scope of early warning at localized livelihood level allows for seasonal and historic nuances to be applied with more usefulness. Regional differences in seasons between Somaliland, Puntland and South Central Somalia can be taken into account, as well as localized geo spatial considerations. Further, communities come to early warning with a host of historic information and understanding, this knowledge should be championed in early warning scenarios. Resilience programming is a good vehicle to invest in existing traditional local structures and advocate for their sustainability through proper funding, development of best practice and capacity building of institutions that acknowledge the need for early warning at the local level.

5. Discussion and Conclusion

The pilot study while not statistically significant raises numerous issues as regards how we plan and implement different stages of the development cycle. It also calls into question the existing architecture of the aid industry. Consistent with SomReP’s approach to resilience, early actions are not simply intended to manage crises in order to maintain a status quo, they are intended to be part of a process of transformation and long-term betterment what has been coined "developmental relief". They seek to manage long-term risk, not only short term crisis.

A number of learning points emerged from the pilot which bring into question how early actions contribute to resilience and how we segregate relief, rehabilitation and development. Firstly the need to clarify triggers for early action versus indicators that classify food & nutrition security phases. Early Actions in the activity matrix must be differentiated from normal development or humanitarian activities. Somalis – individuals, business, government and particularly young people must engage in decisions to act, how and for whom. When is early? Early Action must occur in advance of a crisis outcome – effectively when there is no crisis. The complexity and nature of a slow-onset crisis, such as a drought in Somalia, requires early actions to be taken to minimise human and economic costs, but knowing what to do and when remains a challenge. A clear and emerging challenge to existing early warning systems in Somalia is a need for triggers for action rather than outcome based, or rather ex post indicators such as the classification of food security phases.

Food security phases do enable early actions however a more holistic predictable and preventative approach is needed if early actions are to achieve their intended impact. Early Actions need to address underlying causes of vulnerability by becoming an integral part of programming across all stages of the continuum rather than just an early response to a crisis. In Somalia the IPC classifications used already indicate that the areas of the pilot were already stressed or in crisis. Equally this learning highlights the need to assess early warning information and develop corresponding early action prior to a crisis occurring. In a context such as Somalia which is constantly in crisis this poses a large number of both conceptual (from the perspective of a continuum) and practical questions. Early Actions in a resilience programme must speak to a future state of Somalia, which requires research as to future trends and aspirations of the Somali people (McDowell, 2014a).

Processes such as urbanisation need to be further analysed and early actions compiled with a forward looking contextual perspective. Traditional notions of life-saving or livelihood protecting early actions will need to give way to new forms of early actions which are demand driven, have coverage (to ensure that those actually at risk are covered) and promote long-term development and or transformation will be necessary. Early Actions will need to take into account awareness of this changing livelihood and risk context in Somalia, but must also do so in a highly charged, volatile conflict setting. The pilot highlighted that we do need to take into account information from the community level, in particular as regards price changes. However the pilot also found that there needs to be a trade off at the household level in terms of the difficulty and frequency of which data can be collected in order to allow for timely predictive early warning triggers. Further research into how the architecture and community structures which comprise traditional early warning mechanism can be harnessed in order to work in tandem with newer formal methods of early warning is necessary.

The funding of Early Actions is politically charged as it requires donor governments to utilise public funds on a crisis that in theory may never occur. Bailey (2013, p.4), highlights the difficulty in securing funding for early actions “Domestically, budgetary constraints and declining public support for aid increase the political risks of funding early action: in the absence of a high-profile disaster relayed by the broadcast media, skeptical publics may punish politicians for spending taxpayers’ money on a crisis that is to all intents and purposes invisible and may not even happen.” In 2014 a consortium of development actors in Somalia successfully received funds for early actions. Perhaps more importantly for future iterations of the Crisis Modifier System was that these agencies additionally reallocated and reprogrammed existing funds and activities to towards early actions. While a successful initial undertaking, these agencies recognise that they must continue to adapt their crisis modifier system to reflect an evolving understanding of EWEA and particularly how those concepts apply to a resilience programme in Somalia (McDowell, 2014a).

Early action in the Somalia context resides in what Audet (2014), referred to as the grey area of the continuum. If Early Actions are to achieve their intended impact they must be both predictive and preventative in nature. Early Action triggers must anticipate humanitarian conditions and form an integral part of resilience programming.

References

Ahmed, I., and Herbold, R., 1999. “The Heritage of War and State Collapse in Somalia and Somaliland: Local-Level Effects, External Interventions and Reconstruction.” Third World Quarterly, 20 (1), p. 113-127.

Audet, F., 2014. From disaster relief to development assistance: Why simple solutions don’t work. International Journal: Canada's Journal of Global Policy Analysis, 0(0), p. 1–9.

Bailey, R., 2012. Famine Early Warning and Early Action: The Cost of Delay. A Chatham House Report. July 2012.

Bailey, R., 2013. Managing Famine Risk. Linking Early Warning to Early Action. A Chatham House Report. April 2013.

Buchanan-Smith, M., and Maxwell, S., 1994. “Linking Relief and Development: An Introduction and Overview.” IDS Bulletin 25 (4), p. 2-16

Campbell, D.,1990. “Community-based Strategies for Coping with Food Scarcity: A Role in African Famine Early-warning Systems”. GeoJournal 20 (3), p. 231-241

Collins, A. E., 2009. Disaster and Development: Volume 8 of Routledge perspectives on development. Routledge: London /New York. 0415426685

Darcy, J., Bonardand P., and Dini, S., 2012. Real Time Evaluation of the Humanitarian Response to the Horn of Africa Drought Crisis: Somalia 2011–2012. New York: Inter Agency Standing Committee, 2012.

Famine Early Warning Network (FEWSNET)., 2013. Mortality among populations of southern and central Somalia affected by severe food insecurity and famine during 2010-2012. FEWSNET: Nairobi.

Food Security Analysis Unit (FSNAU)., 2014. Post Gu 2014 Analysis, Technical Series Report, Number VII 55 p.49

Federal Republic of Somalia., 2013. Somalia National Adaptation Programme of Action to Climate Change. Federal republic of Somalia. Ministry of Natural resources.

Intergovernmental Authority on Development (IGAD)., 2013. Drought Disaster Resilience and sustainability Initiative: Country Programming Paper (Somalia). IGAD: Nairobi

Levine, S., Crosskey A., and Abdinoor, M., 2011. “System Failure? Revisiting the problems of timely response to crises in the Horn of Africa.” Humanitarian Practice Network Paper 71. Overseas Development Institute: London.

Maxwell, D., Nisar Majid., Heather Stobaugh., Jeeyon Janet Kim., Jacqueline Lauer., and Eliza Paul., 2014.

Lessons Learned from the Somalia Famine and the Greater Horn of Africa Crisis 2011–2012: Desk Review of Literature. Feinstein International Center, Tufts University: Medford, USA.

McDowell., 2014a. Capturing the use of the SomReP Crisis Modifier. World Vision International. Unpublished.

McDowell., 2014b. SomReP and Early Action Version 2. Somalia Resilience Program. Unpublished.

Mutua, S., 2011. Strengthening Drought Early Warning at the Community and District Levels: Analysis of Traditional community warning systems in Wajir & Turkana counties. Oxfam Great Britain: Kenya

Organization for Economic Cooperation and Development, 2012. Towards better humanitarian donorship: 12 lessons learnt from OECD-DAC peer reviews. Paris: OECD

Pratt, C., 2002. Traditional Early Warning Systems and Coping Strategies for Drought Among Pastoralist Communities Northeastern Province, Kenya. Feinstein international Famine Center, Working Paper No. 8, Fletcher School of Law & Diplomacy, Tufts University

Radich, H., and Tekle, A., 2011. Technical Brief: Pastoral community-based Early Warning systems why don’t we really understand them? Save The Children UK: London

United Nations International Strategy for Disaster Reduction. UNISDR Terminology on Disaster Risk Reduction. Geneva: United Nations International Strategy for Disaster Reduction, 2009.

Venton, C. C., Fitzgibbon, C., Shitarek, T., Coulter, L., and Dooley, O., 2012. The economics of early response and disaster resilience: Lessons from Kenya and Ethiopia. London: Department for International Development.

The sustainability issue of housing material loans (HML) for public housing in the Philippines: recipe for cyclical disaster risk?'

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Abstract

The Philippines' pilot housing agency, the National Housing Authority (NHA), offers various modes of housing delivery for the lowest thirty percent income Filipino earners. One of these modes is the awarding of the housing material loans (HML) for the former residents along the Philippine National Railays (PNR) who were relocated to Southville 1 Cabuyao, Laguna last 2007. This housing delivery concept, was that the residents were given money in instalments by the government to buy construction materials, and they built their shelters under technical supervision and following design of and by the NHA. The resettlement site suffered numerous natural calamities since their transfer like the massive flooding caused by the typhoon Ketsana (Ondoy). Findings indicate that the built houses did not pass structural integrity in terms of faulty roofing construction and short-changing of materials against NHA-provided minimum design specifications, increasing of likelihood of future cyclical natural disaster risks.

Keywords: Cyclical risk, housing material loan (HML), sustainability, shelters, structural integrity

1. Study background and locus

The Philippines is one of the natural disaster hotspots in the world, ranking 12^{th} out of 200 countries, in terms of MRI (mortality rate index) when it comes to exposure of the human population to natural disasters [21], impacting negatively on the socio-economic aspects of the lives of Filipinos, especially the poor. The country was ranked in the year 2011 as having the world's most number of disaster occurrences [11]. Natural disasters also affect the economic sustainability and fiscal position of the country, draining billions of pesos and enormous resources annually for post-disaster reconstruction projects and programs, which could have otherwise been allotted for social services and infrastructure development. With this, the Republic Act (R.A.) 10121 was enacted into law, which superseded the more than twenty-year old law Presidential Decree (P.D.) 1566, causing a shift from the usual post-disaster relief and rehabilitation activities to disaster-prevention, disaster-mitigation and disaster-reduction through a restructured bureaucratic set-up, from the National Government, to the LGUs up to the grassroots level.

The typhoon *Ondoy* (international name *Ketsana*) which has paralyzed 85 percent of Metro Manila, last September 2009, displacing 500,000 individuals and causing damages of around Php7 billion is one glaring example [8], not to mention the recent reverse tsunami which claimed more than 1,000 lives in Northern Mindanao, caused by the typhoon *Sendong (Washi)*. Other notable disasters were the typhoon *Gener (Saola)* last 2012, super-typhoon *Yolanda (Haiyan)* last November 2013 which heavily damaged much of Eastern Visayas and the strongest tropical cyclone ever to hit land globally since the era of recorded history at 305 KpH, and the typhoon *Glenda (Rammasun)* last July 2014) which paralysed much of Metro Manila for weeks after its brief three-hour visit. Given this predicament, the Philippines, with almost seventy percent (70%) of its citizens living below annual poverty threshold, has more of its lower-income residents exposed to natural disasters, compared to those with higher-income citizens due to lower adaptive capacities (per capita GDP and availability of resources which can be used to enable immediate recovery after a disaster) and socio-economic sensitivities (people per city, wealth or Gross Domestic Product (GDP) and contribution to national GDP) [27]. This is congruent with the findings that 97% of the global disaster mortality risk is concentrated in low- and middle-income countries [23] which includes the Philippines, where only 43.4% of the lower income residents have access to decent dwellings of "strong" materials [13].

Thus, the National Housing Authority (NHA) guided by the National Shelter Program of 1986 of the Philippine government and its Constitution, was tasked to provide public housing units for the lowest thirty percentile (30%) income-earners in the country. - which includes the homeless, informal settlers and economically and politically-displaced citizens. Last 2007, under the tutelage of then Philippine National Vice President and concurrent Housing and Urban Development Coordinating Council (HUDCC) Chairman Noli de Castro, spearheaded the North Rail relocation program towards the peaceful relocation of 38,206 families and that of the South Rail part (55,632 inhabitants, or more than 20,000 families) who were then living along the Philippine National Railway (PNR) right-of-way to safer government-provided mass housing relocation sites in Bulacan and Laguna, one of which was the Southville 1 resettlement site in Cabuyao, Laguna. A typical resettlement program, according to the National Housing Authority (NHA), involves the acquisition and development of large tracts of raw land to generate serviced lots and/or housing units for families displaced from sites earmarked for government infrastructure projects and those occupying danger areas such as waterways, esteros, and railroad tracks [12]. It was also during this time, that Integrated Community Extension Services (ICES) Director Fr. Atilano 'Nonong' Fajardo, considered adopting Southville 1 as its centrepiece Vincentian Corporate Social Responsibility (VCSR) beneficiary then for the Adamson University's pro-poor-oriented programs and activities.

Southville 1 is one of the major NHA relocation sites (South Rail Relocation project) in Philippine territorial Region IV-A, particularly involving three barangays - Marinig, Niugan and Banay-Banay in Cabuyao, Laguna, shown in Figure 1. Barangay Marinig, with a 2010 population of 37,610 and population density 9,494/sqm., has the highest annual population growth rate in the newly-instituted City of Cabuyao (at 5.01%) and its second largest barangay in terms of population. It is also located along the fringes of a body of water- *Laguna de Bay*, which is predominantly a source of freshwater species for fisher folks in the said region, which places it as one of the most directly affected during the 2009 typhoon *Ondoy* (Ketsana) flooding onslaught, the super-cyclone *Yolanda* (Haiyan) last 2013, and the typhoon *Glenda* (Ramassun) last July 2014. For this reason, Southville 1 particularly Barangay Marinig was chosen as the locus of this study. For the past seven (7) years since the relocatees' transfer to Southville 1, it suffered heavily from the ravages of typhoons, blowing off some of the relocatees' roofing and causing severe flooding in some parts of the study locus. Being situated along the edge of Laguna de Bay, this makes it prone to natural diseases due to the slow subsidence of the said bay's flooding due to water stagnation and rotting of the dead fishes. This was particularly evident during the monsoon seasons of 2009 and 2012.

The housing relocates, based from focus group discussion (FGD), were awarded identical empty plots of land by the NHA by drawing of lots in 2007. Each of the awarded family-beneficiary was allotted with Php100,000 lot purchase loan (payable in monthly amortisations for a period of twenty-five to thirty years) and given Php50,000 outright housing material loan (HML), totalling Php150,000.00 (2007 figures). Each rectangular lot measures uniformly plus/minus forty (40.00) square meters, with 4,00 meters as frontage and 10.00 meters as depth while the HML was allotted for the construction of a single-storey dwelling unit consisting of a combined living-diining-kitchen (LDK) areas without any room partition, an enclosed toilet and bath room and an enclosed bedroom employing the reinforced concrete structural frame with concrete hollow block wall construction. Then National President Her Excellency Gloria Macapagal-Arroyo subsidized Php25,000 from the Php150,000 total amount, under her livelihood programs. For the Php50,000 HML, these were given into two (2) successive instalments - Php25,000 was given as outright cash downpayment for the purchase of the construction materials by the beneficiaries, and when the house was partially built (with fifty percent of the walls and columns already built as required and inspected by NHA field engineering division), the balance amount shall be given in staggered payments, following the housing design template given by the said housing agency. The distribution of these housing units were laid out in typical subdivision plan pattern, except that for every ten (10) dwelling units, they were oriented in a U-arrangement with a small open space with an artesian deep well inside the "U," with the open end facing the street. This falls within the category of aided self-help housing [14] where the government provides for the sites and services while the housing beneficiaries take charge with the construction of their dwelling units.

However, ocular inspection indicates inconsistent dwelling appearances among the VCSR and non-VCSR residents deviating from the prescribed government design. This predicament led to this study proposal in conducting a structural investigation of the NHA design, with a physical disaster resistance assessment of the existing dwelling units built in the said resettlement sites and if these units follow the NHA house design. These methods will in turn determine if the housing material loans (HML) mode of housing delivery translate to a disaster-resistant design.

Figure 1. Map of Cabuyao, Laguna

2. Related Literature review

In this study, the terms housing and shelter are used interchangeably to avoid confusion, though both were defined differently [15]. Disaster risks for the dwelling unit include possible physical damage, livelihood disruption and loss of human lives caused by materials shortchanging or faulty engineering design on the housing donor's side, considered as one of technological hazards [20] [21] or depends on the housing recipient's side [4] [17] [2], United Nations – Office for the Coordination of Humanitarian Affairs [24] [16] where the outcome of a disaster is shaped both by the physical nature of the hazard and the vulnerability of people who are involved like those residing in hazard-prone locations, substandard housing quality and lack of disaster preparedness [4]. Any lapses in the conduct of post-disaster housing programs will give way to possible risks to future natural calamities as well [24]. And speaking of vulnerability in the context of disaster risk management, this was originally oriented towards the level of physical resistance of engineering structures to natural disasters [19], but have evolved to more recent views which already include the make-up and profile of environmental and socio-political processes and interactions. Vulnerability refers to the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. A structure is said to be 'at-risk' or 'vulnerable', when it is exposed to known hazards and is likely to be adversely affected by the impact of those hazards if and when they occur [22] At a global perspective, the root causes of vulnerability to natural disasters include population explosion, rapid urbanization and poverty incidence [24] while at the local levels are due to the unsafe pre-disaster housing on a danger zone, with minimal understanding of the risks they face from hazards, and limited options to protect themselves [26]. Vulnerability can cover internal risk factors (within a person itself)[3], up to a multi-dimensional form which encompasses physical, social, economic, environmental, and institutional aspects [18] while UN/ISDR [21] classifies vulnerability into social, economic, physical and environmental components. However, the scope of this study is limited to the physical (in terms of the disaster-resistance of both the NHA housing design and that of the built dwelling units in terms of their respective unique housing design profile and actual condition) and economic aspects (determining if the housing material loan amount translate to a disaster-resistant shelter). However, if a particular mass housing project was not properly carried out, in terms of stricter quality control in the physical construction of the dwelling units, this might lead to greater vulnerability to future natural calamities [25] leading to a vicious cycle of reconstruction after each calamity, leading to waste of limited resources both by the government and that by the indigent dwelling beneficiaries, which in turn undermines the sustainability of a housing programme. The sustainability of a housing program also depends on community involvement, ready access to good quality materials to which homeowners can afford, building standards, housing finance mechanisms and land availability[5] thus assessment of possible disaster risks is necessary to ensure sustainability [10].

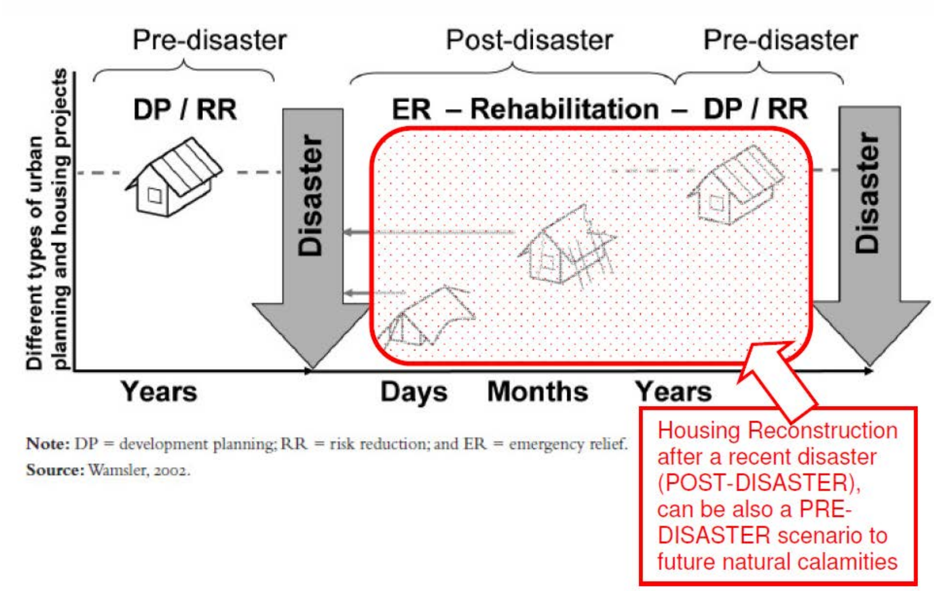

Figure 1: Housing Reconstruction in the Context of Cyclical Risk. (Adapted from Wamsler, 2006)

3. Study methodology

Generally, the study, involved a *mixed methods* approach [6] in chronological order, namely ocular site inspection, a cartographical analysis in terms of flood and earthquake fault line, a materials cost estimate of the NHA housing design, a focus group discussion among housing beneficiaries representing all community phases regarding their experiences with natural calamities in the resettlement site for the past even years, a structural investigation of the model housing design by the NHA for Southville 1 resettlement site with a structural engineer-external consultant as basis for the two test instruments on dwelling disaster resistance, namely - conduct of disaster risk assessment of both the existing built housing units based on their unique design profiles and their respective actual shelter conditions. The locus of the study covered only Barangay Marinig (upper portion of) Southville 1 NHA Resettlement Site in Cabuyao, Laguna. The said barangay covers five (5) phases, namely I, II, III, IV and V, in terms of geographical subdivision. The entire study intermittently took fourteen (14) months, within a span of more than two-and-a-half (2 1/2) years from February 2012 to August 2014.

As above-mentioned, the administered two (2) test instruments were as follows- *Instrument 1: Structural Description of Housing Donor's Housing Design Assessment Form* and *Instrument 2: Actual Housing Damage Level Self-Assessment Survey*

Test Instrument No. 1 was distributed among one hundred (100) randomly-sampled housing units within the study locus (or ten (10) housing units owned by each of the VCSR and non-VCSR members, or twenty (20) per phase) (see Fig. 2), to be answered by their original residents who relocated last 2007, and assisted by trained Architecture student-volunteers from Adamson University. This instrument is a Likert-coded (from 1 to 4) descriptive assessment survey form, represented by four (4) descriptive sub-statements, with increasing structural resistance to natural disasters for each descriptive sub-statements 1 to 4. Each four (4) descriptive sub-statements makes up to one (1) descriptive general statement, and the entire survey kit consists of fifty (50) descriptive general statements, covering practically every part of the dwelling units that was divided into four (4) major parts, namely - foundation, structural frames (beams, columns and walls), trusses or rafters with purlins, and environmental factors (typhoons, earthquakes and floods). These four (4) major parts considers both (a.) the structural profile description of the structure itself (24 descriptive general statements) and (b.) the environmental conditions (26 general descriptive statements) where the said structure is situated, totalling 50 in all. A basic design template for a single-storey family dwelling unit that was provided for by the NHA for Southville 1 resettlement site was structurally analysed and from which any lapses to intended structural resiliency to Intensity 8 earthquake and 250 KpH typhoon and one meter high flooding were taken into account towards the production of these fifty-six (56) descriptive statements. Graphic images were also provided for most of the descriptive statements. These fifty (50) general descriptive statements were adapted from the United Nations International Strategy for Disaster Reduction Guidance Notes on Safer School Construction Checklist [20], the Philippines' National Building Code (Presidential Decree 1096), the National Structural Code of the Philippines (NSCP), Association of Structural Engineers of the Philippines (ASEP) Manuals [1], the Unified Soil Classification (USC) system and other relevant literature for structural engineering. The minimum baseline average score is 3.0, interpreted as disaster-resistant, from the combined scores of all fifty-six (56) general statements where it is assumed that the minimum structural requirements for Intensity 8.0 Earthquake, NSCP Zone IV (250 Kph) wind load and 3.0 meter high flooding were satisfactorily met, supported by complete structural computations that were prepared by the external consultant (structural engineer). It is imperative to include environmental conditions (like presence and location of water table, soil liquefaction, distance from earthquake fault lines, etc.), not only the building's physical make-up, in this assessment form since this also critically affect building damage during natural calamities [9]. This form was utilised only by the researcher, in coordination with the external consultant-structural engineer, as shown in Fig. 3 below.

Figure 2: Existing Site Development Map of Southville 1 community showing demarcation (by the researcher) among Phases I, II, III, IV and V with shaded portions for randomly -selected VCSR and non-VCSR study respondents

1. Size and spacing of Purlins used:

(1) Purlins are not made of steel C-Channel
(2) Size of steel Purlins are less than 50mmX100mm steel C-Channel spaced 0.70m o.c. or more
(3) Size of steel Purlins are 50mmX100mm steel C-Channel spaced 0.70m o.c. or less
(4) Size of steel Purlins are greater than 50mmX100mm steel C-Channel spaced 0.70m o.c. or less

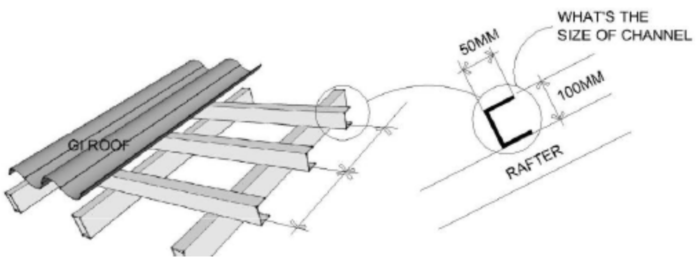

Figure 3: A portion of Test Instrument No. 1. Structural Description of Housing Donor's Housing Design Assessment Form which shows Likert type of assessment

Moreover, Test Instrument No. 2, with a similar Likert set-up (1 to 4) with that of the Structural Description Assessment Form with the same households, however, contains three (3) major parts, namely typhoon (with three statements), earthquake (with four statements) and flooding (two statements). Each part was treated separately in obtaining their mean Likert scores. Each of the natural calamity (typhoon, earthquake and flooding) has their own respective descriptive statements for each part of dwelling (roof, walls, windows/doors, columns, beams, entire dwelling unit), assigned with Likert coded values from 1 to 4. Graphical images were provided for each of the Likert-coded statement. Minimum baseline average score per part (calamity) is 3.0 which is interpreted as not vulnerable to damage, while scores lower than 3.0 are interpreted increasingly from vulnerable to highly vulnerable to damage. This self-assessment survey form was answered by the housing beneficiaries based from their experiences on any subsequent actual damage on their donor-provided housing units upon their relocation to the resettlement sites for the past seven years.

4. Results and Discussion

Shown below are the results of this study. Focus group discussions indicate that Phase 1 - Blocks 1, 2 and Phase 2 - Blocks 9 and 10 were heavily flooded last 2009 (Ondoy) while the entire study locus suffered flooding for that same year, based from cartographical analysis.

On the other hand, the three Southville 1 Barangays (Marinig, Niugan and Banay-Banay) were plotted by the researchers in the scaled earthquake fault line and liquefaction map provided by the Department of Science and Technology [7]. The resettlement site in Cabuyao is not prone to liquefaction, and is located 17 kilometres from the Philippine Valley Fault System (earthquake).

Based from structural investigation results jointly made by the researcher with the consultant-structural engineer for the NHA housing design, there were some additional components be added for the roofing components, while the rest fairly passed the minimum structural requirements.

Meanwhile, Table 1 below shows that a significant majority among one hundred (100) randomly-sampled dwelling units among Phases I, II, III, IV and V were considered *prone to disaster risk over-all*, covering both the dwelling's physical profile based from this study's criteria and the site where these houses are located, having not reached the minimum average score of 3.0, with average scores ranging from the lowest 2.36 among Phase V VCSR households and highest 2.62 among Phase 2 non-VCSR households. Excluding site profile, the roofing system (Part III.Trusses or Rafters) poses highest vulnerability to disaster risks, with scores among Phases I to V ranging between 1.65 to 2.55, still way below the minimum 3.0 baseline score. On the other hand, in terms of environmental factors, the dwelling units in relation with the existing conditions are most vulnerable to disaster risks due to floods, followed by windstorm and earthquake. This also indicates that the homeowners did not strictly follow the minimum material and quantity specifications based from a dwelling design set forth by the NHA, using less amount of materials in order to maximise the Php50,000.00 housing material loan (HML) given by the government for each household for house construction.

Table 1: Over-all Summary of Results for Test Instrument No.1:
Structural Description of Housing Donor's Housing Design Assessment Form

Average from randomly sampled 10 dwelling units per VCSR/non-VCSR members per phase (P)	**P1** VCSR	**P1** NON-VCSR	**P2** VCSR	**P2** NON-VCSR	**P3** VCSR	**P3** NON-VCSR	**P4** VCSR	**P4** NON-VCSR	**P5** VCSR	**P5** NON-VCSR
A. Dwelling Structure Only										
I. Foundation										
I.A. RC Footing Slab	2.83	3.03	2.70	3.10	2.90	2.67	2.80	2.53	2.74	2.27
I.B. Exterior RC Wall Footing	2.40	2.08	1.64	2.38	2.13	1.93	1.53	2.05	2.03	2.15
I.C.Footing Slab	2.95	2.58	1.73	2.48	2.08	1.95	1.80	2.15	2.00	2.23
II. Structural Frames										
II.A. Structural Column	2.50	2.58	2.55	2.90	2.43	2.40	2.45	2.40	2.40	2.43
II.B. RC Beam	2.60	2.70	2.38	2.75	2.10	2.03	2.43	2.10	2.55	2.30
II.C. RC Exterior Walls	3.10	3.10	2.37	2.80	2.67	2.90	2.97	2.94	2.83	2.57
III. Trusses or Rafters	2.30	2.55	1.70	2.00	1.40	1.70	1.83	1.65	2.15	2.00
AVERAGE (Structure Only)	***2.68***	***2.64***	***2.26***	***2.76***	***2.32***	***2.22***	***2.21***	***2.27***	***2.37***	***2.29***
B. Environmental Factors Only										
IV.1. Earthquake	2.78	2.81	2.71	2.78	2.64	2.66	2.92	2.79	2.58	2.48
IV.2. Windstorm	2.68	2.72	2.73	2.73	2.68	2.60	2.66	2.63	2.44	2.20
IV.3 Floods	1.87	2.15	2.08	2.02	2.07	1.95	1.98	1.93	2.08	2.20
AVERAGE (Environmental Site Conditions only)	***2.53***	***2.62***	***2.58***	***2.58***	***2.53***	***2.47***	***2.60***	***2.53***	***2.41***	***2.43***

Average from randomly sampled 10 dwelling units per VCSR/non-VCSR members per phase (P)	P1 VCSR	P1 NON-VCSR	P2 VCSR	P2 NON-VCSR	P3 VCSR	P3 NON-VCSR	P4 VCSR	P4 NON-VCSR	P5 VCSR	P5 NON-VCSR
OVERALL AVERAGE (Structure +Site) (Per Phase STRUCTURAL DESCRIPTION)	**2.60**	**2.53**	**2.42**	**2.62**	**2.42**	**2.35**	**2.42**	**2.41**	**2.39**	**2.36**

INTERPRETATION: 1.00 - 1.99 Highly Disaster Prone
2.00 - 2.99 Disaster-Prone
3.00 - 4.00 Disaster-Resistant

Table 2 above indicates that the dwelling units, generally were not much affected due to natural calamities that visited the resettlement site having an over-all score of 3.50 out of 4.00 based from the past six (6) years, which indicates that the intensity of these calamities which affected the site for the past six years were not that strong enough as to inflict heavy damage. However, examining further, it was the typhoon which has the biggest impact (3.16 out of 4.00) on these dwelling units. This corroborates the previous homeowners' reports during the focus group discussion (FGD) that some of their roofs were "blown apart" by strong winds during previous typhoons. Moreover, this supports the findings from Test Instrument No.1 as previously discussed where the roofing system (either rafters or purlins) were considered most vulnerable. This was followed by flooding (3.60) and lastly by earthquake (3.73). The last part corroborates the structural engineer's report that the site is in fairly safe distance from the fault line. Actual housing damage level extends also to degradation of wooden members for doors and windows being exposed to weather elements.

Table 2: Over-all Summary of Results for Test Instrument No.2: Actual Housing Damage Level Self-Assessment Survey

Actual Housing Damage Level	VCSR M/F	COMBINED (M/F, VCSR-NONVCSR)	NON VCSR M/F
Typhoon (Bagyo)	2.79	**3.16**	3.52
Earthquake (Lindol)	3.78	**3.73**	3.69
Flooding (Baha)	3.59	**3.60**	3.62
AVERAGE (VCSR / NON-VCSR)	**3.39**		**3.61**
		M/F	
OVERALL AVE (Actual Housing Damage Level):		**3.50**	

INTERPRETATION: 1.00 - 1.99 Highly Vulnerable to Damage
2.00 - 2.99 Vulnerable to Damage
3.00 - 4.00 Not Vulnerable to damage

5. Conclusions and Recommendations

The results therefore indicate the following: a.) the overall general average score results of Test Instrument No.1 ranging from 2.36 to 2.62 (way below the minimum baseline average of 3.0) among all community phases indicate that strict compliance by housing beneficiaries with the minimum design specifications set forth by the NHA generally fell short, which b.) might indicate that the Php50,000 amount allocated for the housing material loan (HML) is not sufficient enough to complete such structure, based from both focus group discussion and independent cost estimates conducted by the researcher. This also indicates that c.) there were lax monitoring by the government with regards to the two-part release of the HML during the construction phase. Summing all of these, these current scenario might possibly lead to d.) increasing disaster risk to future natural calamities especially typhoons since the existing built structures fell short of minimum design specifications.

Even though the results of Test Instrument No.2 Actual Housing Damage level show that these dwelling units only suffered relatively minor damages (up to roofs being blown apart, corroborating the results of Test Instrument No.1,-Part III: Trusses or Rafters with scores ranging between 1.40 to 2.55, still below the 3.0 baseline score) during typhoons, these imperil the longevity of the said housing programme since the housing beneficiaries generally lack the financial capacity to repair nor reinforce their dwelling units, which will also entail additional expenses for the government in the long-term. Combining all these factors (physical, economic and social) [21], these might lead to a cyclical disaster risk [25].

In order to address these issues, the following are therefore recommended, firstly, the NHA should enforce stricter monitoring during the construction phase for this mode of housing delivery - housing material loan (HML) to more than one ocular site inspection while the houses are being constructed. Secondly, the NHA should improve the roofing design of its housing design to meet the 250 Kph typhoon winds by reinforcing with additional materials. Thirdly, NHA should review and update its funding allocation for the HML which was at Php50,000.00 last 2007, and consider the use of alternative indigenous materials to make it more cost-effective. Fourthly, the NHA should make a simple user-friendly house maintenance checklist that is highly graphic for the housing beneficiaries to clearly follow through and understand, or this particularly can be done by the researcher in a separate study, in collaboration with the General Education department (Linguistics, Filipino) and a structural engineer. Fifth, further studies have to be made on coming up with house designs that both addresses disaster resistance and flexibility of usage for the ever-growing typical Filipino households with a sense of individuality. And lastly, NHA regulations should be instituted in requiring homeowners to comply that the maximum number of storeys (level) per dwelling should be no more than one storey, unless a new design which anticipates future vertical expansion due to emerging family needs is to be prepared by the government.

References

[1] Agoncillo, M. (2004). *ASEP Steel Handbook. Vol. 1: Dimensions and Properties 3rd Ed.* Quezon City: Association of Structural Engineers of the Philippines

[2] Bencze, O. and Tilotta, D. (2010). *Perceptions on the Natural Disaster Resilience of Homes in the Southeastern United States.* Raleigh NC USA: Carolina State University.

[3] Bohle, H.G. (2001) ‘‘Vulnerability and Criticality: Perspectives from Social Geography’’, *IHDP Update 2/2001*, Newsletter of the International Human Dimensions Programme on Global Environmental Change: 1–7.

[4] Bosher, L. (2011, March). Household and Government Perceptions of Risk: Implications for the Appropriateness of Housing Provision in South India. In. *Housing Studies*, Vol. 26, No. 2, pp. 241–257, Routledge.

[5] Choguill, C. (2007) The search for policies to support sustainable housing (Editorial) In *Habitat International* 31 (2007) pp. 143-149. Elsevier.

[6] Creswell, J.W. (2002) *Qualitative, Quantitative, and Mixed Methods Approaches*. USA: SAGE.

[7] *Department of Science and Technology*. (2013). Philippines

[8] De Vera, E., Villas, A. & Antonio, R. (2009, September 28). Flood blamed on record rainfall. *Manila Bulletin.* Retrieved from http://www.mb.com.ph/articles/222285/flood-blamed-record-rainfall

[9] International Association for Earthquake Engineering, United Nations Educational, Scientific and Cultural Organization & International Institute of Seismology and Earthquake

Engineering. (IAEE, UNESCO & IISEE) (2010). *Guidelines for Earthquake Resistant Non-Engineered Construction.* (Draft, as of July 2010).

[10] Krysiak, F. (2009). Risk Management as a Tool for Sustainability. Taken *from Journal of Business Ethics.* (2009) 85:483–492. DOI 10.1007/s10551-009- 0217-7 Springer Link.

[11] Mabasa, R. (January 27, 2012). Philippines Tops Natural Disasters List. *Manila Bulletin* (online). Retrieved from http://www.mb.com.ph/node/349474/philippine#.UNyEaeTqkzU

[12] *National Housing Authority* (2014). Accessed 2014. Retrieved from www.nha.gov.ph/pages/rail.php

[13] *National Statistics Office* (2005) NSO. Republic of the Philippines

[14] Pugh, C. (2001) The theory and practice of housing sector development for developing countries, 1950-99. In *Housing Studies*, Vol. 16 (4): pp. 399-423.

[15] Quarantelli, E.L (1995) 'Patterns of shelter and housing in US disasters'. *Disaster Prevention and Management* 4(3). pp. 43–53.

[16] Sinha, D. (2007) *Natural disaster reduction: South East Asian realities, risk perception and global strategies.* Anthem Press. ISBN: 1843317044.

[17] Turner, R. H., Nigg, J. M., and Paz, D. H. (1986*) Waiting for disaster: Earthquake watch in California*. Los Angeles : University of California Press.

[18] Turner, B. L., R.E. Kasperson, P.A. Matson, J.J. McCarthy, R.W. Corell, L. Christensen, N. Eckley, J.X. Kasperson, A. Luers, M.L. Martello, C. Polsky, A. Pulsipher and A. Schiller (2003) ''*A framework for vulnerability analysis in sustainability science''*, Proceedings of the National Academy of Sciences,100(14): 8074–8079.

[19] United Nations Department of Humanitarian Affairs (UN/DHA). (1992, December). *Glossary: International Agreed Glossary of Basic Terms Related to Disaster Management* (DHA/93/36). Geneva, Switzerland Retrieved from http://www.em-dat.net/glossary.htm ; and at: http://www.reliefweb.int/rw/lib.nsf/db900SID/LGEL-5EQNZV/$FILE/dha-glossary-1992.pdf?OpenElement

[20] United Nations - International Bank for Reconstruction and Development (2009). *Guidance Notes for Safer School Construction*.

[21] United Nations - International Strategy for Disaster Reduction (UN/ISDR) (2004a). *Living with Risk: A Global Review of Disaster Reduction Initiatives, 2004 ver*sion, Geneva: UN Publications.

[22] *United Nations - International Strategy for Disaster Reduction. Terminology* (2007) .Retrieved from http://www.unisdr.org/we/inform/terminology.

[23] United Nations - International Strategy for Disaster Reduction (UN/ISDR) (2010). *Accelerating MDGs by Reducing Risk to Natural Hazards- Invest Today for a Safer Tomorrow.* Background Document Draft. United Nations

[24] United Nations – Office for the Coordination of Humanitarian Affairs (UN/OCHA) (2006). *Exploring key* changes and developments in postdisaster settlement, shelter and housing,

1982 – 2006. Scoping study to inform the revision of 'Shelter after Disaster: Guidelines for Assistance' Geneva: UN Publications.

[25] Wamsler, C. (2006). “Mainstreaming risk reduction in urban planning and housing: a challenge for international aid organizations.” In *Disasters*. by Overseas Development Institute. MA USA: Blackwell Publishing. [30(2): 151−177]

[26] Wisner, B., Blaikie, P., Cannon, T. and Davis, I. (2004). *At Risk, Natural hazards, people’s vulnerability and disasters (Second edition)*. Routledge: London

[27] World Wide Fund. (2009). *Mega-Stress for Mega-Cities: A Climate Vulnerability Ranking of Major Coastal Cities in Asia*. (Report). Switzerland.

Resilience and Adaptive Capacities in Cyclone Larry

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Abstract

The paper presents a theoretical overview of the concept of resilience. The overview comprises current understandings of resilience, and its main components: stress; adaptation; wellbeing; and resources. The paper also analyses the relationship between resources and their dynamic attributes; a network of adaptive capacities; and rapid adaptation after a disruption, ─ the key attribute of resilient systems. Community resilience is manifested in quick restoration of community functioning and individual welfare, and wellbeing after a disruptive event. The paper also argues that community resilience should be built long before an event from four categorisations of adaptive capacities: (1) wealth and economic development; (2) social networks and social capital; (3) effective information dissemination and communication systems as well as (4) technical knowledge and competence. The paper concludes by describing empirical case examples of some effective resilience strategies in the management of the Cyclone Larry disaster of March 20, 2006.

Key words:

Introduction

This paper addresses three questions: What is the current theoretical and empirical understanding of resilience? What are the key components of resilience and their relationships? How can we design resilience into contemporary Australian communities to better withstand disasters? The rest of the paper is structured as follows: first, I discuss the current theoretical and empirical understanding of resilience; second, I define a ‘disaster’; and third, I provide an analysis of the most important components of community disaster resilience and adaptive capacities and argue that resilience can and should be built into communities in the preparing for disasters. This section is then followed by a description of some empirical case examples drawn from the preparedness and response phase of the management of Cyclone Larry 2006, because, in general, there is a consensus that Cyclone Larry is an exemplar case from which lessons of resilience may be drawn. In the penultimate section, six recommendations for policy, and practice are discussed, and then the paper concludes with a summary.

The concept of resilience

Resilience is a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance (Norris et al 2008). Resilience is a commonly used concept in disaster management research; and several studies have linked the genesis of resilience to the disciplines of physics and mathematics (e.g. Comfort et al 2010; Norris et al 2008; Paton and Johnston, 2006; Pelling, 2003). Resilience was traditionally used to describe the capacity of a material or system to return to equilibrium after a displacement. In mathematics a resilient item, for instance will bend, and flex and bounce back, rather than break when flexed, or stressed (Bodin and Wiman 2004; Gordon, 1978). Similarly but differently, in physics, resilience is not a matter of how large the initial flex, or displacement is, but is more about the speed of recovery to its initial state i.e., the speed with which homeostasis achieved.

Furthermore, the concept of resilience has often been used to describe biological and ecological systems such as the term 'ecological resilience' coined by Holling (1973); and recently, the seminal case study of the role of traditional ecological knowledge to cope with challenges from global environmental change by Gómez- Baggethun et al (2012). Resilience has also been used to describe the capacity of individuals to adapt to difficult situations in the discipline of psychology (e.g. Weine, 2013; Bonanno, 2004, 2005; Richardson, 2002), and child psychology (e.g. Butler et al. 2007).

More recently, the concept of resilience was adapted to fit the context of human communities as used in the term 'community resilience' (e.g. Poortinga, 2012; Cutter et al 2008; Sonn and Fisher 1998; Godschalk 2003), and other areas. In summary, the concept of resilience is diverse in application, and may be understood, and addressed at different levels of analysis.

However, notwithstanding the origins of the concept, or the sheer diversity of contexts in which the concept has been studied, and applied; two things are clear: first, most analysis emphasize a capacity for effective adaptation, and adaptability rather than stability in the face of disturbance, stress, or adversity (e.g. Waller 2001; Handmer and Dovers 1996). Second, resilience is often analysed as an ability or a process rather than as an outcome (e.g. McManus et al 2008; Pfefferbaum et al. 2005).

In this paper, I focus on the resilience of communities in the face of, and context of disasters. Community resilience is a process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent community populations after a disturbance (Norris et al 2008). Such focus is because disasters are a part of life and their incidence is increasing (Oloruntoba, 2005; McEntire, 2002, 1999). Also, the socio-economic impacts of natural disasters are increasing (Centre of Research for the Epidemiology of Disasters, 2009). For example, in 2010, more than 290,000 people were killed, and over 217 million were affected by natural disasters worldwide (Centre of Research for the Epidemiology of Disasters, 2009). Worldwide disaster-related economic damage was estimated at roughly US$124 billion (Guha-Sapir et al., 2011). In other words, the focus of community resilience is on developing systems of capacities to face disasters, and to reduce vulnerabilities.

The concept of disasters

I adopt the definition of a disaster as 'a potentially traumatic event that is collectively experienced, has an acute onset, and is time delimited; disasters may be attributed to natural, technological, or human causes' (McFarlane and Norris, 2006, p.4). Thus, a disaster is a non- routine event that exceeds the capacity of the affected area to respond to it in such a way as to save lives; to preserve property; and to maintain the social, ecological, economic, and political stability of the affected region.

The definition includes natural events, such as cyclones, or hurricanes as they are referred to in North America. Other examples of disasters include earthquakes, floods, heat waves; large transportation, nuclear, or industrial accidents. The definition excludes chronic environmental hazards, or slow-on set events such as drought and famine, ongoing wars and conflict, political and community violence, and epidemics. These are excluded because how such disasters (or community stressors) latently 'cook' often undetected for years, before they erupt are often different. The dynamics of how such disasters unfold over time often differs enough to warrant boundaries of the potential applicability of theory and research (see Turner, 1976; 1976b for a comprehensive account of slow-onset disasters). Given the multi-disciplinary and inter-disciplinary nature of disaster studies and disaster management, I draw upon existing resilience literature in a range of disciplines with a particular focus on disaster studies and disaster management. I draw on the disciplines of sociology, anthropology, geography, public administration, emergency management, economics, health, organisation studies, technology, and communications.

Components of community disaster resilience

I have summarised the key components of the resilience of communities in the face of disasters into four broad categories: (a) stress and stressors; (b) adaptation and adaptability; (c) community wellbeing; and (d) resources.

(a) Stressors and stress;

A stressor is an aversive circumstance that threatens the well-being, or functioning of the individual, organization, neighbourhood, community, or society (Murray and Zautra, 2012). For example, a disaster such as an earthquake or a sudden volcanic eruption is a stressor of the affected community. The process by which a stressor stresses a community is dependent on factors such as: the features of the stressor (e.g. scale, intensity, duration, surprise); subjective appraisals and evaluations of the stressor (e.g. by public safety officials or members of the community); the response to and impact effects of the stressor (e.g. physical, social, economic, psychological impacts) and a range of factors that influence the network of relationships between the stressor, stress appraisal, and response to the stress (e.g. by individual members of the community, or public safety officials).

The level of community exposure to the stressor interacts with pre-existing individual and community vulnerabilities. This in turn influences the magnitude and severity of the impact of the stressor on the community, and the individuals within it i.e. the level of stress. Ultimately, the level of stress also determines to a large extent the ability of the individual, and community to respond as well as the nature of individual, and the nature of the community response to the stressor (Paton, 2008; Benight et al 2006; Benight, 2004).

Community stressors arising from the range of impacts of disasters often include: injury to self or family member; life threat; and bereavement. Others include damage to property, neighbourhood, or community destruction, financial and economic loss, and displacement. Disasters are stressful not only for individuals experiencing personal loss but also for the community at large (e.g., Murray and Zautra, 2012; Paton, 2008; Mollica et al 2004; Norris et al 1994; Raphael et al 1986).

The unpredictable nature of the dangers confronting contemporary communities, planners and governments has been comprehensively addressed by several authors (e.g. Comfort, 2010, 2007; Allenby and Fink 2005; Longstaff, 2005; Barnes and Oloruntoba, 2005; Boin and Lagadec, 2000; Mitroff and Alpasian, 2003; Perrow, 1984). The world is increasingly complex, interconnected, with systems in constant flux in reaction to the dynamism of other changing systems, making surprise more common than predictability. Ultimately, community well-being depends in part on the effectiveness of organizational and societal preparedness and responses. However, since it is impossible for communities to be so prepared for all eventualities that there is a nil chance of a stressor event such as a disaster occurring; the situation thus calls for broad resilience strategies. Ultimately, the purpose of disaster management is to maintain the safety and well-being of the public, and to promptly restore community well-being if it is jeopardised.

(b) Adaptation and adaptability;

Stressors such as disasters cause a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of the affected people to cope using only their own resources (Asian Development Bank, 2005; Asian Disaster Reduction Centre, 2005; Quanrantelli, 1986). Hence, theoretically speaking, it is always a balancing act between stressors and available resources according to resilience theory and disaster theory; and demands often outweigh resources in disasters and other stressor situations (Rutter, 1987; Quanrantelli, 1986). Indeed, the impacts of disasters arise not only from the needs of the community but from the community's inability, or capacity to meet their needs. The ideal outcome after a disaster is resistance ─ adequate resources effectively blocking the stressor and consequently the absence of any dysfunction whatsoever. Fire resistant buildings are an example of resistant systems. However, resistance strategies are often valuable only for disasters that are likely to occur with some frequency and can be planned in advance. Hence, the path of resistance is unlikely for communities, individuals, and even for emergency systems in the aftermath of disasters. Temporary or transient dysfunction is therefore more likely than resistance.

Disaster theory indicates that, often, the typical pattern is for distress and dysfunction to be nearly universal in the first few weeks after a disaster (e.g. Raphael et al 1986). However, a disaster's adverse impacts slowly dissipate over time, leaving only a relatively small number of individuals within affected communities chronically impaired. Much of the time, such transient dysfunction is followed by a gradual return to pre-disaster levels of functioning. The process that produces adapted outcomes is resilience; and the more rapid the return to pre- event functioning, the greater the resilience (Norris et al 2008; Bonano, 2004). Thus, the trajectory of resilience, often involves transient perturbations that may last for weeks, but in general, it returns to a stable trajectory of healthy functioning.

Hence, resilience does not preclude dysfunction or distress but dysfunction is transient. However, post-disaster functioning may not be the exact equivalent of pre-disaster functioning as a result of the need to adapt to an altered environment. Such adapted functioning may not necessarily be superior in its effectiveness, nature, character, or level when compared to pre-disaster functioning; it is simply different (Norris et al 2008; Bonano, 2004).Such renewed and adapted functioning becomes the 'new normal' as it has been termed by Redlener and Morse (2006), and the alternative outcome is persistent dysfunction. In other words, the community has adapted and is not in a state of persistent dysfunction. Community functioning and wellbeing, and the wellbeing of individuals in the community is therefore the manifestation of adaptation after a stressor (Norris et al 2008; Bonano, 2004).

(c) Community wellbeing

There is no consensus on how to measure community well-being after a disaster, and measures vary from discipline to discipline (see Forgeard et al.2011; Higgins, 2008; Tiliouine et al. 2006). However, in general, community well-being is often characterised by: minimal impairment of functioning of the community and the individuals within it despite some distress and challenges; rapid recovery from distress and damage, or no distress or damage occurred, or remains at all. At the level of each individual, personal wellbeing seems a viable indicator that adaptation has occurred. It has to do with personal feelings of empowerment, and resilience as well as healthy patterns of behaviour (Bonano, 2005; Cowen, 2000). Personal wellbeing comprises adequate role functioning at home, school, and/or work; and a high quality of life (Bonano, 2005; Cowen, 2000). Quality of life is how people perceive their lives as a whole in the domains of work, family life, health, leisure, and neighbourhood (Bonano, 2005; Cowen, 2000). Cowen (2000) noted that wellness is a continuum. Individuals and communities show varying degrees of wellness before, and after disasters, and this must be taken into consideration in any post-disaster assessment of adaptation and adaptability.

(d) Resources

Resources determine the process, and ultimately, the outcome of a disaster, whether a community is able to be resilient or not (Hobfoll, 2006). Resources are a range of objects, assets, conditions, characteristics, and energies that people value, and they often provide protection against the consequences of a disaster (Hobfoll, 2006). Resources are dynamic attributes of resilience (Bruneau et al 2003). Several types of resources have been shown, or theorized to influence community resilience (Bruneau et al. 2003). I will go a through a few dynamic attributes of resources which resources must possess in order to be able to engender resilience (Bruneau et al. 2003). The four attributes may be used for monitoring the performance of the organizational, social, technical and economic systems of a community.

(1)Robustness

- Robustness is the ability to withstand stress without suffering degradation. Hence, a resistance strategy is robust if it counteracts a wide variety of dangers. However, it is fragile if it only works in a small number of possible disaster scenarios (Longstaff 2005; Bruneau et al. 2003).

(2)Redundancy

- Redundancy is the extent to which elements are substitutable in the event of disruption or degradation. For instance, industrial and technological systems such as power grids and airplanes have extensive redundancy or duplicates, and triplicates built into them. Individuals that possess larger social networks for example have redundancy. Hence, redundancy is a type of 'resource diversity.' Likewise, a community relying only on a limited or narrow range of resources is less able to cope with change that involves the depletion of that resource (Hobfoll, 2006).

(3)Rapidity

- Rapidity is the ability to achieve goals in a timely manner in order to contain losses, and avoid disruption. It relates to agility, responsiveness, and speed (Hobfoll 2006).

(4) Resourcefulness

- Resourcefulness is the capacity to identify problems, and mobilize resources when conditions threaten the system. These four are attributes of resources rather than characteristics of systems. Hence, in summary, resilience-resources often possess four dynamic properties: *robustness, redundancy, rapidity,* and *resourcefulness.* A resource need have only one of these attributes to engender resilience (Hobfall, 2006). However, resilience may fail when resilience-resources are themselves severely disrupted, or damaged by a stressor such as a disaster. This demonstrates the importance of robustness as an essential quality of resilience-resources. Disasters often result in simultaneous resource deterioration, and resource mobilization, with the hope that newly mobilised resources are sufficient to protect, or replenish vulnerable resources, however, this not always the case.

Stress often occur when resources are lost, or threatened (Hobfall, 2006). Stress often is the result, when individuals fail to gain resources following a significant investment of other resources. Individuals often invest resources in order to protect against resource loss, recover from losses, and gain resources. Hence, individuals, communities and systems with greater resources are less vulnerable to resource loss and more capable of resource gain; and as a result are more resilient. Disasters threaten a range of resources such as: housing; personal resources (e.g. sense of well-being, optimism, and safety); social resources (e.g. companionship); and energies (money, free time). Thus, an event in which resources are themselves harmed by the stressors they are supposed to buffer significantly limits the protection resources available. In short, resource loss has highly correlated with the severity of disasters and stressors in several studies (e.g. Norris et al. 2002).

Adaptive capacities

Adaptive capacity is the property of an ecosystem that describes changes in stability landscapes and resilience (Link et al. 2013; Berman et al.2012; Smith and Wandel, 2006; Woods and Cooks, 2006). It comprises the pre-existing features of communities that influence their ability to identify, mobilize, and address social problems and other problems that relate to the public such as disasters, or other stressors. Adaptive capacity often comprises the pre-disaster cultivation and post-disaster use of transferable skills, knowledge, resources, technology, and systems that affect individual and community-level changes consistent with goals and objectives relating public wellbeing. Such capacities may be seen as adaptive capacities when they are *redundant*, *rapidly accessible* and *robust*, and therefore able to offset a sudden disaster or stressor.

Categories of adaptive capacities that enable community resilience include (1) wealth and economic development; (2) social networks and social capital; (3) information dissemination and communication systems; and (4) technical knowledge and competence. In the following section, I illustrate the key antecedents and indicators of community resilience in the Cyclone Larry response.

Antecedents and indicators in Cyclone Larry

First, I discuss why and how cyclone Larry was selected as an example to demonstrate antecedents and indicators of community resilience in the aftermath of a major stressor. Second, I describe Cyclone Larry in terms of its geographical area of impact, and its physical, social, and economic characteristics. Third, I draw out some examples of antecedents and indicators of community resilience in Cyclone Larry. The analysis in this paper focuses mostly on the immediate emergency response phase. However, the analysis draws on relevant background mitigation, preparedness and planning activities that appear to have contributed to the resilience of cyclone impacted communities.

The rationale for Cyclone Larry

Prior evaluations of the perceptions of disaster preparedness and management of cyclones revealed that relative to other cyclones, Cyclone Larry was the biggest and best prepared and managed disaster in Australian history (see Dufty, 2014; Turton, 2008; Cyclone Summit, 2006). Commonly evaluated factors align with factors that contribute to the community's ability to adapt, and return to functioning and wellbeing. Respondents are often asked to rank aspects of disaster preparedness, response, recovery, and management such as relief, gender and children care, agriculture, education, logistics, food aid, public health and epidemiology, water and sanitation and emergency shelter. Questions often rated quality and speed of: (1) coordination and logistics amongst responding organisations; (2) food and water delivery; (3) restoration of houses, schools and buildings; (4) infrastructure restoration; (5) restoration of health/hygiene; (6) provision of emergency shelter; and (7) non-food relief items. The preparedness, response and management of Cyclone Larry was often ranked as most exhibiting indicators of resilience when compared to Cyclones Ted (1976), Winifred (1986), Aivu (1989), and Steve (2000). Thus, there seems to be a consensus that Cyclone Larry is an exemplar case from which lessons could be learnt (see also Oloruntoba, 2010; Queensland State Disaster Management Group, 2009).

Cyclone Larry

Cyclone Larry was first tracked on 16 March 2006 (Bureau of Meteorology, 2006) (BOM). On 18 March 2006 it was classified as a Category 5 cyclone as it approached the Queensland coast. At 4:45 a.m. on 20 March 2006 and with winds over 260 km/h it made landfall near Innisfail and wreaked havoc on the northern coast of Queensland (ABC, 2006). Innisfail, a town of 8000 people, about 1700 km north of Brisbane suffered the brunt of the cyclone. Wind gusts were estimated to have been up to 240 km/h (Category 4) in the area of Innisfail and up to 290 km/h in other areas (category 5) (BOM, 2007). Cyclone Larry travelled almost 450 km inland to around Croydon before being downgraded to a rain depression, however, there was severe flooding (ABC, 2006).Cyclone Larry devastated communities in an area over a 17,000 km2. Over 25,000 people lost their homes and/or farms, and personal properties and many others experienced damage (Cyclone summit, 2006). More than 140,000 people lost their electricity while 30,000 lost their telephone services for days. Approximately

280,000 people were affected, 30,000 people in the worst affected area (BOM, 2006). Affected areas suffered extensive damage to infrastructure and crops with the total estimated loss of over $A1.5 billion (ABC, 2006). Dozens of towns and villages that rely on income generated by tourism and the tropical fruit plantations e.g. sugar cane, avocados and banana farms were wiped out with attendant consequences on the regional economy (ABC, 2006).

Also, water supply systems, schools, farms, hospitals, and basic sanitary infrastructure were destroyed or damaged. Major roads were made impassable as fallen trees and debris blocked access (ABC, 2006). Floods and strong winds destroyed or damaged fishing equipment in the affected areas (ABC, 2006). In addition, since agriculture, tourism and fishing are the main sources of income in the region; the most-affected households faced an aggravated income shortage as well as a decrease in food reserves because routine commercial/retail supply chains were out of action. Cyclone Larry sparked Australia's biggest ever relief effort (Queensland Government, 2009). Although, Cyclone Larry caused extensive damage to the environment, infrastructure and property (Turton, 2008), there were minimal injuries and no loss of life resulting from its direct or indirect effects (BOM, 2006).Within two weeks of Cyclone Larry, and the emergency response life rapidly returned to 'normal', the 'new normal' before long term recovery and rebuilding activities commenced.

Examples of Indicators of Adaptive Capacities in Cyclone Larry

As earlier discussed, resources are dynamic attributes of resilience, and several types of resources influence community resilience (Bruneau et al 2003). However, resources themselves must possess the *dynamic attributes* of robustness, redundancy, and rapidity in order to be able to engender resilience (Bruneau et al. 2003). The four basic categorisations of adaptive capacities are: (1) wealth and economic development; (2) social networks and social capital; (3) effective information dissemination and communication systems as well as

(4) technical knowledge and competence.

The discussion is structured into two consecutive parts: (1) examples, factors, antecedents and indicators (of resilience) in the cyclone preparedness and planning phase — including activities undertaken and resources made available before the cyclone that are core to the adaptive capacity, hence resilience of the affected community, and (2) factors and issues emerging during the cyclone itself and its immediate aftermath that contributed to adaptation and resilience.

Wealth and economic development

[A] Pre-disaster

The far north of Queensland is known for its tropical fruits plantation industries, mining, as well as its tourism and offshore economies. Hence, the region can be said to be relatively prosperous and experiencing economic growth and stability of livelihoods. Furthermore, being a regional area far from densely populated urban south east Queensland, the cost of living is more affordable than in any Australian capital city. Also, the distribution of income and assets within populations is more equitable compared to capital cities like Sydney. Land and housing is more affordable and accessible. Furthermore, because of the agricultural base of the region (e.g. cattle, dairy farming, bananas, and assorted tropical fruits) there were sufficient employment opportunities. Sometimes transient farm labour from overseas and other parts of Australia are hired to harvest crops. Overall, such an economic landscape seems to have been an essential part of the resource base of the community before the cyclone struck.

[B] Post-disaster

However, there are extensive interdependencies at the regional, state and national macroeconomic level as the resilience of the regional economy and livelihoods is dependent on both the capacities of individual businesses and the capacities of all the entities that depend on them and on which they depend. For example, resources were sent rapidly from Canberra and Brisbane to prop up the devastated agricultural industries.

The Queensland and Commonwealth government made special pre-planned disaster relief provisions for affected economic segments of the region. The first stage was to ensure that immediate aid, and assistance packages are provided to businesses and industry. Afterwards, other short and longer term disaster assistance such as job and support programmes such as 'work for the dole' type arrangements. These economic assistance and livelihood packages ensured that people could be employed under those arrangements with a fractional often negligible financial top-up from the companies or the farms that were receiving relief. These include banana, avocado and sugar cane growers, as well as vessel owners and operators in the tourism sector. Owners of commercial, recreational and other vessels in the ports and harbours from Cairns, just north of the eye of the Cyclone, to Cardwell in the south were able to repair their assets or procure new assets. Likewise, owners of tourism aircrafts and vessel owners operating in the World Heritage listed Great Barrier Reef (a key attraction for rich Japanese tourists). The then State Premier and then Prime Minister visited umbrella associations of the industry and economic groups in the region and announced various immediate special grants, and longer term soft loans often with 0% interest for the various groups. Under the NDRAA relief scheme, primary producers and businesses were given concessional loans of up to $500,000.

In addition, hundreds of emergency electricity generators were distributed free of charge to the dairy and aquaculture industries to maintain animal welfare. Portable cow milking machines were air-freighted to scores of north Queensland dairy farms including trucks and trailers for six weeks in order to kick-start the milking of cows and economic output. Without the Queensland and Commonwealth governments concurrently providing such financial and economic resources to the regional economy, the outcome would have been different. The economy of the region was given as much attention as individual recovery, thus contributing to economic resilience and ultimately community resilience. Thus, the case for a link between economic resources, livelihoods, and jobs and individual post-disaster wellness and wellbeing is clear. Hence, poor communities are not only at greater risk of death and severe damage, but they are often less successful in mobilizing support after disasters.

Social networks and social capital

[A]Pre-disaster

The basic idea of social capital is that individuals invest, access, and use resources embedded in social networks to gain returns (Fullilove and Saul 2006; Comfort 2005; Lin, 2001; Goodman et al.1998). An aspect of community capacity is the use of inter organizational networks that are characterized by reciprocal links, and supportive interactions that overlap with other networks. Social capital also includes the ability to form new associations, and cooperative decision-making processes as well as efforts to broaden the scope of actors, agents, and knowledge that can be mobilised.

The AUSASSIST plan describes how Australian civil and military assets might be jointly deployed in response to a natural disaster. The plan was developed long before the Cyclone Larry disaster, and has been used in various disaster assistance scenarios around the world. For instance, in the Asian tsunami disaster of 2004, the crisis in Timor-Leste and in the Solomon Islands. The plan paves the way for smooth implementation of disaster response aided by the placement of liaison officers for the initial stages of a disaster response. The liaison officers are the first point of contact (POC) with the civil authorities. Only the State Premier can request military assistance from the Attorney-General in Canberra, who then makes a case to the Minister of Defence and the Prime Minister.

[B]Post-disaster

The joint military-civil response strategies were smooth, flexible and highly collaborative with other civil government agencies and non-government organisations (NGOs). This seem may be explained by the social capital and goodwill cultivated before the cyclone, and enjoyed by all responding parties that managed the disaster relief and recovery. This is because of the pre-existing good camaraderie, inter-personal, and inter-organisational relationships (social capital) cultivated and maintained over the years. Moreover regular practice among government actors and agencies synchronised with the regular nature of cyclones in the region seemed to have helped the various actors know each other relatively well. Hence, there was a unity of direction amongst responding government agencies and top officials of the various tiers of government:

> "…the Prime Minister has spoken with the Queensland Premier offering every assistance in the face of the cyclone. The ADF stands ready to help our fellow Australians in their time of need and will provide whatever assistance it can to help those affected by Cyclone Larry"— Minister of Defence (Media release 029/06, 20 March, 2006).

The larger Australian national community also recognised the social legitimacy of the affected peoples of Queensland. Funds were raised across the country and sent to help the affected region in addition to government disaster response. This demonstrated that the larger community including the government and the Australian Defence Force (ADF) cared about the needs and well-being of affected members of the Australian community. This is tantamount to self-help, mutual support, and national cohesion. It also highlights the social relationships and bonds that exists (social embeddedness), and the benefits that 'legitimate' members receive from their social ties. Furthermore, social capital comprises relationships between individuals and their larger neighbourhoods and communities as demonstrated in this analysis; and such social ties are critical to community capacity, and ultimately, community resilience.

Information dissemination & communication systems

[A]Pre-disaster

Information dissemination and communication systems are arguably the key resource in technical and organizational systems that enable adaptive performance. There seemed to be two categories of information dissemination and communication systems: (a) public cyclone education and awareness information, and early warning; and (b) inter organisational information and communications flow during the response.

<u>Cyclone education and awareness</u>

Queensland in northern Australia is the most disaster and cyclone prone region of Australia (Queensland State Counter Disaster Organisation, 2001). Over the decades the people and government have undertaken routine cyclone awareness and education campaigns in order to maintain an adequate level of preparedness amongst at risk communities. Seasonal media campaigns have always taken place amongst the residents of north Queensland because of the cyclical cyclone season from November through April. Cyclone awareness and education campaigns to the public and community at large consisted of non-specific cyclone preparation advice that is issued at the beginning of each cyclone season in November and reiterated throughout the season to reduce vulnerability (Cyclone summit, 2006). As a result, much of the population knew what to expect and what to do to prepare, and be safe. Despite routine cyclone education and awareness campaign and the expected high level of awareness among the affected communities, disaster managers kept the campaigns going.

As regards early warning, the Bureau of Meteorology (BOM) routinely provides weather, hydrological, climatic, and oceanographic forecasts and information in the context of mitigating disasters. BOM also issued early warnings to the Australian government of gales, storms and other weather conditions likely to endanger property or life (BOM website, 2009). A part of such warning information dissemination and communication system is the Tropical Cyclone Warning System (TCWS). The TCWS comprises BOM receiving high-resolution satellite imagery every hour from the Japanese geostationary meteorological satellite MTSAT-1R. The imagery was then processed by BOM to determine the precise intensity, direction and area of landfall of Cyclone Larry on 16th March, 2006, 4 days before the cyclone made landfall. Weather forecasters undertook several specific radio and television campaigns as well as live interviews and discussions during the cyclone's life at sea up to 96 hours before it made landfall. They issued explicit and specific cyclone watch and cyclone warning advice.

The BOM regularly updated the council, state, and commonwealth governments on the level of threat, including the State Premier who put the ADF on stand-by, and the Prime Minister. BOM also updated disaster managers, the community, and other emergency professionals. The local populace was instructed to bunker down, self-evacuate, or be forcibly evacuated in areas prone to storm surges under the State Government's Declaration of Disaster Situation announced on the 18th of March two days before cyclone Larry made landfall. Based on these warnings persons who were not directly in the path of the cyclone were asked to bunker down by sealing off windows of their homes with boards. Those unsure self-evacuated to friends and family in safer communities (EMQ, 2006).

Specific cyclone early warnings were repeatedly broadcast to the public just before the cyclone made landfall at the predicted impact areas. The specific cyclone warnings intensified throughout Sunday 19th March until the cyclone made landfall. The standard emergency warning signal (SEWS) was used in the delivery of public warnings and messages on TV and radio. SEWS was used as an alert signal played on public media to draw listeners' attention to a following emergency warning. As part of the specific warnings, it appeared that the public in areas that were prone to storm surges were either compulsorily evacuated by the Police, or simply told to move on (ABC, 2006) under the state declaration of disaster; residents of low lying communities could be forcibly evacuated by the Police. Overall, the residents, the authorities, and the ADF were reasonably expecting the cyclone, and were well prepared for its arrival.

[B] Post-disaster

As regards, the effectiveness of inter organisational information and communication flows, a trusted source of information is the most important resilience asset that any individual or group can have (Longstaff 2005). The appointment of a well-known and trusted General by the Prime Minister to head a special recovery taskforce at a high strategic and coordinative level ensured that accurate information was available to the myriad of responding organisations. Furthermore, the taskforce set up a 'one-stop shop' where representatives of all local, state and commonwealth governments were represented to provide accurate information to affected members of the community on any issues ranging from insurance to rebuilding houses.

The hub also had representatives of the banks, insurance companies, trades people and so forth. Hence, there was no need to search for information. Each day the taskforce relayed updated response-related information to the response and recovery organisations as well as the members of the community. The taskforce used radio, flyers, billboards and personal visits to inform the community of positive developments on the response on a daily basis and also collected information on what is yet undone, which they relayed to builders for action.

Technical knowledge and competence

Technical knowledge and competence are the knowledge and capabilities to perform specialized tasks related to a specific field. Disaster managers using a range of other professionals such as social workers, doctors and builders often need to have technical skills in order to communicate effectively with line workers and coordinate efforts. Individual professionals such as nurses and builders have their own specialised skills which they contribute to the disaster response effort.

The first responders (the ADF and the Queensland State Disaster Management teams) were highly skilled. Emergency Management Queensland was quite professional in the way the cyclone was managed from the moment it became public knowledge that a cyclone was approaching to the moment the last responder flew back home. For example, responders targeted the restoration of specific services in a certain order for those affected by the cyclone. The phased restoration of public services appears to be another element of strategic planning and competency. The responders had prior guidelines on what their priorities were. Although, search and rescue, food, water and medical services were the priority, quick restoration of the environment was of paramount importance (EMQ, 2007). These services or tasks had to be undertaken first before other tasks could be undertaken.

The highest priority tasks included: the quick restoration of public radio broadcasting to re- assure communities that help had arrived; the clean-up process to ensure the safety, and the free movement of vehicles through the clearing of blocked roads (foliage and felled trees) and the neutralisation of live electricity cables. Clearing the roads first is crucial to securing access to disaster sites by other complementary teams of responders such as ADF chain saw crews who were promptly sent out to clear fallen trees which provided access. In turn access means the ability to assess requirements of those affected and to meet their needs. Thus, these early "services" were not targeted directly to those affected but to the quick restoration of the disaster site to bring it rapidly to a semblance of normality through the restoration of critical infrastructure such as water, electricity, communications, roads and public broadcasting (EMQ, 2007).

Implications and recommendations for policy and practice

Community resilience and the adaptive capacities to secure it as discussed provide a practical guide for designing and enhancing resilience to disasters in communities. I now describe **five** policy recommendations that are most probably necessary for building community resilience to natural disasters.

Access to economic resources

- Governments, the private sector together with communities must develop economic resources, reduce resource inequities, and address social vulnerability within the community. Unleashing an overwhelming amount of organised and coordinated resources very early and very quickly in a post-disaster relief response in a strategic fashion is important for resilience. However, merely pouring in resources after a disaster is inadequate. Pre-disaster mitigation activities should be undertaken concurrently with activities related to the equitable distribution of resources, social justice, and regional and community economic development in order to be resilient. Diversification of economic resources will increase the probability of community resilience to disasters and other stressors.

Access to social capital

- Social capital is one of the key resources of any community. Participatory and inclusive approaches to disaster planning, prevention, and other mitigations activities is pivotal to building community resilience and local people must be engaged in every step of the mitigation process.

Communities, governments, and public safety officials must together identify and address their own vulnerabilities to hazards. Communities must identify and invest in their own networks of assistance and information, empower themselves, and enhance their own capacities to solve problems and to take charge of the direction of change. Governments must together with communities identify community strengths and capabilities, mobilise them to help the community to become self-sufficient, and also integrate them into the disaster response plan. Networks of assistance and empowering communities will increase the probability of community resilience to disasters and other stressors.

<u>Relationships and networks</u>

- Governments, the private sector together with communities must cultivate and develop pre-existing coalitions, organizational networks, cooperative agreements, and relationships long before a crisis or disaster occurs. Organizational plans should be explicit on how key constituencies will be involved. Relationships are crucial to the rapid mobilization of emergency disaster response and long term recovery, rebuilding, and provision of other ongoing support services for disaster survivors. Hence, developing effective relationships and networks will increase the probability of community resilience to disasters and other stressors.

<u>Effective information and communication resources</u>

- Governments, the private sector together with communities must cultivate and develop timely and trusted sources of information for fast decision-making such as early warning systems for risk communication with the community. Also, such information systems will be most valuable for coordinating multi-organisational response to disasters, and will thus increase the probability of community resilience to disasters and other stressors.

<u>A coordinated public sector response</u>

- A decentralised but strongly coordinated public sector response with a visible and strong leadership should contribute to community resilience. For instance, with the ADF, the State Premier of Queensland, and the Prime Minister of Australia governed by a single, comprehensive framework in domestic natural disasters (Aussasist), the response was well coordinated; and as a result increasing the probability of community resilience to disasters and other stressors.

<u>Technical knowledge and competence</u>

- Technical knowledge and competence are the knowledge and capabilities to perform specialized tasks related to a specific field. Technical knowledge and competency was for instance demonstrated by the “whole of care approach”. This was supplemented by the prioritised delivery of restoration and relief services, where the environmental, infrastructural, informational, emotional, financial, psychological, medical and nutritional needs of those affected were provided.

Summary and Conclusion

R e s i l i e n c e is a process that results in adaptation to a disturbance, or a stressor such as a disaster not stability, and definitely not an outcome. Stressors will probably result in short term periods of dysfunction before adaptation to an altered environment – a 'new normal.' Community resilience and wellness often emerge from a range of adaptive capacities such as resources with dynamic attributes such as robustness, redundancy, and rapidity. The networks of adaptive capacities such as resources often recombine, strengthen, weaken, evolve, and rebound. Hence, adaptive capacities are not a fixed condition that can be easily measured, captured or monitored because they possess dynamic attributes and relationships. They are also governed by political and economic factors. Networks of adaptive capacities can and should be designed into our communities by governments and planners to enable more resilient societies that can better withstand disasters as discussed in the paper.

References

ABC (2006) Australian Broadcasting Corporation. http://www.abc.net.au/news/newsitems/200603/s1597062.htm〉 (accessed 2 June 2006)

Asian Development Bank (2005), 'An initial assessment of the impact of earthquake and tsunami of December 26, 2004 on South and Southeast Asia', Asian Development Bank, Manilla, available www.adb/org/Documents/Others/Tsunami/impactearthquake.tsunami.pdf (accessed 16 January 2004)

Asian Disaster Reduction Centre (2005), 'Total Disaster Risk Management: Good Practices', http://www.adrc.or.jp/publications/TDRM2005/TDRM_Good_Practices/PDF/Chapter3_3.3.2-1.pdf (accessed 26 June 2009).

Allenby, B. & Fink, J. (2005), 'Toward inherently secure and resilient societies', Science, 309, 1034–1036.

BOM (2006), Bureau of Meteorology website www.bom.gov.au (accessed 10 December 2006)

BOM (2007), Bureau of Meteorology website Severe tropical Cyclone Larry http://www.bom.gov.au/weather/qld/cyclone/tc_larry/〉 (accessed February 2009).

Barnes, P. & Oloruntoba, R. (2005), 'Assurance of security in maritime supply chains: Conceptual issues of vulnerability and crisis management'. *Journal of International Management*, 11(4), 519-540.

Benight, C (2004), 'Collective efficacy following a series of natural disasters.' *Anxiety, Stress, and Coping*, 17, 401–420.

Benight, C., McFarlane, A. & Norris, F. (2006), 'Formulating questions about post-disaster mental health. In F. Norris, S.

Berman, R, Quinn, C, & Paavola, J. (2012), 'The role of institutions in the transformation of coping capacity to sustainable adaptive capacity', *Environmental Development*, 2, 86-100.

Galea, S & Norris, F. (2006), 'Public mental health surveillance and monitoring', In F. Norris, S. Galea, M. Friedman, & P. Watson (Eds.), *Methods for disaster mental health research* (pp. 177–193). New York: Guilford Press.

Bodin, P, & Wiman, B (2004), 'Resilience and other stability concepts in ecology: Notes on their origin, validity, and usefulness'. *ESS Bulletin*, 2, 33–43.

Boin, A & Lagadec, P (2000), 'Preparing for the future: critical challenges in crisis management', *Journal of Contingencies and Crisis Management*, 8 (4) (2000), pp. 185–191

Bonanno, G. (2004), 'Loss, trauma, and human resilience: Have we underestimated the human capacity to thrive after extremely aversive events? *American Psychologist*, 59, 20–28.

Bonanno, G. (2005), 'Clarifying and extending the construct of adult resilience', *American Psychologist*, 60, 265–267

Boon, H. J, Cottrell, A, King, D., Stevenson, R. B, & Millar, J. (2012), 'Bronfenbrenner's bioecological theory for modelling community resilience to natural disasters', *Natural hazards*, 60(2), 381-408.

Butler L, Morland L, & Leskin, G. (2007), Psychological resilience in the face of terrorism. In B. Bongar, L. Brown, L. Beutler, J. Breckenridge, & P. Zimbardo (Eds.), *Psychology of terrorism* (pp. 400–417). NY: Oxford University Press.

Bruneau, M, Chang, S, Eguchi, R, Lee, G, O'Rourke, T, Reinhorn, A, et al. (2003), 'A framework to quantitatively assess and enhance the seismic resilience of communities', *Earthquake Spectra*, 19, 733–752.

Centre of Research for the Epidemiology of Disasters, (2009), International Disaster Database, Centre of Research for the Epidemiology of Disasters, Belgium
Posted from http://www.emdat.be/Database/Trends/trends.html (accessed 27 May 2015)

Comfort, L.K, Boin, A, & Demchak, C.C (2010) (Eds.), *Designing Resilience: Preparing for Extreme Events*, University of Pittsburgh Press

Comfort, L. K. (2007), 'Crisis management in hindsight: Cognition, communication, coordination, and control', *Public Administration Review*, 67(s1), 189-197

Comfort, L. (2005), 'Risk, security, and disaster management', *Annual Review of Political Science* 8, 335–356.

Cowen, E. (2000), Community psychology and routes to psychological wellness. In J. Rappaport & E. Seidman (Eds.), *Handbook of community psychology* (pp. 79–99). Dordrecht, Netherlands: Kluwer Academic Publishers.

Cutter, S. L, Barnes, L, Berry, M, Burton, C, Evans, E, Tate, E, & Webb, J. (2008), 'A place-based model for understanding community resilience to natural disasters', *Global* *environmental change*, 18(4), 598-606.

Cyclone summit, 2006. Living with cyclones—Queensland prepared. In: Proceedings of Cyclone Larry Summit. December Cairns, Queensland, Australia. 〈http://www.thepremier.qld.gov.au/library/pdf/CycloneSummit7Dec06.pdf〉(accessed December 2007).

Dufty, N. (2014), An evaluation of the effectiveness of early warning systems used in Australia.

Dufty, N. (2012), 'Using social media to build community disaster resilience,' *The Australian Journal of Emergency Management*, 27(1), 40-45.

Emergency Management Queensland (2006) http://www.emergency.qld.gov.au/emq/ (accessed January 2009)

Emergency Management Australia (2006), EMA Disasters Database, EMA online. 〈http://www.ema.gov.au/ema/emadisasters.nsf/9d804be3fb07ff5cca256d1100189e22/b84244eb6226c1cfca2571840022ae82?OpenDocument〉 (accessed October 2009).

Forgeard, M. J, Jayawickreme, E, Kern, M. L, & Seligman, M. E. (2011), 'Doing the right thing: Measuring wellbeing for public policy,' *International Journal of Wellbeing*, 1(1).

Fullilove, M., & Saul, J. (2006), Rebuilding communities post-disaster in New York. In Neria, Y, Gross, R, Marshall, R & Susser, E (Eds.), *9/11: Mental health in the wake of terrorist attacks* (pp. 164–177). New York: Cambridge.

Godschalk, D. (2003), 'Urban hazard mitigation: Creating resilient cities,' *Natural Hazards Review*, 4, 136–143.

Gómez-Baggethun, E., Reyes-García, V., Olsson, P., & Montes, C. (2012). Traditional ecological knowledge and community resilience to environmental extremes: A case study in Doñana, SW Spain. *Global Environmental Change*, 22(3), 640-650.

Gordon, J (1978), *Structures* Harmondsworth, UK: Penguin Books.

Goodman, R, Speers, M, McLeroy, K, Fawcett, S, Kegler, M, Parker, E, et al. (1998), 'Identifying and defining the dimensions of community capacity to provide a basis for measurement,' *Health Education & Behaviour*, 25, 258–278.

Guha-Sapir, D, Vos, F, Below, R & Ponserre, R (2011), Annual Disaster Statistical Review 2010: The Numbers and Trends Université Catholique de Louvain, Brussels, Belgium. http://www.cred.be/sites/default/files/ADSR_2010.pdf (accessed 27 May 2015)

Handmer, J., & Dovers, S. (1996), 'A typology of resilience: Rethinking institutions for sustainable development,' *Industrial and Environmental Crisis Quarterly*, 9, 482–511.

Higgins, J. P. (Ed.) (2008), Cochrane handbook for systematic reviews of interventions (Vol. 5). Chichester: Wiley-Blackwell.

Hobfoll, S. (2006), Guiding community intervention following terrorist attack. In Neria, Y, Gross, R, Marshall, R & Susser, E (Eds.), *9/11: Mental health in the wake of terrorist attacks* New York: Cambridge (pp. 215–228).

Holling, C. (1973), 'Resilience and stability of ecological systems', *Annual Review of Ecology and Systematics,* 4, 1–23.

Link, P. M, Piontek, F, Scheffran, J, & Schilling, J. (2013), 'On foes and flows: vulnerabilities, adaptive capacities and trans-boundary relations in the Nile river basin in times of climate change', *L'Europe en formation,* (3), 99-138.

Lin, N. (2001), *Social capital: A theory of social structure and action.* New York: Cambridge University Press.

Longstaff, P. (2005), *Security, resilience, and communication in unpredictable environments such as terrorism, natural disasters, and complex technology* Syracuse, New York

McEntire, D. (1999), 'Issues in disaster relief: progress, perpetual problems and prospective solutions', *Disaster Prevention and Management,* Vol. 8 No. 5, pp. 351-61.

McEntire, D. (2002), 'Coordinating multi-organisational responses to disaster: lessons from the March 28, 2000 Forth Worth tornado', *Disaster Prevention and Management,* Vol. 11 No. 5, pp. 369-79.

McFarlane, A. C. & Norris, F (2006), Definitions and concepts in disaster research. In F. Norris, S. Galea, M. Friedman, & P.Watson (Eds.), *Methods for disaster mental health research* (pp.3–19). New York: Guilford Press.

McManus, S., Seville, E., Vargo, J., & Brunsdon, D. (2008), 'Facilitated process for improving organizational resilience,' *Natural Hazards Review*, 9(2), 81-90.

Mitroff, I.I. & Alpaslan, M.C (2003), 'Preparing for evil', *Harvard Business Review*, pp. 109–115 (April)

Mollica, R. F, Cardozo, B. L, Osofsky, H. J, Raphael, B, Ager, A, & Salama, P. (2004), 'Mental health in complex emergencies', *The Lancet*, 364(9450), 2058-2067.

Murray, K, & Zautra, A. (2012), 'Community resilience: Fostering recovery, sustainability, and growth,' *In The Social Ecology of Resilience* (pp. 337-345), Springer New York.

Norris, F. H, Stevens, S. P, Pfefferbaum, B, Wyche, K. F, & Pfefferbaum, R. L (2008), 'Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness,' *American Journal of Community Psychology,* 41(1-2), 127-150.

Norris, F., Friedman, M., Watson, P., Byrne, C., Diaz, E., & Kaniasty, K (2002), 60,000 Disaster victims speak: Part I, an empirical review of the empirical literature, 1981–2001. Psychiatry, 65,207–239.

Norris, F., Phifer, J., & Kaniasty, K. (1994). Individual and community reactions to the Kentucky floods: Findings from a longitudinal study of older adults. In Ursano, R, McCaughey, B & Fullerton, C (Eds.), *Individual and community responses to trauma and disaster: The structure of human chaos* (pp. 378– 400). Cambridge: Cambridge University

Press

Oloruntoba, R. (2010), ‘An analysis of the Cyclone Larry emergency relief chain: Some key success factors’, *International Journal of Production Economics*, 126(1), 85-101.

Oloruntoba, R. (2005), ‘A wave of destruction and the waves of relief: issues, challenges and strategies,’ *Disaster Prevention and Management: An International Journal*, 14(4), 506-521.

Paton, D., & Johnston, D. M. (Eds.), (2006), *Disaster resilience: an integrated approach*. Charles C Thomas Publisher.

Paton, D. (2008). Community resilience: Integrating individual, community and societal perspectives. *The phoenix of natural disasters: community resilience*. Nova Science Publishers Inc., Hauppauge NY, 13-31.

Pelling, M. (2003). The vulnerability of cities, *Natural Disasters and Social Resilience* (London: Earthscan).

Perrow, C (1984), *Normal Accidents: Living with High Risk Technologies* Basic Books, New York

Pfefferbaum, B., Reissman, D., Pfefferbaum, R., Klomp, R., & Gurwitch, R. (2005). Building resilience to mass trauma events, In L. Doll, S. Bonzo, J. Mercy, & D. Sleet (Eds.), *Handbook on injury and violence prevention interventions* New York: Kluwer Academic Publishers.

Poortinga, W. (2012), ‘Community resilience and health: The role of bonding, bridging, and linking aspects of social capital’, *Health & Place*, 18(2), 286-295.

Quarantelli, E. (1986). What is disaster? The need for clarification in definition, conceptualization in research. In B. Sowder & M. Lystad (Eds.), Disasters and mental health: elected contemporary perspectives (pp. 49–81). Rockville, MD: National Institute of Mental Health.

Queensland Government, 2009. 〈http://www.qld.gov.au/〉 (accessed September 2009).

Queensland State Counter Disaster Organisation, 2001. State Counter Disaster Plan March 6

Raphael, B., Singh, B., & Bradbury, L. (1986), *Disaster. In Coping with Life Crises* (pp. 323-329), Springer US.

Redlener, I., & Morse, S. (2006). Life under the ‘‘new normal’’: Notes on the future of preparedness. In Neria, Y, Gross, R, Marshall, R & Susser, E (Eds.), *9/11: Mental health in the wake of terrorist attacks* (pp. 592–604). New York: Cambridge.

Richardson, G. E. (2002), ‘The metatheory of resilience and resiliency’, *Journal of clinical psychology*, 58(3), 307-321

Rutter, M. (1987), ‘Psychosocial resilience and protective mechanisms,’ *American Journal of Orthopsychiatry*, 57, 316–331

Smit, B., & Wandel, J. (2006), 'Adaptation, adaptive capacity and vulnerability,' *Global environmental change*, 16(3), 282-292

Sonn, C., & Fisher, A. (1998), 'Sense of community: Community resilient responses to oppression and change,' *Journal of Community Psychology*, 26, 457–472.

State Disaster Management Group (2009), http://www.disaster.qld.gov.au/publications/#7 (accessed 8 February 2009).

Tiliouine, H, Cummins, R A, & Davern, M. (2006), 'Measuring wellbeing in developing countries: The case of Algeria,' *Social Indicators Research*, 75(1), 1-30

Turner B (1976), 'The organizational and inter-organizational development of disasters', *Administrative Science Quarterly* 21 pp. 378–397

Turner B (1976b), 'The development of disasters—a sequence model for the analysis of the origins of disasters', *Sociological Review* 24, pp. 753–774

Turton, S (2008), 'Ecological impacts of tropical cyclones on Australian terrestrial ecosystems: insights from Cyclones Larry and Monica', *Austral Ecology*, 33 (4) (2008), pp. 365–584

Waller, M (2001), 'Resilience in ecosystemic context: Evolution of the concept,' American *Journal of Orthopsychiatry*, 71, 290–297

Weine, S. (2013), 'Building Community Resilience to Violent Extremism' Georgetown *Journal of International Affairs*, 14(2), 81.

Woods, D. D, & Cook, R. I. (2006), *Incidents–markers of resilience or brittleness. Resilience Engineering Concepts and Precepts*, Ashgate, Aldershot, UK.

An integrated framework for resilience management of inter-network city infrastructures

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Abstract

Functioning, resilient, safe, secure and sustainable city assets, infrastructure systems and networks are essential to underpin our modern society. Cities of various scales are all facing unprecedented challenges of complexities and uncertainties to provide quality services to their citizens, due to growing population, rapid urbanization, changing climate and ineffective infrastructure investment with insufficient plans for disaster risk. These cities are becoming highly fragile and vulnerable to climate change extremes, natural hazards and/or man-made threats, as they have already evolved into intricate webs or system of systems; and the failure of or damage to any part of the infrastructure components could induce cascading effects to all interconnected and interdependent city infrastructures, resulting in catastrophic economic losses and huge social disruptions.

Despite great efforts have been attributed to resilience research over the last decades, there still lacks an integrated view of the practices, guidance, methodologies and models, decision supporting tools and solutions for city authorities, inter-network infrastructure operators, the public and all the other stakeholders to work collaboratively to achieve whole city resilience. To fill the gap, a holistic integrated framework for resilience management of inter-network city infrastructures is developed. The framework leverages emerging information and communication technologies, such as internet of things, cloud computing, big data analytics, social network, geographical information system and building information modeling to capture, synthesize, process, standardize, store, share and analyze the static and dynamic data on inter-network city infrastructures' structures and operation status in order to identify the threats, reduce the vulnerabilities, minimize the impacts of, respond to and recover from man-made or natural incidents. Case study is discussed to verify the framework's validity.

Keywords: Resilience management; integrated framework; inter-network infrastructure; city resilience; information modelling

1. Background

Functioning, resilient, safe, secure and sustainable city assets, infrastructure systems and network are essential to drive economic growth, improve the human welfare and increase the long-run wealth and prosperity of mankind. The world today is experiencing an unprecedented shift toward urbanization in human history. By 2050, two thirds of the estimated 6.3 billion people will live in cities, and 41 mega-cities with 10 million inhabitants are expected to emerge (WEF, 2015).

However, cities of various sizes are facing increasing challenges of complexities and uncertainties to provide quality services to their citizens, due to rapid urbanization, growing population, accelerated globalization, changing climate, and ineffective infrastructure investment with few plans for known risks and unexpected disruptions. These cities are becoming highly fragile and vulnerable to climate change extremes, natural hazards and/or man-made threats, as they have already evolved into intricate webs or system of systems. Failure of or damage to any part of the infrastructure components could induce cascade effects to all interconnected and interdependent city infrastructures, resulting in catastrophic economic losses and huge social disruptions. It becomes extremely difficult to predict and control the occurrence of all disruptions and the consequential cascading consequences or calamities. Managing the increasingly interconnected cities and the extremely vulnerable networked infrastructures has already become one of the most significant challenges in the twenty-first century for every country around the world.

Over the past few years, the concepts of resilience being derived from ecology and psychology are received a greater acceptance. Since then, resilience has been adopted by policymakers, practitioners and academic researchers as a strategy to tackle a wider range of risks and threats a nation, region or city is exposed to (Zolli & Healy, 2013). Examples include the United States's PPD-21 plan and EO-1336 order (U.S. DHS, 2013); the European Union's 2008/114/EC directive; and the 100 Resilient Cities project by the Rockefeller Foundation (Rodin, 2014).

The research and practice of resilience is in transition from conceptual debates to operational paradigm and then the development of resilience engineering (Linkov *et al*., 2014). Preferably, resilience should be investigated from the global, network, systematic and integrated perspectives (Helbing, 2013). Today, resilience-oriented competent leaders, organizations, communities and individuals are playing critical roles for sustaining a resilient system. More and more emerging information and communication technologies (ICTs), tools and systems are being adopted and leveraged to support resilience management (Comfort *et al*., 2010; Difallah *et al*., 2013; Landegren *et al*., 2014).

Regarding the inter-network infrastructures, e.g. power grids, transportation networks, water distribution systems, sewage and drainage networks, internet infrastructures and buildings, of a city as socio-technical systems, there still lacks integrated frameworks and information management solutions which enable relevant stakeholders to put resilience principles and theories into operational activities, and thus supporting them to build resilience capacity. To fill the gap, a holistic integrated framework for managing the resilience of inter-network city infrastructures is presented in this paper. Not only can the framework be utilized to develop new urban resilience management solutions, but it also can facilitate the integration of resilience monitoring and analysis software components into the existing city infrastructure asset management systems or future smart city solutions.

The rest of the paper is organized as follows. Section 2 reviews previous related works which include the evolution of the resilience concepts; the frameworks, models and tools for resilience management of networked civil infrastructures; and the applications of ICT technologies. The proposed framework is then presented in Section 3 and a software architecture design for the development of the resilience management systems is put forward. Case studies and preliminary results are discussed in Section 4. Finally, the issues and open questions for applying the proposed framework along with the conclusions are given in the last section.

2. Related works

2.1 Evolution of resilience concept

In the past decades, the term 'resilience' has been increasingly employed in a number of disciplines and domains, such as ecology, engineering, psychology and sociology. However, a consensus on how 'resilience' should be defined, assessed, planned and managed has yet to be reached among different researchers and practitioners (Martin-Breen & Anderies, 2011). Various principles and strategies, such as continuous monitoring, iterative learning, learning by doing, feedback integration, self-organization, modularity, threshold controlling and adaptive cycle, have been raised to sustain and manage the ecological resilience, engineering resilience and general resilience of social-ecological systems (Martin-Breen & Anderies, 2011). Resilience engineering paradigm has recently been introduced and developed in the field of safety management to improve the four abilities – monitoring, responding, anticipating and learning – of a sociotechnical system (Hollnagel , 2014).

In recent years, the life cycle based resilience concepts have also been put forward to strengthen the physical security, cyber-security and resilience of critical infrastructures. It is believed that the concepts and approaches developed from socio-technical view are more suitable for being applied to study the resilience of inter-network infrastructure systems especially when the systems are made up of large-scale interdependent physical infrastructures which are designed, built, operated and managed by complex human communities as well as immersed in and supported by intricate web of communication and information infrastructures (Comfort *et al.*, 2010).

2.2 Frameworks, models and tools for resilience management of networked infrastructures

Several conceptual frameworks have been put forward for managing the resilience of networked infrastructures and cities. They include the well-known R4 framework (i.e. robustness, redundancy, resourcefulness and rapidity); the resilience analysis grid (RAG) framework (Hollnagel, 2014), and the city resilience framework (Rodin, 2014). The most relevant framework to the current research is perhaps the networked infrastructure resilience assessment (NIRA) framework as it focuses on the impact assessment of disruptions on individual infrastructure system (Omer, 2013).

A volume of models and simulation approaches have been proposed by researchers of various disciplines to study the dynamic behaviors, interdependency, cascading effects, vulnerability, fragility and resilience of infrastructure systems (Landegren *et al*., 2014). On the other hand, a THREVI2 project is put forward to develop ontologies, database and software tools for categorizing all hazards threating critical infrastructures and generate disruption scenarios so as to identify vulnerability models (Trucco & Petrenj, 2015). Linkov *et al* (2013) developed a generic resilience matrix framework to facilitate the development of quantitative and qualitative resilience metrics for cyber and energy systems. However, these approaches and models cannot be utilized directly and efficiently by front-line end-users unless easy-to-use tools are implemented. Moreover, expert knowledge is required to understand the simulation and analysis results.

A few information systems, tools or prototypes have also been developed in recent years for urban or infrastructure resilience management. Examples of these include the web-based geographic information system (GIS) for analyzing the absorption capacity of road network (Lhomme *et al*., 2013), twitter earthquake detector (Zolli & Healy, 2013), and digital building operating systems solution (Rodin, 2014).

Emerging ICT technologies, such as the internet of things (IoTs), smart city, advanced metering infrastructure, cloud computing, big data analytics, open data, social network, GIS, and building information modeling (BIM) have presented remarkable potentials to help detect anomalies of large-scale infrastructure networks and improve the efficiency of city management (Difallah *et al*., 2013). Despite that, there are still lots of unresolved issues in applying them to bolster the infrastructure and urban resilience management.

2.3 Challenges for resilience management of inter-network infrastructures

The major challenges facing the resilience management of inter-network infrastructures, especially when putting resilience principles into operational practices include but are not only limited to:

- growing number and types of ageing and deteriorated built infrastructure assets and facilities;
- accelerating interdependencies between infrastructures and between the services being provided;
- increasing types and frequencies of adverse events, as well as ranges and scales of their negative impacts;

- incomplete, incorrect and inconsistent understanding and awareness across multiple stakeholders on resilience;
- outdated hierarchical organization structure and bureaucratic management philosophy for resilience management;
- lack of unified methodology and metrics to assess and measure the resilience performance;
- fragmented, vague and untraceable resilience management processes;
- lack of quality data to manage the processes and to evaluate based on the resilience performance indicators;
- lack of supporting tools and systems for data collection, data analysis and decision-making;
- lack of integrated framework and ICT solutions to support resilience management;
- lack of proven best practices for benchmarking; and
- no long-term roadmap and strategy for launching large-scale and cross-scale resilience management initiatives.

3. The proposed framework for resilience management

Seeing inter-network city infrastructures as a socio-technical system, an ICT-driven inter-network infrastructures resilience management (ICT-IN-IRM) framework is hereby proposed to support relevant stakeholders coping with the challenges highlighted above. The framework leverages emerging ICT technologies to capture, synthesize, process, standardize, store, share and analyze static and real-time data pertinent to the structures and operation status of inter-network city infrastructures. This is indeed very critical for analyzing the interdependency and identifying the vulnerabilities of the systems in order to minimize the impacts of, respond to and recover from any natural disasters, man-made threats and/or operational deficiencies.

Figure 1 demonstrates the major components and steps of the ICT-IN-IRM framework, which include: (1) establishing / optimizing the resilience working group through actors identification and leader appointment; (2) setting system boundary and prioritizing targeted adverse events; (3) developing resilience management processes; (4) devising resilience metrics; (5) determining suitable emergin ... grated resilience management solu ... n with resilience management comp ... ıce for continuous improvement. It is ... tecture design for developing an inte ... ramework.

Figure 1: The ICT-driven Inter-network Infrastructures Resilience Management (ICT-IN-IRM) Framework

3.1 Actors, leaders, organization structure

A long list of organizational and individual actors could be involved in the resilience management of inter-network infrastructure networks. They may include: government agencies, non-governmental organizations, private owners and operators of infrastructures, policy makers, city managers, infrastructure construction and service contractors, software service providers, and users and consumers of infrastructure services.

Motivated by a multi-stakeholder approach, the adhocracy concept for social resilience management (Zolli & Healy, 2013), and the idea of the 100 Resilient Cities initiative for setting up a Chief Resilience Officer position in city management (Rodin, 2014), It is imperative for the concerned stakeholders of inter-network infrastructure systems to set up a real or virtual resilience-oriented knowledge worker ‘clique’ to coordinate the resilience building and management activities. The clique shall take the responsibilities of (1) developing a systematic knowledge base related to the current physical, engineered, and social status of the systems; (2) reviewing the existing practices and programs; (3) identifying any potential disruptions and hazards; (4) performing interdependency and vulnerability analysis; (5) formalizing infrastructure performance measures; (6) delimiting the system boundary and priorities for resilience improvement; (7) developing relevant resilience management processes and resilience metrics; (8) clarifying the functional requirements of resilience management systems and watching over its deployment; (9) monitoring and assessing resilience performance; and (10) developing programs to promote citizens’ engagement and commitment. Members of the clique could come from government agencies, private entities, technical experts, and representatives of the general public. A resilience captain shall also be appointed to lead the clique, supervise the overall operation, report to the city administrators, and communicate with the peers.

3.2 System boundary and priorities

System boundary and hazard priorities for the resilience initiative can be set according to the following steps: (1) conduct a thorough overview and reflection on a city's chronic stresses, past shocks, incidents and disasters with reference to available adverse event taxonomies to filter out 3-4 most significant threats that the city is exposed to; (2) designate a housing district, a town or a geographic district as the target area of which community and infrastructures resilience is to be explored and managed; (3) perform a preliminary examination on the profiles of the infrastructure networks within the designated district as well as their interdependencies; and (4) select the networked infrastructure systems in at least two different sectors (e.g. building facilities and water distribution system), which are highly interdependent and ready for piloting the ICT applications, as the target of which resilience is to be built and sustained. Besides, other spatial, temporal, operational, and organizational characteristics of a city's interdependent infrastructures also need to be investigated to specify the boundary (Omer, 2013).

3.3 Resilience management processes

The resilience management processes can be devised based on the city's existing management practices in infrastructure asset management, risk management, security and safety management and smart city management. Existing processes can be reframed, refined and supplemented through resilience principles as lens to obtain the resilient management processes. The processes shall include such new elements as the plan-absorb-recover-adapt life cycle processes for adverse events management; the processes for assessing absorption capacity, vulnerability, interdependencies, cascading impacts, disruption losses, recovery cost and adaptability; and the processes for integrating resilience data and calculating resilience metrics. Domain knowledge should also be encoded into the relevant processes so as to include the operational details and core activities of those sector-specific infrastructures.

Risk management components of the state-of-the-art infrastructure asset management practices (e.g. the ISO 55000 standard and the International Infrastructure Management Manual) are also good references as starting points.

3.4 Resilience metrics

Resilience metrics are formulated based upon the magnitude of impacts caused by adverse events on the performance of a socio-technical system. Because performance measures describing the operating states of interdependent infrastructures and scale of interdependency-related disruptions are sorely lacking (Rinaldi *et al*., 2001), new method has to be devised to define the resilience metrics of inter-network city infrastructures; and these metrics should also include a range of social, economic, environmental and security considerations.

Stakeholders should formulate a multi-dimensional matrix or cube of resilience metrics to elucidate the possible combinations among the infrastructure systems, magnitude and longevity of catastrophic or disruption induced shocks, risks and hazards of infrastructure failure, and societal and economic stresses. The matrix or cube could be used to delineate the disruption scenarios and the likely consequences influencing the resilience of inter-network infrastructures socio-technical system. Such quantitative metrics could also be used to validate and verify any resilience enhancement schemes; model and simulate disruption scenarios; develop baseline benchmark; identify pinch points and hotspots; and prioritize interdependency-related vulnerabilities, threats and risks.

3.5 Enabling information and communication technologies for resilience management

Resilience capacity building thrives on data; resilience benefits accrue from the efficient use of ICT technologies to enable low-cost, real-time data collection, accessing, storing, sharing, searching and analyzing on the way inter-network infrastructures are performing (Zolli & Healy, 2013).

The stakeholders can identify viable enabling ICT technologies for resilience by: (1) carrying out a thorough examination on their existing information management systems as well as taking resilience as a powerful lens and potential systems include the asset management system (AMS), computerized maintenance management system (CMMS), enterprise resource planning system (ERP), supervisory control and data acquisition (SCADA) system, BIM and GIS after careful examination of the software architecture and information integration capabilities of these systems; (2) articulating the information models, data interface specifications and software architecture design alternatives for the resilience management system; (3) developing resilience management proof-of-concept prototypes through pilot projects; and (4) evaluating the pilots results to determine the most suitable ICT technologies.

3.6 Software architecture of integrated resilience management solutions

As an initial step of investigation, a general software architecture design for developing the big data and IoTs enabled integrated resilience management (BIT-IN-IRM) solutions is proposed. As shown in Figure 2, the BIT-IN-IRM architecture consists of eight core components: (1) OT-IT integration service engine; 2) IN-IRM big data warehouse; 3) smart IN-IRM knowledge base; (4) smart IN-IRM data integrator; (5) smart IN-IRM data service engine; (6) system administration suite; (7) IN-IRM lifecycle application service engine; and (8) system administration suite. The BIT-IN-IRM architecture is designed by referring to the state-of-the-art software architectural approaches, such as the software-as-a-service (SaaS) cloud computing architectures. Various innovative front-end resilience management applications can also be developed based on the BIT-IN-IRM architecture, and examples of these include the interdependency analyzer, fragility detector, resilience metrics calculator, resilience analyzer, disruptions generator, adverse event planner, etc.

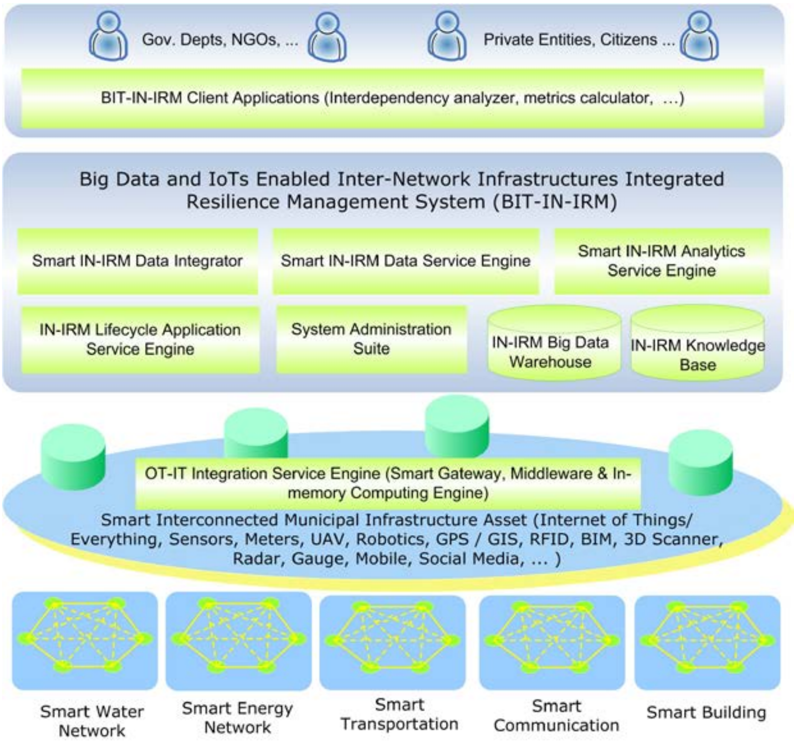

Figure 2: The Proposed Big Data and IoTs Enabled Integrated Resilience Management (BIT-IN-IRM) Software Architecture Framework

3.7 Monitoring of resilience performance for continuous improvement through rehearsing and reflection

Having holistic and robust data in hand does not necessarily guarantee all possible adverse events and disruptions can be accurately anticipated. The performance of resilience management should, therefore, be improved through continuous efforts. With the integrated resilience management solutions, stakeholders shall be able to generate the possible, probable and preferable scenarios and what-if questions; rehearse the plans and consequences of disruptions; discuss, learn and reflect collectively on lessons and experiences for achieving greater resilience. Resilience performance also can be monitored, tracked and traced through various resilience innovations bolstered by the solutions. A cost-benefit analysis can also be performed to evaluate different resilience strategies and plans.

4. Case study

4.1 Background

Hong Kong is a unique metropolis in the world as it is an advanced and densely populated economic hub. Apart from the transportation systems, more than 50 types of infrastructure assets including power cable, water main, gas pipe, etc. owned or managed by 20 government departments and utility companies exist in a single road or pavement section. Only water pipes alone add up to a length of 8,000 kilometers, and a quarter of which have been existed for 30 years or beyond. Therefore, a small failure could lead to domino and rippling effects among its infrastructure systems, causing catastrophic impacts on Hong Kong citizens.

Until now, efforts on urban resilience in Hong Kong remain sparse and fragmented. Only several government departments have established various centres and systems to deal with the home security, cyber-attack, slope safety, drainage system, etc. Hong Kong desperately needs a city resilience strategy and a detailed implementation roadmap to orchestrate and align its segregated risk and resilience management initiatives (HKSAR Government, 2014).

Public housing related construction and infrastructure asset is one of the largest city infrastructure asset portfolios of Hong Kong. By March 2014, more than 743,000 public rental housing flats were built in over 160 estates across various districts of Hong Kong to provide homes and accommodations for almost a third of the population in the city (HKHA, 2011).

To satisfy Hong Kong's needs for urban resilience, a case study has been initiated by the authors using the proposed ICT-IN-IRM framework to examine the resilience management issues of inter-network infrastructures in Hong Kong. As a preliminary attempt, the study takes the public housing asset network and its dependent city infrastructures as an example. Where the study is still underway, preliminary results are presented in this paper.

4.2 Preliminary results

Being a statutory body, the Hong Kong Housing Authority (HA) is established to manage the development and implementation of the local public housing program. HA plans designs, builds, manages and maintains different types of public housings including the rental housing estates, interim housing estates and transit centres. HA has made extraordinary efforts to implement housing-related infrastructure projects, ranging from site formation, water work, road construction, slope upgrading and drainage system maintenance, to the construction of various community facilities. The Authority has long and complicated processes to build and manage public housing: feasibility study and conceptual layout, scheme design and project budget, detailed design and specification, tender evaluation, construction, completion and maintenance (HKHA, 2011).

Currently, HA is taking some measures to manage the risks to which public housing residents are possibly exposed, e.g. typhoon, heavy rainfall, extreme weather, flooding, landslide, urban heat island effect, epidemics and communicable diseases. For instance, HA is committed to stabilizing the slopes within the boundary of their housing estates to cope with the effect caused by intense rainfall; developing effective drainage systems and slope surface protection to minimize surface infiltration; and regularizing slope inspection and maintenance works to ensure proper functioning of drainage facilities (HKSAR Government, 2014). However, these are HA's internal qualitative risk and resilience management measures only. To build smart and resilient public housing communities, it is imperative for HA to collaborate with other government departments, its contractors, suppliers and service providers as well as the public housing residents to come up with and implement a synergised resilience plan.

Should Hong Kong be launching a community resilience initiative via the public housing estates, the journey could be commenced with inter-network infrastructure resilience based on the following the steps:

1) Build a joint working group across different divisions of housing management department, other relevant government departments, its contractors, suppliers and service providers as well as the public housing residents, and appoint an existing senior staff or hire a new expert as the chief resilience captain;
2) Select a housing estate consisting of old building blocks and newly constructed blocks as the target of inter-network infrastructures resilience study;
3) Prioritize flooding and landslide as the top two shocks that the resilience initiative aims to tackle;
4) Perform a complete review through resilience lens on its housing and infrastructure asset management practices with reference to the state-of-the-art infrastructure asset management practices;
5) Design a set of integrated infrastructure asset management and resilience management processes and develop a set of resilience metrics to concert resilience efforts among all relevant stakeholders;
6) Develop a big data and IoTs enabled real-time whole lifecycle cross-sector infrastructure asset management and resilience management service platform (BIT-CIAM-SP) according to the proposed framework;
7) Pilot the BIT-CIAM-SP platform at the selected public housing estate;
8) Evaluate the pilot results through real-time monitoring and rehearsing for hypothetical disruption scenarios.

5. Conclusion and future work

Modern cities are becoming more and more vulnerable to climate change extremes, natural disasters and/or man-made threats due to their increasingly interdependent and interconnected infrastructure networks and the uncertainties and complexities of various risks that they are exposed to. While emerging ICTs are being widely piloted and adopted for developing smart city solutions, limited research has been done on how to leverage them for resilience management of inter-network infrastructures.

Viewing inter-network city infrastructures as a socio-technical system, a holistic ICT-driven integrated framework, the ICT-IN-IRM framework, is proposed in this paper. Not only can the framework facilitate various stakeholders putting resilience concepts and principles into operation, but stakeholders can also develop innovative integrated resilience management components and solutions based upon the proposed ICT-IN-IRM architecture. A case study together with some very preliminary results is presented, taking Hong Kong's public housing asset and its interdependent infrastructure networks as an example of inter-network infrastructures.

Smart city and urban resilience concepts have been acknowledged by the Government of Hong Kong Special Administrative Region. The proposed ICT-IN-IRM framework can serve as a platform to examine the city's existing initiatives for articulating a clear roadmap for smart and resilient Hong Kong. As resilience management varies a lot among different disciplines and infrastructure networks, there are still a number of issues which deserve further investigation on the proposed framework.

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References

[1] Comfort, L.K., Boin, A. & Demchak, C.C. (2010) Resilience Revisited: An Action Agenda for Managing Extreme Events. In L.K. Comfort, A. Boin & C.C. Demchak, eds. Designing Resilience: Preparing for Extreme Events. University of Pittsburgh Press. pp 272-284.

[2] Difallah, D.E., Cudre-Mauroux, P. & McKenna, S.A. (2013) Scalable Anomaly Detection for Smart City Infrastructure Networks. Internet Computing, IEEE, Vol. 17, No. 6, pp 39-47.

[3] Helbing, D. (2013) Globally Networked Risks and How to Respond. Nature, 497, pp 51-59.

[4] HKSAR Government (2014) Adaptation & Resilience to Climate Change. Presentation at HKSAR Government Adaptation & Resilience Forum.

[5] Hollnagel, E. (2014) Becoming Resilient. In P.N. Christopher & E. Hollnagel, eds. Resilience Engineering in Practice, Volume 2, Becoming Resilient. Farnham, Surrey: Ashgate Publishing Company. pp 179-92.

[6] HKHA (2011) Planning, Design, and Delivery of Quality Public Housing in the New Millennium. Hong Kong: Hong Kong Housing Authority.

[7] Landegren, F., Johansson, J. & Samuelsson, O. (2014) Review of Computer Based Approaches for Modeling and Simulating Critical Infrastructures as Socio-Technical Systems. In R.D.J.M. Steenbergen, P.H.A.J.M.v. Gelder, S. Miraglia & A.C.W.M. Vrouwenvelder, eds. Safety, Reliability and Risk Analysis: Beyond the Horizon. London: CRC Press, Taylor & Francis Group. pp 2047-2054.

[8] Lhomme, S., Serre, D., Diab, Y. & Laganier, R. (2013) Analyzing Resilience of Urban Networks: A Preliminary Step Towards More Flood Resilient Cities. Natural Hazards and Earth System Sciences, Vol. 13, No. 2, pp 221-230.

[9] Linkov, I. et al. (2014) Changing the Resilience Paradigm. Nature Climate Change, Vol. 4, No. 6, pp 407-409.

[10] Martin-Breen, P. & Anderies, J.M. (2011) Resilience: A Literature Review. The Rockefeller Foundation.

[11] Omer, M. (2013) The Resilience of Networked Infrastructure Systems. Singapore: World Scientific Publishing Co. Pte. Ltd.

[12] Rinaldi, S.M., Peerenboom, J.P. & Kelly, T.K. (2001) Identifying, Understanding, and Analyzing Critical Infrastructure Interdependencies. Control Systems, IEEE, Vol. 21, No. 6, pp 11-25.

[13] Rodin, J. (2014) The Resilience Dividend: Being Strong in a World Where Things Go Wrong. New York: PublicAffairs, Perseus Books Group.

[14] Trucco, P. & Petrenj, B. (2015) An Ontology-based Approach to Vulnerability and Interdependency Modelling for Critical Infrastructure Systems. In T. Nowakowski, M. Młyńczak, A. Jodejko-Pietruczuk & S. Werbińska-Wojciechowska, eds. Safety and Reliability: Methodology and Applications. London: CRC Press, Taylor & Francis Group. pp 49-56.

[15] U.S. DHS (2013) NIPP 2013 - Partnering for Critical Infrastructure Security and Resilience. United States Department of Homeland Security.

[16] WEF (2015) Global Risks 2015, 10th Edition. World Economic Forum, Cologny/Geneva, Switzerland.

[17] Zolli, A. & Healy, A.M. (2013) Resilience: Why Things Bounce Back. London: Business Plus, Headline Publishing Group.

Understanding the Roles of Property Investors and Insurers and Earthquake Risk Mitigation

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Abstract

Property investors and risk insurers have since play a minimal role in promoting pre-disaster mitigation for earthquake prone buildings. The research objective focussed on understanding how property investors, financial institutions and risk insurers can assist to promote earthquake risk mitigation. A qualitative research method, using interview as the data collection methods was adopted. The results obtained so far showed that property investors, financial institutions and risk insurers have the capacity to promote seismic risk mitigation, because insurance and finance availability ensure the business sustainability of the property market before and after a disaster event. The research findings revealed that lenders and insurers to date have contributed to a situation in which earthquake risk is not managed equitably in the market place, ensuring that the government could bear a significant portion of the risk by paying for response-rescue activities and clean-up and recovery costs, in an earthquake event. Recommendations arising from this study suggested that financial organisations should participate in improved urban planning programs aimed at reducing earthquake vulnerability within the built environment such as the provision of long-term low interest loans to building owners, and the adoption of a risk-based approach for calculating earthquake insurance premiums.

Keywords: Property investors; Risk insurers; Property owners, Earthquake; Pre-disaster Mitigation Decisions

1. Introduction

Earthquake risk mitigation is essential to reduce losses associated with seismic disasters. Buildings (EPBs) with insufficient seismic capacity known as earthquake-prone buildings (EPBs) contribute to the susceptibility of the built environment to earthquake hazard (Spence, 2007). An EPB is considered as a building that will have their ultimate structural performance capacity exceeded in a moderate earthquake, and would probably collapse causing injury or death to persons within the buildings (Department of Building and Housing, 2004). EPB is a standard term used to describe such category of buildings in New Zealand. Approximately 3867 Unreinforced Masonry (URM) buildings in New Zealand require seismic retrofitting in order to reduce the impacts of earthquake disasters. The 2011 Canterbury earthquakes in New Zealand revealed that property owners adopted risk reduction measures in varying degrees without adequate consideration of their vulnerability to seismic hazard (Egbelakin et al., 2011c, Egbelakin et al., 2013). Earthquake disaster losses could be minimised by implementing appropriate risk mitigation decisions regarding seismic retrofitting of existing EPBs (Dowrick, 2003). These buildings are constructed, owned and inhabited by owners who make a range of decisions and choices that shape their level of vulnerability. Some owners make decisions to minimise their exposure to risks by adopting mitigation measures, some choose to ignore the risks, while others accept the risk without undertaking any protective measures (Egbelakin et al., 2011b).

Promoting seismic risk mitigation is a major challenge in many earthquake-prone regions such as in New Zealand, despite the availability of a significant number of risk reduction measures such as technical design solutions and regulatory frameworks necessary to facilitate successful risk reduction activities. Seismic rehabilitation of EPBs lags behind advances in scientific and engineering understanding, because little attention has focused on understanding and developing strategies to overcome the barriers associated with implementing seismic retrofit (Hopkins et al., 2006). Previous studies in the social, economic and decision sciences have sought to address property owners' uptake of mitigation measures from different perspectives such as socio-behavioural, regulatory, economic, cultural, and institutional, but these efforts have not resulted in satisfactory success (Tierney et al., 2005, Smith, 2009, Egbelakin, 2013a). Despite this volume of studies, building owners are still found unwilling to adopt adequate mitigation measures (Egbelakin et al., 2011c). It is possible that the practices of property investors, insurers and financial institutions contribute to property owners' unwillingness to adopt adequate mitigation measures in their EPBs. This research focussed on pre-1976 buildings used for commercial purposes in New Zealand. Older commercial buildings are often earthquake prone due to inadequate seismic strength, age and deterioration of construction materials. For instance, Wellington (New Zealand's capital city) has about 52% of its building stock classified as potential EPBs, deduced by raw property counts (Stevens and Wheeler, 2008). The research findings in this paper provide background information useful to policy development aimed at increasing the likelihood of building owners undertaking mitigation actions to reduce earthquake hazard vulnerability in New Zealand.

2. Stakeholders Involved in Seismic Risk Mitigation Decisions

Seismic retrofit implementation involves making the decision to reduce the built environment's earthquake vulnerability. For the purpose of this study, stakeholders involved in earthquake risk mitigation include owners of buildings and businesses, local councils, industry groups, property investors, developers and valuers, real estate agents, managers of financial and insurance institutions, tenants/users and hazard-related professionals such as engineers (Egbelakin, 2013c, Egbelakin and Wilkinson, 2008). These stakeholders could have direct or indirect impacts on building owners' earthquake mitigation decisions. For instance, a building tenant's choice to lease, live or use buildings in hazard-prone locations can potentially influence a property owner mitigation decision through the demand for retrofitted EPBs (Egbelakin, 2013a). The industry groups and local councils involved in natural hazard mitigation enact legislation and other related guidelines for earthquake risk reduction, which could positively or negatively influence property owners mitigation decisions (Egbelakin et al., 2013). Property managers, valuers and real estate agents contribute to the moderation of business transactions of EPBs in the property market and valuation assessments, which could affect market perception of EPBs and sale transactions (Egbelakin et al., 2011a). Similarly, managers in charge of earthquake insurance policies and mortgage funds in insurance and financial organisations have the capacity to influence building owner's seismic mitigation and property investment decisions via the availability or non-availability of affordable insurance premiums and finance for seismic retrofit implementation (Kunreuther and Michel-Kerjan, 2009). Lastly, the building owner among these stakeholders is central to earthquake risk mitigation decision because they incur personal losses in an earthquake event, and are responsible for making the final decisions whether or not to adopt mitigation measures. The type of mitigation decision adopted by these owners is often a function of the ownership type and type of information received from the different stakeholders. The interplay between these stakeholders' activities and operative environments plays an important role that could fashion the type of earthquake mitigation decision adopted by building owners and on the overall earthquake mitigation landscape(Egbelakin, 2013a).

3. Challenges Associated with Seismic Retrofit Decisions

Seismic risk mitigation decisions involve the evaluation and selection of an appropriate course of action to reduce losses from earthquake disasters. However, people's response to seismic risks mitigation differs because various factors interact to influence their decisions. Seismic retrofitting of existing EPBs is rarely the sole consideration during a building rehabilitation programme, but instead sits alongside competing factors such as mechanical upgrades and maintenance, increasing rental value and other risks related to the property which includes fire and flood (Egbelakin, 2013c). The context in which each decision is made is a major determinant and many trade-offs are considered during the process. Earthquake mitigation decisions are further influenced by factors such as psychological, social, economic, cultural, institutional, political and processes within the community which renders seismic risk mitigation challenging and complex (Egbelakin et al., 2011c, Solberg et al., 2010). The final decision to adopt earthquake risk mitigation mechanisms would also be influenced by compliance to building regulations, profit-making, heritage conservation and ensuring safety. For instance, Egbelakin et al. (2013) found that that certain regulatory provisions such as seismic design philosophy, lack of mandatory disclosure of seismic risks and ineffective timeframes for strengthening vulnerable buildings could pose as a constraints to property owners decision to adopt appropriate strengthening of EPBs. The complexity of the decision-making process discourages building owners and impedes the decision to adopt and implement adequate seismic mitigation measures. Egbelakin (2013c) highlight the need for a transformation in the traditional decision-making processes of earthquake risk mitigation towards more sustainable practices, strategies and outcomes.

Another significant problem associated with earthquake mitigation decision-making relates to the cost of implementing seismic mitigation mechanisms, specifically structural rehabilitation of EPBs. Retrofit cost is a significant economic driving force affecting the decision to adopt risk reduction measures (Egbelakin et al., 2014). According to Bradley et al. (2008), the cost involved in seismic retrofitting can vary widely making it difficult to adequately estimate the total amount of cost that might be involved in retrofitting, which could be a constraint in seismic retrofit decisions. Moreover, Egbelakin *et al.* (2011c) found that a preconceived notion that adopting high seismic performance standard correlates to high retrofit cost exist among the stakeholders involved in retrofit decisions which acts as an impediment to the mitigation decision. Likewise, the lack of a risk-based insurance premium system has significant implication for the uptake of seismic mitigation measures. Cost expended on seismic retrofitting are not reflected in the cost of insurance premiums and deductibles, thereby acting as an impediment to seismic retrofitting (Egbelakin and Wilkinson, 2008). Likewise, high insurance deductibles and premiums associated with earthquake insurance policy impede building owners' decisions to retrofit their EPBs because they increase the building's operational expenses (Egbelakin et al., 2011b, Kunreuther, 2008).

Property market conditions and practices within the market could act as constraint to property owners' unwillingness to strengthen their EPBs because of lack of knowledge about earthquake risks mitigation among stakeholders (Egbelakin et al., 2011b). Most of the stakeholders in the market have little or no knowledge about seismic retrofit performance standards, legal obligations and potential liabilities relating to earthquake risks (Nakhies, 2009). Thus, obligations imposed by changes in the legislation are not factored into the market and investment analysis (Onder et al., 2004), thereby rendering retrofitting of such EPBs less viable in the market. The lack of access to individual buildings' seismic risks information affect other stakeholders practices in the property market (Butcher and Cooper, 2004). For instance, insurers and property valuers need access to the relevant information regarding a building's seismic risk properties in order to determine the likely risk premiums and appropriate building property values. Lack of access to buildings earthquake risks information could mislead the market stakeholders regarding issues surrounding a building's vulnerability to earthquake risks which renders the market for retrofitted and non-retrofitted EPBs inefficient based on erroneous property valuation and insurance risk premiums assessment. In summary, previous research around engineering, disaster and emergency management, social and decision science disciplines have used several measures to understand the factors affecting building owners' decisions to adopt appropriate mitigation measures in their EPBs. An important aspect of earthquake hazard reduction identified by the

New Zealand Institute of Economic Research Centre (2011) focused on how to understand the economic related constraints impeding voluntary seismic retrofit decisions in different seismic risk regions in New Zealand. Critical economic-related barriers to successful earthquake risk mitigation and how these barriers affect building owners' mitigation decisions are examined in this study.

4. Research Method

A qualitative research method was adopted in this study. Face-to-face semi-structured interviews was adopted because provide an opportunity whereby the adoption and implementation of seismic mitigation measures can be explored in terms of its relevance to the identified stakeholders operating in different seismic zones. Semi-structured interview allows the different stakeholders involved in earthquake risk management to describe the complex retrofit decision-making process, and offer insights and explanations regarding the challenges to seismic retrofit implementation. An interview protocol was developed and used as the data collection instrument. Participants interviewed were selected using purposeful sampling method. This sampling method is appropriate in the context of this study, because participants were selected based on their experience and involvement in EPBs projects. Interviews were conducted in four cities in New Zealand selected based on their seismicity, hazard factor, percentage of non-retrofitted and retrofitted EPBs, earthquake probability and likely severity (see Table 1).

Table 1: Profile of Research Participants

Interview Participants Profile				
Category	**Case 1**	**Case 2**	**Case 3**	**Case 4**
Consultants - Architect	-	1	-	1
Consultants - Engineers	1	2	2	2
City Councils officials	1	1	1	1
Managers of insurance companies	1	3	2	1
Property valuers	2	3	2	1
Building owners	3	8	5	4
Total interviewees	8	18	12	10
Hazard factor (Z)	0.13	0.22	0.36	0.4
Level of earthquake risks	Low	Medium	High	Very High
Last significant earthquake	Oct. 2010	Feb. 2011	Dec. 2007	Aug. 1942
Percentage of EPBs (%)	42%	48%	88%	52%
Retrofit standard adopted	33% NBS	33% NBS	68%	52%
Mitigation Approach	Passive	Active/Passive	52%	Active
Population	1,354,900	390,300	46,600	389, 700
Area (Km^2)	5,600	45,346	8,351	8, 124
Sub- National GDP	US$28,250 billion	US$15,08 million	US$66.3 million	US$142.5 million

Notes:

- Hazard factor (z) - The equivalent to an acceleration coefficient with an annual probability of exceedance in 1/500) for different locations in New Zealand (Standards New Zealand, 2004)
- Seismicity - used to establish the probability and severity of a seismic event, which varies between provinces.
- Sub-National GDP; sourced from Statistics New Zealand (2011).
- EPBs are determined using the performance achievement ratio (PAR); a measure of an individual building's expected performance in an earthquake event, independent of location and which primarily takes into consideration the critical structural weakness such as plan, vertical irregularity and pounding potential (Standards New Zealand, 2004)

Interview participants were contacted by email and phone call to explain the nature of the research and obtain their consent to participate in the study. The primary researcher conducted the interviews within a period of three months. 48 interviews were conducted in the selected geographic regions, which ranged from one to two hours. The interviews were audiotaped and transcribed with the interviewee's permission. Care was taken to ensure that the information provided by the participants was transcribed accurately and validated by the participants. Content analysis was used for the analysis of the relevant documents (Yin, 2013). The interview data were analysed thematically using NVIVO qualitative data analysis software, with the objective to identify trends or themes that appeared or were repeated in the interviews. The data was coded and major themes were developed. All identified themes and subthemes were categorised separately and presented in Table 2.

5. Findings

The findings reported in this paper are extracted from the research results currently conducted at Massey University. The roles played by property investors, insurers and financial institutions in acting as challenges towards promoting earthquake risk mitigation were revealed in this study from their current adopted practices. These findings summarised in Table 2 and discussed in the subsequent subsections.

Table 2: Impacts of current practices of property investors, insurers and financial institutions on earthquake risk mitigation

Players	**Impacts of Current Practices on Earthquake Risk mitigation**
Insurance Companies	High Insurance Premiums and deductibles
	Lack of a risk-based insurance premium scale
Property Investors	Lack of demand for improved performance of older buildings
	Lack of short-term perceived financial benefits from adopting seismic mitigations
	Motive for property acquisition
Financial Institutions	Difficulty in securing and finance loans to retrofit EPBs
	High loan interest rates & loan value ratios
	Use of insurance as a only risk mitigation tool

5.1 Role of Risk Insurers in Earthquake Pre-disaster Mitigation

Insurance is a major component in the overall risk management strategy for a building, and using this as a risk management strategy has significant implications for earthquake mitigation (Spence and Coburn, 2006). The lack of a risk-based insurance premium assessment, high insurance deductibles and premiums were identified as impediments to building owners adopting adequate mitigation measures in their EPBs (see Table 2).

5.1.1 High Insurance Premium and Deductible

Generally, the cost of earthquake insurance and the policy deductibles is relatively high in New Zealand, when compared to other seismically active countries. The qualitative findings indicate that earthquake insurance premiums and policy deductibles are viewed by many property owners as too costly, which often reduce their willingness to purchase an insurance policy. 86% of the participants in Case 2 mentioned that owners of EPBs often find it difficult to obtain earthquake insurance and in most cases pay high insurance premiums and are being subjected to higher deductibles. One of the building owners stated that:

"It was very difficult for me to get insurance for this building and I have to pay a huge amount of money in insurance premiums. Moreover, the deductibles are really high. How can I source for such an amount of money if an earthquake does occur?

High premiums further increase building operating costs, thus becoming an obstacle to seismic retrofitting of EPBs. The recent significant earthquake in February 2011 has demonstrated the economic implication of disasters, thus contributing to the increase in insurance premiums and deductibles. Generally, among the participants the high earthquake insurance premium and deductible in New Zealand were attributed to the country's high seismicity, recent devastating earthquake and short-term insurance policy programme. Insights from the interviews suggested that properties in seismically active zones usually carry higher deductibles and premium rates than those in regions that are less seismically active. Participants from the insurance industry occupying senior management positions argued that the market usually reacts to risk and uncertainty by increasing investment risk premiums as evidenced by the impacts of the recent earthquake events in New Zealand.

5.1.2 Lack of a Risk-Based Insurance Premium

The lack of a risk-based insurance premium assessment was identified as some of the factors that affect building owners' pre-disaster mitigation decisions. A participant stated;

"The insurance broker told me even if I retrofit my building to higher performance level, the insurance premium and deductible is not likely to change, so why retrofit my building".

Also, evidence from the findings showed that the cost of insurance premiums does not reflect seismic mitigation actions implemented in a retrofitted EPB. 82% of the participants explained that generally the insurance premium is not calculated in terms of risk-based analysis and complained about the lack of a risk-based premium scale. 48% of the owners interviewed who have retrofitted some of their EPBs to a structural performance standard greater than 67% of New Building Standard (NBS), complained that they were unable to secure a policy that reflects the level of risks posed by their retrofitted EPBs. Insights from the interviews suggested that insurance premiums should reflect risk and take into account mitigation actions on the building, provided the potential insurance losses on the structure are reduced by implementing such action. This is yet to be the case in New Zealand. Participants from the insurance industry claimed that accessing individual seismic mitigation actions on EPBs is difficult and costly because each building is different, requiring separate assessments. Moreover, the lack of a reliable database for information regarding the seismic risk characteristics of these buildings hampers the assessment of the mitigation actions undertaken. 92% of the interviewees suggested that buildings retrofitted well beyond minimum requirement should be eligible for premium discounts, indicating that a reduction in insurance premiums is a key component of any hazard mitigation programme aimed at improving seismic retrofit decisions and implementation in EPBs. However, insurers are unwilling to offer a discount because a reduction in insurance premiums is likely to attract more owners of EPBs which increases an insurance company's risk exposure in the event of an earthquake.

5.2 Role of Property Investors in Earthquake Pre-disaster Mitigation

A pertinent issue identified as roles of property investors' contribution to property owners' unwillingness toward pre-disaster mitigation include motive for property acquisition, the lack of perceived financial benefits and low of demand for improved performance of older buildings.

5.2.1 Motive for property acquisition

The motive for property acquisition plays an important role in seismic retrofit decisions of EPBs. Most medium to large scale owners such as developers and property investors hold properties for a few years at most. Also, 88% of the owners interviewed argued that developers typically do not engage in seismic retrofitting, such that earthquake risks are usually transferred to future owners because the buildings are viewed as short-term investments. Sixty-six percent of the participants mentioned that most developers acquire older buildings for anticipated future redevelopment as they are usually demolished and their sites used temporarily as car parks. The demolition of EPBs reduces the potential for implementing their seismic rehabilitation and heritage preservation. Most pre-1976 EPBs have significant heritage characteristics which are difficult to quantify. Approximately 3800 heritage buildings are listed earthquake prone remains in New Zealand, primarily occupying key locations at the centre of 'village communities' in larger cities or on the main Street of small-town New Zealand. Stimulating increased investment from owners of New Zealand's heritage EPBs is necessary to protect appearance and ambiance of these town-scapes, and the sense of connectedness that the people of New Zealand feel with their built environment.

5.2.2 Lack of perceived financial benefits

The lack of perceived financial benefits from adopting seismic mitigations in the short-term was found as a constraint to earthquake risk mitigation decisions for long-term owners. Ninety-two percent of the building owners interviewed asserted that seismic retrofit cost can be enormous. These owners explained it is difficult to recapture money expended on seismic retrofitting of EPBs from increased property market values or income streams. Hence, EPB owners are not motivated to adopt seismic mitigations because of the lack of perceived financial benefits either at the time of sale or during a lease. Increasing the income streams from a retrofitted EPB correlates to an occupier‘s willingness to pay for improved safety, which is only possible if they are well informed about the benefits of implementing seismic risk mitigation. However, most occupiers are unaware or less concerned about the significance of retrofitting EPBs (Egbelakin et al., 2014). Eighty-six percent of property valuers argued that differentiating the income-producing capacity of buildings that have been retrofitted from those that have not been retrofitted becomes difficult as the occupiers are likely to pay the same rents for both building types provided they are similar in terms of rental space and location. Therefore, owners are unable to capture the added value from their expenditure on seismic retrofit, which possibly explains why most of the upper floors of older buildings within the city centre remain empty. In addition, ninety-two percent of the building owners consulted explained that seismic retrofitting can impair the building‘s functional utility such as the possible loss of useable or rentable floor area, thus reducing their income stream. These constraints discourage any form of appropriate mitigation decision such as seismic retrofitting of EPBs.

5.2.3 Lack of demand for older buildings

Lack of demand for improved performance of older buildings was identified as an obstacle to property owners and investors decision to invest in pre-disaster earthquake mitigation such as seismically retrofitting of EPBs (see Table 2). Most of the older buildings within the city centres and suburbs of the cities included in this study were found to have their first or upper floor(s) unoccupied. Anecdotal evidence from the interviews suggests that there is a gradual decrease in the demand for older buildings, as market preference now tends towards newer buildings where energy efficiency and sustainability can be optimally achieved. Lack of demand of for this category of buildings was found as an impediment to property investors' decision to invest in seismic risk mitigation of existing EPBs. Egbelakin (2013a) suggests that another way to increase demand of retrofitted EPBs is for the property to achieve lower operating costs to the users. This can be in terms of improving the building‘s sustainability or obtaining higher occupancy rates by overcoming market concerns regarding health and safety issues. In addition, insights from the interviews suggested that an informed market could possibly force down the property value of non-retrofitted EPBs in the property market.

5.3 Role of Financial Institutions in Earthquake Pre-disaster Mitigation

The role financial institutions roles in moderating property owners' earthquake mitigation decisions revealed in this study are high loan interest rates, difficulty in securing finance loans to retrofit and use of insurance as an only risk mitigation tool.

5.3.1 High Loan Interest Rates

The role of the financial institutions within the property market significantly influences seismic mitigation decisions by moderation of business transactions such as investment decisions in the property market. Sixty-eight percent of property owners explained that high interest rates attached to loans sought for building rehabilitation often discourages seismic mitigation decisions. They explained that other bank requirements such as loan-value-ratios, credit issues and debt service coverage (ratio of funds available to make loan repayments) on the property before giving out loans to property owners to rehabilitate their EPBs are overburdening criteria to qualify for such loans. Likewise, one of the owners explained that financial institutions usually request a full replacement earthquake insurance cover as part of the collateral before approving the desired loan to strengthen an EPB. Most insurers are unwilling to provide full replacement cover for such a building. Therefore, potential owners are discouraged from retrofitting their EPB. Erdik and Durukal (2008) suggest that financial organisations should participate in comprehensive urban regeneration projects aimed at reducing earthquake vulnerability within the built environment by providing long term low interest loans to building owners to implement risk reduction measures. Lenders to date have contributed to a situation in which earthquake risks is not managed equitably in the market place.

5.3.2 Difficulty in Securing and Finance Loans to Retrofit EPBs

Financial institutions or lenders have a significant stake in a catastrophic event, especially to the degree that a substantial portion of their financial assets are at risk from a single earthquake disaster (Lindell et al., 1997). They provide owners with mortgages and loans to buy or rehabilitate buildings, thus lenders have a vital stake in the risk management process as they are unlikely to recover the full value of a loan/mortgage on a piece of property destroyed by a catastrophe. Therefore, lenders can play a significant role in managing risks of extreme events by providing capital and funding opportunities for risk reduction programs. Findings from the interview revealed that property owners often found it difficult to secure as banks are often less eager to lend to owners of older buildings unless the owners have built up enough equity to support the loan. Access to financing thus becomes difficult for some EPB owners as financial institutions become more stringent with loan applications while introducing skyrocketing interest rates. Therefore, most small-scale owners often find it difficult to secure loans to retrofit their EPBs. Financial institutions have the capacity to influence building owner‘s seismic mitigation decisions because funds availability ensure the business sustainability of the property market during the recovery and reconstruction phase following an earthquake disaster.

6. Discussion of Findings

The property investment landscape as a whole has gained considerable attention in moderating the market value of a building but little emphasis has been placed on understanding its full impact on earthquake risk mitigation. The findings provide insights as to why earthquake risk reduction measures are not adequately implemented in New Zealand across low to moderate and high seismic risk regions by exploring the roles of property insurers and financial institutions in earthquake risk mitigation. The interview analysis revealed that earthquake risk receives a marginal consideration in the current investment practices in New Zealand. Given that earthquake risk appears to have potential significant effect on the overall income return from a property and on the building‘s market value, yet seismic risk is poorly accounted for in investment decisions especially in low seismic regions. The financial and insurance institutions in New Zealand play a minimal role in promoting seismic retrofit decision or implementation. The parts played by property insurers and financial institution towards earthquake risk management such as lack of a risk-based insurance premium and high loan interest rates for rehabilitating EPBs impede property owners seismic risk mitigation decisions.

Several market-based incentives were suggested via the research findings and deductive reasoning as potential strategies to enhance the current practices of property insurers and financial institutions in order to promote earthquake risk mitigation. The market-based incentives suggested include, provision of a unified seismic risk information system, mandatory disclosure of seismic risk information in property market transactions, accuracy in earthquake risk assessment methods and the use of a risk-based insurance premium system. The availability of a unified seismic risk information system would help other relevant professional groups to access any building’s risk data. This data would help them become aware of commonly encountered issues and imperatives regarding earthquake risks. Insurer would adequately estimate the building’s seismic risk through a risk-based premium, reducing the capitalisation rates of retrofitted buildings due to lower investment risks and premiums. Lower insurance premiums for retrofitted EPBs would assure building owners of reduced operational costs, thus serving as an incentive to retrofit EPBs. Accuracy in earthquake risks assessments is closely related to the methods of identifying strategies for mitigation. Improved risk assessment would enhance both appropriate risk estimation and adoption of adequate mitigation measures in retrofitted EPBs, would help insurers to accurately set premiums, and tailor their portfolio to reduce the chances of insolvency, and would reduce information irregularities between insurers, reinsurers and financial institutions(Egbelakin, 2013b). The research results appear to confirm that mandatory disclosure of seismic risk in earthquake policies would provide accurate information to the buyer, insurer and lending institution. All parties involved in the property market transaction would understand the risks inherent in the building before completing a transaction. For instance, property traders would become aware that property value would be reduced if the building seismic risks are disclosed, while the insurer would be able to adequately estimate the building risks through a risk-based premium.

Findings from the qualitative study revealed that the use of transferable development rights (TDR) when used a regulatory incentive, particularly for large-scale developers and owners could help influence their decisions to invest in property earthquake pre-disaster mitigation. TDR are special forms of land acquisition regulation which compensate landowners in exchange for use of restrictions on their land aimed at achieving effective urban growth management and land conservation. TRR would offers building owners financial incentive or bonuses for the conservation and maintenance of the environmental, heritage or agricultural values of their land. Most of the large-scale private owners comprising of more than five people interviewed mentioned that the use of TDR may likely save many potential historic buildings in our cities. Its implementation will allow the historic building owners to make almost as much money, if not more, without demolishing the building. The use of TDR would diminish the motive of acquisition of most medium-scale and large-scale developers identified as an impediment to seismic retrofitting of EPBs (Egbelakin, 2013c). TDR will provide incentives and financials benefits for this category of owners by encouraging heritage conservation, since a majority of the pre- 1976 EPBs have significant heritage characteristics. The use of TDR enabled rebuilding homeowners to participate in the reconstruction programs while those unwilling to rebuild received fair compensation.

The implementation of the market-based incentives identified in this paper, although they operate independently, requires a collective and holistic approach, in order to achieve the wider disaster mitigation objectives. The research findings thus highlight the need for collective adaptive utility among all the stakeholders involved in the property and earthquake disaster management such as owners of buildings and businesses, government/regulatory bodies (local councils, industry groups), property investors and developers, managers of financial and insurance institutions. It can be therefore inferred that when stakeholders, such as insurers and regulatory institutions, who regulate transactions in the property market, adopt practices aimed at improving earthquake risk mitigation, it could result in a type of leverage that attempts to regulate the choices of other stakeholders such as building owners with regards to mitigation options.

7. Conclusion

This study examined how the practices of the property investors, insurers and the financial institutions influence building owners' mitigation decisions. The practices that could become impediments to effective mitigation decision-making include, lack of demand for retrofitted older buildings, high earthquake insurance deductibles and lack of a unified risk information system. These factors were determined through a qualitative study approach. Further several market-based incentives were suggested as potential strategies to improve current practices, and for enhancing property owners' mitigation decisions. These incentives include; the mandatory disclosure of property seismic risks during market transactions and provision of a unified risk information system. These incentives could act as motivators and/or persuasive reasons for property owners, insurers and financial institutions and the public at large to retain, care, invest, and act responsibly in the rehabilitation of EPBs. Findings from this research are beneficial to both researchers and professionals involved in seismic rehabilitation of EPBs. The findings of this study suggest that insurance and financial institutions should assume greater responsibilities in raising earthquake risk awareness in the property market and encouraging owners to adopt seismic retrofit implementation. Most importantly, the research findings reported in this study should be seen as an initial effort to understand how the practices of insurers and financial institutions affect seismic rehabilitation of EPBs. There is a need for further empirical analysis of retrofitting actions adopted following the dissemination of this research report in order to determine the adequacy of these incentives in actual promotion of earthquake risk mitigation.

8. References

Bradley, B. A., Dhakal, R. P., Cubrinovski, M. & MacRae, G. A. (2008) Seismic loss estimation for efficient decision making, in New Zealand Society for Earthquake Engineering (NZSEE) Conference:Engineering an Earthquake Resilient New Zealand, 11-13 April 2008, Wairakei, New Zealand.

Butcher, P. & Cooper, K. (2004) Selling earthquake engineering services to clients, in New Zealand Society of Earthquake Engineering: Getting the message across and moving ahead,, 2004, Rotorua, New Zealand: New Zealand Society of Earthquake Engineering (NZSEE),.

Department of Building and Housing (2004) *The Building Act*, Brookers Ltd, Wellington.

Dowrick, D. J. (2003) Earthqauke risks reduction actions for New Zealand. *Bulletin of the New Zealand Society for Earthquake Engineering (NZSEE),* **36**(4), 249-259.

Egbelakin, T. (2013a) *Earthquake Risks Mitigation- A Stakeholder's Perspective,* Lambert Academic Publishing, Singapore

Egbelakin, T. (2013b) Information Provision and Communication Strategies for Improving Earthquake Risk Mitigation in In Proceedings of CIB World Building Congress: Construction and Society, 2013b, Queenstown University of Technology, Brisbane, Australia.

Egbelakin, T. & Wilkinson, S. (2008) Factors affecting motivation for improved seismic retrofit implementation in Australian Earthquake Engineering (AEES) Conference, November 21-23, 2008 2008, Ballarat, Victoria, Australia: Australian Earthquake Engineering (AEES), pp. 26.

Egbelakin, T., Wilkinson, S. & Ingham, J. (2014) Economic impediments to successful seismic retrofitting decisions. *Structural Survey,* **32**(5), 449-466.

Egbelakin, T., Wilkinson, S. & Nahkies, P. B. (2011a) Impacts of the property investment market on seismic retrofit decisions, in Building an Earthquake-Resilient Society: Proceedings of the Ninth Pacific Conference on Earthquake Engineering, 2011a, 14-16.

Egbelakin, T., Wilkinson, S., Potangaroa, R. & Ingham, J. (2011b) Enhancing seismic risk mitigation decisions: a motivational approach. *Construction Management and Economics,* **29**(10), 1003-1016.

Egbelakin, T., Wilkinson, S., Potangaroa, R. & Ingham, J. (2013) Improving regulatory frameworks for earthquake risk mitigation. *Building Research & Information,* 1-13.

Egbelakin, T., Wilkinson, S., Potangaroa, R. & Ingham, J. M. (2011c) Challenges to successful seismic retrofit implementation: a socio-behavioural perspective. *Building Research & Information* **39**(3), 286 - 300

Egbelakin, T. K. (2013c). *Incentives and Motivators for Enhancing Earthquake Risk Mitigation Decision.* PhD Thesis PhD, University of Auckland. Auckland, New Zealand.

Erdik, M. & Durukal, E. (2008) Earthquake risk and its mitigation in Istanbul. *Natural Hazards,* **44**(2), 181-197.

Hopkins, D., Sharpe, R., Sucuoğlu, H. & Kubin, D. (2006) Residential retrofitting in Istanbul: key issues to make implementation possible, in 8th U.S. National Conference: Earthquake Engineering, 18-22 April, 2006 2006, San Francisco, California.

Kunreuther, H. (2008) Reducing Losses from Catastrophic Risks through Long-Term Insurance and Mitigation. *Social Research*, **75**(3), 905-930.

Kunreuther, H. & Michel-Kerjan, E. (2009) Market and Government Failure in Insuring and Mitigating Natural Catastrophes: How Long-Term Contracts Can Help. *Private Markets and Public Insurance Programs*.

Lindell, M. K., Alesch, D., Bolton, P. A., Greene, M. R., Larson, L. A., Lopes, R., May, R., Mulilis, P. J., Nathe, S., Nigg, J. M., Palm, R., Pate, P., Perry, R. W., Pine, J., Tubbesing, S. K. & Whitney, D. J. (1997) Adoption and implementation of hazard adjustments. *International Journal of Mass Emergencies and Disasters* **15**(Special issue), 327- 453.

Nakhies, P. (2009) Seismic Upgrading – Meeting the Economic Challenge, in Pacific Rim Real Estate (RIM) Conference, 18-21 January 2009, Sydney, Australia.

New Zealand Institute of Economic Research (NZIER) (2011) Canterbury after the earthquakes.Available: http://nzier.live.egressive.com/publications.

Onder, Z., Dokmeci, V. & Keskin, B. (2004) The Impact of Public Perception of Earthquake Risk on Istanbul's Housing Market. *Journal of Real Estate Literature*, **12**, 181-196.

Smith, K. (2009) *Environmental Hazards: Assessing Risk and Reducing Disaster*, Routledge, London and New York.

Solberg, C., Rossetto, T., Joffe, H., Gayer, G., Leschka, S., Nöhren, I., Larsen, O. & Günther, H. (2010) The social psychology of seismic hazard adjustment: re-evaluating the international literature. *Nat. Hazards Earth Syst. Sci*, **10**, 1663-1677.

Spence, R. (2007) Saving lives in earthquakes: successes and failures in seismic protection since 1960. *Bulletin of Earthquake Engineering*, **5**(2), 139-251.

Spence, R. & Coburn, A. (2006). Earthquake Risk and Insurance, in Atilla Ansal, K. (ed.) *Assessing and Managing Earthquake Risk*. Springer,Dordrecht, The Netherlands, pp. 385-402.

Standards New Zealand (2004). NZS 1170.5:2004, Structural Design Actions *Part 5: Earthquake Actions*. Wellington, New Zealand: Standards New Zealand.

Statistics New Zealand. (2011). *Subnational population estimates and structure* [Online]. Wellington, New Zealand: Statistics New Zealand. Available: http://www.stats.govt.nz/~/media/Statistics/Methods%20and%20Services/Tables/Subnational%20population%20estimates/subnational-pop-estimate-jun2001-2010.ashx [Accessed on 26/10 2010].

Stevens, C. M. & Wheeler, K. E. (2008) Implementing Earthquake prone building policy under the Building Act 2004 – Wellington City's Approach, in Proceedings of New Zealand Society for Earthquake Engineering: Engineering an Earthquake Resilient New Zealand (NZSEE) Conference, 11-13 April 2008 2008, Wairakei, New Zealand

Tierney, K., Khazai, B., Tobin, L. & Krimgold, F. (2005) Social and Public Policy Issues Following the 2003 Bam, Iran, Earthquake. *Earthquake spectra*, **21**(S1), S513-S534.

Yin, R. K. (2013) *Case study research : design and methods*, Sage Publications, Los Angeles, Calif.

Framework for Improving Property Owners Earthquake Disaster Preparedness Decisions

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Abstract

The increasing scale of losses from earthquake disasters has reinforced the need for property owners to become proactive in seismic risk reduction programs. However, despite advancement in seismic design methods and legislative frameworks, building owners are found unwilling or lack motivation to adopt adequate mitigation measures that will reduce their vulnerability to earthquake disasters. Various theories and empirical findings have been used to explain the adoption of protective behaviours including seismic mitigation decisions, but their application has been inadequate to enhance building owners' protective decisions. A holistic framework that incorporates the social, cultural, economic, regulatory, institutional and political realms of earthquake risk mitigation to enhance building owners' decisions to voluntarily implement seismic mitigation measures is proposed that will need to be scientifically tested. In addition, this framework attempts to address any multidisciplinary barriers that exist, by ensuring stakeholders involvement in seismic mitigation decisions.

Keywords: Earthquake risk mitigation, Disaster Management, Property owners, Decision-making and Motivation

1. Background

Earthquake disasters pose a serious threat to many seismically active communities. Buildings having insufficient seismic capacity contribute to the built environment's susceptibility to earthquake hazard and are the key contributors to earthquake losses (Spence, 2007). These buildings are constructed, owned and inhabited by owners who make a range of decisions and choices that shape their level of vulnerability. Some owners make the decision to minimise their exposure to risks by adopting mitigation measures, some choose to ignore the risks, while others accept the risk without undertaking any protective measures (Burton et al., 2002). Earthquake disaster losses can be minimised or avoided by implementing appropriate risk mitigation decisions (Bostrom et al., 2006), specifically, decisions on seismic retrofitting of earthquake-prone buildings (EPBs) (Dowrick, 2003). An EPB is considered as a building that will have its ultimate structural performance capacity exceeded in a moderate earthquake, and would likely collapse causing injury or death to people in the building, or those in a nearby property, or damage to adjoining structures (Department of Building and Housing, 2004). The term EPB is the standard language used in New Zealand, and similar terms may be used in other countries. Seismic risk mitigation decisions refer to the choices made by property owners on whether or not to adopt pre-disaster earthquake mitigation measures (McGuire, 2008). Pre-disaster seismic mitigation includes either actions taken by people to reduce the immediate risk of damage and loss during an earthquake event, or preparation for post-impact conditions that might adversely affect survival probabilities (Spittal et al., 2008, Solberg et al., 2010). Examples of pre-disaster seismic mitigation measures include adopting structural and non-structural mechanisms to retrofit existing EPBs, buying of earthquake insurance and securing house contents.

Previous studies revealed that these owners are often unwilling to adopt earthquake mitigation measures, due to several challenges associated the decision-making process (Egbelakin et al., 2011b, Egbelakin et al., 2014). For example, the complexity of the decision-making process discourages building owners and impedes the decision to implement adequate earthquake mitigation measures. The context and associated environments in which each decision is made is a major determinant, and many trade-offs are considered during the process. The final decision becomes complex because the factors affecting earthquake risk decisions are inter-related and difficult to analyse individually, thereby confounding the decision-making process. Kasperson *et al.,* (1988) suggested that decision to reduce seismic risks are determined by the interactions of the psychological, social, economic, cultural, institutional and political processes within the communities. These interactions are characterised by factors associated with individuals, groups or government agents such as trust, values, attitudes, social relations and cultural identity (MacGregor et al., 2008). Some of these factors contribute to the capacity to adopt seismic mitigation measures while others may intensify susceptibility to the detrimental consequences of disaster impacts. The examination of these factors, and the inter-relationships amongst them, may help to explain why there are differences in building owners' behavioural responses to earthquake risk mitigation.

Past studies have also demonstrated that building owners' seismic mitigation decisions are influenced by the motivational nature of human decisions and psychosocial factors, most especially when making them under risk and uncertainty (Weber et al., 2002). These studies highlight how people perceive and assess risks-based on subjective criteria, and make distinctive trade-offs between risk and reward before they finally decide to accept, avoid or mitigate the risks. Despite the extensive studies in natural hazard and disaster management, the rate of property owners' adopt risk mitigation measures lags behind advances in the scientific and engineering understanding of earthquakes (Egbelakin, 2013b), which is evident in the recent devastating earthquakes in Christchurch, New Zealand in 2011 and in others areas around the globe. Possible explanations for the lack of implementation of mitigation measures could be related to lack of personal motivation from owners to adopt adequate mechanisms. Therefore, factors beyond the control of environmental hazard managers such as fatalistic attitudes, differences in risk perception and mass media impacts may cause the difficulties in enhancing building owners' adoption of mitigation mechanisms (Egbelakin, 2013b). Lindell and Perry (2000) highlight the necessity for better theories that recognise the relevance of broader literature and a holistic perspective in earthquake risk and disaster management research. Therefore, research in this area must take account of a comprehensive framework that: (i) examines the inter-relationships among the different factors affecting owners' seismic mitigation decisions and (ii) examines how motivational orientation influences the decision-making process. Consequently, it is necessary to develop a comprehensive framework that adopts a holistic perspective for earthquake risk mitigation and allows an empirical analysis of these relationships to be carried out. Overall, the objective of this research sought to address how property owners can be motivated in order to increase the likelihood of EPBs owners undertaking adequate mitigation actions by tying the physical, social, economic, regulatory and environments reforms in disaster reduction and management into a holistic framework to assess the mitigation efforts.

2. Theoretical Perspectives of Earthquake Risk Mitigation Decisions

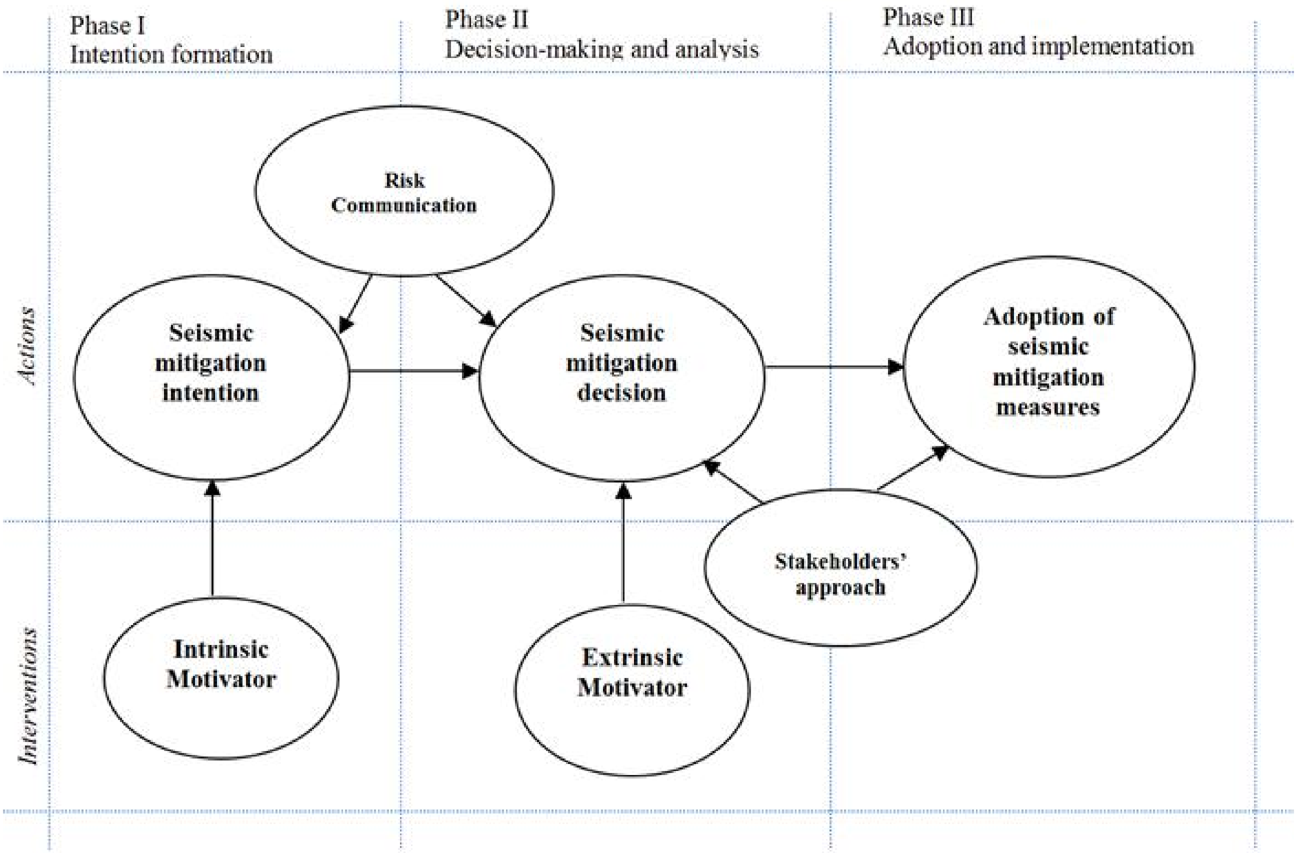
Several theoretical perspectives from psychology, sociology, economic have been used to explain the adoption of protective behaviours including seismic mitigation decisions, but their application has been inadequate to enhance building owners' protective decisions. The main theoretical perspectives applied to earthquake risk mitigation include attitude-behavioural theories and social and cognitive processes theories (Lindell and Perry, 2000, Kirschenbaum, 2004). Within the tenets of the attitude-behavioural theories, main theories applied to earthquake risk mitigation are the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) (Ajzen, 1991). These theories seek to explain the rationale behind individuals' behavioural patterns by emphasising the role of behavioural intentions in human decisions and behaviour, and identifying the variables that influence the strength of these associations. Although, these theories are different from each other and are developed in diverse contexts, people's interpretive process is influenced by cognitive biases and people's sociological background, thus limiting their potential to predict protective adoption behaviour (Paton, 2008). Theories incorporating social and cognitive processes address the psychosocial constructs that explain why people make the decisions they do. Four of these theories which are: Protection Motivation Theory (PMT) (Rogers, 1975); Person-Relative-to-Event Theory (PrE) (Mulilis and Duval, 1995a); Protective Action Decision Model (PDAM) (Lindell and Perry, 2004); and Social Cognitive Preparation Model (Paton, 2003) were examined in this study. The PrE theory for instance, assumes that people's intention to adopt seismic measures is determined by the level of perceived threat in relation to the resources required to mitigate the threat. The presence of unanticipated problems to the intended action such of lack of financial resources limits its usage to understand how risk mitigation decisions are formed and mitigation actions are undertaken. Similarly, most of these theories tend to focus on how perception of risk affects people's decisions and their responses to environmental hazards mitigation. For example, the protection motivation theory was developed to explain the behavioural changes that individuals make when faced with a perceived threat. However, the theory's ability to predict changes in actual behaviour remains unanswered because of the theory's inability to explain how its key theoretical variables combine to initiate how people respond to environmental hazards (Neuwirth et al., 2000).

The emergence of the Social Cognitive Preparation model (Douglas and Wildavsky, 1982) recognised the need to understand the "reasoning and judgment that underpin decisions regarding disaster preparedness". The model indicates that variables such as risk perception, self-efficacy, response efficacy and problem-focused coping are predictors of behavioural intention to adopt disaster preparedness measures. The model has been modified to study the impact of the different proposed variables on several hazards such as earthquakes, volcanic eruptions and tsunami (Paton, 2003). However, comparisons of the different adaptations of the model found substantial discontinuity between people's perception of risk and their level of preparation which suggests that seismic mitigation decisions are influenced by additional interpretative and motivational processes (Paton, 2003). The theories discussed above have many useful features and offer some plausible explanations regarding how people respond to earthquake risk mitigation; however, their very generality limits their ability to investigate how building owners' earthquake mitigation decisions can be motivated. Relevant elements from the reviewed theoretical approaches can be integrated with the findings from earthquake risk and disaster management research and other related disciplines such as the decision sciences and psychology to provide a more complete understanding of the process necessary to induce, enhance and sustain appropriate decisions to adopt risk mitigation measures. Submissions from this study thus sought to integrate the utility of motivational theories and relevant elements from findings from disaster research to enhance building owners' seismic mitigation decisions.

Motivational theories seek to explain the rationale behind people's decisions, why they carry out a particular action, and how the outcomes of such actions help to achieve their objectives (Cavalier, 2000, Dahlgaard and Dahlgaard, 2003, Halepota, 2005). Three categories of motivational theories' relevance to decision-making examined in this study are *need theories* such as Maslow's Hierarchy of Needs (Maslow, 1954),Acquired Needs theory (McClelland, 1971) and Alderfer's ERG theory (Alderfer, 1972). In addition , *reinforcement theories* that include Skinner's Reinforcement theory (1953), Higgins Regulatory Focus theory (1998), and *process theories* such as expectancy theory of motivation (Vroom, 1964) and Porter and Lawler Motivation model (1968) were examined. Building on relevant literature, motivation is conceptualised in this study as the rationale behind any decision or action to achieve an objective which can be initiated, sustained or ignored. A review of motivational theories mentioned above revealed three common components of motivation: (1) what prompts human behaviour; (2) what channels such behaviour; and (3) how behaviour can be sustained? The first component implies how intrinsic human factors such as perception of risk and behavioural control, needs, beliefs and attitudes drive behaviour. The second component considers intentionality as the rationale for behaviour ascertaining that an individual's behaviour is directed towards achieving a particular objective. The third component relates to a system orientation that describes how behavioural intention, intrinsic and extrinsic forces interact to either dissuade or reinforce a behaviour or decision. The first two components of motivation have been enumerated through the application of the theories discussed earlier both in disaster management and decision sciences research (Cavalier, 2000). The third component defines the approach of the applied motivational theories in this study, by examining how the interaction of behavioural intention, intrinsic and extrinsic factors and corresponding motivators, would reinforce decisions towards a particular direction. This approach could lead to an understanding of the motivation orientations that underlie disaster preparedness decisions, and how protective behaviours can be enhanced.

3. Conceptual Framework Development and Theoretical Synthesis

By integrating the theoretical fields of natural hazard management and motivation, and including a wider range of variables established in literature, a comprehensive multi-phased conceptual framework, illustrated in Figure 1, was developed to examine how seismic retrofit decisions can be motivated and sustained. The framework builds upon exiting framework and approach framework and findings of Egbelakin *et al.* (2011a). The framework shows that the process of making seismic mitigation decisions comprised of three inter-related stages that can be influenced by a specific sets of motivators. The first stage concerns intrinsic factors within humans that prompt an intention to make decisions to achieve a particular goal (intention precursors), with



The three sequential phases presented in Figure 1 above are cross-validated by examining the major theoretical frames supported by the previous literature on earthquake risk mitigation, decision-making and motivation. Six theoretical frames that emerged from the review of literature that render the proposed three sequential phases essential are; Theory of Reasoned Action (TRA), Theory of Planned Behaviour, Protection Motivation Theory, Person Relative to Event Theory (PrE), Protective Action Decision Model (PDAM) and the Social Cognitive Preparation Model (see Section 2.0). Likewise, four significant theoretical frames that include Skinner's reinforcement theory, Higgins regulatory focus theory, Goal-setting theory and Expectancy theory emerged from the review of the motivational theories. In addition, the six main constructs conceptualised for predicting building owners' likelihood to adopt seismic mitigation are derived from these ten theoretical frames. Figure 2 shows the relationships among the theoretical frames, dimensions of seismic mitigation phases, constructs and the successful adoption and implementation of seismic mitigation. These ten theoretical frames provide empirical support for the development of the framework. For instance, Theory of Planned Behaviour maps into seismic mitigation intention, while Protection Motivation Theory maps into seismic mitigation decision, and the intrinsic and extrinsic motivator constructs. The mapping of the theoretical forms, dimensions of seismic mitigation decision phases, constructs and successful adoption and implementation of seismic mitigation provide a theoretical validation of the conceptualisation of the framework used in this study. The constructs and variables described at the three inter-related stages in subsequent sections represent the key determinant predictors of earthquake mitigation decisions.

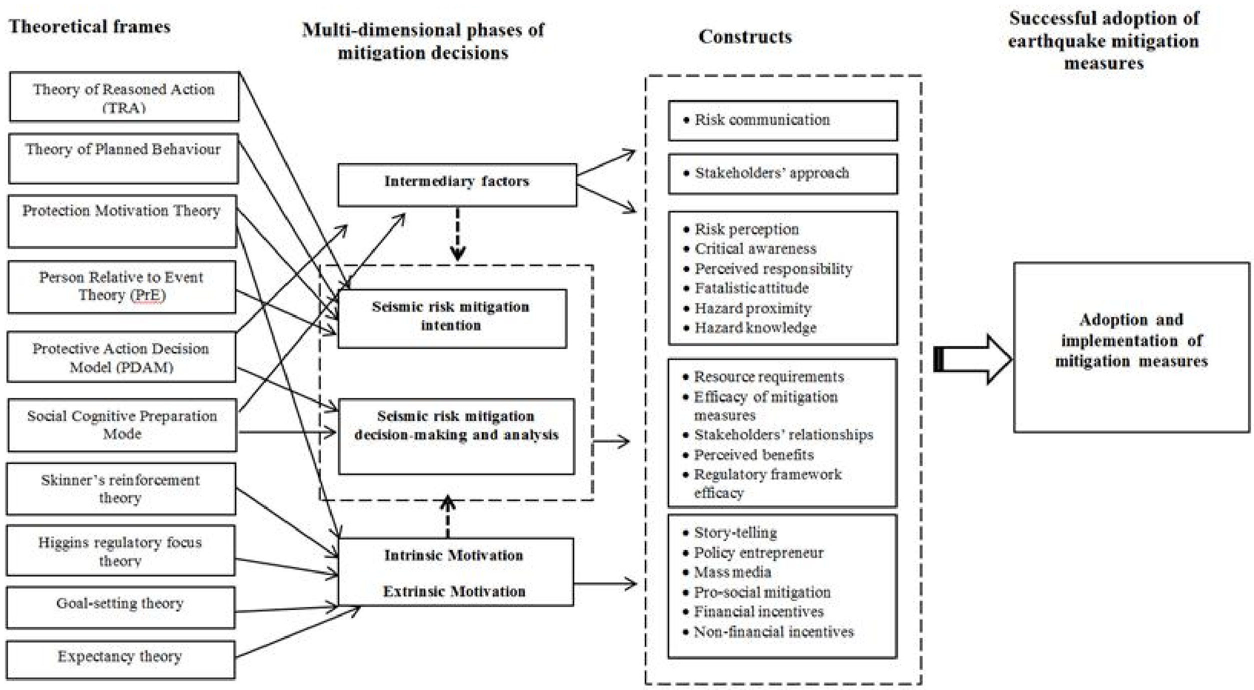


Figure 2 Theoretical formulation and validation of the framework

3.1 Intention Formation Phase

As illustrated in Figure 1, the first stage comprises the formation of intentions to prepare for earthquake disaster. “Intention” or willingness to adopt seismic mitigation measures is a behavioural attribute evoked by human intrinsic factors or stimuli to explain why some individuals and not others are involved in earthquake risk mitigation (Paton, 2003). In relation to long-term mitigation, specifically structural modification of existing EPBs considered in this study, intention should not be taken to automatically imply their conversion to actions or decisions because of the presence of moderators such as uncertainty in earthquake probability and severity limit the predictive capabilities of behavioural intentions (Lindell and Perry, 2004). Explicitly, “intention to prepare” is conceptualised in this study as the extent to which an individual is willing to make decisions regarding whether or not to adopt seismic mitigation, and is initiated by ‘precursors’ such as risk perception, fatalistic attitude, critical awareness, perceived responsibility, past earthquake experience, hazard knowledge and proximity (Paton, 2003, Egbelakin et al., 2011a).

3.1.1 Seismic Mitigation Intention

Several factors identified in empirical findings in the earthquake risk management literature such as risk perception, fatalistic attitude, critical awareness, perceived responsibility, past earthquake experience, hazard knowledge and proximity have been attributed to predict behavioural intentions (Ajzen and Albarracín, 2007). Perception of risk is shaped by how people interpret and personalise hazard and its related impacts, and has been established as a valid precursor to disaster preparedness intention (Solberg et al., 2010). Critical awareness refers to the extent of thought, discussion and information receipt about earthquake risk mitigation on a regular basis which raises personal concern about earthquake hazard that is judged to be important to a person (Paton, 2003). The degree to which critical awareness cause people to stop thinking about other tasks and focus on their vulnerability to earthquake risk was found as a significant predictor of seismic mitigation adoption (Lindell and Perry, 2004). Previous research suggested that a fatalistic attitude about earthquake damage can affect intentions to prepare for natural hazard (McClure et al., 2007). Hazard proximity provides an indication of the geographic distance from the hazard source such as existing fault lines, and has been be perceived as a potential risk when people make decisions regarding alternative location to reside (Lindell and Hwang, 2008). Perceived responsibility denotes the extent to which an individual feels responsible for ensuring personal or close family members’ safety (Mulilis and Duval, 1995b). People who feel that they are responsible for preparedness against earthquake disasters are likely to develop behavioural intention to adopt mitigation measures. According to Lindell and Perry (2004), previous disaster experience has a direct effect on hazard mitigation intention or decision, but there are possibilities that additional unidentified variables mediate the effect of disaster experience on hazard mitigation adoption. Effective risk communication and awareness programs are significant parameters that can ameliorate people’s perception and intention about risk mitigation (MacGregor et al., 2008).

3.1.2 Intrinsic Motivators

As conceptualised in this study, intrinsic motivators is necessary to expedite the transitional process of transforming seismic mitigation intention to decision because the intention to adopt long-term hazard mitigation can change over time in the presence of other competing needs (see Figure 1). Four intrinsic motivations adopted are, story-telling, the use of policy entrepreneurs, mass media and encouraging pro-social mitigation behaviour. Storey-telling from past earthquake experiences and coping strategies among family and community members can augment the level of acceptability of earthquake reality, and address change in people's preparedness decision by casting the key information somewhere along a wide range of sense-making possibilities, other than information accorded with scientific jargons (Brown et al., 2009). Empirical findings have documented the fundamental role that policy entrepreneurs play during the policy formulation and adoption process, which entails mobilising community support for relevant policies and ensures it stays on the agenda until the desirable objectives are achieved (Wood, 2004). The media can be used to improve the salience of earthquake risk issues, and can influence people's preparedness towards hazard mitigation by constructing, amplifying, and dramatising the extent of risk exposure (Paton, 2006). In earthquake risk mitigation, pro-social behaviour refers to voluntary actions that are intended to help or benefit another individual or society, which includes the act of promoting seismic rehabilitation of EPBs (Dahlgaard and Dahlgaard, 2003, Goodwin, 2009). For instance, the values that individuals or a group of people assign to heritage buildings can promote earthquake risk mitigation behaviour and action towards EPBs as some of these buildings have heritage attributes.

Summarising the discussion on the intention formation phase, it is plausible to conclude that risk perception, fatalistic attitude, critical awareness, perceived responsibility, past earthquake experience, hazard knowledge and proximity are proposed variables required to initiate the reasoning process that underlies whether a protective behaviour will be developed or not. That is, some level of their presence is required for the seismic mitigation adoption process to commence. Likewise, the application of the intrinsic motivators would enable a low motivated person to progress to the decision stage and sustain the motivation of the already motivated individual.

3.2 Decision-making and Analysis Phase

The decision-making and analysis phase is an intermediary stage between the formations of intention and the actual adoption and implementation of seismic mitigation (see Figure 1). This phase refers to the extent that a building owner who has developed the intention to retrofit, and have analysed critically the decision whether to adopt seismic mitigation and to what seismic performance standard required for the EPB.

3.2.1 Seismic Mitigation Decision

Seismic retrofit decision-making can be influenced by resource requirements, mitigation efficacy, trust in stakeholders' relationships, perceived benefits of adopting seismic mitigation and regulatory requirements as well as stakeholder characteristics(Egbelakin et al., 2011a). Perceived benefits of retrofitting such as ensuring safety, financial returns and public recognition refer to the extent to which people's judgement regarding the cumulative rewards obtainable from retrofitting their EPBs influence their decision to adopt mitigation measures (Egbelakin, 2013c). The efficacy of earthquake related policies and regulations relate to the extent that the formulation and implementation of these regulations affects building owners' adoption of mitigation measures (Lindell and Prater, 2000). Stakeholder characteristics affect mitigation decisions through the acceptance or non-acceptance of information regarding earthquake risks mitigation (Arlikatti et al., 2007). Resource requirements describes the belief about the adequacy of knowledge, skills and resources that include finance, materials and equipment to mitigate disaster impacts (Johnston et al., 2005). For instance, if an individual lacks sufficient resources such as money to mitigate hazard impacts, it is unlikely that they will implement adequate mitigation measures. Seismic adjustments efficacy denotes presumed success of risk mitigation measures such as the extent to which the structural designs adopted in the retrofitting of EPBs is perceived to protect both persons and property in an earthquake event (Lindell et al., 2009). Trust in stakeholder inter-relationships determine the credibility of risk information accorded to hazard management experts (Siegrist and Cvetkovich, 2000). Lack of trust undermines the assumptions that people make concerning the motivation of those providing the information, their competence and the reliability of the information given (Earle, 2004), and consequently their decision to adopt seismic mitigation.

3.2.2 Extrinsic Motivators

Extrinsic motivators introduced at the second phase would allow a seismic retrofit decision to proceed to the final adoption and implementation stage through the use of incentives. The extrinsic motivators adopted are financial-based incentive (McClean, 2009), technological-based incentive (Lindell and Perry, 2004), regulatory-based incentive and property-market based incentive (Egbelakin, 2013c). Financial incentives could enhance the adoption of seismic hazard mitigation by reducing the initial cost of implementation (McClean, 2009). Financial incentives considered in this study are: reduction in consent fees, tax credits and deductibles, reduced insurance premium, public low-interest loan programs, reduced permit fees, fee waivers and a cost-sharing approach. Technological innovations such as sustainable and cost-effective seismic retrofitting design solutions signify a more advanced way of achieving risk reduction because they could reduce the trade-off between efficacy and cost. Regulatory-based incentives include implementing mandatory disclosure of earthquake risks at the point of sale/rent; comprisal of seismic risks in property valuation assessments; implementing sanctions for building owners not retrofitting their EPBs; improving building standards, guidelines and building code; implementing a grading system; developing public policies tied to seismic strengthening to promote earthquake hazard mitigation, specified permitted uses, plot ratios or site intensity zoning; and mandating the use of transferable development rights (Egbelakin, 2013a). Three property-market based incentives proposed are mandatory recognition of seismic risks in property valuation assessment; public awareness and education programs about seismic risks for property market stakeholders; and creating value for seismic risks in the property market (Nakhies, 2009). A stakeholder's approach refers to a collective system orientation that combines the interactions of the constructs in the first and second phases (seismic mitigation intention and decision-making phases), immersed in *a "social context"* to influence the adoption of seismic mitigation decision and adoption". A seismic mitigation decision immersed in a social context is significant for social relationships and developments that foster collective protective actions against environmental threats (Egbelakin, 2013b).

To summarise the discussion on the decision-making and analysis phase, the identified factors influencing seismic risk mitigation decision could be enhanced by the presence of the extrinsic motivators, allowing a less motivated property owner to progress from the decision-making and analysis phase to the adoption and implementation phase. Similarly, the application of the stakeholder's approach depicts that the immersion of the first two phases in a social context would have a significant effect on all stages of the protective actions and seismic mitigation adoption and implementation.

3.3 Adoption and Implementation Phase

The final phase relates to the adoption and implementation of seismic mitigation measures. At this phase, all the factors identified as influencing the decision to adopt mitigation measures have been assumed to be satisfactorily considered and enhanced. Hence, a seismic mitigation measure likely to be most effective at achieving protection and other related benefits, and logically feasible to implement would be adopted and implemented.

4. Research method - Interviewing Subject Matter Experts

This section provides an update on the on-going research conducted at the University of Massey, New Zealand. Subject matter experts (SME) would be used in this study to examine the external validity and applicability of the developed framework to real-life situations. A subject-matter expert (SME) expert is a person who is an expert in a particular area, activity or topic (Sugar and Schwen, 1995). The research is mindful of the need to examine the developed framework's capabilities, limitations, and appropriateness for addressing the research problem addressed in this study, hence the engagement of SMEs to assess the conceptual framework before commencing on large scale empirical testing. Five SMEs who have been involved in earthquake risk mitigation in New Zealand for at least twenty years had so far agreed to participate in this research. Face-to-face interviews would be conducted with selected SMEs that comprised two private building owners, two directors from the city councils and one director of a property valuation company.

The SMEs would be asked to comment on the practicality and comprehensiveness of the theoretical framework and the identified intrinsic and extrinsic motivators. To facilitate the interviewing process, an interview guide would be developed and would be consist of: (i) a brief introduction to the research process; (ii) a list of questions; and (iii) the framework diagram showing the influences and inter-relationships among the motivators and the three sequential process of seismic risk mitigation decision and adoption of measures. During the interviews, the framework diagram would be presented to the five experts. They will be requested to comment on whether the framework has adequately met the research rationale that necessitated the need to improve property owners' earthquake preparedness decisions, as well as address the following issues:

i. adequacy of the framework to reduce the complexity of the seismic risk decision-making process in order to ensure that owners of EPBs adopt preventive measures
ii. adequacy of the framework to relatively integrate the different roles of the various stakeholders involved in seismic retrofitting of EPBs to successfully initiate and sustain property owners' mitigation decisions.
iii. practicality of the identified motivators and their potential impact on earthquake risk mitigation

5. Conclusion

Figure 1 presents a new framework to address how property owners' earthquake preparedness decisions could be enhanced. The framework derives its strength by integrating theories and research in natural hazard management and motivation by amalgamating the different empirical findings on risk decisions and motivation. The utility of the framework lies in its function to examine how human motivational orientations influence decisions regarding disaster preparedness, how individuals make choices regarding seismic risks mitigation, and how the motivational orientations can subsequently be used to predict voluntary adoption of seismic mitigation under specific conditions of the inter-related motivational factors. Thus, the framework developed in this study aims to address the gaps in literature and theory on how to induce, promote and sustain appropriate seismic risk mitigation decisions and actions. The conceptual framework developed in this study needs to be empirically evaluated through quantitative or qualitative approaches before valid conclusions could be made about is applicability and success for enhancing property owners mitigation decisions, and consequently reducing their vulnerability to earthquake disasters. The next stage of the research entails a preliminary qualitative review of the framework using subject matter expects, and subsequently a nation-wide quantitative empirical testing would be conducted. The framework developed in this study for enhancing earthquake preparedness decisions incorporating a multi-disciplinary approach has great potential for building property owners and community resilience before adverse events.

References

Ajzen, I. (1991) The theory of planned behavior. *Organizational Behavior and Human Decision Processes,* **50**(2), 179-211.

Ajzen, I. & Albarracín, D. (2007) Predicting and changing behavior: A reasoned action approach. *Prediction and change of health behavior: Applying the reasoned action approach,* 1-21.

Alderfer, C. P. (1972) *Existence, Relatedness and Growth.,* Free Press, New York, NY.

Arlikatti, S., Lindell, M. K., Prater, C. S. & Johnston, D. (2007) Perceived stakeholder role relationships and adoption of seismic hazard adjustments. *International Journal of Mass Emergencies and Disasters,* **25**(3), 218-256.

Bostrom, A., Turaga, R. & Ponomariov, B. (2006) Earthquake Mitigation Decisions and Consequences. *Earthquake spectra,* **22**(2), 313-327.

Brown, A. D., Gabriel, Y. & Gherardi, S. (2009) Storytelling and change: an unfolding story. *Organization,* **16**(3), 323.

Burton, I., Huq, S., Lim, B., Pilifosova, O. & Schipper, E. L. (2002) From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate Policy,* **2**(2), 145-159.

Cavalier, R. (2000) *Personal motivation: a model for decision making,* Praeger, Westport CT, London.

Dahlgaard, P. S. & Dahlgaard, J. J. (2003) Towards a holistic understanding of human motivation: core values—the entrance to people's commitment? *AI & Society,* **17**(2), 150-180.

Department of Building and Housing (2004) *The Building Act,* Brookers Ltd, Wellington.

Douglas, M. & Wildavsky, A. (1982) *Risk and Culture: An Essay on Selection of Technological and Environmental Dangers,* California University Press, Berkeley.

Dowrick, D. J. (2003) Earthqauke risks reduction actions for New Zealand. *Bulletin of the New Zealand Society for Earthquake Engineering (NZSEE),* **36**(4), 249-259.

Earle, T. C. (2004) Thinking aloud about trust: a protocol analysis of trust in risk management. *Risk Analysis,* **24**(1), 169-183.

Egbelakin, T. (2013a) Assessing Regulatory Framework Efficacy for Seismic Retrofit Implementation in New Zealand, in In Proceedings of CIB World Building Congress: Construction and Society, 5-9 May 2013 2013a, Queenstown University of Technology, Brisbane, Australia.

Egbelakin, T. (2013b) *Earthquake Risks Mitigation- A Stakeholder's Perspective,* Lambert Academic Publishing, Singapore

Egbelakin, T., Wilkinson, S. & Ingham, J. (2014) Economic impediments to successful seismic retrofitting decisions. *Structural Survey,* **32**(5), 449-466.

Egbelakin, T., Wilkinson, S., Potangaroa, R. & Ingham, J. (2011a) Enhancing seismic risk mitigation decisions: a motivational approach. *Construction Management and Economics,* **29**(10), 1003-1016.

Egbelakin, T., Wilkinson, S., Potangaroa, R. & Ingham, J. M. (2011b) Challenges to successful seismic retrofit implementation: a socio-behavioural perspective. *Building Research & Information* **39**(3), 286 - 300

Egbelakin, T. K. (2013c). *Incentives and Motivators for Enhancing Earthquake Risk Mitigation Decision.* PhD Thesis PhD, University of Auckland. Auckland, New Zealand.

Goodwin, C. O. (2009) Identifying Heritage Value In URM Buildings *Journal of Sturctural Engineering Society New Zealand,* **22**(2), 16-28.

Halepota, H. A. (2005) Motivational Theories and Their Application in Construction. *Cost Engineering,* **47**(3), 14-18.

Higgins, E. T. (1998). Promotion and prevention: Regulatory focus as a motivational principle, in Zanna, M. P. (ed.) *Advances in experimental social psychology*. Academic Press,New York, 1-46.

Johnston, D., Paton, D., Crawford, G., Ronan, K., Houghton, B. & Bürgelt, P. (2005) Measuring tsunami preparedness in coastal Washington, United States. *Developing Tsunami-Resilient Communities*, 173-184.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., Kasperson, J. X. & Ratick, S. (1988) The Social Amplification of Risk: A Conceptual Framework. *Risk Analysis,* **8**(2), 177-187.
Kirschenbaum, A. (2004) Generic sources of disaster communities: a social network approach. *International Journal of Sociology and Social Policy,* **24**(10/11), 94-129.
Lindell, K. M. & Prater, C. S. (2000) Household Adoption of Seismic Hazard Adjustments: A Comparison of Residents in Two States. *International Journal of Mass Emergencies and Disasters,* **18**(2), 317-338.
Lindell, M. & Perry, R. (2004) *Communicating environmental risk in multiethnic communities,* Sage Publications, Inc.
Lindell, M. K., Arlikatti, S. & Prater, C. S. (2009) Why People Do What They Do to Protect Against Earthquake Risk: Perceptions of Hazard Adjustment Attributes. *Risk Analysis,* **29**(8), 1072-1088.
Lindell, M. K. & Hwang, S. N. (2008) Households' Perceived Personal Risk and Responses in a Multihazard Environment. *Risk Analysis,* **28**(2), 539-556.
Lindell, M. K. & Perry, R. W. (2000) Household Adjustment to Earthquake Hazard: A Review of Research. *Environment and Behavior,* **32**(4), 461-501.
MacGregor, D. G., Finucane, M. & Gonzalez-Caban, A. (2008). The effects of risk perception and adaptation on health and safety interventions, in Martin, W. E., Raish, C. & Kent, B. (eds.): *Wildfire Risk: Human Perceptions and Management Implications*. Resources for the Future Press,Washington, DC 142–155.
Maslow, A. (1954) *Motivation and personality,* Harper, New York, NY.
McClean, R. (2009) *Regulation and Incentives for Historic Heritage - Theoretical and Legislative Overview* Brookers Ltd, Wellingtion, New Zealand.
McClelland, D. C. (1971) *Assessing Human Motivation.* , General Learning Press, Morristown, New York.
McClure, J., Sutton, R. M. & Sibley, C. G. (2007) Listening to Reporters or Engineers? How Instance Based Messages About Building Design Affect Earthquake Fatalism1. *Journal of Applied Social Psychology,* **37**(9), 1956-1973.
McGuire, R. K. (2008). Seismic Risk Mitigation Decisions Under Uncertainty, in Bostrom, A., French, S. & Gottlieb, S. (eds.): *Risk Assessment, Modeling and Decision Support*. Springer Berlin Heidelberg, 185-198.
Mulilis, J.-P. & Duval, T. S. (1995a) Negative Threat Appeals and Earthquake Preparedness: A Person-Relative-to-Event (PrE) Model of Coping With Threat. *Journal of Applied Social Psychology,* **25**(15), 1319-1339.
Mulilis, J. & Duval, T. (1995b) Negative Threat Appeals and Earthquake Preparedness: A Person Relative to Event (PrE) Model of Coping With Threat1. *Journal of Applied Social Psychology,* **25**(15), 1319-1339.
Nakhies, P. (2009) Seismic Upgrading – Meeting the Economic Challenge, in Pacific Rim Real Estate (RIM) Conference, 18-21 January 2009, Sydney, Australia.
Neuwirth, K., Dunwoody, S. & Griffin, R. J. (2000) Protection Motivation and Risk Communication. *Risk Analysis,* **20**(5), 721-734.
Paton, D. (2003) Disaster preparedness: a social-cognitive perspective. *Disaster Prevention and Management,* **12**(3), 210-216.
Paton, D. (2006). Disaster Resilience: Integrating individual, community, institutional and environmental perspectives, in Paton, D. & Johnston, D. (eds.): *in Disaster Resilience: An Integrated Approach*. Charles C. Thomas,Springfield, Ill, 306-319.
Paton, D. (2008). Community Resilience: Integrating Individual, Community and Societal Perspectives, in Gow, K. & Paton, D. (eds.): *Phoenix of Natural Disasters: Community resilience*. Nova Science Pub Inc,New York 13-31.
Porter, L. W. & Lawler, E. E. (1968) *Managerial attitudes and performance,* Irwin, Homewood, Illinois.
Rogers, R. (1975) A Protection Motivation Theory of Fear Appeals and Attitude Change1. *The Journal of Psychology,* **91**(1), 93-114.
Siegrist, M. & Cvetkovich, G. (2000) Perception of hazards: The role of social trust and knowledge. *Risk Analysis,* **20**(5), 713-720.

Skinner, B. F. (1953) *Science and human behaviour,* The Free Press, New York.

Solberg, C., Rossetto, T., Joffe, H., Gayer, G., Leschka, S., Nöhren, I., Larsen, O. & Günther, H. (2010) The social psychology of seismic hazard adjustment: re-evaluating the international literature. *Nat. Hazards Earth Syst. Sci,* **10**, 1663-1677.

Spence, R. (2007) Saving lives in earthquakes: successes and failures in seismic protection since 1960. *Bulletin of Earthquake Engineering,* **5**(2), 139-251.

Spittal, M. J., McClure, J., Siegert, R. J. & Walkey, F. H. (2008) Predictors of Two Types of Earthquake Preparation. *Environment and Behavior,* **40**(6), 798-817.

Sugar, W. & Schwen, T. (1995). Glossary of Technical Terms., in Kelly, L. (ed.) *ASTD Technical and Skills Training Handbook.* McGraw-Hill,New York

Vroom, V. H. (1964) *Work and Motivation,* Wiley, New York.

Weber, E. U., Blais, A. & Betz, N. E. (2002) A domain-specific risk-attitude scale: measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making,* **15**(4), 263-290.

Wood, R. S. (2004) Earthquake entrepreneurs: Local policy systems and the regulation of public risks in California. *State & Local Government Review,* **36**(3), 198-211.

Take up of property-level flood protection: An exploratory study in Worcester, UK

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Abstract

Significant numbers of homes within the UK are at risk of flooding. Although community level flood protection schemes are the first line of defence for mitigating flood risk, not all properties are protectable. Property-Level Flood Protection (PLFP) provides those unprotected homeowners with an approach for protecting their homes from flooding. This study sought to establish why property-level flood protection is needed and secondly assess the extent of take up using Worcester as the study area. An exploratory questionnaire survey was conducted to achieve these objectives. After consultation of available literature it was established that the introduction of PLFP protection provided numerous benefits including limiting the health & psychological effects flooding poses, the direct financial benefits and also the possible influence on gaining flood insurance. Despite the benefits and the recognition given to PLFP by the government it was found that the overall take up of the measures was low, findings which were further backed up by data collected in the study area of Worcester with only 23% of the sample having introduced PLFP measures. Reasoning for the low take up numbers typically included; unawareness of the measures, low risk of flood event, installation costs and inability to introduce due to tenancy. Age was noted as a significant impacting factor in the study area with none of the respondents under 25 suggesting they had “a good amount of knowledge of PLFP measures” even when they claimed their properties to be at risk of flooding. Guidance and support is especially recommended to those who are unable to manage their own flood risk for e.g. social housing/rental tenants.

Keywords: Adaptation, Flood risk, Incentives, Property-level flood protection, Resilience

1. Introduction

Within England estimations suggest that around 1 in 6 properties are at risk of flooding (coastal, river or surface water flooding) equating to around 5.2 million properties (Environment Agency, 2009a). Of those properties not all will benefit from community-level protection schemes as it is impossible and uneconomical to protect all from flood events through such schemes (Environment Agency, 2009a). Furthermore as forecasters predict precipitation rates to increase by 16% and sea levels to rise by up to 36cm by the year 2080 in the UK (Defra, 2009), we can assume the number of properties at risk will increase, given the direct link between precipitation and sea level rise to flooding (Met Office, 2011). The prior figures suggest there is extensive material need for individuals to personally protect their homes from flooding, via harnessing the use of resistant or resilient measures.

Currently despite the well documented availability of Property-Level Flood Protection (PLFP) measures by the Department for Environment Food and Rural Affairs (Defra) and the Environment Agency (EA), along with the expressed financial benefits (RICS 2014); take up still remains low (Harries, 2012). A survey undertaken by Harries in 2012, suggested that “only 33% of people who have experienced a flood take steps to protect their homes from further flooding and less than 8% of those do who have never been flooded”.

With the addition that researches forecast an increase in extreme weather events for the UK and an increase in sea levels (Defra, 2009). It is imperative that homeowners are proactive in their approach to managing floods and are aware of the possible protection means available, to help minimise the personal detriments that may arise. This paper seeks to investigate the role of government incentives (cash or reward based) in wider uptake of property-level flood protection measures and whether such incentives will result in higher take up levels.

2. Property-level flood protection

Community Level flood protection schemes are often the first line of defence against flooding (Wedawatta et al 2012),mainly due to their ability to protect high numbers of homes and the 99%performance security suggested by the EA (Environment Agency, 2009a). Typical forms include active defences i.e. barriers, pumps and gates or passive defences such as embankments, walls and overflow channels (Nicholls, 2007).

The EA do however recognise that even with increased investment on community schemes; around 500,000 properties will still be left at high risk of flooding by 2035 (Environment agency 2009b), as it is impossible & uneconomical to reduce all flood risk or defend against all possible floods (Environment Agency, 2009a). To combat the underlying factor that not all homes are able to benefit from community level protection; PLFP measures can be utilised as an effective means of managing flood risk for existing buildings.

Further, homes benefiting from community level schemes may not however obtain 100% assurances on protection. Risks will still be present if the passive or active defences fail; recent extreme examples have occurred in Huddersfield, Worcester and South Wales where the subsequent active measures failed (ITV News, 2012). Although the probability remains unlikely there will always remain a possibility (JBA Trust, no date). JBA Trust (No Date) went on to conclude that models suggest around 200 failures are expected per year but in reality the defences are performing much better.

Historically homeowners only reacted to a flood when it became inevitable, introducing temporary means such as sandbags and door guards (May, 2012). Sandbags proving the most sustainable option for homeowners as they are typically provided by the local authority at no cost, however past a certain point of a flood they can become largely ineffective, encompassing the need for more robust protection measures.

PLFP is primarily divided into two forms; resistant & resilient measures. “Resistant measures are those that aim to prevent flood water reaching the inside of properties (for example door guards), while resilient measures aim to minimise damage caused by floods which enter properties (for example water proof plaster) (Bowker, 2007). Some although not all PLFP measures are permanent structures installed to a home for constant protection. Temporary resistant measures used within communities at risk of flooding include air brick covers and manually sealing entry (Thurston et al, 2008).

2.1 Current Take up of Property Level Protection

Despite the well documented availability of custom property-level flood protection (Environment Agency, 2010) take up of the measures generally remains low (Harries, 2012); an interesting observation given that Defra imply that “Property-level flood protection goes to the heart of achieving many of the objectives and local actions to manage flood risk” (May, 2012). A survey conducted by Thurston et al for Defra and the EA in 2007 found that in significant areas of flood risk only 16% of households had taken active measures to limit the potential future flood damage. In a more recent study undertaken by Harries in 2012, found that “only 33% of people who have experienced a flood take steps to protect their homes from further flooding and less than 8% of those do who have never been flooded”. In spite of the low take up figures a survey undertaken by Bichard & Kazmierczak in 2009 on homeowners in the Salford area of Greater Manchester, found that homeowners were willing to introduce a variety of PLFP measures. This suggests willingness to introduce measures, however given the suggested low take up numbers there seems to be some factors hindering the introduction on PLFP, factors which are considered in the next Section (Reasons for low take up).

2.2 Reasons for Low Take up

There are a number of factors determining the noticeable low take up of property level flood protection measures; “homeowners initially raised concerns over its affordability and the potential impacts on property prices” (Harries, 2012). Installing such PLFP measures as discussed above requires significant investment by the homeowner who may potentially not receive its benefits if the risk does not materialise, however the EA suggest that in the event of a significant flood the standard repairs of a property are likely to be more than the installation costs of such measures (Environment Agency, 2009a).

Homeowners surveyed in the 2008 Defra study by Thurston et al (2008) had the tendency to either underestimate or deny the risk of flooding. Typically property owners are often guilty of switching the responsibility of flooding onto their respective local authorities or governing bodies (Harries, 2012). The two prior statements however provide an unclear representation of the "typical homeowners" response to flooding or flood management, as a survey conducted by Kazmierczak & Bichard (2010), suggests; "the field of homeowners surveyed generally felt they were responsible for protecting their homes from flooding. Ultimately the underlying factor is that citizens are positioned as active individuals responsible for knowing and mitigating their own flood risk (Butler et al 2011), in spite of this Defra still recognises the need for the EA to utilise their position in the area and promote, provide advice and encourage the use of property-level flood protection (DEFRA 2012).

A study was undertaken by Bichard & Kazmierczak (2009) on homeowners in a given area, with the aim of establishing who homeowners believe are responsible for property level flood protection; homeowners or the government. The results indicate a near 50-50 split between government responsibility and homeowners. This analysis by Bichard & Kazmierczak (2009) coupled with the mixed views from the prior statements of Kazmierczak & Bichard (2010), Harries (2012) and Thurston et al (2008) suggest the question of who is responsible for PLFP and the subsequent installation costs as being a key impacting factor for the low take up of PLFP measures.

3. Research method

3.1 Study Area

To achieve the objectives and the overall aim of this research project a county has been selected for study that has significant flooding history. Worcestershire was selected as the subject area; the county is particularly vulnerable to flooding incidents due to its geography (Worcestershire partnership, No Date). Since 1998 Worcestershire has been subject to four major flooding events according to Defra, the most significant being the summer floods of July 2007. Pershore college in the county recorded the total rainfall over a 48 hour period as 157.7mm (Met Office, 2014), four times the typical amount for July as a whole (EA, 2007). Subsequently around 4,500 homes were damaged within the region (Evesham Journal, 2014). The EA estimated the likelihood of the summer floods occurring again in any given year at 2 – 4.9% resulting in a flood return period of 21- 50 years the highest estimate return period given.

The county is also expected to be subject to significant growth. Under the South Worcestershire Development Plan a further 6,200 dwellings are proposed by the year 2030 (SW Development Plan, Dec 2014). Further increasing the possibility of flood damage, JBA consulting indicated in 2012 that of the selected 177 sites set to house the provision of dwellings; 91 are susceptible to surface water flooding 9 are included within the EA's flood zone 2 (Medium risk between 0.1% - 1% annual probability of river flooding) and 15 were determined to be in EA's flood zone 3 (High risk 1%≥ annual probability) (JBA Consulting, 2012).

3.2 Data Collection Method

An exploratory study was undertaken to investigate the uptake of property-level flood protection within the case study area selected. The technique utilised for gathering primary data within this research was a questionnaire survey, with the confidence that a survey questionnaire allows collection of large amounts of data in an economical way (Saunders et al, 2009). One of the constraints of this project is the tight window for data collection and analysis/discussions, the questionnaire allows for efficiency in terms of time and data processing, questionnaires are also seen as faster than other respective collection methods (Dornyei et al. 2010).

Professional research studies have also recognised the suitability of questionnaires in capturing public perceptions of flood risk and or damage, for example research reported in a journal paper by Wedawatta G et al 2014; examined the effects of flooding on small businesses. Although the targeted subjects were different, the principles with respect to property level flood protection were similar. A further study completed by Bichard & Kazmierczak (2009) also harnessed the use of questionnaire surveys to test homeowner's attitudes towards flood risk, further justifying the selection of the technique for use within this project.

The survey was distributed in two ways; the Primary distribution method of the questionnaire's was a physical door to door approach, either filling out on the spot or collecting on a given date. In total this approach yielded (31) responses from (45) distributions; resulting in a response rate of (68%). The second method used to complement the prior approach involved the development of an online version using Google forms, a link was then uploaded to two Facebook pages 1) National Flood Forum & 2) Flood Group UK. The response from the members of the pages was low (8) possibly due to the limited number of members from the required specific target area (Worcestershire) being analysed. Both methods subsequently provided a total sample size of 39.

4. Findings and Analysis

4.1 Information about respondents

82% (32) of the respondents were the owners of the property they were residing in, subsequently 18% (7) of those surveyed were living in homes under rental agreements or social housing provisions.

The ages of the respondents varied though the bulk of homeowners surveyed lay between the age groups of 41 – 55 and 55 or over equating to 33% and 31% of the sample respectively, 26% were between the age of 26 – 40 and only 10% were under the age of 25. Exact numbers are provided in the Figure-1 below.

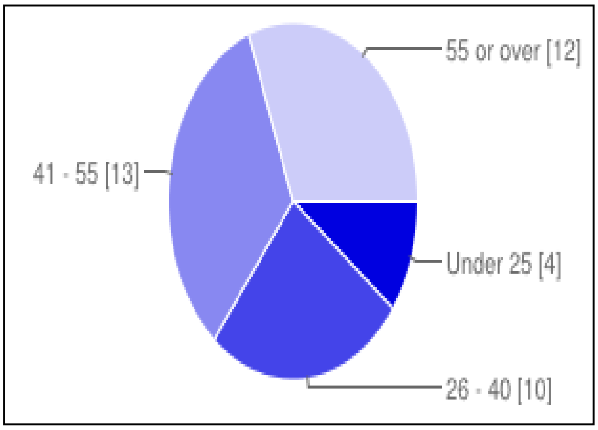

Figure 1 - Age-wise distribution of respondents

4.2 Flood Risk Experience and Acceptance

Of the homes surveyed 54% (21) had been previously flooded internally, leaving 18 of the properties not having experienced internal flooding, however some of the respondents noted that flooding of gardens, garages and outbuildings had previously occurred. In addition one respondent had experienced flooding of a cellar/basement but detailed its cause to be non-fluvial but the rise of the water table in the area. The majority of respondents 78% (30) suggested that their properties were currently at risk of flooding as illustrated in Figure 2. This can be expected given the probabilities of flooding in certain areas of Worcestershire. The remainder of the sample although in perceived areas of flood risk either benefited from surrounding high ground elevating their properties or community-level protection schemes.

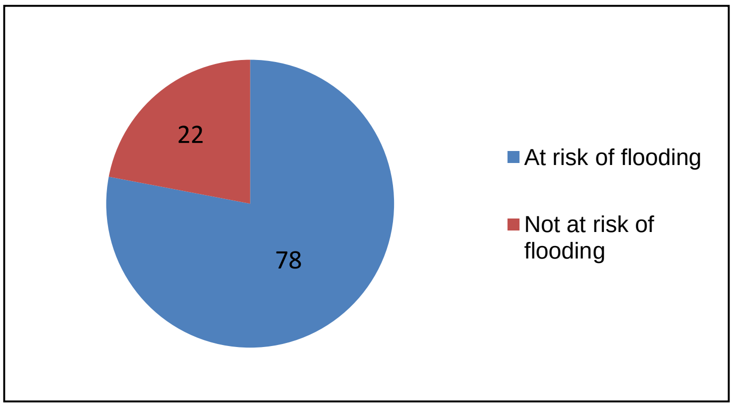

Figure 2 – Perceived flood risk

Roughly only a quarter of the respondents (9) benefit from a form of community-level flood protection either a permanent asset or an active procedure such as temporary flood barriers. Over half of the homeowners surveyed (21) were not covered by any community level scheme. The number given for non-coverage of community protection (21) is likely to be more as the remaining respondents (9) were unsure if they benefited from any such protection. In the scenario where residents are unsure if community schemes are present; the likelihood is that any such schemes will not be present as they are often well known and publicised.

Interestingly 3 of the respondents, who benefit from a community-level protection scheme, did however provide additional information regarding its failure to protect and subsequent flooding due to breakdown. The homeowners were all from the same area benefiting from the community protection in the form of a pumping station, one of the respondents provided the following information on the situation; “Currently covered by a community pumping station which stops the brook flooding by pumping back into river, it is however constantly being attended to for maintenance. Pumping station in 2013 broke down and the brook came into the street again flooding many of my neighbours. Although the EA recognise that failures are a possibility, it is suggested that community alleviation and adaptation measures provide 98% protection certainty in the event of a flood (JBA Trust, no date).

Of the 30 respondents who deemed their homes to be at risk of flooding, over one third suggested that the property they reside in had never to which they were aware been flooded internally. Homeowners in the area are clearly recognising the potential risk of a flood even if they have not personally experienced an event. One possible explanation for the views of these homeowners is that they may have witnessed the effects of floods i.e. financial, psychological etc. within close proximity to their homes, exacerbating their concern of an event occurring.

4.3 Awareness of Property-Level Flood Protection

Respondents were asked to detail their knowledge of property level flood protection measures. In summary of the 39 homeowners surveyed 21% (8) expressed that they had no knowledge or minimal knowledge of the available measures. 46% (18) of homeowners suggested they had vague knowledge of the available measures. Taken together, majority of respondents (67%) suggested they had vague or minimal knowledge of the available measures. 28% (11) of the respondents stated that they had a good amount of knowledge of the measures. Only 5% (2) of the respondents suggested that they had a very good knowledge of available measures. Generally those who mentioned that they had good or very good knowledge were those homeowners who had installed measures of protection or had previously experienced a flood event and potentially researched available options. Findings in the Worcestershire area with regards to knowledge of PLFP measures were similar to that of study by Bichard & Kazmierczak 2009 which detailed that knowledge of PLFP was generally low. The period between this study (2015) and the report 2009 begs the question of; if enough is being done to raise the awareness of PLFP measures by the relevant stakeholders.

Only two of the respondents below the age of 40 claimed to have good knowledge of property level flood protection, the remaining 12 of the sample suggested they had minimal or vague knowledge of the measures. Furthermore none of the respondents under the age of 25 detailed that they had a good knowledge, findings which are made more significant when all of those respondents felt the properties they were residing in are at risk of flooding. Findings in the Worcestershire area lead to suggest that younger homeowners or tenants generally have less knowledge of PLFP than those over the age of 40. Whilst the smaller sample size hinders this being generalised across the region / country, this suggests that more information has to be provided to these age groups regarding PLFP and highlight its importance in managing flood risk.

4.4 Uptake of Property-Level Flood Protection

In total 23% (9) of the sample had introduced a form of personal property level flood protection to their homes. The remaining 77% of the respondents (30) had not introduced any measures to personally protect their homes; the questionnaire included a question which aimed to understand why such measures had not been utilised.

Of those homeowners who deem their property to be at risk of flooding (29) one third had introduced PLFP measures to try and reduce any future flood damage. In theory you would expect to see an increase in uptake figures for those who had previously been flooded (21) however again only 33% of the homes had protection measures installed. A similar percentage of introductions were obtained in a study by Harries 2012, however within the report it was also documented that only 8% of homeowners who had never been flooded introduced such means. Although over two thirds of the sample suggested their homes were at risk of flooding but still currently remain unprotected, the take up figures are much greater than reported in other similar studies such as Thurston et al 2007 who observed that only 16% of the sample admit to having introduced such means of protection.

Responses of survey participants with regard to reasons for non-installation are presented in Figure 3: Reasons for Non-Installation of Protection Measures. Respondents could provide multiple reasons for non-installation. In summary the three main influences for non- installation were; 1) Installation costs with 30% of the respondents highlighting it as an issue 2) Unawareness of the measures suggested by 25% of the sample, finally 3) low risk of flood event expressed as a reason by 20% of the respondents. As indicated along with the three main influences for non-installation a fair number of respondents 18% (7) would not be able to introduce such means of protection due to the ownership of the property.

If the nine respondents are removed who feel their property is “at low risk of a flood event”, the majority of the remaining homeowners detailed that unawareness of the measures, installation costs and inability to alter due to ownership were the key factors for not introducing PLFP measures. Other reasons included property aesthetics (2) covered by community scheme (4) effort levels required (1) and one home surveyed was a listed building so no alterations to the building fabric was possible. The reasoning’s observed in this study holds both similarities and differences to that found in other projects. The similarities being the concern over installation costs and the general low awareness of the protection measures available detailed by both Harries 2012 & Thurston et al 2007. However neither of the reports draws to the issue of protecting rental or housing association properties. Nearly a quarter of those who believe they are at risk of flooding are unable to introduce any means of PLFP due to their housing agreements.

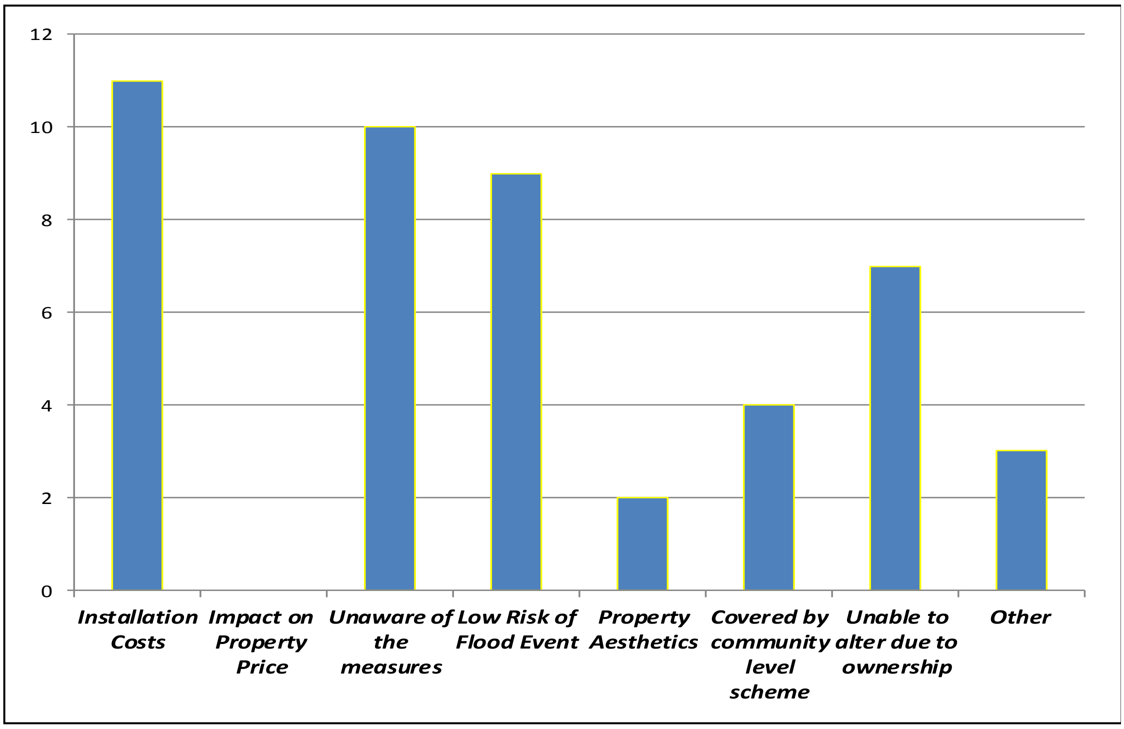

Figure 3 – Reasons for non-installation of protection measures

Of the total sample 7 of the respondents did not own the property they were residing in; they were living under either under tenancy agreements or social housing provisions. Of the seven homes surveyed 5 of them had previously been flooded and all importantly; all 7 tenants suggested the properties they were living were at risk of flooding. Given the apparent risk none of the properties had any means of property level flood protection installed although one was covered by a community level scheme. All seven respondents claimed they would be unable to alter the property without agreement with owners; subsequently protecting the properties was out of their hands. Six of the seven respondents stated that they would be happy for protection to be introduced and in one case the tenant stated that they would be willing to partly fund if permission was granted. The one tenant covered by the community level protection scheme had previously requested that protection was installed however the response from the homeowner was that "he will not provide any funding for protection cause of the community pump installed"

Clearly there is an apparent need for support and advice to both tenants and landlords/housing associations with respect to property-level flood protection measures. The fact that all seven of the tenants feel their homes are at risk of flooding but no such protection is present is of concern. Bichard & Kazmierczak (2009) did undertake some primary research on both landlords and other property owners i.e. councils or associations and found that; in most cases landlords and association managers were in favour of preparing homes for the effects of climate change, however most were concerned about the cost of any such works. Most were though interested in the possibility of rewards for undertaking any works. The possible introduction of incentives and or grants therefore has the potential to increase the likelihood of landlords and other owners introducing PLFP measures to properties.

5. Conclusion

Roughly 5.2 million properties are at risk of flooding in the UK either; costal, fluvial or surface water; Numbers which are predicted to increase given the future weather trends and the established link between precipitation/sea level rise and flooding. Most importantly not all of those homes are protectable by community-level protection schemes, as it is impossible and ultimately uneconomical. PLFP measures therefore provide unprotected homeowners with an effective means of managing their own flood risk.

Despite the well documented availability of PLFP measures and suggestions from Defra that PLFP goes to the heart of achieving many of the actions to manage flood risk, take up still remains low. An observation drawn from available literature which was further backed up by the findings in the primary research within this study, with 33% of homeowners who deemed themselves to be at risk of flooding introducing means of protection. Only one of the nine homeowners with protection installed had not previously been flooded, suggesting that flood experience has a major influence on the introduction of PLFP. Typical reasoning amongst others regarding the low take numbers included; concern over the cost of installation, unawareness of the measures, low risk of flood event and unable to alter property due to ownership.

Both the primary research and available literature suggest that generally the knowledge of PLFP is low. Within the study area over two thirds of the respondents detailed having vague or minimal knowledge of the means of protection. Age was found to be an impacting factor on the knowledge of PLFP means with only two of the respondents under the age of 40 expressing a good amount of knowledge, furthered by the observation that none of the respondents under age of 25 had even a good amount of knowledge of PLFP even though they deemed their homes to be at risk of flooding. Guidance and support is recommended to those who are unable to manage their own flood risk i.e. social housing/rental tenants.

References

Bichard E and Kazmierczak A, 2009. Resilient Homes: Reward-based methods to motivate householders to address dangerous climate change. Environment Agency. University of Salford, Manchester.

Bowker P, 2007. Flood resistance and resilience a research and development study, Independent consultant, for DEFRA & Environment Agency.

Chatterton J, Viavattene C, Morris J, Penning-Rowsell & Tapsell S. 2010. Delivering Benefits Through Evidence. DEFRA, Environment Agency. Bristol, United Kingdom

Defra. 2013. Adapting to climate change. Defra, Secretary of State. London, United Kingdom.

Defra. 2013. Securing the future of flood insurance, Secretary of State. DEFRA, London, United Kingdom

Dornyei Z, Taguchi T. 2010. Questionnaire's in Second Language Research; 2nd Edition. Routledge, New York.

Environment Agency. 2007. Review of 2007 Floods EA (No Date), [Online] Available at, www.environmentagency.gov.uk/static/documents/Research/returnperiods_1918541.pdf. [Accessed 2nd February 2015]

Environment Agency. 2009a. Flooding in England: A National Assessment of Flood Risk, Environment Agency, Bristol, United Kingdom

Environment Agency. 2009b. Investing for the Future: Flood and Coastal Risk Management in England, Environment Agency, London, United Kingdom

Environment Agency. 2010. Preparing your home for a flood: a guide for householders and small businesses. Defra. Bristol, United Kingdom

Environment Agency. 2013. Defra Capacity Building Programme Property-level Protection – from pilots to mainstream schemes. Defra. Bristol, United Kingdom

Harries T. 2012. Flood hazards impacts and responses for the built environment, Chapter 24, Pg 327 – 341, why most at risk homeowners do not protect their homes from flooding. London, United Kingdom.

ITV News. 2012. Defence Failure, [Online] Available at, www.itvnews.com. [Accessed 2nd February 2015]

JBA Consulting. 2012. Evaluation of the Defra Property-level Flood Protection Scheme. Environment Agency. Defra. Newport, South Wales

JBA Trust. No Date. Flood Defence Performance, [Online] Available at, http://www.jbatrust.org/sites/www.jbatrust.org/files/pictures/Flood%20defence%20model%20performance%20170114.pdf. [Accessed 12th March 2015]

Kazmierczak A and Bichard E. 2010. Investigating homeowners interest in property level flood protection, University of Salford, Manchester.

Kearney D. 2012. South Worcestershire Strategic Flood Risk Assessment Level 2 Update, JBA Consulting. Wychavon district Council, Worcester City Council and Malvern Hills District Council, England.

Malvern Hills, Worcester City & Wychavon Councils. 2014. South Worcestershire Development Plan (December, 2014), [Online] Available at, http://www.swdevelopmentplan.org/?p=9540 [Accessed 2nd February 2015]

May P, 2012. Establishing the cost effectiveness of Property Level Flood Protection. JBA Consulting, DEFRA. United Kingdom

Met Office 2011, Climate: Observations, projections and impacts. Exeter, United Kingdom.

Met Office. 2011. Flooding in 2007, [Online] Available at, http://www.metoffice.gov.uk/about-us/who/how/case-studies/summer-2007. [Accessed 2nd February 2015]

Met Office. 2014. UK Flood Predictions (2014), [Online] Available at, http://www.metoffice.gov.uk/climatechange/science/monitoring/ukcp09. [Accessed 25th February 2015]

Nicholls D, 2007. Risk Assessment for Flood Incident Management; Impacts of Failure of Flood Defence Asset Operation. DEFRA & Environment Agency. Bristol, United Kingdom

Royal Institute of Charted Surveyors (RICS), 2014. A clear impartial guide to flooding. London, United Kingdom

Saunders M, Lewis P & Thornhill A, 2009. Research Methods for Business Students: 5th Edition. Pearson Education limited, England.

Thurston N, Finlinson B, Breakspear R ,Williams N and Shaw and Chatterton J. 2008. Developing the evidence base for flood resilience and resistance. Entec, Greenstreet Berman and John Chatterton Associates, for DEFRA & Environment Agency.

Wedawatta G, Ingirige B, (2012),"Resilience and adaptation of small and medium-sized enterprises to flood risk", Disaster Prevention and Management, Vol. 21 Iss: 4 pp. 474 – 488.

Worcestershire Partnership. No Date. Extreme flooding in Worcester, [Online] Available at, http://www.worcestershirepartnership.org.uk/cms/pdf/Extreme%20Weather%20Event.pdf. [Accessed 2nd February 2015]

Professional doctorates: applicability to the construction industry in increasing societal resilience to disasters

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Abstract

With the increase in occurrence of high impact disasters, the role of Higher Education Institutes (HEIs) in enhancing the disaster related knowledge and skills of construction professionals is highly recognised. HEIs are expected to contribute to both theory and practice in the development of societal resilience to disasters through the development of curricular and modules to update the knowledge and skills that employees have obtained in the past. Doctoral education is identified as one of the methods in upgrading the knowledge of the construction professionals in this regard. Due to the shortcomings of the traditional doctoral programmes in addressing the needs of the industry and professionals, professional doctorates have become increasingly recognised. As such professional doctoral programmes have been considered as more appropriate in developing knowledge and skills of the construction professionals. Accordingly, a EU funded project, CADRE, aims to develop and test an innovative professional doctoral programme that integrates professional and academic knowledge in the construction industry to develop societal resilience to disasters. As part of this project, the paper aims to analyse the applicability of professional doctorates to the construction industry in developing societal resilience. Based on an extensive review of literature, paper introduces the concept of professional doctoral programmes and its applicability to the construction industry in developing societal resilience.

Keywords: Professional doctorates; disaster resilience; construction; education

1. Introduction

The trend of natural disasters is becoming more frequent causing widespread damage to human and property. Indian Ocean tsunami in 2004, hurricane Katrina in 2005, Haiti earthquake in 2010, New Zealand earthquake in 2011, Japan earthquake and tsunami in 2011, Typhoon Haiyan in 2013, Nepal earthquake in 2015 are some of the major catastrophic disasters over the past decade, which caused devastating and long-term impacts to the affected communities, countries and to the entire nation. Meeting the cost related to natural disasters has increased from US$ 50 billion a year in the 1980s to US$200 billion a year in the last decade (Georgieva, 2014). The damage to built environment accounts for most of the economic losses of disasters and its failure often determine the amount of fatalities (Witt et al., 2014) where collapsing of buildings and infrastructure pose one of the main threats. Accordingly, rehabilitation and reconstruction of the built environment places a huge demand on the funds available for recovery where housing and infrastructure development often account for up to 50% of recovery disbursements (Max Lock Centre, 2009). Consequently, authors such as, Bosher et al. (2007), have highlighted the inadequate role of the construction sector in contributing to disaster risk management. Accordingly, with the increase in occurrence of high impact disasters, together with the increase in economic losses, the role of Higher Education Institutes (HEIs) in enhancing the disaster related knowledge and skills of construction professionals is highly recognised. HEIs are expected to contribute to both theory and practice in the development of societal resilience to disasters through the development of curricular and modules to update the knowledge and skills that employees have obtained in the past. Doctoral education is identified as one of the methods in upgrading the knowledge of the construction professionals in this regard. Due to shortcomings of the traditional doctoral programmes in addressing the needs of the industry and professionals, professional doctorates have become increasingly recognised. As such, professional doctoral programmes have been considered as more appropriate in developing knowledge and skills of the construction professionals. In the context, the paper reports initial findings of an EU funded research project, CADRE (Collaborative Action for Disaster Resilience Education) which aims to develop a professional doctorate to integrate the professional and academic knowledge of the construction in developing societal resilience to disasters. Accordingly, it is intended to develop a structured professional doctoral programme, which reflects how the construction sector and its professionals could contribute in achieving resilience for increasing threats from natural and human induced hazards. As part of this project, the paper aims to analyse the applicability of professional doctorates (DProfs) to the construction industry in developing societal resilience.

The paper is based on review of existing literature in order to explore the applicability of professional doctorates to the construction industry in developing societal resilience. The literature review has been conducted by referring books, journal articles, conference proceedings, reports and websites published by various institutions. Accordingly, the paper provides an introduction to the CADRE project and presents a synthesis of literature related to disaster resilience education to construction professionals. The paper then provides an introduction to professional doctorates and concludes by analysing its applicability to construction sector in developing societal resilience to disasters followed by the way forward.

2. Collaborative Action towards Disaster Resilience Education (CADRE)

There are wide-ranging origins and causes to the many disasters that have affected communities across Europe and globally with ever-greater frequency. If construction researchers and practitioners are to be able to contribute to reduce risk through resilient buildings, spaces and places, it is important that capacity is developed for modern design, planning, construction and maintenance that are inclusive, inter-disciplinary, and integrative. In order to address this challenge, CADRE which is an ERASMUS multilateral project supported by an EU grant will develop an innovative professional doctorate programme that addresses the requirements for lifelong learning and actively promotes collaboration between European HEIs, industry and the community. This novel programme will address the career needs, and upgrade the knowledge and skills, of practising professionals working to make communities more resilient to disasters, and particularly those in, or who aspire to, senior positions within their profession. The candidates will undertake research aimed at making a contribution to the knowledge of professional practice and will involve applied rather than pure research. It will require candidates to establish the research problems from the viewpoint of industry and the community, thus encouraging healthy communication channels between industry, community and university (ICU) and establishing a strong platform for through life learning. In this context, the project, will improve the quality and relevance of higher education through active cooperation between HEIs and partners from outside academia, including construction professional bodies, local/national/international bodies and social partners. Project will achieve this aim by; 1) Establishing a framework for ICU integration to address societal concerns; 2) Developing and testing an innovative professional doctoral programme that integrates professional and academic knowledge in the construction industry to develop societal resilience to disasters; 3) Creating world-class curricula and modules to support the programme and address current and emerging capacity gaps in the development of societal resilience to disasters; 4) Exploiting ICT to enable cross-border cooperation in the sharing and delivery of educational resources that support the professional doctoral programme.

The next section highlights the importance of disaster resilience education to construction professionals.

3. Disaster resilience education to construction professionals

The built environment provides a core to many human activities and facilitates everyday life of human beings. In general terms, the built environment refers to human settlements, buildings and infrastructure (Max Lock Centre, 2009). Hazards cause various disruptions to built environment. The damage to built environment accounts for most of the economic losses of disasters and its failure often determine the amount of fatalities (Witt et al., 2014). As such, professionals related to construction sector are expected to play a major role in mitigating such impacts of disasters. Bosher et al. (2007) identified two elements of mitigation, structural and non-structural. In structural mitigation, it is expected to strengthen the built environment exposed to hazards by way of better building codes, design and construction practises and in non-structural mitigation, it is expected to direct new developments away from hazards through better land use planning and regulations. Construction professionals therefore are required playing a significant role in contributing to both structural as well as non-structural mitigation. At the same time, it is the duty of the professionals attached to construction sector, to plan, design, construct and operate necessary risk reduction infrastructure and other services to protect the communities exposed to hazards. Besides, it is where the people turn for safety and shelter at a time of a disaster (Witt et al., 2014). As such built environment should be planned, designed, built and operated in such a way that it can withstand at a time of a disaster. Furthermore, disasters are now widely seen as a consequence of vulnerability, and the naturalness of natural disasters were questioned by authors such as O'Keefe et al. (1976) from 1970s. Accordingly, it was highlighted that disasters result from a combination of natural hazards and social and human vulnerability. In addition, as pointed out by Cutter et al. (2008) the immediate effects are attenuated or amplified as a result of the coping responses of social systems, natural systems and the built environment. Hence, poorly planned and designed buildings, housing stocks and infrastructure increase the risk of disasters. As such, construction industry is a key contributor in disaster management and mitigation (Chang et al., 2010) and the disciplines associated with the construction sector are required to become more involved with disaster risk reduction and management initiatives (Bosher et al., 2007). Therefore construction professionals are expected to provide a significant contribution to disaster risk reduction and management (Max Lock Centre, 2009, Bosher et al., 2007). Construction professionals are the professionals associated with planning, designing, constructing and maintaining the built environment. These professionals mainly include, architects, engineers, planners and surveyors (Max Lock Centre, 2009). Accordingly, a greater integration of input is required from all built environment related stakeholders, including those govern/ advise on the built environment and those who actually design, build and operate it (Bosher et al., 2007).

However, recent literature concerning disasters has highlighted the inadequate engagement of the construction industry in mitigating the impacts of disasters (Chang et al., 2010). Agreeing with Chang et al. (2010), Bosher et al. (2007) also highlighted the inadequate involvement of professions associated with the construction sector and development, with the stakeholder groups who are integral to the mainstreaming of disaster risk management. This emphasise the need to improve the engagement of construction professionals with the stakeholders who are integral to mainstreaming the disaster risk management to ensure societal resilience to disasters. Therefore, as argued by Ofori (2004), it is of importance to provide construction industries with the necessary capacity and capability to plan, design and build structures in a way that will reduce their vulnerability to disasters and to respond effectively to disasters in order to save and protect lives, rehabilitate vital infrastructure, and reinstate economic activities. In doing so, it is necessary to provide knowledge and skills related to disaster resilience and management to construction professionals.

Disaster resilience education is all about strengthening the disaster resilience knowledge and capabilities of relevant stakeholders and industries. As a result of prominent gaps in knowledge, Sendai Framework for Disaster Risk Reduction (2015-2030) has identified the need of enhancing the capacities of relevant stakeholders and industries. Accordingly, the framework suggested to "*build the knowledge of government officials at all levels, civil society, communities and volunteers, as well as the private sector, through sharing experiences, lessons learned, good practices and training and education on disaster risk reduction, including the use of existing training and education mechanisms and peer learning*" (UNISDR, 2015). As previously highlighted, professionals attached to construction sector play an important role in disaster resilience and management and it is therefore important to design educational and training courses to enable them to successfully fulfil this role (Witt et al., 2014). Therefore as argued by Bosher et al. (2007), risk and hazard awareness training needs to be integrated systematically into the professional training of architects, planners, engineers, developers, etc.

Education and training for construction professionals are generally provided by HEIs; vocational education and training providers; built environment professional bodies; construction organisations, and training and development authorities (Thayaparan et al., 2015). Out of these, higher educational institutes are expected to play a key role in developing capacities of built environment professionals in contributing to disaster resilience (Witt et al., 2014, Thayaparan et al., 2015). Learning opportunities provided by HEIs can mainly be categorised as formal learning through organised programmes recognised by a qualification or part of a qualification (OECD, 2004). However, studies such as Siriwardena et al. (2013), highlights that providing disaster management education as a degree programme is ineffective due to the complexity and multi-disciplinary nature of the subject. Furthermore, the study highlights, lack of industry involvement and the lack of research and development activities on disaster management by construction sector professionals as a hindrance to effective disaster management education. Accordingly, it has suggested the need of continuously updating the skills and knowledge of construction professionals, in order to contribute effectively to disaster resilience (Thayaparan et al., 2015). Thus, in overcoming the challenges of existing approaches of disaster management education, lifelong-learning has been identified as the most appropriate approach to educate construction professionals in the context of disaster resilience and management by the authors such as Thayaparan et al. (2015) and Siriwardena et al. (2013).

In supporting the concept of lifelong learning and in overcoming the identified challenges of existing approaches to disaster resilience education, it is therefore proposed to develop a professional doctorate on disaster management to construction professionals. By developing a professional doctorate, it is expected that challenges such as, complexity and multi-disciplinary nature of the subject; lack of industry involvement; and lack of research and development activities on disaster management by built environment professionals, could tackle successfully. Moreover, a DProf is intended to be a form of in-service professional development and much significant at a time when "continuing professional development" and "lifelong learning" have had an important influence on the policy climate, and when the intellectual climate of curriculum development has shifted from the development of initial skills and competencies to critical reflection, reflective practice and continuous professional development and is concerned with making a research-based contribution to practice within the context of upselling construction professionals with disaster resilience expertise. However, before discussing the specific applicability of professional doctorates, it is important to understand what constitutes a professional doctorate. Accordingly, the next section provides an introduction to the professional doctorates.

4. Introduction to professional doctorates

4.1 Professional doctorates

Before looking into the applicability of professional doctorates to disaster resilience education, it is important to understand what is a professional doctorate. Professional doctorates are now widely available in many UK universities for various disciplines. Most of these professional doctorates target practicing professionals and aim to integrate professional and academic knowledge in the selected discipline. These are available in an increasingly wide range of subjects, such as, education, engineering, health and social care, business, marketing, art and design, musical arts and clinical psychology (McGraw-Hill Education, 2014).

The development of professional doctorates began in 1990s and led to a reconsideration of the nature of the doctoral award (Maxwell, 2003). According to Kot and Hendel (2012), PhDs for many decades claimed as the most prestigious award in the academia. Accordingly, PhDs were offered in wide variety of disciplines including the professional disciplines. As noted by Bourner et al. (2001) the modern Doctor of Philosophy, was originated in Berlin University in the early 19th century and spread across the German universities due to the growth in the importance of research in universities. However, as noted by, Kot and Hendel (2012), during the first half of the twentieth century PhD tradition has been challenged and as a result new trends were emerged in PhD studies. One of the important trend emerged in number of countries was the creation of new forms of doctoral degrees, such as professional doctorates, applied doctorates, practitioner doctorates, clinical doctorates in various disciplines (Kot and Hendel, 2012). Out of these new forms of doctorates, professional doctorates were widely adopted in countries such as USA, UK and Australia and as of 2012, more than 50 professional doctorate awards were offered in the USA and in the UK, and around 20 in Australia and showed a steady increase in professional doctorates (Kot and Hendel, 2012). However, authors further revealed that there is no agreement within and across countries on the core characteristics and standards of professional doctorates. Accordingly Kot and Hendel (2012) noted that there is no standard definition to professional doctorates. As such professional doctorates may differ across institutions and subjects and even within subjects (Bourner et al., 2001). However, authors claimed that most of the professional doctorates have been designed to develop the research based career development for experienced practitioners in the profession whereas traditional PhDs intend to develop professional researchers. Accordingly, authors argued that professional doctorates are designed to develop ‘researching professionals’. Agreeing to this, Neumann (2005) emphasised that the major difference between a PhD and professional doctorates is in the target populations and selection criteria for students. In addition the amount of fees is another contrasting feature in some disciplines and in some institutions. However, The UK Council for Graduate Education has defined a professional doctorate as '*a programme of advanced study which, whilst satisfying the university criteria for the award of a doctorate, is designed to meet the specific needs of a professional group external to the University, and which develops the capability of individuals to work within a professional context*' (UKCGE, 2002). Accordingly, professional doctorates have certain characteristics that distinguish from a traditional PhD. According to McGraw-Hill Education (2014), "*professional practice, the development and/or application of expertise directly in the practice setting and practitioner research are central to professional doctorates*". As such most professional doctorates expect the candidates to research on a topic, which relates to their own working lives (Bourner et al., 2001). Accordingly, candidates are expected to start the research with a problem in professional practice and to make original contribution to knowledge of professional practice through research (Bourner et al., 2001). Maxwell (2003) has identified two generations of professional doctorates; first generation sometimes referred to as 'PhD plus coursework' where more emphasis was given to academic over professional knowledge and outputs. In contrast, in the second generation, more emphasis was given to realities of workplace and to make improvements to the profession. The next section highlights the evolution of the professional doctorates in the UK.

4.2 Professional doctorates in the UK

Since early 1990s the form of the UK doctorates have diversified in order to accommodate the various needs of the student population (The Quality Assurance Agency for Higher Education, 2011). Accordingly, various forms of doctorates have emerged in response to the needs of the various professions. This resulted in the emergence of professional doctorates and practice-based or practice-led doctorates (The Quality Assurance Agency for Higher Education, 2011, Bourner et al., 2001). Accordingly, a number of Professional doctorates came to England in the decade of 1990s and by the end of the decade, professional doctorates were found in over three-quarters of the 'old' universities and a third of the 'new' universities (Bourner et al., 2001). Most of these doctorates have encompassed structured elements, such as lectures and seminars and focussed on acquiring professional knowledge and skills in addition to conducting original research (The Quality Assurance Agency for Higher Education, 2011). In addition, these doctorates provided the opportunity to undertake the research in the workplace and to select a topic, which has direct effect on improving the professional practice, related to the host organisation. These are usually open to experienced professionals employed in any area of work, including emerging professions and disciplines and often taken on part time while working at the host organisation; where successful completion normally leads to professional and/or organisational change (The Quality Assurance Agency for Higher Education, 2011). However, in some cases, candidates are registered as full time students while most of their time is spent working at industrial or professional organisation (Bourner et al., 2001).

Various models of professional doctorates exist even within the UK, and these are usually summarised by the respective institution in their programme specification (The Quality

Assurance Agency for Higher Education, 2011). The UK model of professional doctorates usually consist with a taught component; focussing on the field of study and on research training (Bourner et al., 2001). Though credit is not normally assigned to doctoral degrees, credit may be awarded for successful completion of assessed structured elements (The Quality Assurance Agency for Higher Education, 2011). However, according to Bourner et al. (2001), the taught component is usually structured based on credit rated modules. The next section explores the applicability of professional doctorates for disaster resilience education.

5. Applicability of professional doctorates to the construction industry in developing societal resilience to disasters

As explained in earlier sections, disaster resilience and management is a multi-disciplinary subject area and multi stakeholder efforts are required for successful implementation. Some of the main stakeholders include national and local government institutes; NGOs, INGOs and other international organisations; academia; private sector; and community. Some of these stakeholders employ and/or consult professionals attached to the construction and expect various levels of knowledge and skills to fulfil their organisational needs in developing societal resilience to disasters. Accordingly stakeholders demand certain level of knowledge and skills from construction professionals to reduce the threats posed by natural and human induced hazard. If construction researchers and practitioners are to be able to contribute to reduce risk through resilient buildings, spaces and places, it is important that capacity is developed for modern design, planning, construction and maintenance that are inclusive, inter-disciplinary, and integrative. In order to address this challenge, it is proposed to develop an innovative professional doctorate to integrate professional and academic knowledge in the construction industry to develop societal resilience to disasters. By developing a professional doctorate, it is expected that challenges such as, complexity and multi-disciplinary nature of the subject; lack of industry involvement; and lack of research and development activities on disaster management by built environment professionals, could tackle successfully. Accordingly the aim of this section is to highlight the applicability of DProf programme to construction in developing societal resilience and therefore some of the salient features are highlighted below.

Contribution to theory and practice: In terms of disaster resilience and management, more applied research is required in order to develop the construction industry with necessary capacities to plan, design, build and operate resilient structures to increase societal resilience to disasters. The aim of a DProf programme is to integrate professional and academic knowledge in the selected discipline. Accordingly, it will provide opportunities to the candidates to undertake research aimed at making a contribution to the knowledge of professional practice and will involve applied rather than pure research. It will require candidates to undertake the research in the workplace and to select a topic, which has direct effect on improving the professional practice, related to the host organisation where successful completion normally leads to professional and/or organisational change. It will therefore strengthen not only the academic knowledge and cooperation between the universities and industries, but also the concerns, capabilities and expectations of the relevant stakeholders related to disaster resilience and management. As such, professional doctorates are very much appropriate to construction sector in developing societal resilience to disasters. Accordingly, it will make a research-based contribution to practice within the context of upselling construction professionals with disaster resilience expertise.

Cross-institutional supervisory teams and working environments – One of the main advantages of a DProf is that it enables cross-institution supervisory teams, as well as supervisors from industry. Due to the multi-disciplinary nature of the subjects, having cross-institutional supervisory teams will enhance the quality and relevance of the research and ultimately the contribution to the practice. Unlike a traditional PhD, having supervisors from the industries where research is based on can significantly add value to the research. In addition, DProfs allow students to be based at relevant industries, which will lead to pan stakeholder links, helping to promote inter-disciplinary and inter-sectoral working among candidates, as well as addressing the problem of social and intellectual isolation that is common in doctoral study.

Career needs of practicing professionals: One of the main disadvantages of traditional doctorates is that it is not very attractive to the practicing professionals. As explained earlier, traditional doctorates more often contributes to theory of knowledge and as a result, is not much popular with the practicing professionals in the construction sector. As argued by Bourner et al. (2001) professional doctorates are attractive to those who aspire their own personal development and a commitment to furthering the cause of their profession. Therefore developing a professional doctorate will address the career needs, and will upgrade the knowledge and skills, of practising professionals working to make communities more resilient to disasters, and particularly those in, or who aspire to, senior positions within their profession. The education and training delivered will be more relevant to the world of work, which is vital for the labour market and for people's employability. It will further broaden and deepen the employees' understanding of the disciplines in which they are studying, upgrade their skills, promote inter-disciplinary working, and provide them with appropriate transferable skills. Accordingly it is expected that DProf programmes will attract learners, from the construction industry, to develop solutions to their labour market demands through doctoral studies.

Part time attendance: Another major barrier in traditional PhDs for construction practitioners is that, quite often they are unable to study full-time, and employers are not willing to invest for full-time PhDs. Therefore, in order to meet the needs of practising professionals and their employers, flexible study modes are offered in DProfs, with only part-time attendance necessary; the rest of the time the candidate is expected to spend in industry or a professional organisation. In contrast to traditional doctorates, this will enable universities to provide the structured support that is often missing for other part-time doctoral students.

Collaboration: DProfs promotes collaboration between HEIs and industries, which are key stakeholders in disaster resilience and management. The collaboration is further supported by facilitating cross-institutional supervisory teams and working-groups. Accordingly, it is expected to improve the quality and relevance of DProf programme through active cooperation between

HEIs and partners from outside academia, including construction professional bodies, local/national/international bodies and social partners.

Lifelong learning and continuous professional development: The DProf is intended to be a form of in-service professional development. Construction professionals will therefore benefit from the proposed professional doctoral programme, which will provide opportunities for learners to access lifelong, learning in increasing societal resilience to disasters. In overcoming the challenges of existing approaches of disaster management education, lifelong-learning has been identified as the most appropriate approach to educate construction professionals in the context of disaster resilience and management by the authors such Thayaparan et al. (2015) and Siriwardena et al. (2013). Therefore, developing an innovative professional doctorate will address the requirements for lifelong learning and will enhance not only academic knowledge, but also the concerns, capabilities and expectations of the relevant industries and communities. In turn, this will create the necessary intra Industry, Community and University feedback and feed-forward mechanisms to enable effective lifelong learning.

Customisable: In serving the needs of various stakeholders, it is proposed to develop a professional doctorate with a generic framework, which enables a wide range of professionals from the public, private and voluntary sectors to negotiate programmes that are customized to the needs of their own professions and organisations (Doncaster and Thorne, 2000) serving to reduce the risk of disasters. Accordingly, it is expected that all construction professionals serving all of stakeholder groups attached to disaster resilience and management will benefit from the developed programme.

6. Way forward

Development of the programme involves a substantial level of research activities to study and analyse market needs in order to capture the labour market requirements for disaster resilience and its interface with the construction industry and its professionals. Accordingly, the first phase of research involved, capturing the needs of 5 stakeholder groups associated in disaster resilience and management as well as current and emerging skills and ultimately competencies, applicable to built environment professionals towards enhancing societal resilience to disasters. Accordingly, 87 semi-structured interviews were conducted with national and local government organisations; community; NGOs, INGOs and other international agencies; academia and research organisations; and private sector. The interviews were aimed at capturing the needs as well as skills, applicable to built environment professionals towards enhancing societal resilience to disasters. Accordingly, a structured doctoral programme will be developed to cater the identified needs and skills. The programme will reflect how the construction sector and its professionals can contribute to achieving resilience in the case of increasing threats from natural and human induced hazards. The content of the DProf programme framework will generally attempt to include advanced discipline-based subject study with the relative proportions varying according to the needs that were identified through the market needs analysis; individual reflective professional development; research methodology training; and professional practice-based research projects.

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References

BOSHER, L., DAINTY, A., CARRILLO, P., GLASS AND, J. & PRICE, A. 2007. Integrating disaster risk management into construction: a UK perspective. *Building Research and Information*, 35**,** 163-177.

BOURNER, T., BOWDEN, R. & LAING, S. 2001. Professional Doctorates in England. *Studies in Higher Education,*, 26**,** 65-83.

CHANG, Y., WILKINSON, S., SEVILLE, E. & POTANGAROA, R. 2010. Resourcing for a resilient post- disaster reconstruction environment. *International Journal of Disaster Resilience in the Built Environment*, 1**,** 65-83.

CUTTER, S. L., BARNES, L., BERRY, M., BURTON, C., EVANS, E., TATE, E. & WEBB, J. 2008. A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, 18**,** 598-606.

DONCASTER, K. & THORNE, L. 2000. Reflection and Planning: Essential elements of professional doctorates. *Reflective Practice: International and Multidisciplinary Perspectives*, 1**,** 391-399.

GEORGIEVA, K. 2014. Disaster cost quadrupled in past decades. *Dailymail - mail online*, 5 June 2014.

KOT, F. C. & HENDEL, D. D. 2012. Emergence and growth of professional doctorates in the United States, United Kingdom, Canada and Australia: a comparative analysis. *Studies in Higher Education*, 37**,** 345-364.

MAX LOCK CENTRE 2009. The Built Environment Professions in Disaster Risk Reduction and Response - A guide for humanitarian agencies. Westminster, UK.

MAXWELL, T. 2003. From First to Second Generation Professional Doctorate. *Studies in Higher Education,*, 28**,** 279-291.

MCGRAW-HILL EDUCATION. 2014. *Appraising professional doctorates: what, who and why?* [Online]. Available: http://www.mheducation.co.uk/openup/chapters/9780335227211.pdf [Accessed 15 June 2015].

NEUMANN, R. 2005. Doctoral Differences: Professional doctorates and PhDs compared. *Journal of Higher Education Policy and Management*, 27**,** 173-188.

O'KEEFE, P., WESTGATE, K. & WISNER, B. 1976. Taking the naturalness out of natural disasters. *Nature*, 260**,** 566-567.

OECD. 2004. Lifelong learning. *OECD Policy Brief* [Online]. Available: http://www.oecd.org/dataoecd/17/11/29478789.pdf [Accessed 15 April 2015].

OFORI, G. 2004. Construction industry development for disaster prevention and response. Available: http://www.grif.umontreal.ca/pages/i-rec papers/ofori.pdf.

SIRIWARDENA, M., MALALGODA, C., THAYAPARAN, M., AMARATUNGA, D. & KERAMINIYAGE, K. 2013. Disaster resilient built environment: role of lifelong learning and the implications for higher education. *International Journal of Strategic Property Management*, 17**,** 174-187.

THAYAPARAN, M., SIRIWARDENA, M., MALALGODA, C. I., AMARATUNGA, D., LILL, I. & KAKLAUSKAS, A. 2015. Enhancing post-disaster reconstruction capacity through lifelong learning in higher education. *Disaster Prevention and Management: An International Journal*, 24**,** 338-354.

THE QUALITY ASSURANCE AGENCY FOR HIGHER EDUCATION 2011. Doctoral degree characteristics.

UKCGE 2002. Professional Doctorates UKCGE. Dudley, UK.
UNISDR 2015. Sendai Framework for Disaster Risk Reduction 2015 - 2030. Geneva, Switzerland: UNISDR.
WITT, E., BACH, C., LILL, I., PALLIYAGURU, R., PERDIKOU, S. & ÖZMEN, F. 2014. Determining Demand for Disaster Resilience Education through Capacity Analysis of European Public Authorities. *CIB INTERNATIONAL CONFERENCE 2014: W55/65/89/92/96/102/117 & TG72/74/81/83 Construction in a Changing World.* Kandalama, Sri Lanka.