UNISDR Science and Technical Advisory Group Report 2015

SCIENCE IS USED FOR DISASTER RISK REDUCTION

UNISDR
The United Nations Office for Disaster Risk Reduction

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Front cover image kindly provided by Bradley Ambrose showing the damage caused by the 2011 Christchurch earthquake, New Zealand.

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Foreword

During the negotiations for the Post-2015 Framework for Disaster Risk Reduction Member States have recognised the importance of science and technology to reduce disaster risk and requested to support the implementation of the priorities for action outlined in this new framework

Science and technology's continued advancements and research have allowed us to apply strategies and policy to mitigate risks and build resilience to natural and human-made disasters in ways that were unimaginable 20 years ago.

This broader, more comprehensive understanding of the global systems and interdependencies that contribute to disaster risk, has meant that governments and officials are able to base policy and procedural decisions on evidence. Whether through the use of newly developed software in a satellite that can be used to provide geographical information systems allowing farmers and land-managers the tools to prevent large scale crop damage during a drought, or the use of systematic reviews to inform humanitarian workers how best to prevent post-traumatic stress disorder in disaster victims or even through using complex weather forecasting models to influence planning decisions of officials who want to build a development in an area at risk of wildfires, scientific and technical knowledge has been and will remain vital to reducing those losses associated with disasters.

The importance of science and technology in better understanding the processes before, during and after disasters is becoming increasingly important. Climate change has meant that an increasing number of the world's population would be impacted by a climate-based disaster. Additionally, the economic costs continue to rise. Indeed, within an increasingly interconnected world, we have already started to see disaster events in Asia impacting the economies and livelihoods of countries and people in Europe, Africa or the Americas.

As with previous years, UNISDR has been fortunate to have the expertise and advice of the Science and Technical Advisory Group. Through the hard work of this group, we have seen the importance of science and technology, innovation, research, capacity development and knowledge/technology transfer discussed throughout the negotiations in the run up to the World Conference for Disaster Risk Reduction and the agreement of the post-2015 framework for disaster reduction.

Looking forward, this report discusses the role of science and technology in disaster risk reduction and management but also provides commitments on behalf of the science and technology communities to assist with the implementation of the Post-2015 Framework.

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Glossary

IPCC AR5	IPCC Fifth Assessment Report
CCA	Climate Change Agreements
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EC	European Commission
EU	European Union
GFDRR	Global Facility for Disaster Risk Reduction
HFA	Hyogo Framework for Action 2005 – 2015
HIV	Human Immunodeficiency Virus
ICSU	International Council of Science
IHR	International Health Regulations
IPCC	International Panel on Climate Change
IRDR	Integrated Research on Disaster Risk
MDGs	Millennium Development Goals
MGST	Major Group on Science and Technology
NGO	Non-Governmental Organisations
NRA	National Risk Assessments
OECD	Organisation for Economic Cooperation and Development
SDGs	Sustainable Development Goals
SREX	IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation
STAG	Scientific and Technical Advisory Group
UN	United Nations
UNGA	United Nations General Assembly
UNISDR	United Nations Office for Disaster Risk reduction
WCDRR	The Third World Conference on Disaster Risk Reduction – Sendai, March 2015
WHO	World Health Organisation

Executive Summary

The year 2015 presents an unparalleled opportunity to unify UN policy efforts through the convergence of three landmark UN frameworks: the post-2015 Framework for Disaster Risk Reduction (March 2015), The Sustainable Development Goals (September 2015) and the Climate Change Agreements (December 2015). There is an urgent need to align policy and efface institutional and financial barriers that obstruct the development of resilient communities and enable access to relevant knowledge, equitable participation and sustainable development.

Science and technology have shown that we can reduce or prevent the impact from disasters, and it is therefore the responsibility of Member States to work together with national and international policy and science and technology communities to work together in an effort to reduce disaster risk and prevent disasters where possible.

The UNISDR Scientific and Technical Advisory Group (STAG) and partners have been working to embed a broader approach to disasters which includes prevention, mitigation, preparedness, response and recovery. It is no longer sufficient to react once a disaster has occurred, because even if disasters are well managed, the mental and physical impacts on the survivors, broader society and the economy can be devastating and felt over the long term. With disasters increasing in frequency and severity, the International Panel on Climate Change Assessment Report 5 (2014) recognised the urgent need to focus on sustainable development.

Throughout the post-2015 Framework for Disaster Risk Reduction negotiations and discussions process, the STAG and the Major Group on Science and Technology in partnership with Regional and Global Platforms have identified priority areas for action. This supportive work has been met with an overwhelming call by Member States to actively strengthen the relationship between science, technology, innovation, knowledge development and research to assist in informing policy making and practice. While there are many challenges including the complexity of the risks associated with disasters, terminology that is diverse and often overlapping, the difficulty in prioritisation of targets and issues in aligning global, national and local indicators there is a clear case for the continuing uptake and integration of science into practice to deliver more effective policies that truly benefit human societies and their ecosystem.

While political leadership and community partnerships are required for the successful implementation of effective, science-informed initiatives, the research community has a responsibility to formulate applicable methodologies and tools that respond to real-word challenges. These are often fast-changing and communities that need them have limited resources to respond. Ensuring that research addresses the full cycle of prevention, mitigation, preparedness, response and recovery for those who need it the most is key, while national and international partnerships and networks can ensure the dissemination and sharing of good practice and scientific findings.

To assist this process the STAG has endeavoured, through the process of writing this report, Science is Used for Disaster Risk Reduction, and the publications of case studies to create a repository of good practice on the integration of science and technology into disaster risk reduction.

The repository has gathered applicable case studies through inviting scientists and professionals of all disciplines around the world to demonstrate how technology and science can improve areas such as early warning systems, safer building practices, more relevant education and a greater emphasis on communication and community engagement. We asked partners contributing case studies to explain the problem they were trying to address in reducing disaster risk, how they used science to inform an initiative or policy and whether this made a difference.

As with their predecessors in 2013, the case studies included within this report and on the website identified some common themes for success including more inclusive community participation in the development of science-informed initiatives, clear leadership and high-level commitment to implement and sustain interventions in the long term.

The science and technology communities have stated, through voluntary commitments formulated for the Third UN World Conference on Disaster Risk Reduction, a wish to strengthen the dialogue and collaboration with policy-makers and disaster risk reduction (DRR) practitioners at local, national, regional and global levels to identify needs and knowledge gaps, co-design, co-produce and co-deliver new knowledge, and make science more readily available and accessible. In order to achieve this, science and technology communities and networks will mobilise and strengthen existing capacities and initiatives to support the implementation of the post-2015 framework for DRR from the local to the global scale, and in particular deliver outputs in the following six areas:

(1) Assessment of the current state of data, scientific knowledge and technical availability on disaster risks and resilience (what is known, what is needed, what are the uncertainties, etc.);

(2) Synthesis of scientific evidence in a timely, accessible and policy-relevant manner;

(3) Scientific advice to decision-makers through close collaboration and dialogue to identify knowledge needs including at national and local levels, and review policy options based on scientific evidence; and

(4) Monitoring and review to ensure that new and up-to-date scientific information is used in data collection and monitoring progress towards disaster risk reduction and resilience building.

In addition, two cross-cutting capabilities need to be strengthened:

(5) Communication and engagement among policy-makers, stakeholders in all sectors and in the science and technology domains themselves to ensure useful knowledge is identified and needs are met, and scientists are better equipped to provide evidence and advice;

(6) Capacity development to ensure that all countries can produce, have access to and effectively use scientific information.

Scientific data and information and the tangible application of technology are critical to the development of well-informed policies and decisions across the public, private and voluntary sectors. Much scientific evidence exists but better links to decision-making in policy and planning are needed to continuously enhance our ability to forecast, reduce and respond to disaster risks thereby building resilience.

Science and technology can assist in identifying a problem, developing understanding from research, informing policy and practice and making a difference that can be objectively demonstrated when evaluated. In strengthening the resilience of DRR policies, initiatives and the DRR community, the following recommendations are made:

The post-2015 Framework for Disaster Risk Reduction negotiations and process discussions as well as the UNISDR STAG and the Major Group on Science and Technology in partnership with the Regional and Global platforms identified priority areas for action. The following recommendations are made to help strengthen DRR policies and practices:

1. Share knowledge for action

Greater priority should be put on sharing and disseminating scientific information, including technological advances and translating them into practical methods that can readily be integrated into policies, regulations and implementation plans concerning disaster risk reduction. Cross-disciplinary exchange will identify interdependencies which can help to identify findings for application to complex problems. Capacity development at all levels of society, comprehensive knowledge management and the involvement of science in public awareness-raising, media communication, behaviour change, and education campaigns should be strengthened.

Specific tools should be developed to facilitate science, technology and innovation outputs to help inform policy-making and practice. Additionally institutions and individuals at risk of disasters should be invited to participate in scientific research (surveys, vulnerability assessments and other activities) to collect local knowledge and create reliable databases should be created and so that information can be used to tailor initiatives to the local context while enabling global comparisons and assessments.

2. Use a multidisciplinary approach to research

An all-hazard, risk-based, problem-solving, results-oriented approach should be used in DRR research to address the multifactorial and interdependent nature of the disaster risk chain and to identify relevant solutions and optimize the use of resources. Synergies with the climate change and sustainable development agenda should continue to be articulated and leveraged. This requires collaboration and communication across the scientific disciplines and technical fields, and with all stakeholders including representatives of governmental institutions, communities of policy making, scientific and technical specialists, the technology sector and members of the communities at risk to guide scientific research, set research agendas and support scientific education and training. The potential contribution of affected and vulnerable communities in generating research questions, and in performing research collaboratively or independently, should be valued and facilitated.

3. Build systems resilience through local, national, regional and international partnerships

Science and technology communities wish to strengthen the dialogue and collaboration with policy-makers and DRR practitioners at local, national, regional and global levels to identify needs and knowledge gaps, co-design, co-produce and co-deliver new knowledge, and make science more readily available and accessible. To this end, science and technology communities and networks will mobilise and strengthen existing capacities and initiatives, including national platforms/bodies, to support the implementation of the post-2015 framework for DRR from the local to the global scale, and in particular deliver outputs.

1. Background: The need for a new framework

Over the last three decades, science and technology has been a catalyst in moving disaster science from a specialised technical discipline mainly focused on responding to emergency crises, to a broad-based global movement closely linked to disaster risk reduction (DRR), sustainable development and climate change. A turning point was the UN General Assembly's recognition of 'the importance of reducing the impact of natural disasters for all people, and in particular for developing countries', leading to the designation of the 1990s as a decade in which 'the international community, under the auspices of the United Nations, would pay special attention to fostering international co-operation in the field of natural disaster reduction'.[1]

In 2005, the Second World Conference on Disaster Reduction, in Kobe, Japan, adopted the Hyogo Framework for Action 2005-2015: Building the Resilience of Countries and Communities to Disasters (HFA).[2] HFA was the first multinational plan to set out the work that is required from all different sectors and actors to reduce losses in disasters. The plan was developed and agreed on with the multiple partners needed to reduce disaster risk - governments, international agencies, disaster experts, and many others—bringing them into a common system of coordination. HFA outlined the following five priorities for action:

1) Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation;

2) Identify, assess, and monitor disaster risks and enhance early warning;

3) Use knowledge, innovation, and education to build a culture of safety and resilience at all levels;

4) Reduce the underlying risk factors;

5) Strengthen disaster preparedness.

HFA succeeded in galvanizing many stakeholders including national and local governments, parliamentary fora, inter-governmental bodies, NGOs, commercial partners, academic/technical institutions, media and international organizations to form partnerships and networks,[3] and make commitments to improving governance at all levels, measuring progress and working towards policy coherence internationally with the sustainable development agenda.[4] Ban Ki-Moon, the United Nations Secretary General commenting on the Hyogo Framework for Action stated "Many thousands of people are alive today thanks to better early warning systems, improved weather forecasting, better education on risk and a greater understanding of the dangers posed by natural hazards." For many, this meant new ways of working, both within their institutions and with each other. HFA also helped to catalyze new national legislation, regional agreements, and strengthened preparedness and response. UNISDR has been monitoring the implementation of the HFA,[5] through the national, regional and local HFA Monitor tools and reports of the UN Secretary General Office. The latter includes the 2014 report[6] which refers to a review of ten years of implementation of the HFA. Of significance, HFA contributed to promoting convergence between global policy frameworks by helping to link disaster risk reduction to climate risk management and adaptation with the IPCC/SREX 2012 [7] recognizing that DRR measures like good land use planning, environmental protection, preparedness and early warning systems are effective actions to adapt to climate change.

However, there are persistent challenges around implementation, including earmarking budgets for DRR in countries, addressing deeply rooted underlying causes of vulnerability as well as firmly embedding science and technology into policy.[3] As the post-2015 framework on disaster risk reduction has developed, the need for a more integrative DRR process incorporating bottom-up and top-down actions, local scientific and technical knowledge, and a vast array of stakeholders has been emphasised.[8]

HFA clearly suggested that successful disaster resilience requires scientific and technical capacities with inputs from physical, social, economic, health and engineering disciplines. It has become increasingly apparent that it is vital to produce information, knowledge and

C. Disaster Risk Reduction is the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. *UNISDR Terminology and Disaster Risk Reduction (Geneva, 2009).*

Case study 1

Preventing Post-Traumatic Stress Disorder after the Indian Ocean Tsunami: Using reliable and timely evidence

Image 1 Tsunami damage in Nagapattinam district, Tamil Nadu, India (Image source: Prathap Tharyan)

The Indian Ocean Tsunami claimed over 227,000 lives, people and affected the lives of approximately 5 million more. Psychological impacts in disasters are common. Using evidence collected during a systematic review, public health officials were able to develop an initiative called 'Evidence Aid' which provides evidence to support public health professions

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_preventingposttraumaticstress-disord.pdf

solutions in DRR inclusively with practitioners and local stakeholders, as well as scientists. The critical role and value of scientific information and technology for successful DRR and resilience has long been recognised by the international community with the previous STAG report (2013) highlighting a series of ten case studies where science, technology and innovation have been successfully used and communicated for disaster risk reduction and management. In addition, innovations in methods, tools and analyses have made significant leaps in finding solutions, and more data are becoming widely accessible (see Global Assessment Reports 2009, 2011, 2013).

The 2013 STAG report Chair's summary called for an increased visibility of evidence based on science and its role in reducing the risks associated with disasters.[9] Indeed, since the publication of the 2013 STAG report, STAG and its partners have been attending many scientific and technical meetings,[10,11,12,13] National Platforms on DRR, Regional Platform for DRR (annex 1), and the Third World Conference on Disaster Risk Reduction Preparatory Committees (PrepCom) and negotiations in order to achieve that goal. Ensuring close communication and knowledge sharing with partners has allowed the work of STAG to be developed, debated and where relevant promoted in various meetings and locations. This collaborative working process has meant an increasing role in regional platforms for STAG (annex 1). Along with participation in meetings and a greater level of engagement with partners, the group has also been publishing reports and articles on the subject, and in 2013, sent out a call for further case studies from experts and academics in the field of DRR to highlight examples of science and technology contributing positively to reducing risk. The group has remained active in many UNISDR, WHO, WMO, UNDP and other UN fora and contributed to their reports, including the 2014 IPCC Fifth Assessment Report and the UNISDR 2015 Global Assessment Report (GAR). 14

There is a call for a new framework for DRR to draw more heavily on scientific and technological research, as stated in the draft post-2015 framework for disaster risk reduction that is to be presented at the UN Third World Conference on Disaster Risk Reduction (WCDRR). The new framework should enable critical public policies that are informed by evidence from science and tools from technology to address disaster risk in publically owned, managed or regulated organizations and infrastructures, as well as support actions by households, communities, businesses and individuals. In these different domains, the priority areas should include public policies in prospective and anticipatory disaster risk management (risk prevention), corrective risk management (risk reduction - including mitigation, preparedness, response and recovery / rehabilitation) and synergistic actions across policy domains and, finally, monitoring frameworks to follow implementation.

In summary, there are at least three arguments for producing a new, post-2015 framework for Disaster Risk Reduction which are: a) that the year 2015 is an opportunity to enhance global policy convergence, coherence and synergy; b) that there is an increase in disaster losses and frequency of disasters; and c) there is an opportunity for closing the policy-science gap through science that is useful, usable and used. These are discussed below.

a) The year 2015 is an opportunity to enhance global policy convergence, coherence and synergy

This year - 2015 - presents an unparalleled opportunity to align landmark UN agreements through the convergence of three global policy frameworks: the post-2015 Framework for Disaster Risk Reduction (March 2015), The Sustainable Development Goals (September 2015; SDGs) and the Climate Change Agreements (December 2015: COP21). These major global policy instruments need to align urgently to facilitate and encourage better participation in disaster risk reduction (DRR), sustainable development and climate-change mitigation and adaptation from the science and technology communities. These processes should urgently identify and enhance synergies and be aligned with the full cycle of prevention, mitigation, preparedness, recovery, rehabilitation and response related to disasters and other potential global emergencies. Scientific developments have been vital in shaping the current policy agenda supporting recommendations to achieve ever stronger integration between policies on the one hand and science and technology on the other in DRR for the benefit of societies everywhere. There are opportunities to emphasise cross-cutting themes, including the importance of science, across the different global policy agendas and to build on the tradition of evidence-based decision-making.

b) Disaster losses and frequency are increasing

Disasters destroy lives and livelihoods around the world. Between 2000 and 2012, it is estimated that over 700 thousand people lost their lives, over 1.4 million were injured, and around 23 million were made homeless as a result of disasters. Overall, more than 1.5 billion people were affected by disasters in various ways. Women, children and vulnerable groups were disproportionately affected. The total economic loss was more than $1.3 trillion. Disaster impacts also set back hard-won development gains and affect all institutions, sectors, and socioeconomic strata of society in one way or another. In addition, between 2008 and 2012, 144 million people were displaced by disasters and in 2012 an estimated 32.4 million people in 82 countries were newly displaced by disasters.[9] The damages have significant short and long term consequences for the survival, dignity and livelihood of individuals and communities and have a disproportionate impact on the poor.

The 2004 Indian Ocean earthquake and tsunami event was historically unprecedented in scale (see case study 1). It illustrated the vulnerability of multiple countries and communities to natural hazards that arise in distant locations. However, this event also spurred the global community to adopt the HFA, and identify the global priorities for work and practical steps that are required to achieve disaster resilience. Indeed, over the past ten years, the implementation of HFA has been urged on by other external events, such as Hurricane Katrina, which served to remind society of the terrible consequences of limited planning and preparedness. Other examples include the 2011 Tohoku earthquake and tsunami and 2013 Typhoon Haiyan, as well as the severe 2011 floods in Thailand which hampered the Japanese car industry and the global computer industry for a significant period. [15]The impact of these transboundary events which extend vulnerability and exposure beyond national and physical borders cannot be underestimated and they appear to be occurring more frequently, with both increased human and financial costs.

Disasters are not natural events. They are endogenous to society and disaster risk arises when hazards interact with the physical, social, economic and environmental vulnerabilities and exposure of populations.[16] The majority of destructive hazards are natural in origin and include earthquakes and extreme weather events resulting in floods and drought. However, the Intergovernmental Panel on Climate Change (IPCC) clearly demonstrated that there is much that can be done to reduce the severity and frequency of extreme weather events caused by anthropogenic climate change through implementing sustainable development practices that aim to protect our environment and concomitantly improve human health and wellbeing.[17] Of note, the frequency of major earthquakes has not increased over time, but earthquake disasters have risen due to increased vulnerability and exposure of populations.[28,18]

c) The policy-science gap can be closed with science that is useful, usable and used

While scientific studies document a trend of increasing disaster losses, unsatisfactory translation of research findings into practical actions remains a barrier and prevents the best use of science, technology and innovation.[19] There remains a recognised need for science

Case study 2

The seismic alert system in Mexico City: an example of a successful Early Warning System (EWS)

Image 2 Distribution of sensing stations used in the Mexican Seismic Alert System (Image source: CIRES, Mexico)

The time period between the first observations of a seismic event to the point where damage and injuries and/ or fatalities occur is vitally important. This system uses a series of over 100 sensors throughout Southern Mexico to provide real-time measurements of seismic activity. This system has so far been used in a total of 34 public alerts and 72 preventative warnings from a total of 2,200 earthquakes detected. It has only been used once prematurely and this was during the development stage of the system.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_suarezandgarciaacosta.pdf (and scientists) to provide and communicate actionable knowledge with explicit links to inform effective decision making, in other words: science that is useful, usable and used. [20]

Countries and other major stakeholders have identified a range of science and technology related needs, throughout the preparatory process for the post-2015 DRR framework for achieving resilience, transformation and implementation of the post-2015 DRR framework. A number of key political statements from the UN Office for Disaster Risk Reduction (UNISDR) have echoed the STAG's concern that science and technology and innovation activities are not sufficiently used and integrated into DRR policy. For example, UNISDR's Global Platform in May 2013 issued four recommendations to the international community to:

(1) Encourage science to demonstrate that it can inform policy and practice,

(2) Use a problem-solving approach to research that integrates all hazards and disciplines,

(3) Promote knowledge into action, and;

(4) Regard science as the key to the post-2015 framework for DRR.

Current priorities for the post-2015 framework on disaster risk reduction include ensuring that disaster risk reduction is an international, national and a local priority with a strong institutional basis for implementation and to identify, assess and monitor disaster risks and enhance early warning. To do so, access to interdisciplinary scientific inputs, as well as technological processes, must be in place for all actors, with consideration given to feasibility, local relevance, global scale, cultural factors and the concerns of vulnerable groups including women, children, the elderly, indigenous groups and those with disability or illness whether mental or physical. Widespread support has been given to the enhancement of science and technology use in the process so far.

As illustrated by several of the Case Studies, science and technology can play an essential role in innovation by uncovering new and improved ways to prevent, mitigate, prepare for, respond to and recover from disasters. Science and technology are already helping to save lives and livelihoods in a number of innovative ways including: programmes to forecast floods, providing data on the impact of floods and droughts on crop yields [21], detect tsunami waves, prevent infectious disease outbreaks through vaccination, effectively communicating disaster risk to enhance community resilience and utilising earth observations and imagery for rapid damage assessment, as well as reducing harmful gas emissions that affect the environment. In addition, science can help to evaluate which technologies are most effective in reducing disaster risk and benefiting people and their communities as has been explored in Mexico City's use of technology in developing seismic early warning systems (case study 2). Policies that are formulated based on scientific evidence can play an essential role in these efforts by determining disaster risk and thereby uncovering improved ways to prevent, mitigate, prepare for, recover from and respond to disasters.[23]

GRF Davos, on behalf of the UNISDR STAG, initiated a survey in 2013-2014 amongst Disaster Risk Reduction platforms and networks.[24] The survey responses from 26 UNISDR DRR Thematic Platforms and networks showed the development and promotion of various concepts, methodologies, practices and tools. Topics covered field investigation tools, the development and promotion of different indicators and the use of platform monitoring practices. Information on educational materials and policies were requested including details on the technical and financial support for the implementation and training of professionals. Data on raising awareness with the wider public and relevant governmental institutions focused on disaster risk management issues were also sought.

Other major achievements found as a result of this survey included the strengthening of intergovernmental and intersectoral work, as well as advocacy and policy recommendations. The survey also showed that several platforms and networks have implemented better data collection facilities, including open data centres, crowdsourcing activities, real time data analysis and conferences to foster the sharing of information. The survey allowed STAG to get a deeper insight into the structure and mechanisms of the platforms and networks and to begin to develop strategies on how to make better use of these resources in supporting the UNISDR systems work and to consider whether DRR activities are strengthened through a greater connectivity of existing networks.

Along with other recent science conferences, of note are the outcomes of the Tokyo Conference on International Study for Disaster Risk Reduction and Resilience held in January 2015 which called for policymakers to empower their national DRR platforms through greater engagement with science and technology and by moving towards evidence-based DRR to support sustainable development.

2. Selected topics of current policy concern and scientific interest

DRR activities aim to reduce the human, environmental and economic costs of disasters. As illustrated by the Climate Futures for Tasmania project (case study 3), the approach of DRR has evolved over the years from the 'management'[25] of disasters to a more pro-active and systemic risk reduction strategy that seeks to minimize vulnerability in a society by systematically avoiding (preventing) and limiting the adverse impacts of hazards (preparedness and mitigation), working within the broad context of sustainable development.[19] Currently, the field of DRR widens the activities remit beyond simply responding to disasters, to detailed risk assessment, improving early warning and response capacities, impact based forecasting, better resource management, knowledge-creation and sharing, building public commitment (as shown in Timor-Leste with the sharing of data with local communities, discussed in case study 3) and developing supportive institution-

Case study 3

Integrating scientific and local knowledge for disaster risk reduction and climate change adaptation in Timor-Leste

Image 3 Reforestation in Timor-Leste for disaster risk reduction and climate change adaptation. (Image source: Tim Herbert, Oxfam Australia)

Using advanced, high quality data, an international NGO has developed resources to allow the sharing of information between climate scientists & the local population. This guidance has been utilised by multiple NGOs and other relevant organisations currently working in the country. Issues surrounding DRR & climate change are now routinely included at a National Government level.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_mercertimorleste.pdf

Case study 4

Building climate resilience to reduce disasters across Tasmania, Australia

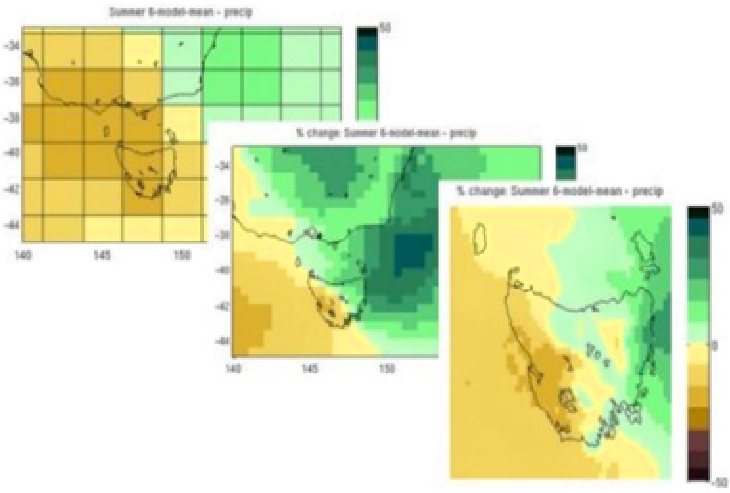

Image 4 Climate Futures for Tasmania, climate modelling steps (Image source: Climate Futures for Tasmania)

Using advanced, high quality data, the 'climate futures for Tasmania' project is now able to provide detailed information to relevant audiences. In addition, it has also allowed for a more comprehensive understanding of the risks associated by a changing climate for planners and policy officials

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_tasmaniaheat.pdf

al frameworks. However, challenges remain in risk governance and assessment as well as monitoring, dissemination, capacity development and shifting the culture from a hazard and response-driven culture to a risk-driven, integrated culture that encompasses the full DRR cycle from prevention to recovery and rehabilitation. [27]

On the positive side, there are many scientific areas where notable progress has been made in furthering our understanding of disaster risk reduction. For example, we now have a much deeper insight into the role of vulnerability, health and climate change and the way they are interlinked and interact. This greater understanding of the complex web of relationships between traditionally separate areas of policy and practice, including the creation of knowledge, values and meaning that inform action, [28] drives the need for a new, updated and more sophisticated Disaster Risk Reduction framework that reflects progress in science, technology and the understanding of human and population behaviour and is therefore able to meet the needs of societies around the world to live a resilient and healthy life in the face of new and/or growing global challenges[29].

2.1. Hazards, risks and vulnerabilities in resilience building

Risks comprise many facets including hazards, the vulnerabilities of exposed people (and their property as with properties at risk of changes in the climate in Tasmania discussed in case study 4) to hazards and the coping capacities and resources available to man-

Case study 5

Integrating Risk Assessment in Land-Use Planning – Mohéli (Comoros)

Image 5 Software R&D-Territoire for in-field data acquisition (assets, roads, risks) – Very high resolution Drone images, and Digital elevation models (Mohéli)

Using high-resolution aerial images (less than 10 cm on the ground), the Comoros Islands project was able to identify hazard zones and other areas of potential risk, identifying the most vulnerable neighbourhoods & providing policy guidance and research for those in charge of land-planning. This information has now been used to develop general guidelines and proven methodology for the integration of risk assessments in planning documents.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_leroiriskassessment.pdf

age the related risks. While the attention in DRR may naturally fall on the hazards and the related physical processes, it is often not the hazard that determines a disaster, but the vulnerability and social limitation of the population to anticipate, respond to and recover from its effects. A shift from pure hazard analysis to the identification, assessment and ranking of vulnerabilities and risks is crucial.[30] In addition, understanding how people interpret risks and make decisions based on their interpretation is vital to any strategy for disaster risk reduction.[31]

Another area of policy and research importance in DRR is addressing the unequal distribution of risk in populations. Human vulnerability entails a complex mix of issues that includes social, economic, ecological, health and cultural factors, which affect the level of exposure to a hazard and vulnerability of communities, groups and individuals.[32] Vulnerability may be related to inequalities and social exclusion, often linked to conflict and displacement (see case study 5 which highlights the vulnerabilities of refugee communities), low income; single-parenting; age (the young and older people); gender; ethnicity, chronic illness and disability.[33] It is the interaction between the hazards to which communities and individuals are exposed and the vulnerabilities and capacities of that community that will determine the ultimate extent of the disaster.

A corollary of risk is the notion of resilience which is a multidimensional concept defined as the ability of a system, community or society exposed to hazards to resist, absorb, adapt 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.[25] Within the context of increased exposure to hazards and their impacts, resilience thinking has emerged as a key issue for the framework and policies. An example is the shift from an approach to flooding risk reduction that is purely engineering-based towards a more holistic approach illustrated by the Dutch Room for the River project.[34] While conservative interpretations of resilience emphasise self-reliance and the ability of a place to recover in the aftermath of a major shock, a more progressive view is to consider resilience in terms of adaptability and transformability to not only recover but also to reduce exposure to future risks. The implication is that social systems (through individual or collective agency and with the assistance of science and technology) can adapt to or search for and develop alternative economic and social development trajectories.[35]

Understanding the complexity of disaster risk in the 21st century calls for closer collaboration among the international science community in order to gain deeper knowledge of the highly interdependent and evolving risks we are exposed to and develop usable tools for assessing and forecasting multiple hazards (), disaster concatenated consequences and compound risk, for example through impact based forecasting,[36] or through the integration of land-use planning and risk assessments as highlighted in illustrated in case study 5.

2.2. Risk assessment and critical infrastructures

In an increasingly complex and interdependent society, emergencies can have increasingly multifaceted and wide ranging effects as discussed above. Risk assessment guides the optimal allocation of scarce resources available to DRR. By identifying and assessing the likelihood and consequences of potentially disastrous events, risk assessment provides governments with a basis for prioritisation of disaster risk reduction activities, the improvement of emergency management capabilities and the design of protection strategies to meet local conditions, needs and preferences.[37] The Intergovernmental Panel on Climate Change (IPCC) Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX), describes how the balance between reducing risk and other disaster risk management strategies is influenced by a range of factors, including the financial and technical capacities of stakeholders, the robustness of the risk assessment information, and cultural elements affecting risk tolerance.

The results of risk assessments may also be used to inform and educate all relevant stakeholders about the most important threats society faces and thereby contribute to developing an informed culture of risk amongst communities and individuals. Risk assessment is thus an essential prerequisite for a full and comprehensive array of DRR plans and policies that contribute to the overarching governmental objective of reducing society's vulnerability and enhancing its resilience. By using a comprehensive all-hazards approach to risk assessment, with definitions of core terms and a transparent methodology, it is possible to identify underlying drivers and uncertainties. Key to ensuring useful planning information is the understanding that it is not the risks themselves that people have to deal with when things go wrong, but their consequences.

Recognizing that most countries continue to have difficulties integrating risk reduction into public investment planning, urban development, spatial planning and management, and social protection, the European Commission (EC) has promoted the use of risk assessment and analysis.[38] An EC report stated that data derived from past losses are useful for the implementation of disaster risk reduction strategies in Europe (from local to national scales) and can help understand wider disaster loss trends at the European level (the Seveso Directive case study 6 examines this) and the global level.[39] The report emphasized that risk modelling is a valuable tool for improving risk assessment and forecasting methods, but loss datasets are needed for calibrating and validating model results, in particular to infer vulnerabilities.

By building on the available national risk assessments, the EC has prepared the first cross-sectoral overview of risks in the EU, taking into account (where possible and relevant) the future impact of climate change and the need for climate adaptation. Following a consistent approach, multi-hazard national risk assessments are to be produced by Member States by the end of 2015 and followed up by an assessment of national risk management capabilities and improved risk management planning.[40] The EC reported that of the 32 countries participating in the Mechanism for Civil Protection, 18 contributed to the review through their national risk assessments (NRAs).[41] Of these, nine Member States provided information on their national assessment criteria and scenario-building. The EC concluded that more systematic and complete information on the assessment criteria and on the risk scenarios assessed may help the Commission carry out an informed and coherent analysis of risks addressed in NRAs (European Commission 2014b).

Case study 6

Prevention of diarrhoea in disasters, refugee camps and developing countries

Image 6 Woman carrying clean water provided through an NGO (Image source: Red Cross)

A systematic review by the Cochrane Collaboration identified that hand-washing can reduce instances of diarrhoea of those in refugee camps by around 30%. This review has been used by at least one major NGO to train & update local volunteers.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_preventingposttraumaticstressdisord.pdf

The role of critical infrastructure as the set of systems upon which society relies to function is becoming increasingly clear. Critical infrastructure can be defined as those physical facilities, supply chains, information technologies and communication networks which, if destroyed, degraded or rendered unavailable for an extended period, would significantly impact on the social or economic wellbeing of communities.[43] Critical infrastructure includes communications, emergency services (such as police, fire and ambulance services), energy, finance, food chain, government services, transport, water and health (including those critical infrastructure resources impacted by war, as illustrated in case study 7 which focuses on the conflict in Darfur),[43] In summary, critical infrastructure is an essential network or supply chain, which constitutes the physical infrastructure as well as the material/information/goods that are required for a functioning system. This approach recognizes that many critical infrastructure systems are vulnerable to a wide range of risks - natural and technological - and that failures in one element of a system can compromise the entire system, or even another system that relies upon it.

For instance, a failure within the communications system can cause disruption to the financial system, and failure within the water system may cause disruption to the food supply.[44] Similarly, the loss of water supply could increase the risk of a diarrhoea outbreaks due to falling hygiene standards (see case study 8). An electric power outage may compromise all of these systems. Increasing interconnectedness has led to greater efficiency and greater functionality, but it has also resulted in greater dependencies, and hence, a higher likelihood that single-points of failure lead to system failure and, in turn, to disas-

Case study 7
Predicting gaps in health service availability in Darfur

Image 7 A hospital in Darfur in 2004 (image source: WHO)

In 2009, the humanitarian workforce in Darfur was treating upwards of 1.1million people with health services across the region. Following the expulsion of all NGO health workers, the World Health Organisation piloted use of the Health Resources Availability Mapping System (HeRAMS). This identified gaps in health services and allowed the Sudan government to provide additional funding.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_ocdarfurhealthservicemonitoring.pdf

ter. Thus, it is important that we commit science and technology resources to understanding and managing the complexity of critical infrastructure systems, as well as safeguarding against the social and economic consequences of disruptions in building a resilient society.

2.3. Convergence, coherence and synergy of global policy frameworks

In 2005, the 2nd World Conference on Disaster Reduction adopted the Hyogo Framework for Action 2005-2015: Building the Resilience of Countries and Communities to Disasters (HFA) in Kobe, Japan. The HFA was the first plan to explain, describe and detail the work that is required from all different sectors and actors to reduce disaster losses. It was developed and agreed on with the many partners needed to reduce disaster risk - governments, international agencies, disaster experts and many others - bringing them into a common system of coordination.[45] There are obvious synergies between the two other UN landmark agreements planned for 2015 - on climate change and sustainable development - which can be emphasised and strengthened to promote policy coherence and facilitate convergence of objectives in implementation.[46]

a) Sustainable development, population wellbeing and DRR

DRR activities are wide and aim to reduce the impact from disasters on societies that affect population wellbeing in terms of economic and social development including loss of life, injury, mental health effects, property damage, loss of livelihoods and services, or environmental damage. Using scientific evidence to inform policy priorities and formulate effective initiatives and interventions is as crucial to DRR as it has been to reducing the impact of diseases and epidemics on population health outcomes including HIV and maternal and child mortality around the world.[47] To build knowledge that can be useful and usable in the broad and complex landscape that links environmental and societal impacts to population health, scientific endeavours should be considered in their widest sense to include the natural, environmental, social, economic, population health and engineering sciences. Scientific capacities should be interpreted broadly to include all relevant resources and skills of a scientific and technical nature that can reduce the impact of disaster hazards on populations and the environment.[48]

Old and emerging environmental, infectious and social risks related to urbanisation and globalisation threaten health security locally, nationally and globally. These risks include disastrous floods, cyclones, earthquakes and droughts around the world, and the Ebola outbreak of 2014. Further, these risks are compounded by uneven economic development, which exacerbates inequality and rapid urbanisation and results in the spread of infectious and non-communicable diseases which can overburden already stretched local public health systems.[49] The overall focus of disaster risk management, therefore, has to shift from shielding social and economic development against what are seen as external events and shocks, to one of transforming development in order to accept and manage risks, as well as to strengthen resilience, thereby ensuring development that is sustainable.

An emerging approach to public health emergency preparedness and response, community resilience encompasses individual preparedness as well as establishing a supportive social context in communities to withstand and recover from disasters and incorporate equity and social justice considerations in preparedness planning and response.[50] Building resilience of communities and countries using this approach is characterised by multisectoral work and international partnership and includes, and goes beyond the guarantee of safe, functioning hospitals.[51] This partnership approach is illustrated by the work behind the heatwave plan to reduce human health impacts of heatwaves in Europe (case study 9).

Improved population health/wellbeing is a clear co-benefit of addressing climate change, disaster risk and sustainable development and constitutes a convergence point in these global frameworks. Population health/wellbeing constitutes human capital in sustainable development as well as being a desirable outcome in its own right.[52] It strengthens resilience to shocks and is a critical element to sustainable development: improving health leads to economic development which usually leads to improvements in health. Furthermore, population health levels and whether health is fairly distributed in society is a good barometer of societal functioning.[53] Health is also one of the main human vulnerabilities in disasters (including climate change related disasters), and can be seriously and irremediably damaged by them.

Important synergies exist between the proposed SDGs and the post-2015 framework targets and indicators. Population health and wellbeing outcomes have been identified explicitly within the SDGs, but these cannot be achieved without managing those risks that are so closely associated with disasters. There is also explicit mention of resilience-building and DRR in the proposed SDG targets. However, a stronger alignment could be made with the five proposed targets and indicators for the post-2015 framework.

The sustainability of development and resilience of populations, nations and the environment depends on sound disaster risk management and governance, which should guide and foster private and public planning and investments. It extends beyond the reduction of existing and familiar risk and includes the prevention, mitigation and adaptation of new and evolving risks. Reflecting this approach, a number of UN bodies representing the diversity of stakeholders in the post-2015 process (including Major Groups and Global Platforms) have highlighted the importance of planning and urbanisation, through the use of science and technology, to create healthy, sustainable cities which minimise vulnerability and maximise resilience to existing and future risks.

b) Climate change and DRR

Warming of our planetary climate is now unequivocal and it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century. Much of the scientific evidence comes from work conducted by the International Panel on Climate Change (IPCC), such as the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX).

Case study 8
Disaster Risk Reduction: plans to reduce human health impacts from heatwaves

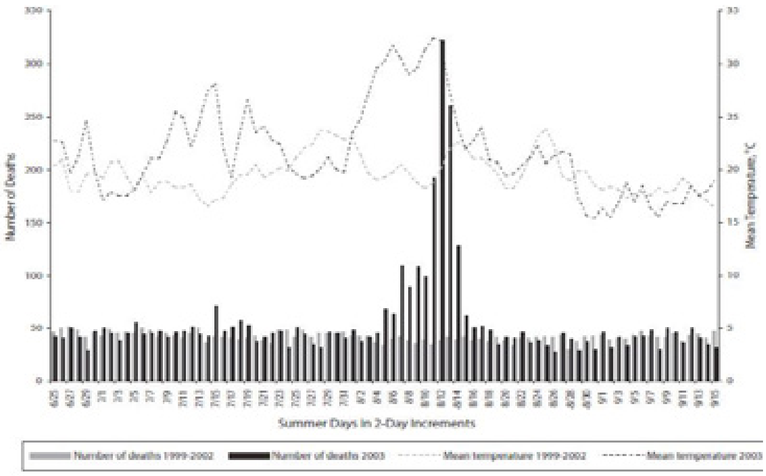

Image 8 Comparison of daily mortality rate and mean temperature in Paris, France *(Image source: Vandentorren, Suzan et al. 2004)*

Using historical heatwave data, scientists have been able to identify possible impacts from an increasing frequency and severity of heatwave events. Using this data and research, policy makers within national governments have been able to introduce Heat Wave Warning Systems (HWWS), which along with plans to increase resilience, have shown reductions in mortality and morbidity.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_leonardiheatwavegl.pdf

The fifth IPCC Assessment Report (2014) highlighted the possibility of high-end climate scenarios, including warming by 4 to 7°C over much of the globe by the year 2100, which would lead to many critical ecological thresholds being crossed.[54] The report also concluded that even for lesser changes in temperature, climate change will result in an increase in the likelihood and/or severity of hydro-meteorological natural hazards. These hazards include floods, severe storm, wildfire, heat waves, and drought, further exacerbating the already increasing upward trend in mortality and economic impact due to increases in the size of populations, their exposure and their vulnerability.

Human loss of life and its converse saving lives and preserving health and wellbeing are not solely the preserve of the health sciences. Engineering, natural science (including the climate-based observations and modelling used to track storms as described in case study 10), social sciences, economics and behavioural sciences to name but a few all have a role in ensuring the individual, societal and environmental elements of our ecosystem exist in harmony. The publication of IPCC AR5 highlighted the urgency of mitigation and adaptation responses as well as the opportunities to link mitigation, adaptation and sustainable development through integrated responses. Successful implementation will depend on multidimensional policies and measures across multiple scales -international, regional, national and sub-national - and crucially, will require adequate support of the development, diffusion and transfer of technology.

Practical approaches in adaptation and disaster risk reduction should be developed in an intertwined process

Case study 9

Linking Weather Forecasts to Disaster Preparedness Insights from Cyclone Phailin, India

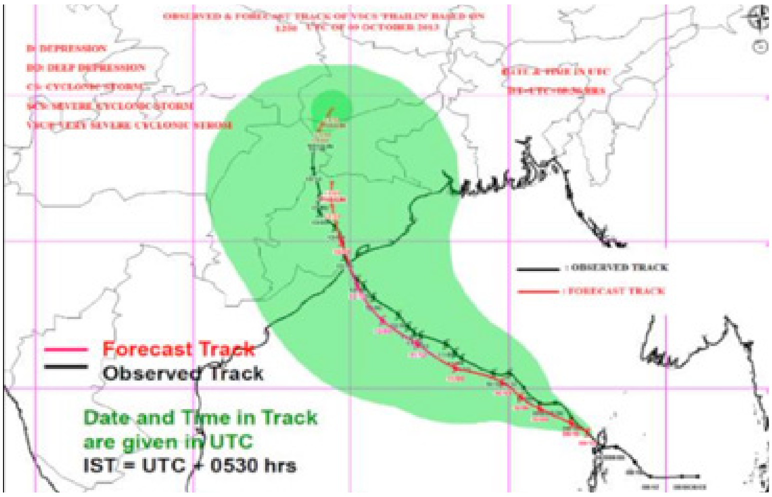

Image 8 Forecast Performance Verification of Cyclone Phailin. *(Image source: L. S. Rathore, 2014)*

To reduce the number of casualties and communities impacted by cyclones alone the Indian coast, the Indian Meteorological Department introduced real-time tracking of storms, including strength & projected path. Updates have helped policy officials and emergency planners to provide advance warning for coastal communities.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. Online Case Studies: Using Science for DRR. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_patraews.pdf

rather than in isolation, as outlined in the recommendations of the IPCC SREX and in the recently published IPPC AR5 summary for Policy makers[55] that are relevant for DRR and include the following findings:

- Integration of adaptation into planning, including policy design, and decision making can promote synergies with development and disaster risk reduction.
- Improving institutions as well as coordination and cooperation in governance can help overcome regional constraints associated with mitigation, adaptation, and disaster risk reduction
- Adaptation options exist in all sectors and regions, with diverse potential and approaches depending on their context in vulnerability reduction, disaster risk management or proactive adaptation planning
- Potential synergies between international finance for disaster risk management and adaptation have not yet been fully realized

2.4. Setting out the way forward: agreeing a common language

Science provides an evidence base that can be relevant to and therefore draw together different areas of policy. Knowledge integration provides a starting point for building and operationalizing resilience through the co-design of policies and interventions by scientists, practitioners, policy makers and communi-

Case study 10

Integrating community and observatory based monitoring to reduce risk at volcán Tungurahua, Ecuador

Image 10 Community groups (known as 'vigias') talk to scientists *(Image source: Stone, J. 2014)*

Lack of effective communication meant that local communities were reluctant to leave their properties when Volcan Tungurahua, Ecuador erupted. Researchers & scientists, using direct collaboration with local actors, involved locals with monitoring and reporting. Since the initiative was launched, communication & trust between the groups has improved along with an increased resilience.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_7935jstoneecuador.pdf

ties themselves (as illustrated by the communication strategy used with 'vigias' in Ecuador in case study 11). Standardised definitions are essential to the operationalization of concepts such as resilience for research, monitoring and implementation purposes. For example, in epidemiology, case ascertainment/definition is essential to accurately understanding the causal relationship between a disease exposure and its outcome.

Common understanding amongst all actors is essential for effective disaster risk reduction and management. With this goal in mind and after consultations with experts and partners, the UNISDR proposed a chapter on 'Terminology: Basic terms of disaster risk reduction' in 2002 included as Annex 1 of 'Living with Risk: A global review of disaster reduction initiatives'. On recommendations articulated in the feedback from specialists and practitioners, a second proposal was issued in the final publication of 'Living with Risk' (2004). [56]

The following year, the Hyogo Framework for Action 2005-2015 made a request to 'update and widely disseminate international terminology related to DRR, at least in all official United Nations languages, for the use in programme and institutional development, operations, research, training curricula and public information programme' (HFA, Priority for Action 3, paragraph (i) (g)).

Responding to this request, the UNISDR reviewed the terminology based on additional consultations with experts and practitioners in various interna-

Case study 11

Using multi-temporal satellite imagery to better understand the history of the Ab Barak land-slide and predict future landslides in the region

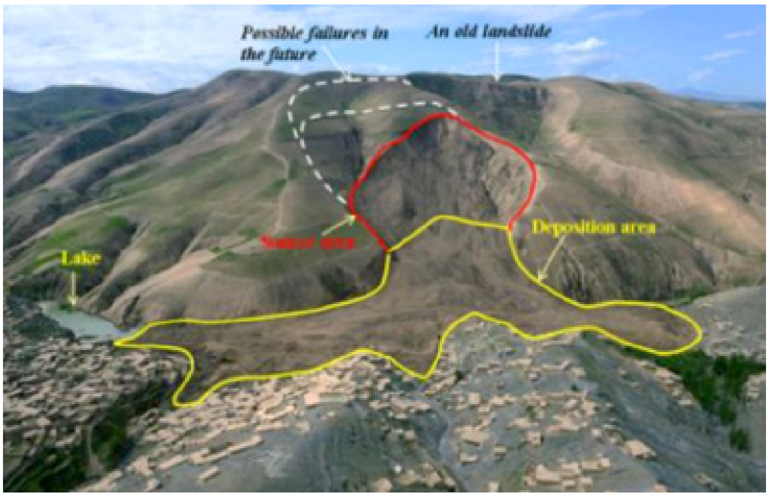

Image 11 An overview picture. There is an old landslide (with unknown age) next to the recent one, indicating that this region is prone to landslide hazards. The white dashed lines show the possible failure scarps in the future (Source and Copyright: The Atlantic)

Remote Sensing (RS) and Geographic Information System (GIS) technologies are useful tools for landslide mapping as well as understanding pre- and post-event situations. These techniques were applied to the Ab Barak landslide. Based on this research, local authorities have recognized from this case that RS and GIS are useful tools for investigating, emergent damage mapping and disaster management. In addition, local authorities agree that carrying out the preventive measures including early warning and landslide hazard mapping is the most cost effective way to reduce landslide risk in such a highly landslide prone area

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_xfanetal.pdf

tional fora, regional discussions and national settings. The revised terminology was published in 2009 and includes evolving practices and emerging concepts related to disaster risk reduction. This terminology was translated into the six UN languages and other languages prior to dissemination. (Available at: http://www.unisdr.org/we/inform/terminology).

Approaching towards 2015, the Joint Research Centre of the European Commission has been contributing to identifying the most common terms and definitions used in disaster risk reduction. This background information would provide a solid basis to continue updating the terminology and contribute to the implementation of the post-2015 framework on disaster risk reduction.

3. Science in DRR: from knowledge to policy and implementation

Requests have been growing from the regional DRR platforms for a more prominent and effective role for science and technology in providing evidence for DRR policy (Annex 1). Practical ways of achieving evidence-based policy in the post-2015 era include shared targets and indicators across frameworks, coordinated monitoring of progress, collaboration in sharing information and common financing mechanisms. A revitalised international partnership for evidence-based DRR could help to deliver this promise through the coordination of existing networks and scientific research institutions at all levels and all regions with the support of the UNISDR STAG.[23]

3.1. Challenges to and solutions for a more resilient science-policy-practice nexus

Many of the gaps and problems identified by countries can be considered products of the fundamental barriers at the science-policy-practice nexus resulting from the underuse or under-usability of science which can result from differing objectives, needs, and priorities, different institutional settings, as well as differing cultural values and understanding.[57] Providing partnerships for connecting the innovative solutions proposed by science and technology, with the expressed needs of users (e.g. policy makers and practitioners) would reduce duplication and redundancy in activities and result in more useful, context-appropriate policies.

Therefore, as in the model for collaborative work between local government and scientists discussed in case study 12, both policy and research programs and projects should be seen as learning opportunities as much as they are solutions to the increasingly complex problems faced in DRR. Evaluation of policy interventions using scientific principles should be built into policy initiatives to identify good practice that can be shared and scaled up, as well as pinpoint errors or unwanted consequences from policies that require policy change or disinvestment.[57] This approach can continually produce knowledge that allows for better-informed policy decisions. Recognised methods for international collaboration and capacity development must be developed and resourced to ensure access to identified best practice and proven scientific concepts.[58] It can help to promote a long-term multi-hazard approach and solution-driven research for disaster risk management to better address gaps, societal challenges and emerging risks and interdependencies.

Improved communication is another pillar for more robust and resilient science-policy-practice nexus. For example, complex messages emerging from new scientific and technological discoveries that are often inaccessible to policy makers and the public could be simplified; and in return, policy processes could embed greater flexibility, responsiveness and receptivity to new scientific understanding as it emerges and systematically share and incorporate learning from evaluations with the scientific and lay communities.[59]

Finally, the DRR community including policy makers and the science, technology and innovation communities must work with the uncertainty inherent in prediction and forecasting methodologies as well as the unpredictability of politically influenced policy processes to define acceptable error margins and risk tolerance alongside local communities. This is especially true for very infrequent hazards, as their uncertainty makes it difficult for users of forecasts - from farmers to government ministers - to act confidently on forecasts and early warnings. This should not preclude action under uncertainty altogether as large uncertainty does not automatically negate the benefits of mitigation or prevention measures and, furthermore, makes the case for preparedness, scenario modelling and community exercises (as illustrated by the EnRiCH system in Canada, see case study 13). Uncertainty and probability can be taken into account in planning and preparation but these must be informed by the best scientific information to provide the most robust estimates of the relationship between the probability/uncertainty of a hazard and its potential disastrous consequences. For example, the nuclear power industry has embraced the need to incorporate rigorous estimates of uncertainty in earthquake risk assessment for nuclear power plant design and safety regulation.[60]

3.2. Learning from the evidence-base movements: integrating science to deliver effective policy and practice

Case study 12

Integrated regulation to reduce wildfire risk in Australia

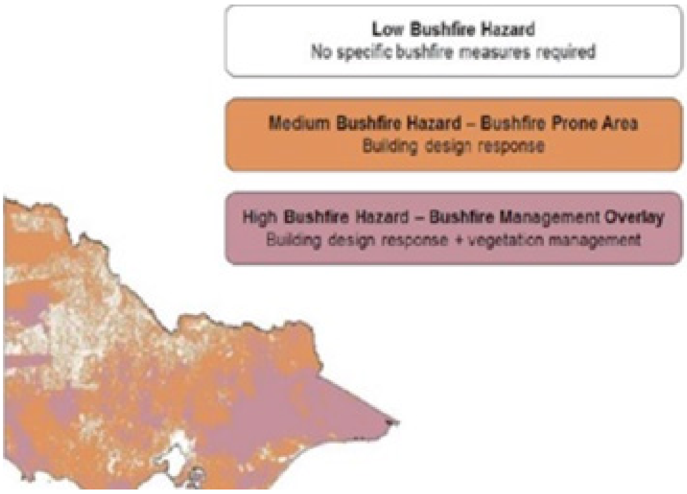

Image 12 Bushfire hazard level in Victoria, Australia *(Image source: Opie et al, 2014)*

Climate change has increased the chance of the conditions necessary for a wildfire (known locally as bushfires) to start. In addition, population growth in the region has meant housing developments in areas prone to wildfires. To recognise that risk, computer modelling systems are produced to provide fire planning information and a higher level of communication between emergency actors and communities.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. Online Case Studies: Using Science for DRR. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_march1austlwildfireera.pdf

Science clearly underpins much of health and population health practice and the evidence-based medicine and policy movements have grown over the last two decades in many parts of the world.[61, 62] Despite persistent challenges, this has led to improved outcomes for people over time by implementing more consistent, safe and effective policies and practices that affect individual and population health. Using evidence-based medicine, which is closely linked to population health practice, a number of achievements have been made: establishing the Cochrane Collaboration to collate and summarise evidence from clinical trials[63]; setting up the National Institute of Health and Care Excellence[D] to assess the cost-effectiveness of interventions, setting methodological and publication standards for primary and secondary research; building national and international infrastructures for developing and updating clinical practice guidelines; developing resources and courses for teaching critical appraisal, and building the knowledge base for implementation and knowledge translation.

A similar movement has been evolving in DRR as well, including a growing role for a number of scientific approaches such as weather forecasting and earth observation tools, centralising data on damage, loss and diverse impacts of disasters for use in research and planning (e.g. DesInventar),[64,65,66] implementing and publishing multisectoral global risk assessments (Global Assessment Reports),[67] and creating global partnerships to assess earthquake risk (Global Earthquake Model),[68] providing technical assistance to high-risk, low-capacity countries to assess their vulnerability to disaster and implementing effective risk

D. The National Institute of health and Care Excellence was set up by the UK government to provide national, evidence-based guidance on best practice in health care (and later social care). https://www.nice.org.uk/

Case study 13

Promoting inclusive engagement and community disaster resilience in Québec City, Canada

Image 13 The CHAMPSS Framework (Image source: Paré, N, 2012)

Ensuring that the science of disaster resilience is effectively communicated for policy makers and communities was a driving force behind an initiative in Quebec City. Using the Enhancing Resilience and Capacity for Health (EnRiCH) system has enabled the Quebec City authorities to involve multiple actors in the development and distribution of resilience plans. This system has been used in a major fire in the city, during which multiple municipal authorities worked closely with civil community organisations.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_quebecenrich.pdf

reduction measures, for example: the Global Facility for Disaster Reduction and Recovery.[69]

As an example of evidence based DRR activities, a consultative process was facilitated to develop guidelines and policy tools for each priority area in the HFA, with relevant national, regional and international expertise, a guide was prepared in 2007 through a long process of drafting and consultation that involved the participation of numerous organizations and individuals in dozens of countries to aid the implementation process. It was created to provide advice on useful strategies for implementing the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA). This guide was designed for use by Member States and their national governments and their subsidiary local governments, since they had the primary responsibility for disaster risk reduction. The guide was intended to be of interest to a diverse audience at different levels including leaders and representatives of specific sectors, civil society organizations, community organizations, the private sector, academia, international and regional organizations, and others working to reduce disaster risk reduction.[70]

3.3. Vision for voluntary commitments by the science and technology community

By working in close collaboration with the International Council of Science (ICSU)[71] and their Integrated Research on Disaster Risk programme[72] whose mission is to 'to develop trans-disciplinary, multi-sectorial alliances for in-depth, practical disaster risk reduction research studies, and the implementation of effective evidence-based disaster risk policies and practices' – STAG has collaborated in the work of the Major Group for Science and Technology which is coordinated by ICSU for the post-2015 Framework for Disaster Risk Reduction negotiations.

Science and technology communities have stated, through voluntary commitments formulated for the Third World Conference on DRR where the post-2015 Disaster Risk Reduction Framework will be presented, a wish to strengthen the dialogue and collaboration with policy-makers and DRR practitioners at local, national, regional and global levels to identify needs and knowledge gaps, co-design, co-produce and co-deliver new knowledge, and make science more readily available and accessible. In order to achieve this, scientific

Case study 14
Recognising and Understanding Collective Resilience in Crowds of Survivors

Image 14 Disaster training exercise (Image source: Public Health England)

With disasters becoming more frequent and impacting on a greater number of people, the impact on crowds has been growing in importance. Using 50 years' worth of research into the psychological and sociological behaviour of crowds in a disaster situation has allowed for governments to design more effective emergency strategies.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. *Online Case Studies: Using Science for DRR*. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_comahcasestudyera.pdf

and technical communities and networks will mobilise and strengthen existing capacities and initiatives to support the implementation of the post-2015 framework for DRR from the local to the global scale, and in particular deliver outputs in the following six areas:

(1) Assessment of the current state of data, scientific knowledge and technical availability on disaster risks and resilience (what is known, what is needed, what are the uncertainties, etc.);

(2) Synthesis of scientific evidence in a timely, accessible and policy-relevant manner;

(3) Scientific advice to decision-makers through close collaboration and dialogue to identify knowledge needs including at national and local levels, and review policy options based on scientific evidence; and

(4) Monitoring and review to ensure that new and up-to-date scientific information is used in data collection and monitoring progress towards disaster risk reduction and resilience building.

In addition, two cross-cutting capabilities need to be strengthened

(5) Communication and engagement among policy-makers, stakeholders in all sectors and in the science and technology domains themselves to ensure useful knowledge is identified and needs are met, and scientists are better equipped to provide evidence and advice

(6) Capacity development to ensure that all countries can produce, have access to and effectively use scientific information

More specifically, outputs to deliver on these six areas will include the following:

1) Mobilizing relevant institutions, networks and initiatives to join-up efforts and support a successful implementation of the Post-2015 framework for DRR at national, regional and global levels

2) Working with UNISDR, UN agencies, countries, scientific organisations, donors and stakeholders (including through consultative forum) to map the current science and technology landscape and articulate the format and content of future science and technology input;

3) Work with these partners, and in particular with STAG, to empower partnerships to deliver on the enhanced contribution of the science and technology community;

4) Work with these partners for activating regional cooperation frameworks bridging national and global levels;

5) Work with partners on related research and action topics (e.g.: science education; disasters and cultural heritage; earth observation and space technology;

6) Deliver concrete outputs in relation to the six areas in collaboration with governments, UN agencies, donors, stakeholders as appropriate; and

7) Strengthen academic education in DRR at all educational levels.

3.4. The importance of capacity development at all levels and across sectors and disciplines

The DRR context is evolving and growing in complexity, as described above. Regions increasingly embrace multi-stakeholder risk governance approaches, both in terms of administrative processes but also in including those at risk (e.g. residents, business owners). Within this context, we are all becoming risk managers as illustrated by research into the collective resilience of crowds in disasters (see case study 14). It should be recognized that capacity development across all societal sectors is an iterative (rather than linear) process and should be participatory and inclusive.[73] Capacity development can change people's behaviours and perception of the risks associated with climate change and natural disasters at all levels of policy making. Developing capacity also supports knowledge generation and uptake of science into the policy and practice of DRR as well as enabling shared understanding and, therefore, unified action in areas of policy and practice that can be conceptually complex. In other words, capacity development is a means to increasing resilience to disaster risks.

Conversely, capacity development is dependent on reducing vulnerability to disasters. The existing Millennium Development Goal on education has a strong focus on enrolment but educational outcomes are dependent on a safe and secure school environment and disasters can damage school buildings and divert children away from learning into activities of post-disaster recovery within households including providing care for sick or injured family members or through labour to help with income generation.[74]

Enabling the kind of contextual transformation for responding to the growing need for multidisciplinary approaches in DRR science, policy and practice requires continuing education and knowledge sharing across individuals and organizations.[75] Countries with successful social policies demonstrate the importance of developing capacity and systems that can support the collection of data and information as well as knowledge synthesis and sharing in order to develop new policies that benefit communities.

3.5. Creating incentives at local, national, regional and global levels

Knowledge and evidence generated by scientific research and technological advances can contribute to enhancing the local, national, regional and global legitimacy of decision making processes and facilitate change. Yet, linking science, technology and innovation to policy requires a conscious effort, both from the supply side (researchers & experts) and the demand side (policy-makers and practitioners), to use results of scientific analyses and assessments in the formulation of policy interventions, and governments will be particularly concerned by cost-effectiveness of DRR interventions. This broader collaborative approach can be seen in Victoria, Australia with policy makers actively including scientific predictions on wildfires into policy (case study 15). The current body of research and case studies, including estimates of

Case study 15
The Seveso Directives and the UK Control of Major Accident Hazard (COMAH) regulations

Image 15 The Buncefield industrial disaster, UK
(Image source: Public Health England)

Following on from multiple industrial disasters during the 1970's and 80's within Europe, the European Council introduced laws to reduce the number of incidents in facilities that hold large quantities of dangerous substances. Since the introduction of this Directive, there has been a noticeable fall in accidents.

Ref: PreventionWeb (2015). Scientific and Technical Advisory Group. Online Case Studies: Using Science for DRR. Accessed on 11 February 2015 from http://www.preventionweb.net/files/workspace/7935_comahcasestudyera.pdf

cost-benefit ratios of investments in DRR, supports the economic effectiveness of DRR.[76] However, results are not easily transferable as the costs and benefits depend on local values and culture around hazards and risks.

Crucially, governments play a key role in supporting populations affected by natural disasters, including rebuilding infrastructure to ensure continued services and scaling up public safety nets. However, they are increasingly concerned with managing disaster risk through prevention, preparedness and mitigation including mitigating the unpredictable fiscal liability attached to disaster risk. Some countries are working together and creating financial (sovereign catastrophe) risk pools that allow governments to coordinate with one another to insure their uncertain liabilities at lower cost. Cost-benefit analyses have shown that research and partnership with science and technology partners is essential for accurate risk estimates and the viability of the risk pool.[77] For example, crop-cutting experiments help researchers estimate the average yield in the insured area.

The challenge of evaluating costs and benefits can be at least partially addressed in time but it will take continued, committed action to build up the scientific evidence on effectiveness for specific interventions, and reliability for different forecasting models. Regarding the challenge of uncertainty in future forecasts, the UK Foresight Report 'Reducing Risks of Future Disasters: Priorities for Decision Makers' looks ahead to 2040 and takes a broad and independent view of disaster risk reduction. In the short-term, there are evidence-based scientific systems and technological systems that can assist policy-makers with the uncertainty around the costs and benefits of possible disaster risk reduction interventions. These could be adopted immediately alongside the longer-term efforts and include:

- Policy measures designed to be flexible to accommodate different possible outcomes (and therefore different potential benefits – known as adaptive resource management)

- Actively seeking and exploiting disaster risk reduction co-benefits when making other investments, for example in infrastructure planning and in the management of ecosystems. If future disaster risk is factored into the way in which investments are designed, additional benefits may be obtainable at little additional cost.

- Developing collaborative initiatives between public and private sector.

- DRR practices must promote and monitor activities and outcomes that are based on context-specific analysis of the differential needs, vulnerabilities (whether socioeconomic, gender, age or ethnicity based), expectations and existing capacities of all groups for risk management. The post-2015 framework on disaster risk reduction must advocate for practices that reduce people's vulnerability to shocks and stresses, by promoting human rights, fostering community participation, valuing local and indigenous knowledge and ensuring equitable access to assets and resources.

- DRR practices should also acknowledge and strengthen people's capacities, draw upon their self-identified and prioritised needs and empower socially marginalised groups to participate as active agents of change to prepare for and respond to disasters.

- The post-2015 framework monitoring process must incorporate a social vulnerability dimension in the design of the new set of indicators. Data collection, assessments and analysis should be disaggregated according not only to gender but also to other aspects of social vulnerability, where appropriate, including age, disability, ethnicity and socio-economic status.

- Local academic institutions should have an incentive to be involved in policy analysis and the appraisals, monitoring and evaluation of policy reforms for DRR and it is hoped that, at all levels, recommendations of the post-2015 framework will be taken up and, in particular, the recognition of:

- ***"...the importance of science and technology for disaster risk reduction and calls for its mobilization through the coordination of existing networks and scientific research institutions at all levels and all regions with the support of the ISDR Science and Technology Advisory Group to support the implementation of the post-2015 framework."***

4. Recommendations: Encouraging science and technology to demonstrate that it can support policy and practice

Scientific data and information and the tangible application of technology are critical to underpinning well-informed policies and decisions across the public, private and voluntary sectors. Much scientific evidence exists but better links to decision-making in policy and planning are needed to continuously enhance our ability to forecast, reduce and respond to disaster risks thereby building resilience.

Science and technology can assist in identifying a problem, developing understanding from research, informing policy and practice and making a difference that can be objectively demonstrated when evaluated. This report and the associated website offers guiding principles and illustrations through the case studies to promote this sharing of information, and thus promote knowledge transfer to policy-makers and other disaster risk reduction partners.

The post-2015 Framework for Disaster Risk Reduction negotiations and process discussions as well as the UNISDR STAG and the Major Group on Science and Technology in partnership with the Regional and Global platforms identified priority areas for action. The following recommendations are made to help strengthen DRR policies, initiatives and community especially in these areas:

4.1. Share knowledge for action

Greater priority should be put on sharing and disseminating scientific information, including technological advances and translating them into practical methods that can readily be integrated into policies, regulations and implementation plans concerning disaster risk reduction. Cross-disciplinary exchange will identify interdependencies and synergies which can help to identify solutions to complex problems. Capacity development at all levels of society, comprehensive knowledge management and the involvement of science (including behavioural science) in public awareness-raising, media communication, behaviour change, and education campaigns should be strengthened.

Specific tools should be developed to facilitate the incorporation of science inputs into policy-making, for example through a new framework implementation handbook, with appropriate monitoring and evaluation frameworks developed and implemented to track progress. Conversely, institutions and individuals at risk of disasters should be invited to participate in scientific research (surveys, vulnerability assessments) and technology to collect local knowledge and create reliable databases should be created and the information used to tailor initiatives to the local context while enabling global comparisons and assessments.

4.2. Use a multidisciplinary approach to research

An all-hazard, risk-based, problem-solving, results-oriented approach should be used in DRR research to address the multifactorial and interdependent nature of the disaster risk chain and to identify relevant solutions and optimize the use of resources. Synergies with the climate change and sustainable development agenda should continue to be articulated and leveraged. This requires collaboration and communication across the scientific disciplines and technical fields, and with all stakeholders including representatives of governmental institutions, communities of policy making, scientific and technical specialists and members of the communities at risk to guide scientific research, set research agendas, bridge the various gaps between risk assessments and risk perception by stakeholders, and support scientific education and training. The potential contribution of affected and vulnerable communities in generating research questions, and in performing research, collaboratively or independently, should be valued and facilitated.

4.3. Build systems resilience through local, national, regional and international partnership

Science and technology communities wish to strengthen the dialogue and collaboration with policy-makers and DRR practitioners at local, national, regional and global levels to identify needs and knowledge gaps, co-design, co-produce and co-deliver new knowledge, and make science more readily available and accessible. To this end, science and technology communities and networks will mobilise and strengthen existing capacities and initiatives, including national platforms/bodies, to support the implementation of the post-2015 framework for DRR from the local to the global scale, and in particular deliver outputs.

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Annex 1 summarises the statements of support for science and technology from the UNISDR Regional Disaster Risk Reduction Platfoms held in 2014 in Africa, the Americas, the Pacific, Asia, Europe and in the Arab League

At the 5th Africa Regional Platform and 3rd Ministerial Meeting for Disaster Risk Reduction, Abuja, (Nigeria), 13-16 May 2014, Summary Statement – Africa's Contribution to the Post-2015 Framework for Disaster Risk Reduction, it was stated in point 10: 'The establishment of regional mechanisms that enable more active engagement of a wider range of science partners (including health and agriculture) can support broader efforts to establish an international science advisory panel for disaster risk reduction and to bring scientific, local and indigenous knowledge within a common framework of understanding'.[1] From the supporting statement from the Scientific, Technical and Acaademic Communities in Disaster Risk Reduction (5th Regional Platfomr, Abuja, Nigeria) it was noted amongts other issues that there was a request for 'the establishment of an International Science Advisory Mechanism for DRR to strengthen resilience'.[2]

At the Fourth Session of the Regional Platform for Disaster Risk Reduction in the Americas 26-29 May 2014, organised by UNISDR Regional Office for the Americas (UNISDR - Americas) and the Republic of Ecuador, through the Secretariat of Risk Management and the Ministry of Foreign Affairs, in the Comunique of Guayaqil, Ecuador IV Session of the Regional Platform for Disaster Risk Refuction, Guayaquil, 29 May 2014 it was stated in point 34 that there was a need to 'integrate knowledge and information for formulating evidence-based risk management policies. To do so, access to interdisciplinary scientific inputs must be ensured for all actors, with consideration given to local identity as well as conditions regarding culture, gender and special needs. The establishing of a scientific-academic mechanism is desired, with the support of governments, in order to advise country authorities and strengthening exchange networks'.[3] In the reflections of the representatives of the scientific, technical and academic sector who participated in the the Fourth Session of the Regional Platform for Disaster Risk Reduction in the Americas, they called to 'Promote the establishment of an intergovernmental scientific mechanism for disaster risk reduction to strengthen the evidence base to effectively reduce disaster risk and enhance resilience. The mechanism will provide scientific information and evidence to support countries and other stakeholders in the implementation of programs and monitoring and validation of progress on disaster risk reduction and climate change adaptation in the context of the post 2015 sustainable development agenda and the successor to the Hyogo Framework for Action. The mechanism will draw on existing programs, initiatives and resources and introduce new elements where appropriate.[4]

At the Sixth Session of the Pacific Platform for Disaster Risk Management The Way Forward: Climate and Disaster Resilient Development in the Pacific 2-4 June 2014, Suva, Fiji MEETING STATEMENT, it was noted that 'further investment in monitoring systems and scientific research and their practical applications in informing decision-making in disaster risk management, climate change adaptation and low carbon development'.[5]

At the 6th Asian Ministerial Conference on Disaster Risk Reduction, Hosted by the Royal Thai Government in collaboration wiht UNISDR and held in Bangkok Kingdom of Thailand 22-26 June the outcome was summarised in the Bangkok Declaration on Disaster Risk Reduction in Asia and the Pacific 2014.[6] In this Statement it was aknowledged 'the important role of science and technologies in promoting risk prevention and risk reduction by strengthening the capacities of national, sub-national, and local governments, as well as collaboration among the science community, decision makers, and practitioners with a view to promoting a stronger science interface with policy and practice for disaster risk reduction and resilience'. In addition in the section entitled Call on All Governments and Stakeholders To – the following for Science and Technology was requested: 'Promote the use and further development of science, technology, and innovation. Strengthen exchanges among science, technology and innovation communities for synergies. Make innovation and technology accessible, available and affordable to national governments and local communities through development and transfer of technology. Share best practices and data through, inter-alia, open sources and networking. Promote hazard and risk assessments, scenario building, and other research and studies on disaster risk reduction. Empowering national efforts to improve collection and sharing of comparable data on disaster losses, hazards, and vulnerabilities and sharing for best practices. This was reinforced by the extensive Statement of Voluntary Commitments of Asia Science, Technology and Academia Stakeholder Group for the 6th Asian Ministerial Conference for Disaster Risk Reduciton 22-26 June 2014, Bangkok, Thailand which recommended 'support for the establishment of an international science, academia and technological advisory mechanism for disaster risk reduction to strengthen resilience for the post-2015 agenda'.[7]

At the European ministerial meeting on disaster risk reduction: towards a post-2015 framework for disaster risk reduction - building the resilience of nations and communities to disasters 08 July 2014, Milan, Italy they noted that they 'recognize the role of science and technology and the complementarity of disaster risk reduction and Climate Change Mitigation and Adaptation as policy goals and approaches to prevent and address risk, vulnerability, and the impacts of hazard events and climate change on people and society'.[8] In the section on recommendations for the post-2015 Framework on Disaster Risk Reduction: they stated that they needed to 'encourage a more systematic and reinforced science-policy interface, including foresight to address future risks and challenges'. At the follow up meeting to the Ministerial meeting at the 5th European Forum for Disaster Risk Reduction held in Madrid, on 6-8 October 2014, their outcomes report stated the need to 'Champion, reinforce and better connect existing and future initiatives for integrated research and the scientific assessment of disaster risk through an adequate international scientific advisory mechanism, in order to strengthen the evidence base to inform decision-making under the post-2015 framework'. This outcome document went on to 'Acknowledge the reduction of flood losses in Europe. EFDRR will further exchange lessons learnt across different scales including the implementation of the flood directive, link with the science community and private sector'.[9]

At the Second Arab Conference on Disaster Risk Reduction, City of Sharm El Sheikh, Arab Republic of Egypt, 14–16 September 2014 in the Sharm El Sheikh Declaration on Disaster Risk Reduction 16 September 2014 it was noted that there was a need to 'Develop a regional mechanism linking Arab scientists to the International Science and Technology Advisory Group on Disaster Risk Reduction with a view to strengthening the commitment and participation of the academic and scientific communities and mobilizing science and technology to support disaster risk reduction measures'.[10]

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