International Strategy for Disaster Reduction

Drought Risk Reduction Framework and Practices

Contributing to the Implementation of the Hyogo Framework for Action

United Nations

Photo cover: Drip system in Cauliflower in Churiya, Makawanpur, Nepal. Boosting Poor Households' Crop Production with Drip and Sprinkler Irrigation. Manahari Development Institute – Nepal (MDI-Nepal).

Drought Risk Reduction Framework and Practices: Contributing to the Implementation of the Hyogo Framework for Action

Published by the United Nations secretariat of the International Strategy for Disaster Reduction (UNISDR), Geneva, Switzerland, in partnership with the National Drought Mitigation Center (NDMC), University of Nebraska-Lincoln, Lincoln, Nebraska, U.S.A. August 2009

© United Nations, 2009
© UNISDR, 2009
All rights reserved

May be referenced as "UNISDR, 2009. Drought Risk Reduction Framework and Practices: Contributing to the Implementation of the Hyogo Framework for Action. United Nations secretariat of the International Strategy for Disaster Reduction (UNISDR), Geneva, Switzerland, 213 pp."

Any part of this text may be reproduced without permission provided that it is reproduced accurately and not in a misleading context and the source of the material is clearly acknowledged by means of the above title, publisher and date. The wide dissemination, reproduction and use of the document are encouraged. If any reproductions, translations or quotations are generated, a copy of the document or quotation is requested to be forwarded to the UNISDR.

Disclaimer: This publication has been assembled on a best endeavours basis and the UNISDR regrets any errors or omissions present. The information provided does not necessarily reflect the views of the United Nations Secretariat, the members of the ISDR system or the organizations referred to in the publication. The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations or the UNISDR concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

United Nations secretariat of the International Strategy for Disaster Reduction
International Environment House II
7-9 Chemin de Balexert
CH-1219 Chatelaine, Geneva, Switzerland
www.unisdr.org and www.preventionweb.net
Email: isdr@un.org

USA National Drought Mitigation Center,
University of Nebraska-Lincoln
P.O. Box 830988
Lincoln, NE 68583-0988, USA
www.drought.unl.edu
Email: ndmc@unl.edu

Foreword

In an increasingly vulnerable world, nations, communities and individuals are confronted daily with suffering and loss of lives and livelihoods resulting from disasters triggered by natural and human-induced hazards. Worldwide, the number of disasters has grown over recent decades. This trend will be aggravated with the projections related to global climate change. Coordinated actions of the international community are urgently needed in order to address the root causes of disasters and to significantly increase national, local and community capacities to reduce their vulnerabilities.

Drought is one of the major natural hazard threats to people's livelihoods and community socio-economic development. Each year, disasters originating from prolonged drought not only affect tens of millions of people, but also contribute to famine and starvation among millions of people, particularly in some African countries.

Drought is a slow-onset hazard, which provides time to consider and address its complex root causes, such as understanding people's vulnerabilities and identifying unsafe conditions related to poverty, fragile local economy, livelihoods at risk, lack of strategies and plans, limited institutional capacities and resources. Understanding these issues allows government authorities and the public to undertake effective drought mitigation and preparedness measures.

In January 2005, governments adopted the *Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters*, with the primary goal of achieving a substantial global reduction in disaster risk, and contributing to the sustainable development of nations. The HFA provides comprehensive action-oriented policy guidance based on a holistic understanding of disasters, as induced by human vulnerability to natural hazards, and it reflects a solid commitment by governments and organizations to implement an effective disaster reduction agenda. In order to support the implementation of the HFA at all levels, a strong partnership is being forged throught the ISDR system. It comprises government representatives; international, regional, and UN organizations; and civil society organizations, and aims at coordinating programmes and activities, identify good practices and gaps, and promote positive action.

With the aim of guiding the implementation of the HFA in respect to drought, the UNISDR secretariat in cooperation with the National Drought Mitigation Center (University of Nebraska-Lincoln, USA) and other partners has developed the present document, based on current thinking and practice in many countries. It elaborates a framework for understanding drought and vulnerability to drought, and provides guidance on actions to reduce the risks associated with drought. The document discusses drought policy and governance, risk identification and early warning, awareness and knowledge management, and effective mitigation and preparedness measures. These framework elements are illustrated with practical examples, techniques, and extensive background information.

Drought Risk Reduction framework and practices: Contributing to the Implementation of the Hyogo Framework for Action is intended to assist national governments and local communities, as well as international, regional and donor communities, to address the root causes of drought-related disasters, and to reduce drought impacts and the consequences for human welfare and food insecurity. The UNISDR will welcome any feedback, which will be incorporated in complementary versions.

Margareta Wahlström
Special Representative of the Secretary-General for Disaster Risk Reduction
Secretariat of the International Strategy for Disaster Reduction, United Nations

Acknowledgements

The document draws on several sources and expert meetings:

In 2003, the UNISDR convened an Ad Hoc Discussion Group on Drought at the request of the United Nations Inter-Agency Task Force on Disaster Reduction. Experts and practitioners of several institutes and UN agencies discussed new paradigms and actions required to reduce global drought risk. These discussions were captured in a document entitled "Living with Risk: An Integrated Approach to Reducing Societal Vulnerability to Drought", which is one of the guiding documents for the current discussion (see http://www.unisdr.org/eng/task%20force/tf-adhoc/droughts/WGD-doc1.pdf).

In June 2006, some members of the Ad Hoc Group were re-convened in Beijing with the support of the Ministry of Civil Affairs of China and the China National Committee for Disaster Reduction. The group discussions contributed to developing the main elements for a Drought Risk Reduction framework.

In October 2006, a first document was presented in Nairobi at the 2nd African Drought Risk Reduction Forum organized by the UNDP/Drylands Development Centre and the UNISDR. Governments, policymakers, UN organizations, experts and practitioners participated in this forum provided valuable recommendations, information and good practices.

On this basis and considering ongoing discussions, the UNISDR, under the guidance and coordination of Pedro Basabe; and the National Drought Mitigation Center (NDMC), University of Nebraska-Lincoln, United States, with the substantive support of Dr. Cody Knutson, have worked together in identifying and analyzing practical information and tools to present an integrated global framework geared toward defining concepts, understanding people's vulnerability and proposing key elements for a Drought Risk Reduction framework illustrated with practices to guide the implementation of the Hyogo Framework for Action. Complementing this information, the last chapter of this document informs about existing institutions and networks working in drought issues and proposes a global network to enhance knowledge sharing and promote drought risk reduction.

The preliminary version of this document entitled "Drought Risk Reduction framework and practices: contributing to the implementation of the Hyogo Framework for Action" was realised in May 2007.

We wish to express appreciation to other contributors for the 2007 edition, namely:
Nancy Balfour, European Commission Humanitarian Office (ECHO), Nairobi, Kenya
Adelia Branco, Brazil
Alexandre Côté, UNISDR Africa, Nairobi, Kenya
Ulrich Hess, UN World Food Programme, Rome, Italy
Ana Iglesias, Universidad Politécnica de Madrid, Spain
David Jones, National Climate Center, Australian Bureau of Meteorology, Melbourne, Australia
Henri Josserand, FAO, Rome, Italy
Pak Sum Low, UNESCAP, Bangkok, Thailand
Hongjun Miao, UNISDR, Beijing, China
Edward Namusasi, IGAD Climate Prediction and Applications Centre (ICPAC) Nairobi, Kenya
Laban A. Ogallo, IGAD ICPAC, Nairobi, Kenya
Mohammed Omar Mukhier, IFRC, Geneva, Switzerland
Eric Patrick, UNDP Drylands Development Centre, Nairobi, Kenya
Chris Reij, Center for International Cooperation, Vrije University, Amsterdam, Netherlands

S. Piers Simpkin, ICRC, Nairobi, Kenya
M.V.K. Sivakumar, World Meteorological Organization, Geneva, Switzerland
Vladimir Smakhtin, International Water Mgt Institute (IWMI), Colombo, Sri Lanka
Lena Tallaksen, University of Oslo, Norway
Henny A.J. Van Lanen, Wageningen University, Wageningen, Netherlands
Bangzhong Wang, China Meteorological Administration, Beijing, China
ZhenYao Wang, National Disaster Reduction Center of China, Beijing
Richard Wilcox, WFP, Rome, Italy
Donald Wilhite, University of Nebraska, Lincoln, USA

The present 2009 edition of "Drought Risk Reduction framework and practices: contributing to the implementation of the Hyogo Framework for Action" was revised by the UNISDR, mainly by Pedro Basabe and Yoko Hagiwara, based on additional discussions and contribution made at the 3rd African Drought Adaptation Forum in Addis Ababa in September 2008, and complementary research, inputs and comments received from various experts, other UN actors, academic and research institutions and NGOs listed above. It was also reviewed by Sálvano Briceño, Director, UNISDR and UNDP/DDC. Good practices on annex 3 were compiled by Elena Dokhlik under the guidance of Feng Min Kan and edited by Alain Valency. The UNISDR is grateful to Dr. Cody Knutson of the National Drought Mitigation Center, U.S.A. for substantive contributions to the contents of the revised document, and to Ms. Deborah Wood for editing the document. Graphic design was done by Mario Barrantes of UNISDR.

The UNISDR would like to express appreciation to other contributors for the present edition, namely:
Stephan Baas, FAO, Rome, Italy
Inés Brill, OCHA, Geneva, Switzerland
Emmanuel Chinyamakobvu, UNCCD secretariat, Bonn, Germany
Elysabeth David, UNCCD secretariat, Bonn, Germany
Sabine Dier, CARE Deutschland-Luxemburg, Bonn, Germany
Ira Frydman, UNDP Drylands Development Centre, Nairobi, Kenya
Ulrich Hess, WFP, Rome, Italy
Yukie Hori, UNCCD secretariat, Bonn, Germany
Jennifer Nyberg, FAO, Rome, Italy
Mikhail Outkine, UNCCD secretariat, Bonn, Germany
Paolo Paron, FAO, Nairobi, Kenya
Eric Patrick, UNDP Drylands Development Centre, Nairobi, Kenya
Lene Poulsen, Consultant and former UNDP staff
Sálvano Briceño, Feng-Min Kan, Elena Dokhlik, Silvia Llosa, Yvette Stevens, Marilise Turnbull and Juliet Khisa of UNISDR
Valentijn Venus, International Institute for Geo-Information Science and Earth Observation, Netherlands
Sergio Zelaya, UNCCD Secretariat, Bonn, Germany

We also acknowledge the valuable contribution of good practices' authors presented in Annex 3.

The production of this report was made possible through contributions to the ISDR Trust Fund for Disaster Reduction by the following governments: Australia, Canada, China, Denmark, Finland, Germany, Italy, Japan, Luxembourg, Norway, Philippines, South Africa, Sweden, Switzerland, the United Kingdom of Great Britain and Northern Ireland, the European Commission and the World Bank's Global Facility for Disaster Reduction and Recovery.

List of Acronyms

ACMAD	African Centre for Meteorological Applications to Development, Niamey, Niger
ADPC	Asian Disaster Preparedness Center, Bangkok, Thailand
AfDB	African Development Bank
AGRHYMET	Regional Centre for Training and Application in Agro-meteorology and Operational Hydrology, Niamey, Niger
AMCEN	African Ministerial Conference on the Environment
AU	African Union
AUC	African Union Commission
CADRI	Capacity for Disaster Reduction Initiative
CBO	Community-based Organization
CIDA	Canadian International Development Agency
CIHEAM	International Center for Advanced Mediterranean Agronomic Studies
COP	Conference of the Parties
CRED	Centre for Research on the Epidemiology of Disasters
CWWG	Crop Weather Watch Group, India
DFID	Department for International Development, United Kingdom
DMC	Drought Monitoring Centre
ECOWAS	Economic Community of Western African States
ESA	European Space Agency
FAO	Food and Agriculture Organization of the United Nations
FEWS NET	Famine Early Warning System
FIVIMS	Food Insecurity and Vulnerability Information and Mapping Systems
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GIEWS	Global Information and Early Warning System on Food and Agriculture
GIS	Geographic Information System
HFA	Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters
IASC	Inter-Agency Standing Committee
ICARDA	International Center for Agricultural Research in the Dry Areas
IFAD	International Fund for Agricultural Development
IGAD	Intergovernmental Authority on Development
IGAD ICPAC	IGAD Climate Prediction and Application Centre, Nairobi, Kenya
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society, Columbia University, U.S.A.
ITC	International Institute for Geo-Information Science and Earth Observation, Netherlands
MDGs	Millennium Development Goals
MEAs	Multilateral Environmental Agreements
NADM	North American Drought Monitor
NAPs	National Action Programmes

NASA	National Aeronautics and Space Administration, U.S.A.
NCSA	National Capacity Self Assessment
NDMC	National Drought Mitigation Center, University of Nebraska-Lincoln, U.S.A.
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organization
NIDIS	National Integrated Drought Information System, U.S.A.
NOAA	National Oceanic and Atmospheric Administration, U.S.A.
OAS	Organization of American States
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
SADC	Southern African Development Community
SADM	South Asia Drought Monitor
SADNET	Southern Africa Drought Technology Network
SIDA	Swedish International Development Agency
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDAF	United Nations Development Assistance Framework
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNDP BCPR	UNDP Bureau for Crisis Prevention and Recovery
UNDP DDC	UNDP Drylands Development Centre
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCWA	United Nations Economic and Social Commission for Western Asia
UNFCCC	United Nations Framework Convention on Climate Change
UN-HABITAT	United Nations Human Settlements Programme
UNHCR	UN High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNU	United Nations University
USAID	United States Agency for International Development
USDM	United States Drought Monitor
USGS	United States Geological Survey
VAM	Vulnerability Analysis and Mapping (WFP's programme)
WB	World Bank
WFP	United Nations World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization
WSSD	World Summit on Sustainable Development

Executive Summary

Drought is a slow-onset natural hazard that allows for the implementation of disaster risk reduction measures as requested by the Hyogo Framework for Action. In order for planners and the public to implement effective mitigation and preparedness measures to reduce drought impacts, they have to understand its evolution, complexity, social implications and people's vulnerability. To this end, wide-ranging and well-coordinated efforts at international, regional, and national levels are needed to build drought-resilient communities and societies.

Drought is a natural part of climate, although it may be erroneously considered as a rare and random event. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. Drought is a temporary aberration; it differs from aridity, which is restricted to low rainfall regions.

Drought is categorized as a hydro-meteorological hazard. According to the UNISDR Terminology on Disaster Risk Reduction 2009, "hazard" is defined as "a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage". In technical settings, hazards are often described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis.

A broad definition of drought is a deficiency of precipitation over an extended period of time, usually a season or more, which results in a water shortage for some activity, group, or environmental sectors. However, in terms of typologies, droughts are classified as meteorological, agricultural, hydrological, and socio-economic.

Meteorological drought is a natural event that results from climatic causes, which differ from region to region. Agricultural, hydrological, and socio-economic drought, however, place greater emphasis on the human or social aspects of drought. They highlight the interaction between the natural characteristics of meteorological drought and human activities that depend on precipitation to provide adequate water supplies to meet societal and environmental demands.

Multilateral Environmental Agreements such as the United Nations Convention to Combat Desertification (UNCCD) and the United Nations Framework Convention on Climate Change (UNFCCC) are also strongly linked to some aspects of drought risk reduction framework and practices. The UNCCD has its specific definition of "drought" as "the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems".

The risk associated with drought for any region or group is a product of the exposure to the natural hazard and the vulnerability of the society to the event. The UNISDR definition for "vulnerability" is "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Leaders and planners in drought-prone regions should conduct risk assessments to both better understand the drought hazard and identify the factors and processes concerning who and what is most at risk to drought, and why.

The present document proposes main elements of a drought risk reduction framework in line with the priorities of the Hyogo Framework, namely i) policy and governance, ii) drought risk identification and early warning, iii) awareness and education, iv) reducing underlying factors of drought risk, and v) mitigation and preparedness, as well as cross-cutting issues.

Drought risk reduction is a long-term commitment that should complement long-term sustainable development planning efforts, such as meeting the United Nations Millennium Development Goals (MDGs) and in the Poverty

Reduction Strategies. Mainstreaming drought risk reduction into these national development frameworks requires political commitment, high-level engagement, strong institutions and appropriate governance.

The process of drought risk reduction and its mainstreaming into national development frameworks should be participatory, involving a wide range of stakeholders such as national and local governments, community-based and civil society organizations, regional and sub-regional organizations, multilateral and bilateral international bodies, the scientific community, the private sector and the media.

Another important cross-cutting aspect for drought risk reduction is capacity development. Capacity development can be conceived at three different levels, namely individual and group level, institutional level and systematic level. Capacity development for drought risk reduction can be coordinated, implemented and monitored under holistic and nationally owned coordination mechanisms for disaster risk reduction such as multi-sectoral national platforms for disaster risk reduction. Other capacity building activities for drought risk reduction can build on the existing initiatives of ISDR system partners.

As stated earlier, the present document proposes that the five main elements in line with the priorities of the Hyogo Framework be considered for a drought risk reduction framework. An effective drought policy either at national/state/provincial level or local/community level should also take them into consideration.

The first element, ***policy and governance*** should be based on local needs, community participation and political commitment, networks and mechanisms and resource availability. In addition to national and state/provincial drought policies, increased importance has also been placed on local/community level drought policy and planning, emphasizing self-reliance and drought resilience.

Guiding principles

The development of national and local strategies for reducing drought risk, together with the implementation of such a strategy, should be guided by the following principles:

1. Political commitment, high-level engagement, strong institutional setting, clear responsibilities both at central and local levels and appropriate governance are essential for integrating drought risk issues into a sustainable development and disaster risk reduction process;
2. A bottom-up approach with effective decentralization and active community participation for drought risk management in planning, decision making and implementation, is essential to move from policy to practice;
3. Capacity building and knowledge development are usually required to help build political commitment, competent institutions and an informed constituency;
4. Drought risk reduction policies should establish a clear set of principles or operating guidelines to govern the management of drought and its impacts, including the development of a preparedness plan that lays out a strategy to achieve these objectives;
5. Drought-related policies and plans should emphasize risk reduction (prevention, mitigation and preparedness) rather than relying solely on drought (often turned into famine) relief;
6. Drought monitoring, risk assessment and other appropriate risk reduction measures are principal components of drought policies and plans;
7. Institutional mechanisms (policy, legislative and organizational) should be developed and enforced to ensure that drought risk reduction strategies are carried out; and
8. Sound development of long-term investment in risk reduction measures (prevention, mitigation and preparedness) is essential to reduce the effects of drought.

The second element, ***drought risk identification, risk monitoring and early warning***, can be a starting point for promoting a culture of resilience in combination with enhancing knowledge about hazard occurrence, the potential effects of the hazard, and the related vulnerabilities of potentially affected people and activities. Risk assessment methodologies such as hazard assessment, drought impact assessment and vulnerability analysis will be useful in order to better understand specific trends, vulnerability and impacts of drought for specific drought prone areas. It is recommended that common methodologies for defining and assessing risks as well as appropriate drought hazard and vulnerability indicators be developed to meet specific local needs. Enhancing drought monitoring and early warning capacities is also crucial.

Guiding principles

Drought risk identification, impact assessment, and early warning activities should be guided by the following principles:

1. Drought risk is the combination of the natural hazard and the human, social, economic and environmental vulnerability of a community or country, and managing risk requires understanding these two components and related factors in space and time;
2. Increasing individual, community, institutional and national capacities is essential to reducing vulnerability to drought impact;
3. Impact assessment plays an important role in drought risk management, in particular, identifying most vulnerable groups and sectors during drought;
4. Drought monitoring and early warning systems play an important role in risk identification, assessment and management; and
5. Changing climate and the associated changing nature of drought poses a serious risk to the environment, hence to sustainable development and the society.

The third element, ***drought awareness, knowledge management and education***, is another enabling factor for drought risk reduction. Collection, compilation, and dissemination of relevant knowledge and information on hazards, vulnerabilities, and capacities should be linked to community drought risk reduction awareness campaigns, programmes, and projects. Interaction between the generators and users of information is essential for developing useful messages and helping to ensure the use of the information. Education for disaster risk reduction is an interactive process of mutual learning among people and institutions which also involves traditional wisdom and local knowledge. Various educational programmes that focus on drought risk reduction exist in addition to general programmes on DRR.

Guiding principles

In general, drought awareness and knowledge management activities should be guided by the following principles:

1. The effects of drought can be substantially reduced if people are well informed and motivated toward a culture of disaster prevention and resilience;
2. Effective information management and exchange requires strengthening dialogue and networks among disaster researchers, practitioners, and stakeholders in order to foster consistent knowledge collection and meaningful message dissemination;
3. Public awareness programmes should be designed and implemented with a clear understanding of local perspectives and needs, and promote engagement of the media to stimulate a culture of disaster resilience, including resilience to drought and strong community involvement; and
4. Education and training are essential for all people in order to reduce local drought risk.

The fourth element, ***reducing underlying factors of drought risk*** will also contribute to reducing drought vulnerability. These risk factors can be reviewed and reduced by effective environmental and natural resource management, social and economic development practices, and land-use planning and other technical measures. These factors that have an impact on vulnerability to drought need to be reflected in national poverty reduction strategies, development plans, sector development planning and programmes, and environment and natural resource management strategies as well as in post-disaster situations so that effective preparedness and mitigation measures can be considered.

Guiding principles

1. Mechanisms should be in place to systematically bring together practitioners in disaster risk reduction (e.g., national platform members) and key institutions involved in environmental management (e.g., adaptation to climate change, desertification and biodiversity);
2. Areas of overlap and synergy should be identified between existing environmental programmes and disaster risk reduction activities;
3. A mechanism for carrying out joint assessments should be institutionalized to integrate disaster risk reduction and environmental protection parameters (e.g., integrated risk-and-environmental-impact assessments);
4. Specific attention should be given to socio-economic high-risk factors such as age, disabilities, social disparities and gender. By focusing on protection of the most vulnerable groups, the impacts of disasters can be reduced;
5. Post-drought recovery planning can incorporate drought risk reduction strategies for the future; and
6. Safety nets such as insurance mechanisms for properties as well as microcredit and financing for ensuring minimum livelihood means can accelerate post-drought recovery process.

The fifth element, ***enhancing mitigation measures and preparedness for drought*** substantially reduce drought impacts and losses if authorities, individuals, and communities are well-prepared, ready to act, and equipped with the knowledge and capacities for effective drought management. It should be recognized that mitigation and preparedness have a greater impact on reducing the scale and effects of drought disasters than ad-hoc emergency response measures.

Guiding principles

1. Prevention, mitigation and preparedness are central components of disaster risk reduction, and are more important than relying solely on ad-hoc emergency response measures;
2. Dialogue, exchange of information, and coordination are needed between disaster risk reduction, development and emergency management actors;
3. The selection of appropriate drought risk reduction (prevention, mitigation and preparedness) measures requires many considerations, such as integrated environmental and natural resource management, social and economic development, land use planning opportunities, and climate change adaptations;
4. A combination of top-down and bottom-up approaches is required for development and implementation of effective mitigation and preparedness measures;
5. Institutional capacity, coordinated mechanisms, identification of local needs and indigenous knowledge are required to implement effective mitigation and preparedness strategies;
6. Monitoring and early warning are key elements of disaster risk reduction and must be closely linked to other risk reduction actions; and
7. Drought risk reduction (prevention, mitigation and preparedness) requires a long-term commitment of resources.

Currently, various drought preparedness networks, mechanisms and institutions already exist. In order to strengthen them, it is crucial to link the knowledge, expertise and activities of various institutions working in each specialized thematic area related to drought. Among these networks, mechanisms and institutions, the present

document introduces the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR), collaboration between the UNISDR and specific institutions and networks such as the National Drought Mitigation Center (NDMC), University of Nebraska-Lincoln, USA, UNOCHA, the Inter-Agency Standing Committee (IASC), and UNDP Drylands Development Centre (DDC). Some regional networks proposed in Africa, Mediterranean, Near East, South-Eastern Europe, Asia and the Pacific, South America and North America are also presented.

There is a need to establish a strategy on drought risk reduction that is based on a new approach that is more focused on the human dimensions of drought and proactive risk reduction measures. To accomplish this strategy shift, the report of the ISDR Ad-Hoc Discussion Group on Drought in April 2003, Drought: Living with Risk: An Integrated Approach to Reducing Societal Vulnerability to Drought, identified the key issues associated with drought risk reduction, and recommended the development of a global network. Such a network would not duplicate the work of regional or sub-regional networks, but would strengthen and complement activities and capacity development and provide a forum for interregional exchange of ideas, technology and experiences.

In line with the above-mentioned criteria, the present document proposes a "Global Drought Risk Reduction Network" relying mainly on internet and regional forums (e.g., e-workshops) for linking institutions within and between regions to enhance knowledge and communication exchange for more effective policy guidance at all levels. This virtual global network aims to foster the exchange of information to document and support the implementation of practical, real-world drought risk reduction activities and provide better technical assistance to governments and other organizations working on reducing risk and vulnerability to drought.

The ISDR system, comprising governments and international, regional and UN organizations, will continue to seek ways to promote and implement drought risk reduction programmes and knowledge networks to facilitate the implementation of the Hyogo Framework. Although activities will be supported worldwide, the initial emphasis may be placed in Africa, where drought and related factors result in the greatest loss of lives and livelihoods.

The UNISDR could help in promoting and supporting these efforts by the ISDR system partners, through advocacy, information generation, promotion with donor organizations and programmes, coordination of ISDR thematic platforms, and through the encouragement of networks. The regional offices of the UNISDR could actively support related efforts at the regional level.

Table of contents

Annexes

List of tables, figures and boxes

INDIA: Combating water shortage, soil erosion through community action

Using Rainwater Cisterns to Collect Drinking Water, and Rainwater Bunds to Prevent Soil Erosion

Tearfund (in partnership with Discipleship Centre)

Chapter 1

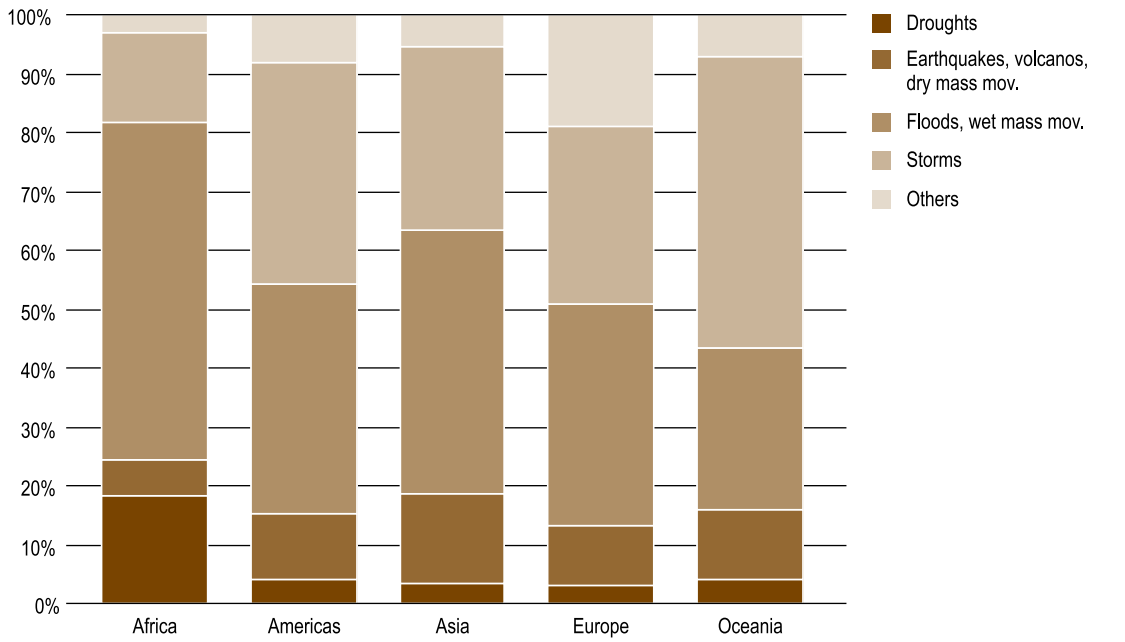
Context and objectives

Drought is one of the major threats among natural hazards to people's livelihoods and socio-economic development. Drought tends to occur less frequently than other hazards (Figure 1). However, when it does occur, it generally affects a broad region for seasons or years at a time. This can result in a larger proportion of the population being affected by drought than by other disasters (Figure 2). For example, Figures 1 and 2 show that drought disasters account for less than 20 percent of all disaster occurrences in Africa, but they account for more than 80 percent of all people affected by natural disasters in the continent.

Some regions are more prone to drought disasters (Figure 3), and each country differs in its capacity to effectively prepare for and respond to the effects of drought. Therefore, the number of people affected by drought and the types of impacts experienced will vary by region (Figure 4). In the Asian region, in particular, India and China recorded the largest number of people affected by drought from 1980 to 2006. However, for the same period, it was Africa that recorded the largest number of peopled killed due to the catastrophic droughts in Ethiopia, Sudan and Mozambique in the 1980s (see http://www.emdat.be/). Disasters triggered by prolonged drought in developing countries can severely harm countries' development, affect millions of people and contribute to malnutrition, famine, loss of life and livelihoods, emigration and conflict situations; whereas droughts in developed countries primarily result in economic losses.

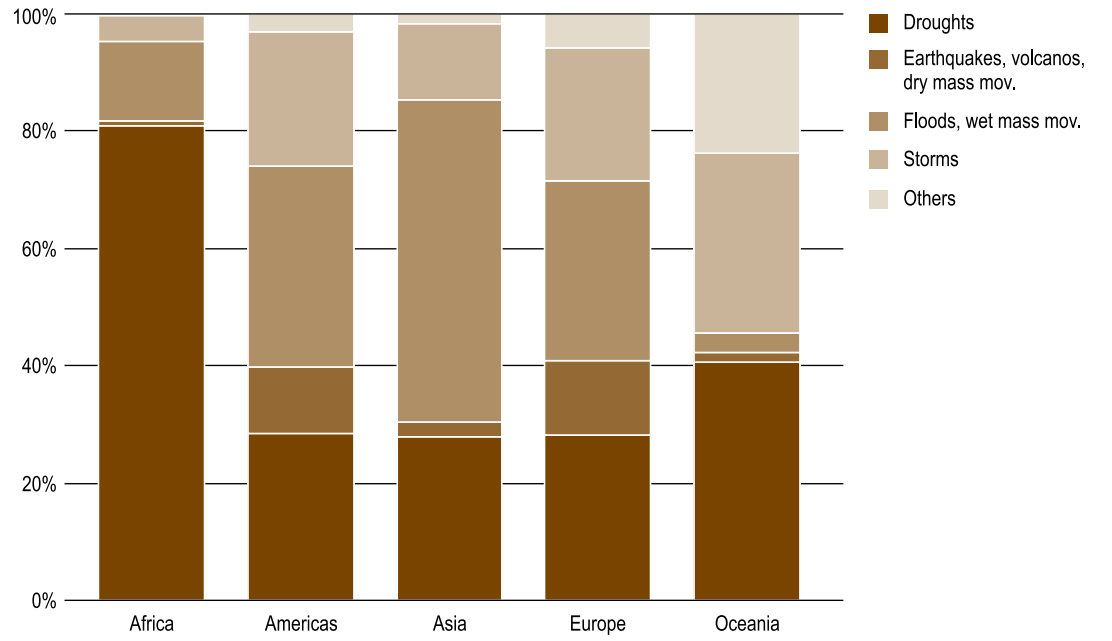
In 2006, extreme drought affected several countries in the Horn of Africa. Especially hard hit were people in the countries of Ethiopia, Somalia, Kenya, Eritrea, and Djibouti, where nearly 18 million people were estimated to be suffering from food shortages during the drought's peak in early 2006. UNICEF surveys revealed acute malnutrition rates of approximately 20 percent among children in many drought-affected communities. In 2008, the Horn of Africa, especially Ethiopia, Somalia, Djibouti, Eritrea, northern Kenya and North-eastern Uganda, faced a humanitarian emergency again because of the recurrence of drought combined with unprecedented food price increases and, in some places, levels of conflict that had not been seen since the 1990s. (http://www.reliefweb.int/rw/rwb.nsf/db900SID/EDIS-7JMQCU)

Figure 1: Proportion of disaster occurrence by continent: 1970-2008



Source: EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be – Université catholique de Louvain – Brussels – Belgium

Figure 2:
Proportion of persons affected by each disaster type per continent:
1970-2008



Source: EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be – Université catholique de Louvain – Brussels – Belgium

In order to reduce the threat of drought around the world, an increasing number of national, regional, and international entities have begun to take action. For example, in 2003, the secretariat of the United Nations International Strategy for Disaster Reduction (UNISDR) facilitated the creation of an Ad Hoc Discussion Group on drought at the request of the United Nations Inter-Agency Task Force on Disaster Reduction. The endeavour brought together prominent scientists and practitioners from a variety of institutes and UN agencies to propose new paradigms and actions required to reduce global drought risk. The initiative resulted in an integrated approach to reducing societal vulnerability to drought, which has been used to promote drought-resilient nations and communities around the world (see http://www.unisdr.org/eng/task%20force/tf-adhoc/droughts/WGD-doc1.pdf).

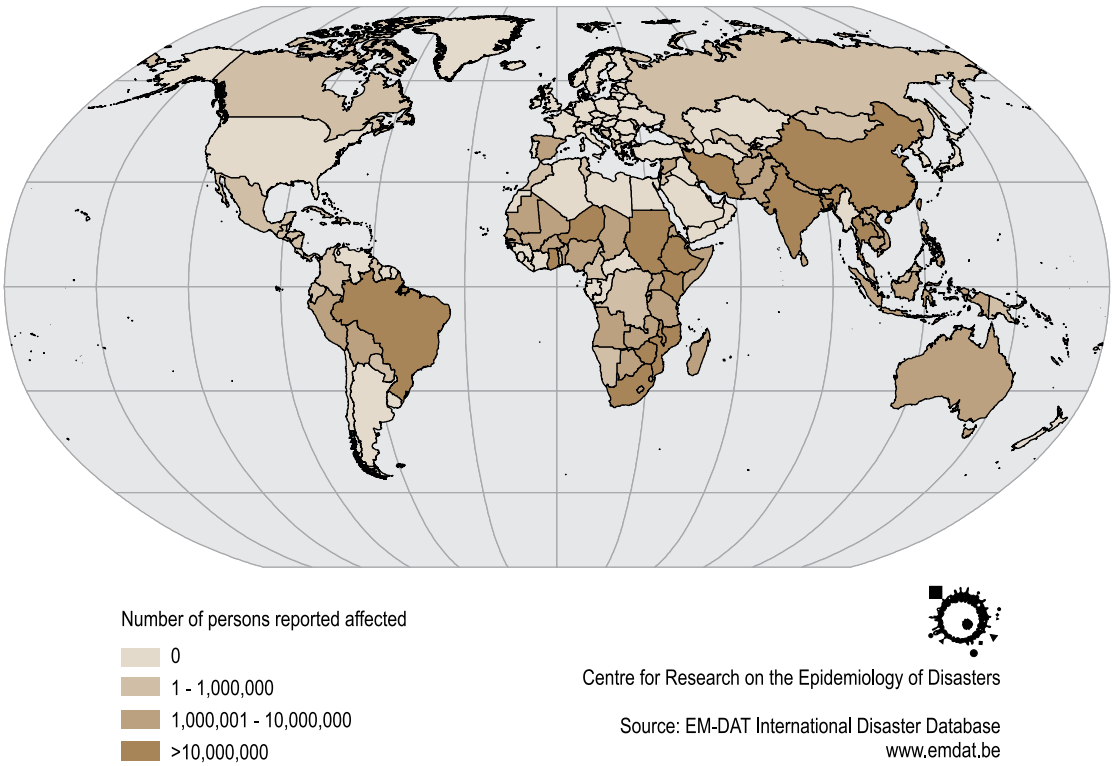
Subsequently, the second World Conference on Disaster Reduction was held in Kobe, Hyogo, Japan, in January 2005, where governments adopted the landmark "Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters". This Framework outlines five priorities to build resilience of nations and communities to natural hazards (see http://www.unisdr.org/hfa):

- Governance: organizational, legal, and policy frameworks;
- Risk identification, assessment, monitoring, and early warning;
- Knowledge management and education;
- Reducing underlying risk factors;
- Preparedness for effective response and recovery.

The primary responsibility for implementing the Hyogo Framework for Action lies with governments of UN Member States, but the ISDR system including UN agencies, regional organizations, academic and civil society institutions and international organizations is also actively involved.

Drought is a slow-onset natural hazard that allows for the implementation of disaster risk reduction measures as requested by the Hyogo Framework for Action. Understanding drought's evolution, complexity, and social implications including people's vulnerability to drought, permits planners and the public to implement effective

Figure 3:
Number of drought disasters reported by country: 1970-2008



mitigation and preparedness measures to reduce drought impacts. To this end, wide-ranging and well-coordinated efforts at international, regional, and national levels are needed to build drought-resilient communities and societies.

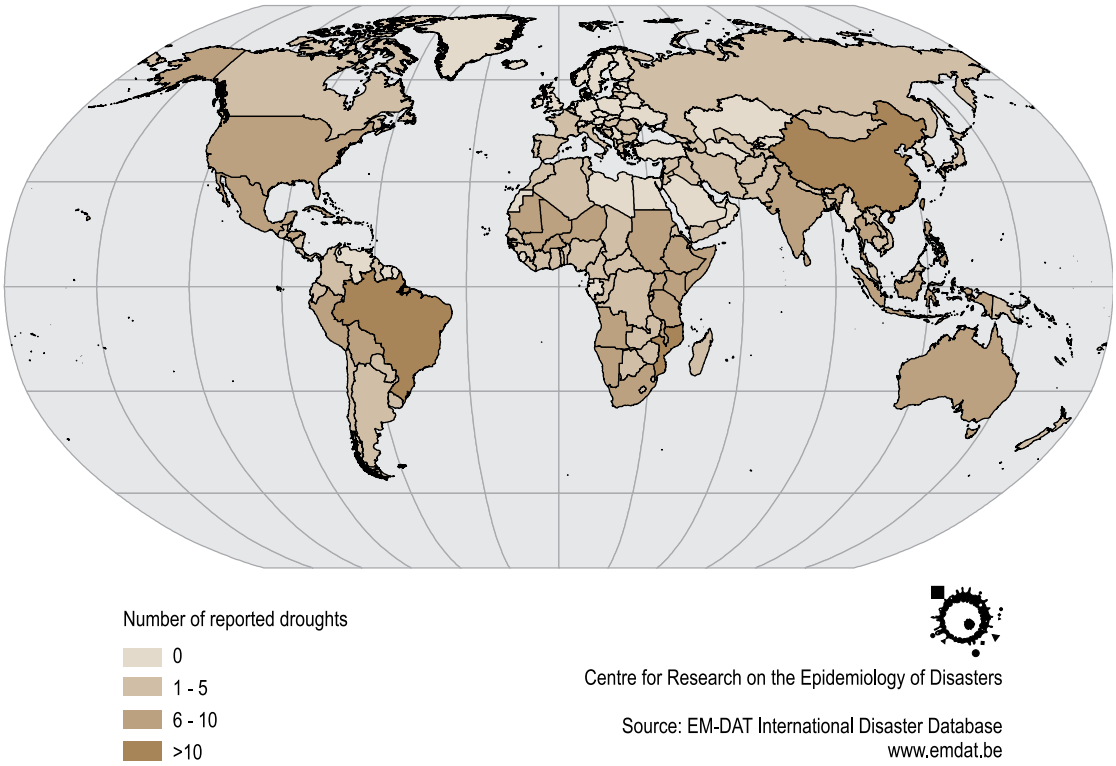
In order to merge criteria from the UNISDR's 2003 drought risk reduction integrated approach and the Hyogo Framework for Action, the members of the Ad Hoc Group on drought were re-convened in Beijing, China, in June 2006, with the support of the Ministry of Civil Affairs and the China National Committee for Disaster Reduction. At this meeting, the members discussed elements for drought policies in line with the priorities of the Hyogo Framework for Action. Later on, an initial draft, which outlined the elements of a framework for drought risk reduction, was presented at the 2nd African Drought Risk and Development Forum. The forum, organized by the UNDP/Drylands Development Centre (DDC) and the UNISDR in Nairobi in October 2006, brought together representatives of governments; international, regional and UN organizations; experts; and practitioners who provided valuable comments to the paper. The preliminary version has been reviewed by various experts and organizations since 2007. Additional contributions were made at the 3rd African Drought Adaptation Forum in Addis Ababa in September 2008. The recommendations made at the Forum are introduced in Chapter 5. A summary of the group discussion at the 3rd African Drought Adaptation Forum is also available in Annex 4.

The present document considers the recommendations of the cited international meetings, ongoing discussions, and the identification of information and good practices to present an integrated global framework geared toward reducing the effects of drought as part of the implementation of the Hyogo Framework for Action.

The present drought risk reduction framework proposes the following five main elements for consideration, namely:

i) Policies and governance for drought risk reduction,
ii) Drought risk identification, impact assessment, and early warning,

Figure 4:
Number of persons reported affected by drought disasters: 1970-2008



iii) Drought awareness and knowledge management
iv) Reducing underlying factors of drought risk, and
v) Effective drought mitigation and preparedness measures

The five elements correspond to the five priorities of the Hyogo Framework for Action. The framework is complemented with information on existing networks and mechanisms to encourage the implementation of international, regional and national programmes for drought risk reduction. The drought risk reduction framework should also build on the work of various existing networks contributing to negotiations for the multilateral environmental agreements (MEAs) such as the Convention to Combat Desertification (UNCCD) and United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD).

The UNCCD is rooted in a Plan of Action to Combat Desertification, adopted by the United Nations Conference on Desertification in 1977. The UNCCD was adopted in 1994 and came into force two years later. As of 31 January 2009, the Convention had 193 country Parties. The eighth session of the Conference of the Parties (COP 8) held in Madrid, Spain, in June 2007, adopted a 10-year strategic plan and framework to enhance the implementation of the Convention (2008-2018) and effectively combat desertification and drought (see report of the COP 8 at http://www.unccd.int/). The 10-year plan clearly defines goals and a time frame with the recognition that the UNCCD had previously lacked such a strategic framework for effective implementation.

The strategic plan will operate through five specific objectives: 1) advocacy, awareness-raising and education, 2) enhanced policy framework, 3) science and technology, 4) capacity building, and 5) financing and technology transfer. In addition, roles and responsibilities of the various UNCCD institutions, partners and stakeholders have been reshaped, including those of the Committee on Science and Technology (CST), the Committee for the Review of the Implementation of the Convention (CRIC), the Global Mechanism (GM) and the UNCCD secretariat.

Drought risk reduction is also connected with another important international environmental convention, the UNFCCC. The UNFCCC encourages the Parties to cooperate in preparing for adaptation to the impacts of climate change and to develop appropriate plans for various areas including water resources, agriculture and rehabilitation of regions, particularly in Africa, affected by drought, desertification and floods (see http://unfccc.int/resource/docs/convkp/conveng.pdf). There are at least two areas where activities related to drought risk reduction can be undertaken within the UNFCCC-led framework: 1) adaptation to the impacts of climate change, and 2) research and systematic observation. Developing more coordination between these types of drought-related programmes is essential for fostering drought risk reduction.

The Bali Action Plan that was agreed by the UNFCCC Thirteenth Conference of the Parties, held in Bali, Indonesia, 3-14 December 2007, sets out directions for adaptation in its Paragraph 1(c). Sub-paragraph 1 (c) (ii) and (iii) call for enhanced action on adaptation through consideration of:

- Risk management and risk reduction strategies, including risk sharing and transfer mechanisms such as insurance;
- Disaster reduction strategies and means to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change.

Through these elements the Parties have made clear that existing knowledge and capacities for coping with extreme weather events must be harnessed to adapt to climate change.
In addition, Sub-paragraph 1 (c) (i) identifies a number of general principles and requirements necessary for adaptation. Many of these have been identified in other settings as being highly relevant to reducing disaster risk, particularly vulnerability assessments, capacity-building and response strategies, as well as integration of actions into sectoral and national planning. There are clear linkages between adaptation and disaster risk reduction. (For full text of the Bali Action Plan, see http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf).

Environmental management and climate change are discussed in greater detail under Section 4.4.1 of this document.

The Convention on Biological Diversity (CBD), administered by UNEP, provides another relevant framework for drought risk reduction. In particular, its programmes on Dry and Sub-humid Lands Biodiversity and Traditional Knowledge, Innovations and Practices, offer valuable expertise and networks to promote and support the objectives of drought risk reduction (for more information, see http://www.cbd.int/drylands/ and http://www.cbd.int/traditional/).

In close collaboration with these existing initiatives and programmes, this document also highlights the need to foster proactive drought risk reduction strategies and activities to address drought's root causes rather than relying solely on emergency response measures. It also stresses a move from policies to practices through the development of a knowledge network to identify indigenous practices, exchange expertise, and propose simple and affordable technologies and good practices that can be promoted and implemented in vulnerable communities through coordinated programmes and projects.

Considerable progress is being made in drought monitoring, mitigation, and preparedness policies and practices in many countries. Collaboration between countries experienced in drought risk reduction and interaction with regional and international initiatives can contribute to enhancement of knowledge networks to reduce the effects of drought.

Chapter 2

Drought definition and typology

Drought is a natural part of climate, although it may be erroneously considered as a rare and random event. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. Drought is a temporary aberration; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate.

Drought is categorized as a hydro-meteorological hazard. According to the UNISDR Terminology on Disaster Risk Reduction 2009, hazard is defined as "a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage". In technical settings, hazards are often described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis.

The above-mentioned publication, "2009 UNISDR Terminology", aims to promote common understanding and common usage of disaster risk reduction concepts and to assist the disaster risk reduction efforts of authorities, practitioners and the public. The 2009 UNISDR Terminology is the result of a process of ongoing review by the UNISDR and consultations with a broad range of experts and practitioners in various international venues, regional discussions and national settings. The Terminology is available in Annex 1. It is also available at: http://www.unisdr.org/eng/terminology/UNISDR-Terminology-English.pdf as well as in the other UN languages. For more details of other hazard-related terms such as biological hazard, geological hazard, natural hazard, socio-natural hazard and technological hazard, see Annex 1.

A broad definition of drought is a deficiency of precipitation over an extended period of time, usually a season or more, which results in a water shortage for some activity, group, or environmental sectors. However, in terms of typologies, droughts are classified as meteorological, agricultural, hydrological, and socio-economic (Figure 5).

Meteorological drought is a natural event that results from climatic causes, which differ from region to region. Agricultural, hydrological, and socio-economic drought, however, place greater emphasis on the human or social aspects of drought. They highlight the interaction between the natural characteristics of meteorological drought and human activities that depend on precipitation to provide adequate water supplies to meet societal and environmental demands.

*Meteorological drough*t is usually defined by a precipitation deficiency over a pre-determined period of time. The thresholds chosen, such as 50 percent of normal precipitation over a six-month time period, will vary by location according to user needs or applications.

Agricultural drought is defined more commonly by the lack of availability of soil water to support crop and forage growth than by the departure of normal precipitation over some specified period of time.

The relationship between precipitation and infiltration of precipitation into the soil is often not direct. Infiltration rates vary depending on antecedent moisture conditions, slope, soil type, and the intensity of the precipitation event. Soil characteristics also differ. For example, some soils have a higher water-holding capacity, which makes them less vulnerable to drought.

Hydrological drought is normally defined by deficiencies in surface and subsurface water supplies relative to average conditions at various points in time through the seasons.

Like agricultural drought, there is no direct relationship between precipitation amounts and the status of surface and subsurface water supplies in lakes, reservoirs, aquifers, and streams because these hydrological system components are used for multiple and competing purposes, such as irrigation, recreation, tourism, flood control, transportation, hydroelectric power production, domestic water supply, protection of endangered species, and environmental and ecosystem management and preservation. There is also a considerable time lag between departures

of precipitation and the point at which these deficiencies become evident in surface and subsurface components of the hydrologic system.

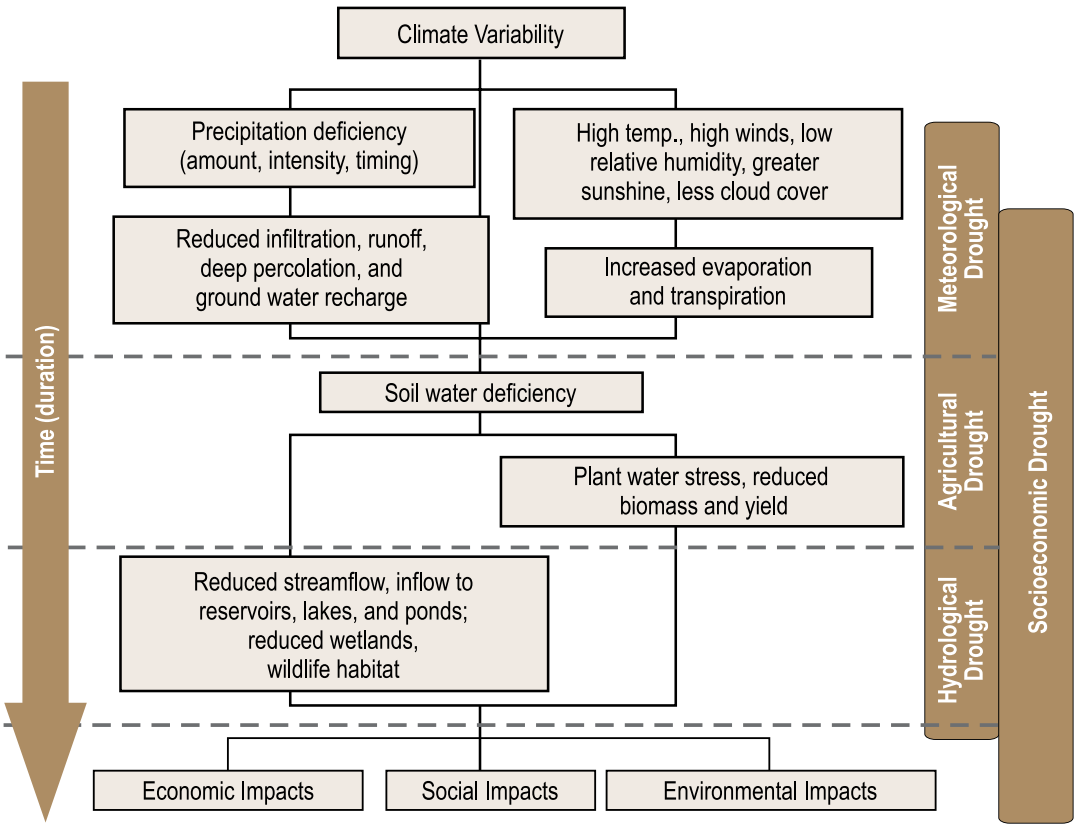
Socio-economic drought differs markedly from the other types of drought because it reflects the relationship between the supply and demand for some commodity or economic good (such as water, livestock forage, or hydroelectric power) that is dependent on precipitation. Supply varies annually as a function of precipitation or water availability. Demand also fluctuates and is often associated with a positive trend as a result of increasing population, development and other factors.

The relationship between these types of drought is illustrated in Figure 5. Agricultural, hydrological and socio-economic drought, occur less frequently than meteorological drought because impacts in these sectors are related to the availability of surface and subsurface water supplies. It usually takes several weeks before precipitation deficiencies begin to produce soil moisture deficiencies leading to stress on crops, pastures, and rangeland. Continued dry conditions for several months at a time bring about a decline in streamflow and reduced reservoir and lake levels and, potentially, a lowering of the groundwater table.

When drought conditions persist for a period of time, agricultural, hydrological and socio-economic drought occur, producing associated impacts. During drought, not only are inflows to recharge surface and subsurface supplies reduced, but demand for these resources increases dramatically as well.

As illustrated in Figure 5, the direct linkage between the main types of drought and precipitation deficiencies is reduced over time because water availability in surface and subsurface systems is affected by how these systems are managed. Changes in the management of these water supplies can either reduce or aggravate the effects of drought. For example, the adoption of appropriate tillage practices and planting more drought-resistant

Figure 5:
Relationship between meteorological, agricultural, hydrological and socio-economic drought



Source: National Drought Mitigation Center, University of Nebraska-Lincoln, USA

crop varieties can diminish the effect of drought significantly by conserving soil water and reducing transpiration. Therefore, the effects of drought are a product of both the physical nature of the hazard and our ability to manage risk.

As explained in Chapter 3, drought does not automatically lead to a disaster. Disaster only occurs when there is a serious disruption of the functioning of a community or a society, which involves widespread human, material, economic or environmental losses and impacts, and which exceeds the ability of the affected community or society to cope using its own resources. These potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period, are defined as "disaster risk".

The term "drought risk" used in this document is coherent with the above-mentioned definition of "disaster risk". By adapting the UNISDR Terminology for "disaster risk management", "drought risk management" can be defined as "the systematic process of using administrative directives, organizations and operational skills and capacities to implement strategies, policies and measures for improved coping capacities in order to lessen, i.e., prevent, mitigate and prepare for, the adverse impacts of drought and the possibility of disaster".

Likewise, "drought risk reduction" can be defined as "the concept and practice of reducing disaster risks though systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to drought (prevention), lessened vulnerability of people and property (mitigation), wise management of land and the environment, and improved preparedness for adverse events", or simply, as the purpose of disaster risk management. Furthermore, "drought mitigation" can be defined as "the lessening or limitation of the adverse impacts of drought and related disasters".

A methodology of "drought risk assessment" aims to determine the nature and extent of drought risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend. Drought risk assessments (and associated risk mapping) include: a review of the technical characteristics of drought such as their location, intensity, frequency and probability, the analysis of exposure and vulnerability including the physical, social, health, economic and environmental dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities in respect to likely risk scenarios. This series of activities is sometimes known as a risk analysis process. More detailed information on drought risk assessment is found in Chapter 4 (4.2).

Box 1:
UNCCD definition of "drought"

Article 1 of the UNCCD defines "drought" as "the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems". Article 1 also defines "mitigating the effects of drought" as "activities related to the prediction of drought and intended to reduce the vulnerability of society and natural systems to drought as it relates to combating desertification" (www.unccd.int/convention/text/convention.php).

Chapter 3

Understanding drought risk and vulnerability

As mentioned in Chapter 2, "disaster risk" is defined as "the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period", based on a definition of "risk" as "the combination of the probability of an event and its negative consequences".

The risk associated with drought for any region or group is a product of the exposure to the natural hazard and the vulnerability of the society to the event (Figure 6). The UNISDR definition for "vulnerability" is "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard" (http://www.unisdr.org/eng/terminology/UNISDR-Terminology-English.pdf). Therefore, leaders and planners in drought-prone regions should conduct risk assessments to both better understand the drought hazard and identify the factors and processes concerning who and what is most at risk to drought, and why. For information on drought risk assessment see Chapter 4 (4.2).

Exposure to drought varies regionally and over time, and there is little, if anything, that can be done to alter its occurrence. However, it is critically important for scientists to understand and communicate the probability of drought events of various levels of intensity and duration. It is also essential to understand precipitation and temperature trends, including changes in variability, because these key meteorological variables may indicate potential changes in the frequency and severity of future drought episodes.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) released the report "Impacts, Adaptation and Vulnerability", as a part of its Fourth Assessment Report "Climate Change 2007". The report confirms that our atmosphere is warming, a trend that will have an impact on the frequency and severity of some natural hazards, such as drought (see http://www.ipcc.ch/ipccreports/ar4-wg2.htm). The report notes that recent climate changes and variations are beginning to affect many natural and human systems. For example, in the Sahel region of Africa, warmer and drier conditions have led to a reduced length of the growing season, with detrimental effects on crops. In southern Africa, longer dry seasons and more uncertain rainfall are prompting adaptation measures. The report also notes that drought-

Figure 6:
Global trends and risk components

Natural and human-induced hazards: Increase in frequency, severity, duration and extent, e.g.: drought and floods combine with extreme climatic events.

Increasing vulnerability (some factors)

Socio-economic:
People's vulnerability, poverty, unsafe conditions, fragile local economy, livelihoods at risk, lack of awareness and plans, limited institutional capacities and resources, etc.

Physical:
Insufficient land use planning, housing and infrastructures located in hazard prone areas, etc.

Environmental:
Degradation of ecosystems, inappropriate or unsustainable management of natural and water resources, etc.

Source: The International Strategy for Disaster Reduction, UNISDR

affected areas will likely increase in extent. Climate change is, therefore, an important factor to be considered in drought risk analysis.

Drought by itself does not trigger an emergency. Whether it becomes an emergency or not depends on its effect on local people, communities and society, and this, in turn, depends on their vulnerability to the stress of the drought.

People's vulnerability to drought is complex. Drought results in substantial effects in both developing and developed countries, but the characteristics of these effects differ considerably. The ability to cope with drought also varies considerably from country to country and from one region, community, or group to another when "coping capacity" is defined as "the ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters" (see Annex 1 of 2009 UNISDR Terminology). Therefore, a vulnerability profile, including analysis of vulnerability factors, is an invaluable tool in assessing local risk. The vulnerability profile is a cornerstone of drought risk reduction planning.

A complete vulnerability analysis requires an assessment of both the macro and micro contexts, and of local people's response to that context. For example, the effect of drought in southern Africa must consider the context of violent conflict in some areas, a major health crisis in the form of the HIV/AIDS pandemic and deepening poverty in many parts of the region. Added to this are well-documented cases of damaging policies, such as the mismanagement of strategic grain reserves and slowness in international relief operations. This macro context has resulted in large numbers of people who are now more vulnerable to the drought than they were ten years ago. The micro context varies, of course, from one location to another.

Micro and macro contexts are also important in developed countries such as the United States, Canada and Australia, where droughts have resulted in widespread and severe effects in many sectors. In these instances, greater institutional capacity and resources are available to monitor, prepare for, and respond to drought, but the effects are still devastating to individual families' livelihoods, as well as to the environment and social fabric of local communities. The interaction and linkage between macro and micro level initiatives are elaborated in Figure 14 in Chapter 4.

To understand what is happening at the micro level requires an understanding of local livelihoods and of coping strategies and capacities. How diverse and drought-resistant are local people's livelihoods? How strong is their asset base to tide them over during a prolonged period of drought? What claims can the most vulnerable groups make on those groups that are not as vulnerable? Understanding these dynamics is essential in understanding vulnerability, the likely effect of drought and appropriate responses.

One way to better understand vulnerability is through a livelihoods approach, especially if it captures both macro and micro factors and long-term trends that affect vulnerability and the impact of short-term shocks. Much work has been done by operational agencies and by researchers to develop various livelihoods frameworks, to make sense of the complex ways in which individuals, households, and communities achieve and sustain their livelihoods, and the likely impact of an external shock such as drought on both lives and livelihoods.

The essence of a livelihoods approach is that it puts people at the centre of the analysis and is cross-sectoral, taking into account economic, political and cultural factors. Understanding the asset base is also crucial, including physical assets such as land and livestock, human capital and social capital. Generally speaking, the stronger and more diverse the household's asset base, the more drought-resilient it is likely to be and the greater its ability to switch between different livelihood strategies.

For example, drought conditions can severely affect agricultural and pastoral livelihoods and increase vulnerability and risks for farmers, pastoralists and people depending on such livelihoods. For farmers who are strongly dependent on rainfall for agricultural activities, crop failure caused by drought can lead to household food insecurity. If appropriate drought mitigation and preparedness actions are not implemented, the only means left

Box 2:
Pastoralism as a risk management strategy

Drought does not automatically lead to disaster. Only when it hits vulnerable people who are unable to cope with its effects does it become a disaster. For example, in order to mitigate risks in variable and unpredictable rangeland environments, pastoralism provides a highly flexible and adaptive livelihood strategy. It incorporates a variety of risk management strategies and resilience enhancement mechanisms, as follows:

1. Livestock mobility: mobility optimizes the use of range, using large diverse ranges comprising wet, dry and drought time grazing areas managed as common property
2. Livestock density: diverse herds and flocks (grazers and browsers) reduces risk from disease, drought and parasites
3. Maximizing stock densities: stock accumulation helps to ensure long term survival after drought stock loss
4. Redistributing assets: mutually supportive relationships and support networks are critical for coping with crises
5. Livelihood diversification: mitigating risk from drought may involve diversification into distant labour or trading markets
6. Herd splitting: herd splitting spreads risks and enables systems of strong social relations and security to be maintained
7. Use of wild foods: households may gather foods in order to supplement reduced yields during droughts
8. Opportunistic cultivation: rain-fed or flood recession agriculture is practiced to spread risk

However, a range of social, economical and political factors can lead to pastoralists' inability to cope with drought. Mobility is an integral aspect of pastoralist methods of coping with drought. However, in many cases their freedom of movement has been restricted because of the creation of national and district boundaries, fencing and tilling of the land, and the establishment of national park and reserves. Water sources are frequently inaccessible to the herds and pastoralists are forced to remain in marginalized areas that are prone to severe natural resource degradation. Conflict and insecurity further restrict mobility in some areas where pastoralists are afraid to utilize the good rangelands. Inadequate physical infrastructure, poorly functioning markets and inaccessibility of market information means that pastoralists do not sell their animals when they need to, thereby negatively affecting off-take rates. Furthermore, pastoralists' interests are often not reflected in government policies. Absent or inadequate policies related to marketing of livestock products and dryland commodities, education, and health (reinforced by weak service delivery and lack of local capacity, especially among women) can further hamper pastoralists' ability to cope with drought, leaving them among the most vulnerable people in the African dryland areas.

Source: WISP Policy Note No. 04, 2007. Pastoralists as Shrewd Managers of Risk and Resilience in the Horn of Africa

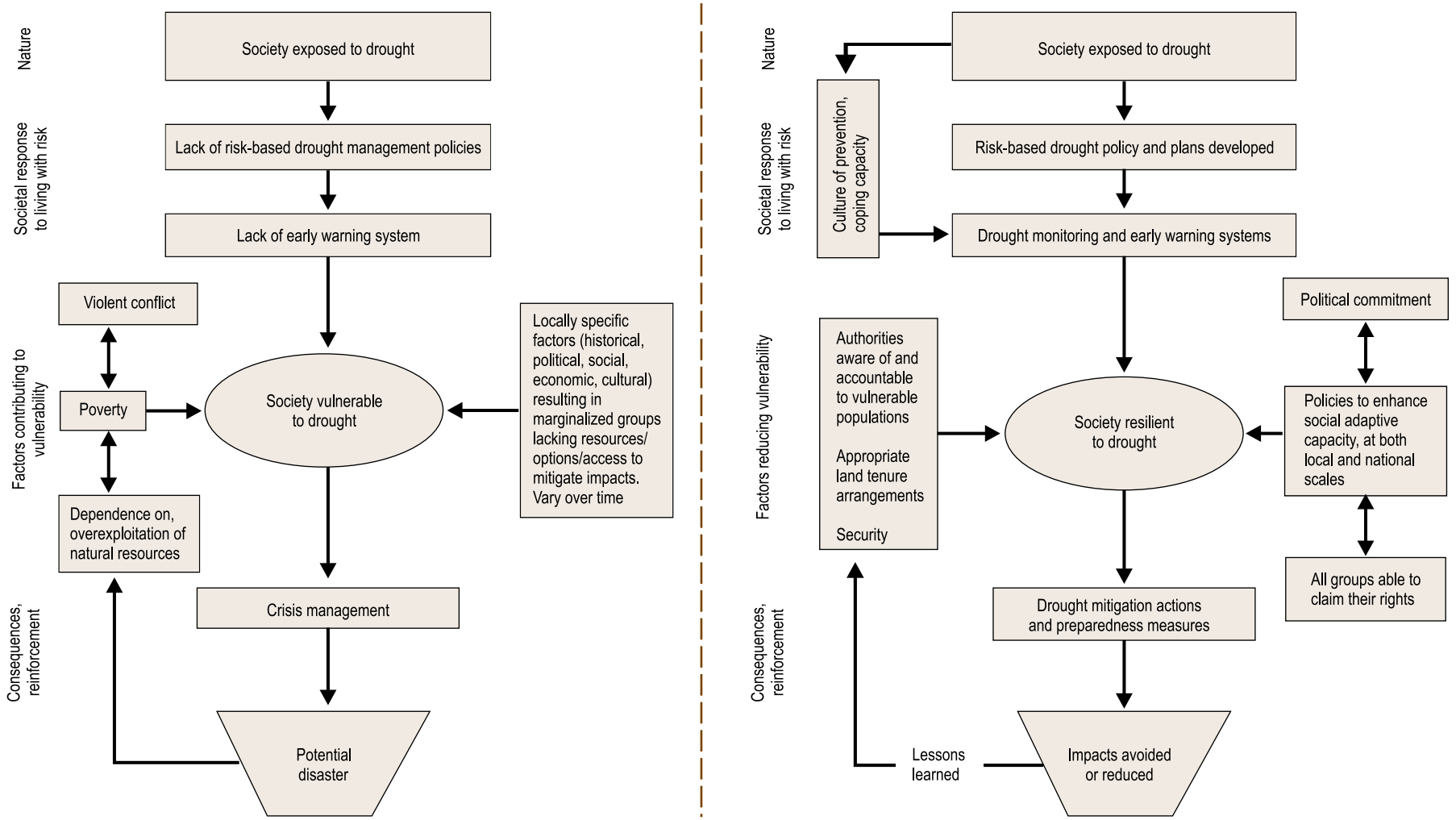
for those households to purchase food and basic necessities at the time of continued drought could be selling assets such as tools and animals.

For pastoralists and agro-pastoralists whose livelihoods and food security depend on livestock, drought conditions can cause malnutrition or disease in livestock because of insufficient fodder and deterioration in pastoral lands. The impacts on local markets can cause a hike in the prices of feed and a significant drop in the prices of livestock. (http://www.usaid.gov/our_work/humanitarian_assistance/disaster_assistance/countries/horn_of_africa/template/files/drought_response_summary.pdf).

These negative impacts on life and livelihoods have been often reduced by the application of pastoralism. This is a highly flexible and adaptive livelihood strategy that has been adopted as a coping strategy by pastoralists for mitigating drought risks. For further details, see Box 2.

It is important to assess livelihood vulnerability in order to fully understand underlying risks and vulnerabilities in specific drought-affected

Figure 7:
Characteristics of drought vulnerable and drought resilient societies



Source: Modified from Drought: Leaving with Risk , International Strategy for Disaster Reduction, UNISDR. 2003

communities. Tree diagrams (Figure 15 and 16) illustrating underlying causes for drought impacts for the agriculture sector and the animal husbandry sector, respectively, are shown in the section on risk assessment methodology (Section 4.2.2).

There are subtle differences between the various agencies' frameworks for analyzing and understanding livelihoods. Those that focus on the macro context and political factors are stronger in incorporating power relationships that are often underplayed.

Overall, drought risk assessment must consider both an improved understanding of the natural hazard and human exposure to this climatic extreme, as well as a better understanding of the micro and macro context of people's vulnerability to drought. With this understanding, enhanced drought mitigation, preparedness, and response measures can be identified and implemented to create a more drought resilient society. Some examples of sector-wise drought impact assessment that involved the analysis of livelihoods in Portugal, the United States, and Viet Nam are introduced in Chapter 4.

Figure 7 illustrates the differences between a society vulnerable to drought and a society resilient to drought, taking into consideration societal behaviour, vulnerability factors, and consequences.

Chapter 4

Main elements for a drought risk reduction framework

The elements for a drought risk reduction framework can be summarized in five main areas of endeavour (Figure 8), all of which consider priorities of the UN International Strategy for Disaster Reduction, the Hyogo Framework for Action, regional strategies, and thematic risk reduction documents:

1. *Policy and governance* as an essential element for drought risk management and political commitment.
2. *Drought risk identification, impact assessment, and early warning,* which includes hazard monitoring and analysis, vulnerability and capability analysis, assessments of possible impacts, and the development of early warning and communication systems.
3. *Drought awareness and knowledge management* to create the basis for a culture of drought risk reduction and resilient communities.
4. *Reducing underlying factors of drought risk* such as changing social, economic and environmental conditions, land use, weather, water, climate variability and climate change.
5. *Strengthening preparedness for drought* to move from policies to practices in order to reduce the potential negative effects of drought.

All of these elements need strong political commitment, community participation, and consideration of local realities and indigenous knowledge. The international and regional communities also play an important role in coordinating activities, transferring knowledge, supporting project implementation, and facilitating effective and affordable practices.

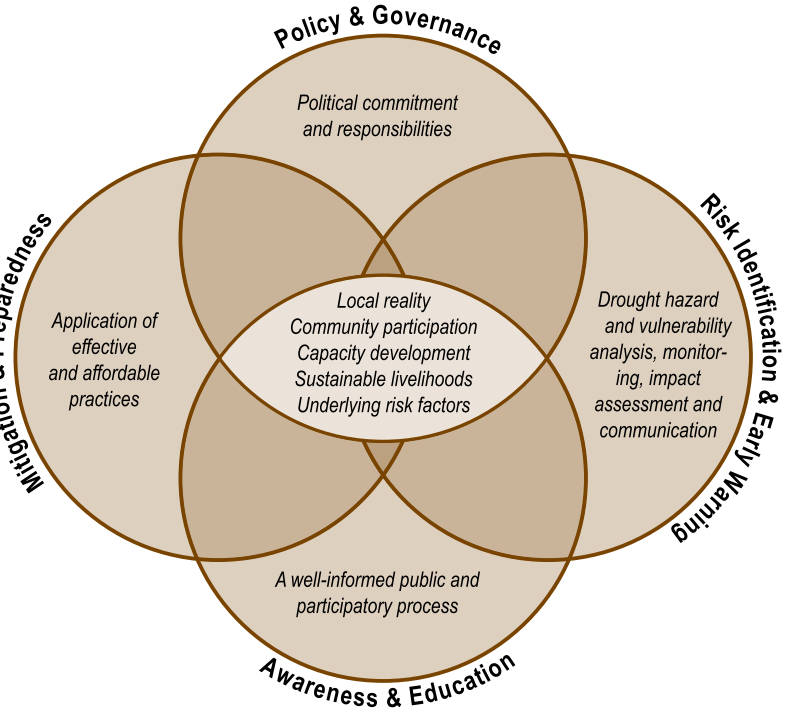


Figure 8: Proposed main elements for Drought Risk Reduction Framework

Source: UNISDR and National Drought Mitigation Center, University of Nebraska-Lincoln, USA

4.1 Policies and governance for drought risk reduction

Related to Priority 1 of the Hyogo Framework for Action: To ensure that drought risk reduction is a national and local priority with a strong institutional basis for implementation.

Leaders and other high-level authorities at the apex of political and economic power need to be fully aware of the danger that drought poses, aware of the hardship it creates for people whose livelihoods are vulnerable to drought, and committed to disseminating information and implementing policies to help reduce human suffering and environmental degradation. Often, people at all levels of government in both developed and developing countries are preoccupied with other faster-moving, seemingly more urgent problems, until drought strikes, at which point it is difficult to implement change.

Building drought resilience thus needs to be part of long-term development considerations and an integral part of policies related to agriculture, water, food security and hazard risk management, ideally, in accord with community-based policies and practices, encouraging practices that reduce vulnerability to drought. All this requires sustainable policies and governance, which may necessitate capacity development to foster meaningful participation in policy and planning processes.

Guiding principles

The development of national and local strategies for reducing drought risk, together with the implementation of such a strategy, should be guided by the following principles:

1 Political commitment, high-level engagement, strong institutional setting, clear responsibilities both at central and local levels and appropriate governance are essential for integrating drought risk issues into a sustainable development and disaster risk reduction process,
2 A bottom-up approach with effective decentralization and active community participation for drought risk management in planning, decision making and implementation, is essential to move from policy to practice,
3 Capacity building and knowledge development are usually required to help build political commitment, competent institutions and an informed constituency,
4 Drought risk reduction policies should establish a clear set of principles or operating guidelines to govern the management of drought and its impacts, including the development of a preparedness plan that lays out a strategy to achieve these objectives,
5 Drought-related policies and plans should emphasize risk reduction (prevention, mitigation and preparedness) rather than relying solely on drought (often turned into famine) relief,
6 Drought monitoring, risk assessment and other appropriate risk reduction measures are principal components of drought policies and plans,
7 Institutional mechanisms (policy, legislative and organizational) should be developed and enforced to ensure that drought risk reduction strategies are carried out, and
8 Sound development of long-term investment in risk reduction measures (prevention, mitigation and preparedness) is essential to reduce the effects of drought.

4.1.1 Building political and public alliances

Political commitment, high-level engagement, strong institutions and appropriate governance are essential for building and maintaining the necessary support to formulate drought policies, and for integrating drought risk issues into a disaster risk reduction and sustainable development process. Drought risk reduction is a long-term commitment that should complement long-term sustainable development planning efforts, such as meeting the United Nations

Millennium Development Goals (MDGs) (www.un.org/millenniumgoals) and in the Poverty Reduction Strategies.

A partnership between UNDP/DDC, UNEP and the Global Mechanism of the UNCCD facilitated the production of a preliminary version of a practical guide for mainstreaming drought risk reduction into national development frameworks in 2007, entitled "Generic Guidelines for Mainstreaming Environment with a particular focus on Drylands into National Development Frameworks". The Guidelines include a wide range of mainstreaming tools, from which to choose for each major step of the mainstreaming process (see Box 3) based on analysis of case studies of various countries in Africa, Asia, Pacific and Latin America and Caribbean.

Community participation, both in decision making and implementation, is also essential in order to move from policy to practice. Participation is required to develop policies and strategies that are relevant, feasible and equitable at the local level. It may also help create a larger sense of community ownership among stakeholders that will foster commitment and responsibility when implementing drought policy. Developing an effective drought risk reduction strategy and implementing it in practical actions requires the contribution and coordination of organizations and institutions at all levels. Each has a particular function for which it is responsible and accountable.

The Hyogo Framework for Action (HFA) describes the responsibilities of different actors for its

Box 3:
Generic steps for drylands mainstreaming

Strategic assessment phase

Step 1: Identifying and analyzing the status of land issues and their environmental, economic and social impacts, taking into account the various direct and indirect drivers of change affecting land issues
Step 2: Identifying and filling information needs/analysis
Step 3: Assessing legal, political and institutional environment for mainstreaming
Step 4: Conducting a stakeholder analysis and defining roles, responsibilities and obligations
Step 5: Carrying out capacity assessment

Awareness, participation and partnership-building phase

Step 1: Drawing up a communication and awareness creation strategy
Step 2: Building partnerships for mainstreaming
Step 3: Planning for participation and consultation processes

Planning phase

Step 1: Undertaking iterative and integrated planning
Step 2: Linking the plans to budgets and funding mechanisms

Implementation phase

Step 1: Building capacity
Step 2: Implementing the plans

Learning, monitoring and evaluation phase

Step 1: M&E of planning frameworks for impacts
Step 2: Evaluation of the effectiveness of mainstreaming processes
Step 3: Revision of the planning frameworks.

Source: Generic Guidelines for Drylands Mainstreaming, Part I: Generic Guidelines for Mainstreaming Drylands Issues into National Development Frameworks, 1st Edition, UNDP, October 2008 available at http://www.undp.org/drylands/docs/publications/Guidelines_Lessons_Learned_for_Mainstreaming_Drylands.pdf

implementation. According to the HFA, the ISDR system supports national policies and coordination mechanisms, facilitates regional and international coordination, stimulates the exchange of good practices, reviews and documents progress toward implementation of the HFA, and produces practical tools to help policymakers and decision makers promote and implement disaster risk reduction measures in their respective countries and regions. In this document, the term "ISDR system" is referred to collectively as various international, regional and national bodies, platforms, programmes and mechanisms expressly established to support the implementation of the ISDR and the HFA. (http://www.unisdr.org/eng/hfa/docs/Words-into-action/Words-Into-Action.pdf)

The roles and responsibilities of the main categories of stakeholders are summarized as below:

A. *Community-based organizations,* particularly those representing the most vulnerable, are key to people-centred drought risk reduction strategies and actions. Their indigenous knowledge and ability to cope with drought and to respond will ultimately determine the extent of risk and drought impact. They should be aware of drought hazards and the related effects to which they are exposed, and be able to take specific actions to minimize the threat of loss or damage. Local communities also promote the use of traditional and local knowledge and know-how.

B. *Local governments* usually have direct responsibilities for citizen safety and considerable knowledge of the hazards to which their communities are exposed. They must be actively involved in the design and implementation of drought risk reduction programmes and projects, and understand all advisory and warning information received in order to be able to advise, instruct, or engage the local population in a manner that increases their safety and reduces the possible loss of resources and livelihoods on which the community depends. Local government also serves as the interface between local and national governments.

C. *National governments* are responsible for policies and frameworks (including national development plans, reflecting the Hyogo Framework, MDGs, PRSPs and MEAs) that facilitate drought risk reduction practices, as well as the technical systems required for preparing and issuing timely warnings. National governments ensure coordination among different line ministries as well as with bilateral and multilateral partners through national platforms for disaster risk reduction (http://www.unisdr.org/guidelines-np¬eng) and other existing mechanisms.

   National governments have responsibility to ensure the implementation of policies and legal instruments, develop risk reduction measures (prevention, mitigation and preparedness), and ensure that transition warnings and related responses address all the population, particularly the most vulnerable. They provide support to local governments and communities to develop coping capabilities and translate drought risk reduction policies into local practices. Undertaking baseline assessments and reviewing the progress toward achieving the objectives and priorities of the Hyogo Framework are also the responsibility of the national governments.

D. *Regional institutions and organizations* provide specialized knowledge and advice in support of national efforts to develop or sustain coping and operational capabilities of countries that share a common drought-prone geographical environment. Regional organizations are crucial to linking international capabilities to the particular needs of individual countries and in facilitating effective drought risk reduction practices among adjacent countries in regard to transboundary disaster risk reduction issues and response (e.g., drought-triggered refugees or migrants). Areas for such regional technical support could include regional baseline assessments, progress reviewing, development of regional early warning capacities and other capacities such as education, training and awareness.

E. *International bodies (multilateral and bilateral)* provide support for national drought risk

reduction programmes and projects and foster the exchange of globally consistent data and knowledge among countries. Support may include provision of advisory information, technical assistance, and policy and organizational support necessary to ensure the development of the operational capabilities of national authorities or agencies responsible for disaster and drought risk reduction. International partners mobilize technical and financial resources to support the preparation, adoption, implementation and review of global agreements such as the Hyogo Framework, MDGs, PRSPs and MEAs. International partners also develop information resources including policy and technical guidance materials as well as tools such as indicators, procedures, good practices, training modules, etc.

F. *Civil society organizations* play a critical role in raising awareness among individuals and neighbourhoods for the implementation of drought risk reduction policies and practices at the community level. This includes religious leaders and organizations that have a powerful voice in communities and can help raising awareness and disseminating public information. In addition, these individuals and groups play an important advocacy role to help ensure that reducing drought risk stays on the agenda of high-level government leaders and policymakers. Some actions promoted by CBOs and NGOs are at the cutting edge of people-centred drought risk reduction practices. They usually have a level of flexibility in accessing funding and implementing pilot strategies and programmes that can inform national and international drought risk reduction policy and practice.

G. *The private sector* has an important and diverse role to play in drought risk reduction, including developing coping capabilities within their own businesses (mainly for business continuity but also for corporate social responsibility). In addition, the private sector has a large untapped potential to help provide skilled services in the form of technical resources, know-¬how, and donations (in-kind and cash) of goods or services, especially for the communication and dissemination of risk reduction measures (prevention, mitigation and preparedness), including the development and communication of early warnings to reduce drought impacts. Contributions and interventions of the private sector that augment and comply with international good practices are essential.

H. *The media* also plays an important role in developing and enhancing disaster reduction consciousness of the general population as well as disseminating early warnings. In many cases, the media is the primary means of communication between policymakers, practitioners and the public. In this regard, the media carries a great responsibility to serve the needs of their audiences, and policymakers and practitioners are tasked with improving ways to formulate messages that are "newsworthy" attracting the public attention through the media.

I. *The scientific community* has a central and critical role in providing specialized scientific and technical input to assist governments and communities in drought risk reduction. Their expertise is fundamental to analyzing natural hazard risks facing communities; identifying and analyzing vulnerability of people and livelihoods; supporting the design of scientific and systematic monitoring, communications, and warning services; supporting data exchange; translating scientific or technical information into comprehensible messages; and disseminating understandable warnings to those at risk. Scientists also analyse and promote the use of traditional and local knowledge as well as the transfer and adaptation of appropriate technology. Through research they assess, promote and further develop a body of knowledge based on lessons learned from concrete experiences in the field.

4.1.2 Capacity development

While political momentum may exist to create new institutional (policy, legislation and organizational)

Table 1: Example of responsibilities of various bodies involved in drought management in Viet Nam

Body	Responsibility
Central government	Provide guidance at the national level
Provincial governments	Provide guidance at the provincial level
Ministry of Agriculture and Rural development - Department of Irrigation - Department of Agriculture and Rural Development in provincial areas	Water supply Research on strategies for land-use planning and water regulation Cropping patterns Cropping schedules
Ministry of Health	Provide health facilities in case of emergency
Ministry of Natural Resource and Environment - Department of Natural Resource and Environment	Drought forecasting Drought declaration Drought assessment Development planning
Ministry of Labour	Food supply Implementation of food-for-work programmes
Ministry of Transportation	Support for other organizations in case of emergency Water-transportation management
Ministry of Finance	Provide finances for long-term and short-term programmes to cope with and mitigate impacts of drought
Other social organizations (women's union, farmers' associations, etc.)	Participate in meetings Provide ideas for better implementation Promote public participation in programmes
Red Cross (and other international NGOs)	Provide relief Conduct strategic research Assess community needs
Local NGOs	Food assistance Capacity building Promotion of sustainable livelihoods for communities
Scientists and research institutes	Conduct research and training in drought-risk mitigation Develop sustainable livelihoods for communities
Communities	Participate in programmes Help various stakeholders to understand impacts of drought and to design better management programmes Cope with impacts of drought
Water supply and irrigation companies	Water supply Implementation of water regulations
Media	Disseminate drought forecasts and better management practices
Ministry of Foreign Affairs	Negotiate the sharing of water resource with other countries

Source: Oxfam in Viet Nam and Graduate School of Global Environmental Studies of Kyoto University, Japan, 2007, Drought-Management Considerations for Climate- Change Adaptation: Focus on the Mekong Region

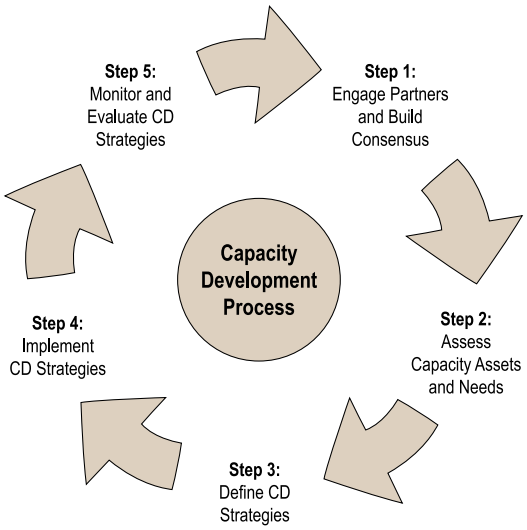
mechanisms for reducing risks, lack of dedicated financial resources in national budgets and trained personnel to implement plans may inhibit the operation of existing systems and mechanisms.

Capacity development is indeed a central strategy for reducing disaster risk. The UNISDR's "Words Into Action: A Guide for Implementing the Hyogo Framework" specifies that "capacity development is needed to build and maintain the ability of people, organizations and societies to manage their risks successfully themselves". This requires not only training and specialized technical assistance, but also the strengthening of the capacities of communities and individuals to recognize and reduce risks in their localities. It includes sustainable technology transfer, information exchange, network development, management skills, professional linkages and other resources. Capacity development needs to be sustained through institutions that support capacity-building and capacity maintenance as permanent ongoing objectives. (http://www.unisdr.org/eng/hfa/docs/Words-into-action/Words-Into-Action.pdf)

According to the ISDR's Inter-Agency Task Force for Disaster Reduction, "Current conceptual approaches conceive capacity building at three different levels. At the *individual and group level*, capacity building refers to the process of changing attitudes and developing skills while maximizing the benefits of participation and knowledge exchange. At the *institutional level*, capacity building concentrates on organizational performance and functional capabilities. In recent years, increased emphasis has also been placed on a third level, the *systemic dimension* of capacity development, with emphasis on the overall policy framework in which individuals and organizations interact with the environment." (Source: Capacity Building for Developing Countries: Inter-Agency Task Force on Disaster Reduction, DOC TF2/6 October 2000, http://www.undp.org/cpr/disred/documents/news/2006/11%20DMTP%20CapacityBuildingConceptSummary%20(2).pdf)

A typical capacity development process is shown in Figure 9. It starts with engaging partners and all parties involved and building consensus. Then, comprehensive and participatory capacity assessment is undertaken to identify specific needs and gaps at different levels. Following the assessment, capacity development strategies and activities are formulated to fill these gaps.

Figure 9: Capacity development process



Source: J. Colville and K. Wignaraja, Capacity Assessment Practice Note, UNDP http://www.capacity.undp.org/).

These specific activities are implemented and monitored. Finally, enhanced capacity is reassessed, and the strategies and process are evaluated to review whether any further capacity development activities are needed.

Because disaster risk reduction requires an interdisciplinary approach, capacity development for drought risk reduction should be dealt with in a holistic manner by building on or linking to ongoing capacity building activities across various sectors at all levels. In order to strengthen national institutional capacity for disaster risk reduction, the HFA calls on all nations to establish nationally owned coordination mechanisms for disaster risk reduction, such as multi-sectoral *national platforms for disaster risk reduction*. The capacity building activities for drought risk reduction can be coordinated, implemented and monitored under these mechanisms.

In a case where National Platforms for DRR have not been established or are not fully operational, capacity development for drought risk reduction can be facilitated by the development of a drought risk reduction (prevention, mitigation and preparedness) policy and designation of a leading institution. Examples of capacity development activities from the Horn of Africa are presented in Box 4.

Various initiatives, programmes, projects and networks for enhancing capacity for drought risk assessment, monitoring and early warning to facilitate actions in HFA Priority 2 are elaborated in Section 4.2 of this document.

Capacity development for drought risk reduction could also build on relevant capacity building programmes in the environment sector, such as the ones for the UN Convention to Combat Desertification (UNCCD), UN Framework Convention on Climate Change (UNFCCC) and the UN Convention on Biological Diversity (UNCBD). For the implementation of the three Rio Conventions alone, various capacity assessment tools, programmes and projects supported the countries in need. For example, the National Capacity Self Assessment programme (NCSA), supported by the Global Environment Facility (GEF), undertakes

Box 4:
Capacity Building for Drought Risk Reduction – Examples from the Horn of Africa

For the period 2006-2007, with funding from the Swedish International Development Agency (SIDA), UNISDR Africa has coordinated support to countries in the Horn of Africa for enhancing coordination mechanisms and harmonizing policies on drought risk reduction. These activities are being implemented in close collaboration with government agencies, bilateral and multilateral agencies, civil society organizations and scientific and academic institutions.

In Kenya, SIDA activities have enabled the National Platform on Disaster Risk Reduction to set up a thematic group of experts on drought. The government is also in the process of adopting a National Disaster Mitigation Policy as well as an Arid and Semi-Arid Land Policy, both of which are factors in drought risk reduction. An analytical report on ways and means of strengthening drought prevention and response is being finalized.

In Uganda, SIDA support has enabled the government to advance the process of consultations toward development of a National Policy on Drought Risk Reduction. The Drought Policy will complement the ongoing capacity building efforts of the government for strengthening national policy framework on disaster risk reduction supported by OCHA, UNDP and UNISDR Africa Regional Unit.

Other countries in the sub-region, in particular Djibouti and Eritrea, have received support to hold consultations to initiate formulation of national drought and disaster risk reduction policies. In Eritrea, under the United Nations Development Assistance Framework (UNDAF), close collaboration with the UN Country Team and the government is expected to lead to the preparation of a National Disaster Policy as well as the establishment of early warning systems on drought.

In order to complement support to national governments, a Horn of Africa Sub-Regional Drought Risk Reduction Policy Framework is being developed in collaboration with the Intergovernmental Authority on Development (IGAD).

This catalytic funding and soft assistance directed toward capacity building of national and sub-regional policies and institutions is expected to enable the countries in the Horn of Africa to address future droughts in a more systematic manner.

Source: The International Strategy for Disaster Reduction

reviews of the existing national capacity and gaps in fully participatory manner regarding the implementation of the UNCCD, the UNFCCC and the UNCBD. The Nairobi Work Programme, a five-year programme to enhance the decision-making capacity of the UNFCCC on a sound scientific, technical and socio-economic basis, is another example of these capacity development activities (see Section 4.4).

In addition to the direct support for the national and regional level capacity development, there are also mechanisms such as the Capacity for Disaster Reduction Initiative (CADRI) to enhance capacity of the international institutions involved in disaster risk reduction. CADRI, a thematic platform of the ISDR system, was created in 2007 by United Nations Development Programme Bureau for Crisis Prevention and Recovery (UNDP/BCPR), the UN Office for Coordination of Humanitarian Affairs (UNOCHA) and the UNISDR (http://www.unisdr.org/cadri/index.html). CADRI's areas of emphasis and support includes enhancement of the UN system's capacity at the national level to effectively execute its disaster risk reduction roles, and support to countries to integrate disaster risk reduction into preparedness for response to disasters.

4.1.3 Components of a drought policy

A drought policy can take many forms, such as a legislative act, a planning document, a group of related programmes, or an informal understanding among collaborators. Nonetheless, the goal in developing any drought policy is that it should establish a clear set of principles, strategy objectives, or operating guidelines for drought risk mitigation and preparedness, drought response, and early recovery and livelihood rehabilitation.

A drought policy should consider the main elements of the proposed drought risk reduction framework based on local needs, community participation and political commitment (Chapter 4), networks and mechanisms (Chapter 5), and resource availability. Major components of effective drought risk reduction policies and plans are proposed in Box 5, in line with the HFA.

As their foundation, drought policies and plans should emphasize prevention, mitigation and preparedness rather than relying solely on crisis management, which has been the primary focus in the past. Drought response efforts are essential, but many actions can be implemented before a drought develops, to reduce the potential effects on people, livelihoods and the environment.

Drought identification, monitoring, vulnerability analysis (risk identification), and risk management are the cornerstones of drought risk reduction (prevention, mitigation and preparedness) plans. A drought monitoring system can provide a historical record to assess changing conditions and provide early warnings of potential threats to people and activities at risk. Risk identification will help to determine regions, population groups, and economic and environmental sectors most vulnerable to the effects of drought, so that risk management actions can be identified and implemented to reduce those risks.

Ultimately, preparedness plans will improve coordination within and between levels of government; procedures for monitoring, assessing, and responding to water shortages; information flow to primary users; and efficiency of resource allocation. The goals of these plans are to reduce water shortage impacts, personal hardships, and conflicts between water and other natural resource users. These plans should promote self-reliance by systematically addressing issues of principal concern to the region or nation in question.

Legislation to ensure that drought risk reduction policies are carried out should be developed and enforced. Creating a drought policy is one task; ensuring the actions identified in the policy are implemented is another task. Political and financial investment in prevention, mitigation and preparedness measures are essential to reduce the effects of drought. Investing in reducing risk of drought impacts is more humane and cost-effective than only dealing with them after they have occurred.

Since entering into force in 1996, the UNCCD has been assisting the affected country Parties in combating desertification and mitigating the effects of drought. Article 10 of the UNCCD obliges the affected developing Parties to prepare national action programmes (NAPs) (http://www.unccd.int/convention/text/convention.php).
A NAP advocates the importance of developing long-term drought risk reduction (prevention, mitigation and preparedness) policies and enhancing national capabilities. A NAP also specifies the respective roles and responsibilities of government, local communities and land users and the resources needed to implement the Convention. As of 1 March 2008, 102 Parties have formulated their NAPs, including 41 countries in Africa, 29 in Asia and the Pacific, 23 in Latin America and the Caribbean, and 9 in Europe.

A NAP includes an assessment of existing drought-related policies and gap areas. The creation of a NAP and other key indicators for the review of the implementation of the UNCCD are shown in Box 6. More general indicators for the review of the Hyogo Framework are presented in the section on tracking progress (Section 4.5.3)

The UNCCD's action programmes can also be prepared at regional and sub-regional levels according to Article 11 of the UNCCD, based on specific conditions of each affected region and sub-region. The UNCCD has five Regional

Box 5:
Proposed components of a drought risk reduction policy and plan

A drought policy should establish a clear set of principles or operating guidelines to govern the mitigation and management of drought and its impacts as well as the development of a preparedness plan that lays out a strategy to achieve these objectives.

A national policy and plan shall specify the respective roles of government, local communities and land users, and the resources available and required to implement appropriate drought risk reduction activities. Although drought policies will vary to reflect local needs, drought risk reduction (prevention, mitigation and preparedness) policies should also address the following concepts:

1 Provide for effective participation at the local, national, and regional levels of non-governmental organizations and populations (both women and men) in policy planning, decision making, and implementation and review of national action programmes;
2 Be rooted in thorough vulnerability, risk, capacity, and needs assessments, highlighting the root causes of the issues related to drought at national, sub-national, local, and transboundary scales;
3 Focus on strengthening the capacities of governments and communities to identify, assess, and monitor drought risks at national and sub-national levels for effective development planning, including strengthening of people-centred early warning systems and preparedness;
4 Incorporate both short and long-term strategies to build the resilience of governments and communities to reduce the risks associated with drought, emphasize implementation of these strategies, and ensure they are integrated with national policies for sustainable development;
5 Link drought early warning indicators with appropriate drought mitigation and response actions to ensure effective drought management;
6 Allow for modifications to be made in response to changing circumstances and be sufficiently flexible at the local level to cope with different socio-economic, biological and geo-physical conditions;
7 Promote policies and strengthen institutional frameworks which develop cooperation and coordination, in a spirit of partnership, between the donor community, governments at all levels, local populations, and community groups, and facilitate access by local populations to appropriate information and technology;
8 Designate agencies and stakeholders responsible for carrying out drought mitigation and response actions, and require regular review of, and progress reports on, their implementation.
9 Strengthen drought preparedness and management, including drought contingency plans at the local, national, sub-regional and regional levels that take into consideration seasonal to inter-annual climate predictions.

Source: USA National Drought Mitigation Center, University of Nebraska-Lincoln; UNDP; UNCCD and UNISDR, 2007

Implementation Annexes for Africa, Asia, Latin America and the Caribbean, the Northern Mediterranean, and Central and Eastern Europe to support this process. Such cooperation may include joint programmes for the sustainable management of transboundary natural resources, scientific and technical cooperation, and strengthening of relevant institutions. To date, regional action programmes (RAPs) have been developed for Africa, Asia and Latin America. The sub-regional action programmes (SRAPs) have been developed mainly in Africa (West Africa, North Africa, Central Africa, East Africa and Southern Africa). Main regional institutions which have been involved in the development of SRAPs are listed in Annex 2 (http://www.unccd.int/convention/text/convention.php).

Various guides for drought management have been developed at national and regional levels to meet the needs of specific users. For example, the European Commission-funded collaboration between scientists from Cyprus, Greece, Italy, Morocco, Spain, and Tunisia has developed Drought Management Guidelines for Mediterranean countries (MEDROPLAN Guidelines)

Box 6:
Key indicators for the review of the implementation of the UNCCD

The UNCCD's guidelines for national reporting provide a list of key elements to be used to review the progress of the implementation of the Convention. These elements include:

1. Designation of a national focal point institution for the UNCCD;
2. Formulation of a National Action Programme (NAP);
3. The implementation of the NAP in the priority fields set out by Decision 8/COP.4, such as:
   - renewable sources of energy;
   - sustainable land-use management, including water, soil and vegetation in affected areas;
   - mountain ecosystem preservation;
   - forest resources assessment;
   - sustainable use and management of rangelands;
   - launch of reforestation/afforestation programmes and intensification of soil conservation programmes;
   - development of early warning systems for food security and drought forecasting;
4. Establishment of a National Coordinating Body (NCB) as a supervisory body in promoting the implementation of the UNCCD;
5. Development of an institutional framework for coherent and functional desertification control;
6. Development of a coherent and functional legal and regulatory framework (e.g., acts and laws);
7. Integration of the NAP into national development and poverty reduction strategies and plans;
8. Making the NAP coherent with other environmental strategic and planning frameworks;
9. Implementation of relevant projects which are directly or indirectly related to the UNCCD;
10. Development, at the national level, of programmes of a sub-regional or regional character;
11. Insurance of effective participation of relevant actors, including local authorities, nongovernmental organizations (NGOs), community based organizations (CBOs), and women's and youth groups in defining national priorities;
12. Strengthening of relevant scientific networks at the national, sub-regional and regional levels for technical cooperation;
13. Recommendation of items by the Committee on Science and Technology, including development and use of benchmarks and indicators, promotion of traditional knowledge, use of early warning systems, training and field studies to identify pilot sites;
14. Adoption of internal and external financial mechanisms and international partnerships;
15. Operational mechanisms for monitoring and evaluation of the implementation of the UNCCD

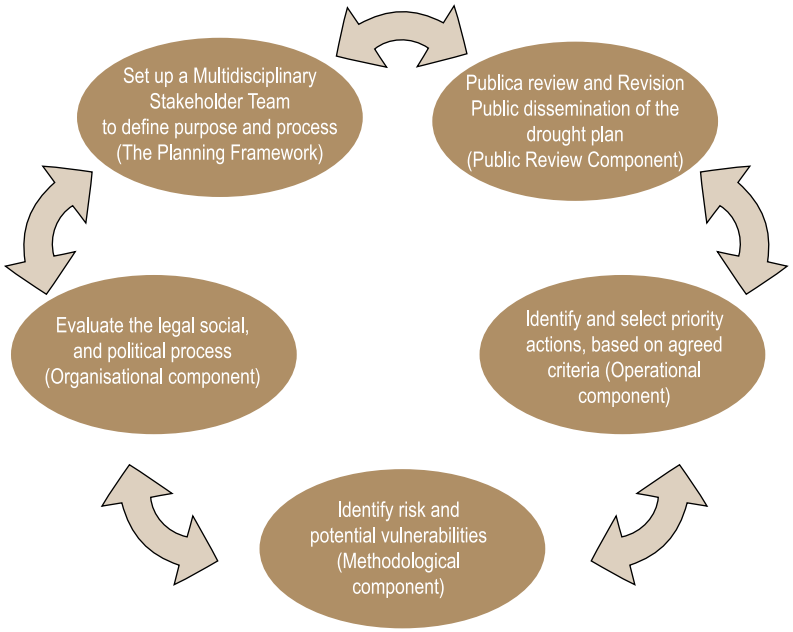
Source: The UNCCD secretariat, National Reporting Process of Affected Country Parties - Explanatory Note and Help Guide, December 2005 (ICCD/CRIC(5)/INF.3), available at: http://www.unccd.int/cop/officialdocs/cric5/pdf/inf3eng.pdf

Box 7:
European Commission-supported drought management guidelines for Mediterranean countries (MEDROPLAN Guidelines)

The MEDROPLAN guidelines provide a systematic approach to developing drought management plans. Although targeted toward Mediterranean countries, the guidelines can provide insights into drought planning in any country (see http://www.iamz.ciheam.org/medroplan/).

The MEDROPLAN Guidelines are designed to contribute to answering key social and policy questions such as: (1) How water management can be improved and how people can best benefit from such changes; and (2) How research can help to develop innovative institutional arrangements and decision-support tools. The Guidelines' systematic approach contributes to linking academic knowledge to operational and policy aspects of drought risk management. The Guidelines place emphasis on the institutional and legal framework and on stakeholder participation, and establishing a wide range of methodologies to cope with drought. The Guidelines are designed to appeal to a broad audience, with special reference to policymakers. The Guidelines have been translated into six languages (Arabic, English, French, Greek, Italian and Spanish).

Figure 10:
Development and revision of a drought management plan based on the MEDROPLAN guidelines



Source: http://www.iamz.ciheam.org/medroplan/guidelines/planning_framework_defining.html

(see Box 7 and Figure 10). The National Drought Mitigation Center (USA) has also developed the Ten-Step Drought Planning Process (http://www.drought.unl.edu/plan/handbook/10step_rev.pdf) that has been utilized worldwide, and worked with the United Nations Food and Agriculture Organization (FAO) to develop the "Near East Drought Planning Manual".

4.1.4 National drought policy case studies

Because of an increased understanding of the effects of drought on people and livelihoods and greater awareness of the value of disaster risk reduction (prevention, mitigation and preparedness), an increasing number of nations have begun developing drought planning and policies processes over the last two decades.

For example, as mentioned earlier, with the support of SIDA and the UNISDR Africa Regional Unit, solid progress has been made on the formulation of a drought risk reduction policy framework at national and sub-regional levels for the countries in the Horn of Africa. This has been in line with the Africa Regional Strategy for Disaster Risk Reduction, adopted by the African Ministerial Conference on the Environment in 2004, and the Hyogo Framework (HFA) adopted in 2005; http://www.unisdr.org/africa/af-hfa/docs/africa-regional-strategy.pdf). In consultation with relevant national stakeholders, existing drought risk reduction policies and programmes in five countries (Djibouti, Eritrea, Kenya, Somalia and Uganda) were reviewed and analysed in 2007. The major findings of the reports from Eritrea, Kenya and Uganda are presented in Box 8. Integration of Uganda's drought risk reduction policy into the country's disaster risk reduction policy is further elaborated in Box 8. Other examples of the development of national drought policies in Namibia, South Africa, Australia and the United States are also shown in this section.

Case Study from Uganda:
Drought risk reduction policy as an integral part of the national disaster risk reduction policy

The government of Uganda has been preparing a drought risk reduction policy framework in parallel with its efforts to review and strengthen

Box 8:
Major findings of the review of existing drought risk reduction policies and programmes in the Horn of Africa

The review of the existing drought risk reduction policies and programmes in Eritrea, Kenya and Uganda, facilitated by the UNISDR Africa Regional Unit, resulted in the following findings.

Drought is one of the major threats for Eritrea, Kenya and Uganda, and therefore national drought policy needed to be developed urgently. The three countries already have various drought-related policies and programmes but do not have comprehensive drought risk reduction policies.

Kenya and Uganda have developed a national policy on disaster risk reduction and have responsible institutions for disaster risk reduction. Eritrea is in the process of developing a policy, and has not yet designated a focal point institution for disaster risk reduction. No country has designated a "drought risk reduction" focal point yet.

Within the existing disaster risk reduction policy and designated institutional structure, "drought risk reduction" has not yet been adequately addressed. Inadequate prioritization of "drought risk reduction" has resulted in inadequate allocation and disbursement of funding for drought risk reduction programmes by government.

Most of the key components proposed earlier in this Chapter (see Box 5) were recommended in these reviews for an effective drought risk reduction policy. In addition, decentralization of administrative systems to local levels has been identified as a crucial component of drought risk reduction. Local and community level capacity building, awareness raising, dissemination of information and early warning, and development of coping mechanisms remain as gap areas in addition to the national level gaps.

Although adoption and transfer of new drought management technologies and practices are increasing, traditional drought management and coping mechanisms have still proven effective at community level.

Coordination and harmonization of policies and programmes are necessary within the government. In addition, coordination between external partners such as the UN system and bilateral development agencies are also crucial.

the existing national disaster risk reduction and management policy framework.

The Ugandan government has reviewed its existing National Disaster Risk Reduction and Management Policy to move its focus from emergency relief to more comprehensive disaster risk management covering disaster mitigation, preparedness and response. Strengthening institutional frameworks and capacity, including district authorities' ability to assess, coordinate and respond to disasters, and clarifying the roles and responsibilities of relevant institutions are some of the first challenges in the process. In order to facilitate the necessary consultation process, OCHA, UNDP and UNISDR Africa Regional Unit have been supporting various workshops and meetings in the country.

The preparation of an effective drought risk reduction policy has been a part of the above-mentioned overall national efforts. The government has continued to demonstrate its commitment to drought risk reduction issues. In fact, the government has identified drought risk reduction as a possible area to be assigned a high priority because of 1) its seriousness or urgency, 2) its potential contributions to the economy and social well-being, and 3) the potential of a drought risk policy to be successful.

In order to facilitate the process of formulating a more comprehensive drought risk reduction policy, UNDP and the UNCCD secretariat initially provided some inputs to the government. Recently, SIDA's support to the UNISDR, through its Horn of Africa drought risk reduction programme, has helped the Ugandan government to undertake an analysis of the current status of the development of a comprehensive drought risk reduction policy.

The study found that the national disaster risk reduction policy still has gaps in its approach to drought risk reduction, particularly in the areas of preparedness, resilience, and prevention. Other gaps were identified in the areas of institutional frameworks, governance, drought risk identification, and knowledge management. The recommendations from the study will be presented to the government to accelerate the development of a comprehensive drought risk reduction policy and the necessary legal and institutional framework for effective mitigation and coordination for drought risk reduction.

Source: Review and Analysis of Existing Drought Risk Reduction Policies and Programmes in Uganda, Second Working Draft, UNISDR, 2007

Case Study from Namibia:
National drought policy

When introducing a package of short-term drought relief measures in May 1995, the government simultaneously established a task force to draw up a national emergency and long-term drought management policy. This was done in recognition of the fact that Namibia is an arid country where dry years are the norm. Declaring drought too frequently is expensive for the government, can create dependency among aid recipients, and can promote resource degradation through inappropriate assistance.

The Task Force convened several consultations from 1996 until the endorsement of the national drought policy by the government in 2005.

Namibia's drought policy is concerned with developing an efficient, equitable and sustainable approach to drought management. The policy aims to shift responsibility for managing drought risk from the government to the farmer, with financial assistance and food security interventions only being considered in the event of an extreme or "disaster" drought being declared.

The thrust of the policy is a move away from regular financial assistance to large numbers of private-tenure and communal-tenure farmers to measures that support the on-farm management of risk. The government's involvement with drought will move beyond an exclusive focus on emergency drought programmes to a broader, longer-term perspective.

Sources: 2nd African Drought Risk and Development Forum Report, Nairobi, October, 2006; Republic of Namibia, National Drought Policy and Strategy, 1997.

Case Study from South Africa:
National drought policy

South Africa has invested a great deal of time and effort into developing a cohesive national drought policy. These efforts were accelerated by the development of the National Consultative Forum on Drought in the early 1990s, which brought more stakeholders to the planning table and allowed more sectors to be included in drought planning efforts.

These efforts resulted in new drought policies that strove to encourage risk management, assist farmers financially, protect natural resources, promote the best use of resources for individual farmers, and help farmers maintain a nucleus breeding herd during a drought. With this policy, farmers must adopt specific resource conservation and long-term sustainability measures, such as adherence to established grazing capacities, to be eligible for financial aid. An agricultural risk insurance bill was also developed in 2002 that sought to supplement agricultural producers' incomes for those most susceptible to crop and livestock losses from natural disasters.

The country's primary challenge has become the maintenance of a policy balance between encouraging a risk management approach for large agricultural enterprises and providing a safety net for the resource-limited sectors of the population.

Source: National Drought Policy, Wilhite et al., Drought and Water Crises: Taylor and Francis, 2005.

Case Study from Australia:
National drought policy

Australia developed a national drought policy in 1992 based on recommendations from the country's Drought Policy Review Task Force. Although the drought policy has been revised over the years, it primarily focuses on improving self-reliance and minimizing the need for government intervention by promoting the implementation of pro-active risk management strategies.

The policy stresses risk management and preparedness rather than disaster response, given the propensity of the Australian climate toward drought. Risk management assistance was initially provided through the main agricultural programme, the Rural Adjustment Scheme.

Under this policy, officials decided when an area was experiencing "exceptional circumstances" in terms of weather and at what point financial support became available. The Rural Adjustment Scheme also stressed improved risk management by encouraging farmers to have financial reserves for times of crisis. In 1997, this scheme was replaced with new programmes under the umbrella Agriculture-Advancing Australia, although the new programmes are very similar to the ones they replaced.

The Australian government is still striving to make the policy more efficient, equitable, and cost-effective.

Source: National Drought Policy, Wilhite et al., Drought and Water Crises: Taylor and Francis, 2005.

Case Study from United States:
National and State Drought Policy

In July 1998, the U.S. Congress enacted the National Drought Policy Act that established an advisory commission to provide advice and recommendations on the creation of a national drought policy. The resulting National Drought Policy Commission published a report that represents the basis for a national drought policy and called for commitment and resolve in providing sufficient resources to achieve the policy goals (http://govinfo.library.unt.edu/drought/finalreport/fullreport/pdf/reportfull.pdf).

Several state governments and American Indian tribes in the United States have also made substantial progress in developing drought policies and plans. During the widespread U.S. drought of 1976-77, no state had a formal drought plan, and in 1982, only three states had drought plans. But as of October 2006, thirty-seven states had drought plans, two delegated planning to local authorities instead of having a single state-level plan, and two states were in the process of developing a plan. Only nine states did not have formal drought plans. Although the majority of state drought plans focus on drought response activities, a growing number of them are focusing more attention on drought mitigation. These state drought plans are available online at (drought.unl.edu/planstateplans.htm).

Source: National Drought Mitigation Center, University of Nebraska-Lincoln, USA

In response to especially severe drought during the late 1990s and early twenty-first century, several other countries in the Near East, Central Asia and Caucasus have also undertaken national drought planning efforts. For example, FAO through its Near East Regional Office has been working with the governments of Syria, Jordan and Iran to initiate drought planning activities and propose national drought mitigation and response policies (see http://www.fao.org/world/regional/rne/). The FAO livelihood approach is explained in Chapter 3.

Similarly, the Canadian International Development Agency has supported research and analysis by the World Bank to better understand drought impacts, vulnerabilities, and mitigation and preparedness options in Central Asia and the Caucasus (see http://www.worldbank.org/eca/drought). The results of this research have been incorporated into draft National Drought Plans for Armenia, Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan.

4.1.5 Local and Community drought policy case studies

In addition to national and state/provincial drought policies, increased importance has also been placed on local/community level drought policy and planning, emphasizing self-reliance and drought resilience.

Case Study from Australia:
Local drought planning, Melbourne

The availability of water has been instrumental in the development of Victoria. Melbourne was settled in 1835 and the city's first water supply reservoir, Yan Yean, came on line in 1857. Australian colonial officials denied the existence of drought during the late 19th century as part of their efforts to attract more European immigrants.
In the 20th century, drought was treated as something to be fought, cured, or beaten. Many schemes in Victoria tried to "drought-proof" towns, districts, or regions by capturing streamflows, building storages, and managing the distribution of water. Managing water demand during drought involved restrictions designed to curb use and conserve water.

After the severe 1972-73 drought, water restrictions were formalized. In 1975, the Melbourne and Metropolitan Board of Works (Melbourne Water's predecessor) and the State Rivers and Water Supply Commission produced an eight-stage set of restrictions. The 1982-83 drought affected most of eastern Australia, and Stage 6 restrictions were introduced in February 1983. Since then, Victorian water authorities have worked to plan for drought and simplify restrictions.

Today, the Australian government and Melbourne Water recognize that traditional water development approaches are no longer sustainable. Therefore, in the early 1990s, drought-management guidelines were completed for non-metropolitan areas, and in 1995, drought response plans were completed for the newly formed metropolitan retail water companies. In March 2005, the government introduced permanent water saving rules across Victoria and penalties for breaches. The 2006 Central Region Sustainable Water Strategy also outlines actions to secure water supplies for urban and industrial use to the year 2055 by exploring alternative water sources, such as re-use, recycling, conservation, increasing efficiency, capturing storm water, desalination, and tapping aquifers.

Source: Living with Drought, Melbourne Water, (http://drought.melbournewater.com.au/Default.asp?bhcp=1)

Case Study from United States:
Hualapai Tribe drought planning

In the United States, at least eight American Indian tribes in the United States are in the process of developing drought plans detailing operational guidelines to help them better prepare for and respond to drought on their reservation lands. These are the Hopi Tribe, Hualapai Nation, Kaibab-Paiute Tribe, Navajo Nation, San Carlos Apache Tribe, and Zuni Pueblo in the states of New Mexico and Arizona and the Fort Peck Tribes and Northern Cheyenne Tribe in the state of Montana.

The Federal Bureau of Reclamation provided funding for the Hualapai Tribe in Arizona, United States, to develop a comprehensive drought plan. The Hualapai Tribe's Department of Natural Resources took the primary lead in developing the plan, but the process ultimately became a collaborative endeavour between several tribal and federal agencies. Community meetings were also held to gather feedback from tribal members throughout the development of the plan.

In developing the plan, the tribe first identified the most vulnerable physical and social sectors of the reservation and tribal population. Based on this understanding, a range of appropriate drought mitigation and response actions were then identified, including the development of a drought early warning system.

The plan is to be reviewed and adapted as necessary on a bi-annual basis. The Hualapai Tribal Council approved and adopted the plan in January

2004 after soliciting comments and review by the cooperating partners. At the request of the Hualapai Tribe, the National Drought Mitigation Center evaluated the Hualapai Drought Plan and conducted a drought exercise to educate tribal members and agency personnel about their roles in implementing the plan, and also to identify potential barriers to the plan's full implementation.

Source: Analyzing Tribal Drought Management, Knutson et al., 2006, www.colorado.edu/hazards/research/qr/qr183/qr183.html

4.2 Drought risk identification, impact assessment and early warning

Related to Priority 2 of the Hyogo Framework for Action: To identify, assess and monitor disaster risks and enhance early warning.

A starting point for reducing drought risk and promoting a culture of resilience lies in gaining knowledge about hazard occurrence, the potential effects of the hazard, and the related vulnerabilities of potentially affected people and activities. The latter includes the physical, political, social, economic, and environmental vulnerabilities to drought that most societies face and the ways in which hazards and vulnerabilities are changing in the short- and long-term.

Understanding the physical nature of the drought hazard and the corresponding impacts and underlying vulnerabilities, and communicating these dangers in an effective manner, forms the basis for developing informed drought mitigation and preparedness measures to reduce the effect of impact of drought while contributing to drought-resilient societies.

Guiding principles

Drought risk identification, impact assessment, and early warning activities should be guided by the following principles:

1 Drought risk is the combination of the natural hazard and the human, social, economic and environmental vulnerability of a community or country, and managing risk requires understanding these two components and related factors in space and time.
2 Increasing individual, community, institutional and national capacities is essential to reducing vulnerability to drought impact.
3 Impact assessment plays an important role in drought risk management, in particular, identifying most vulnerable groups and sectors during drought.
4 Drought monitoring and early warning systems play an important role in risk identification, assessment and management.
5 Changing climate and the associated changing nature of drought poses a serious risk to the environment, hence to sustainable development and the society.

4.2.1 Local, national, and transboundary risk assessments

Drought risk is based on a combination of the frequency, severity, and spatial extent of drought (the physical nature of drought) and the degree to which a population or activity is vulnerable to the effects of drought. The degree of a region's vulnerability depends on the environmental and social characteristics of the region and is measured by inhabitants' ability to anticipate, cope with, resist, and recover from drought.

Vulnerability to drought can be reduced by increasing individual, community, institutional, and national capacities. This capacity refers to the identification, communication and reduction of

risk, as well as absorbing the effects of drought when they occur. A goal of capacity development should be to enable self-reliance in preparing for and responding to drought.

Researchers and practitioners are increasingly promoting the use of consistent terminology and strategies for assessing risk and analyzing the strengths and weakness of these approaches. A risk assessment process promoted by the ISDR system is shown in Figure 11.

The UNISDR and several partners (e.g., UN-HABITAT, UNDP/BCPR, Organization of American States, Asian Disaster Preparedness Centre) have created the Disaster Risk Assessment Portal (http://www.disasterassessment.org/). This portal provides a forum for members of the disaster management community to exchange tools and case studies related to disaster risk assessment. This type of communication and assessment is essential for helping planners determine appropriate methodologies for assessing risk.

In terms of drought, the USA National Drought Mitigation Center has developed a guide, "How to Reduce Drought Risk", to help national entities better understand their own drought risk and develop locally based risk reduction measures (www.drought.unl.edu/planhandbook/risk.pdf). This document provides a step-by-step process for self-assessing drought risk and has been used by planners in several countries.

The risk assessment portion of the guide advocates the analysis of the historical frequency, severity and extent of drought; the identification and ranking of drought-related impacts; and a vulnerability analysis to investigate why the impacts occur. This type of risk assessment identifies the underlying causes of drought impacts, which is essential for identifying effective drought risk reduction (prevention, mitigation and preparedness for response) measures.

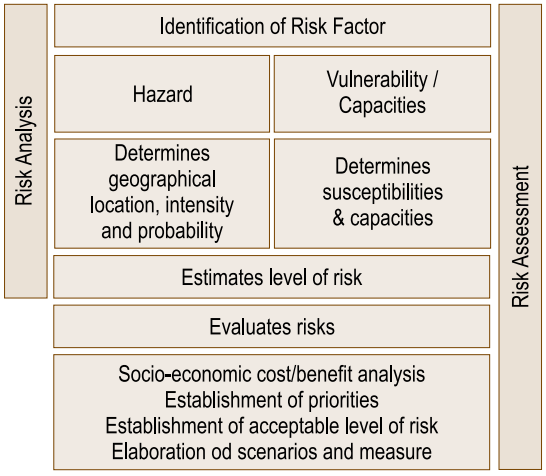


Figure 11: Components of a risk assessment process

Source: Living with Risk, Chapter 2, UNISDR, http://www.unisdr.org/eng/about_isdr/basic_docs/LwR2004/ch2_Section3.pdf

4.2.2. Risk assessment methodology

Hazard assessment

The frequency of occurrence of meteorological drought at various levels of intensity and duration defines the drought hazard for drought-prone nations and regions. It is critical for countries to better understand this hazard and how it varies temporally and spatially, and to establish comprehensive and integrated drought early warning systems that incorporate climate, soil and water supply factors such as precipitation, temperature, soil moisture, snowpack, reservoir and lake levels, groundwater levels and streamflow.

For example, researchers in India have investigated the historical occurrence of drought in the country and classified India's most drought-prone and chronically drought-affected areas. Based on such studies, India's Ministry of Rural Development manages the Drought Prone Areas Programme to target resources to those people most at risk from severe drought conditions (see http://rural.nic.in/).

It is also essential to identify trends in temperature and precipitation amounts, changes in the seasonal distribution and intensity of precipitation events, and other changes in climate that might be helpful in understanding how the hazard may change in duration, frequency and extent in the future. The 2007 IPCC Fourth Assessment Report provides a great deal of information on potential changes in climate around the world (see http://www.ipcc.ch/).

Drought Impact Assessment

Similarly, understanding trends in drought-related impacts over time is important for projecting future impacts and understanding changing vulnerabilities. Each drought produces a unique set of impacts, depending not only on the drought's severity, duration and spatial extent but also on ever-changing social conditions.

For practical purposes, drought impacts can be classified as economic, environmental, or social, even though several of the impacts may actually span more than one sector. These impacts are symptoms of underlying vulnerabilities. Therefore, impact assessments are a good starting point to determine underlying vulnerabilities to target response measures during drought. An impact assessment highlights sectors, populations, or activities that are vulnerable to drought.

Drought impact assessments begin by identifying direct consequences of drought, such as reduced crop yields, livestock losses and reservoir depletion. These direct outcomes can then be traced to secondary consequences (often social effects), such as the forced sale of household assets or land, dislocation, or physical and emotional stress. Impacts should be examined for their occurrence in past or recent droughts, but consideration should also be given to the question "What drought impacts will be seen in the future?" This last question is crucial as populations shift and water demands change.

For example, in response to severe drought in 1996, the state of New Mexico in the United States completed a drought mitigation plan in 1998. To better understand drought impacts within the state, New Mexico organized four impact assessment subgroups representing the sectors most affected by drought in the state, including (1) agriculture, (2) drinking water, (3) wildlife and wildfire protection, and (4) tourism and economic impacts. These subgroups identified the major drought impacts occurring in each sector, although they did not assess how vulnerability is increasing or decreasing.

A second example, an assessment of drought impacts conducted by the Government of Portugal after the severe drought in the country in 2004-2005, also helps to clarify the effects of drought on people and their livelihoods (see Box 9).

A third example, a study carried out by Oxfam in Viet Nam and the Graduate School of Global Environmental Studies of Kyoto University, Japan, in 2007, involved a drought impact assessment at the community level in the context of climate change (see the case study in Section 4.5.1). The study focused on the impacts of the severe drought of 2004 in the most drought-prone areas in Ninh Thuan province, Viet Nam. It elaborated the livelihoods impacts, food security impacts, health impacts, economic impacts, social impacts and environmental impacts. An impact-tree diagram for animal husbandry in this study and suggested policy options are introduced in Chapter 4.

Although the method of impact data collection may vary by country because of technological, financial, political, and other factors, it is essential

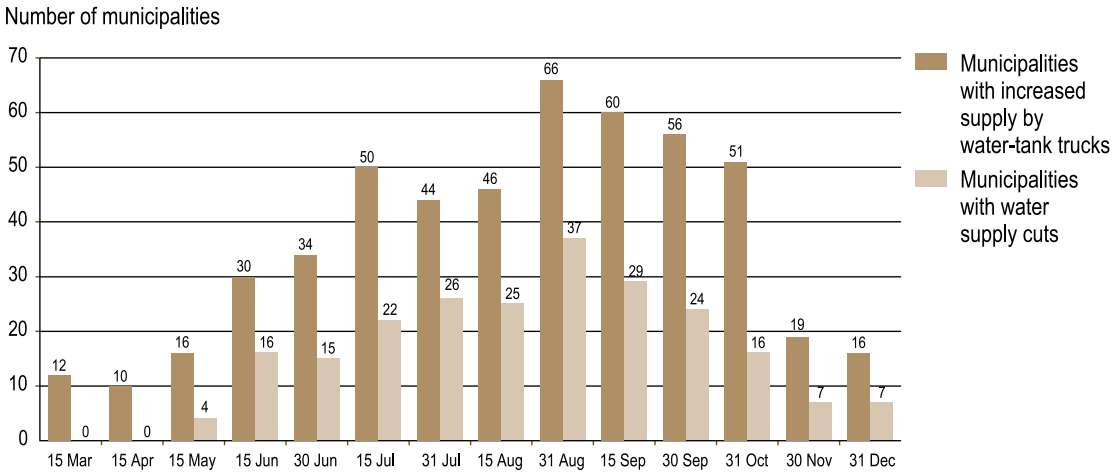
Box 9:
Portugal: Assessing drought impacts

Portugal was affected by a severe drought in 2004-2005. The government conducted an assessment of impacts that occurred during the drought to better understand the effects of drought on the country, its people, and their livelihoods. The primary impacts identified were related to agriculture and cattle breeding, energy, urban water supply, and forest fires.

For example, the drought caused the drying out of water sources and the loss of their annual replenishing capability. The people and municipalities primarily affected were those with small caption systems in small river basins, or small underground reservoirs. The number of municipalities that were forced to increased water supplies or implement water supply cuts/ reductions is listed in Figure 12. This type of impact assessment is essential for identifying vulnerable sectors and populations, and targeting limited resources to high-priority needs.

Source: Institute of Meteorology, Portugal

Figure 12: Number of municipalities needing to increase transport of water supply or cut/reduce household supply



Source: Institute of Meteorology, Portugal,

that impacts are assessed and archived in some manner. Institutional memory is often short and people's recollections biased. Accurate records of drought impacts will help provide more objective information on which to base planning decisions.

Once a drought impact assessment has been performed, the next step is to rank the highest priority impacts. Drought can result in many direct and indirect impacts. Some of these may be more important than others in terms of values and interests. Addressing the most significant impacts first will help target limited resources and hopefully have a larger effect in reducing drought impacts.

At the provincial level, for example, rankings should take into consideration concerns such as cost, areal extent, trends over time, public opinion, fairness, and the ability of the affected area to recover. To assist in this ranking and ensure equitable policy formulation, the general public, community advisory committees, and groups of relevant scientists and policymakers should be included in the process.

In the United States, the National Drought Mitigation Center has created a national drought impact database to assist in documenting and understanding the effects of drought. Users can query the Drought Impact Reporter database to search for impacts that are occurring or have occurred in their region (see http://drought reporter.unl.edu). Impacts are grouped by category, such as agriculture, water, energy, environment, fire, social, etc. This type of activity will help planners identify the range of impacts that are important in a region.

Vulnerability Analysis

Vulnerability analysis provides a framework for identifying the human, social, economic, political, physical, and environmental causes of drought impacts. It directs attention to the underlying causes of vulnerability rather than to its result, the negative impacts, which follow triggering events such as drought.

For example, in drought conditions, the direct impact of a lack of precipitation may be reduced crop yields. The underlying cause of this impact, however, may be that farmers did not plant appropriate crops because of cultural preference or government incentives, other seeds were unavailable or too expensive, or there was no drought warning. Hence, to conduct a vulnerability analysis, begin by asking why significant impacts have occurred (or why they might occur). It is important to realize that a combination of factors (e.g., environmental, economic, and social factors) or underlying causes (e.g., livelihoods at risk, incentive preferences, and inappropriate crops) might produce a given event.

In general terms, Figure 13 illustrates the idea that underlying causes of vulnerability can lead to unsafe conditions that are more susceptible to natural hazards. There are many underlying causes of vulnerability

In assessing vulnerability, it might also be beneficial to diagram these causal relationships in some form of a tree diagram. An example of a tree diagram related to income losses due to crop failures is shown in Figure 15 and a tree diagram for animal husbandry is shown in Figure 16. The tree diagrams illustrate the complexity of understanding drought impacts, and demonstrate that impacts must be examined from several perspectives to expose their true underlying causes. Case studies and scenario building are other ways to better understand drought vulnerability.

It is also useful to analyse micro-macro linkages to better understand vulnerability (Figure 14). Policy instruments such as macroeconomic policy can either positively or negatively influence households and communities, which, in turn, could either increase or decrease their vulnerability.

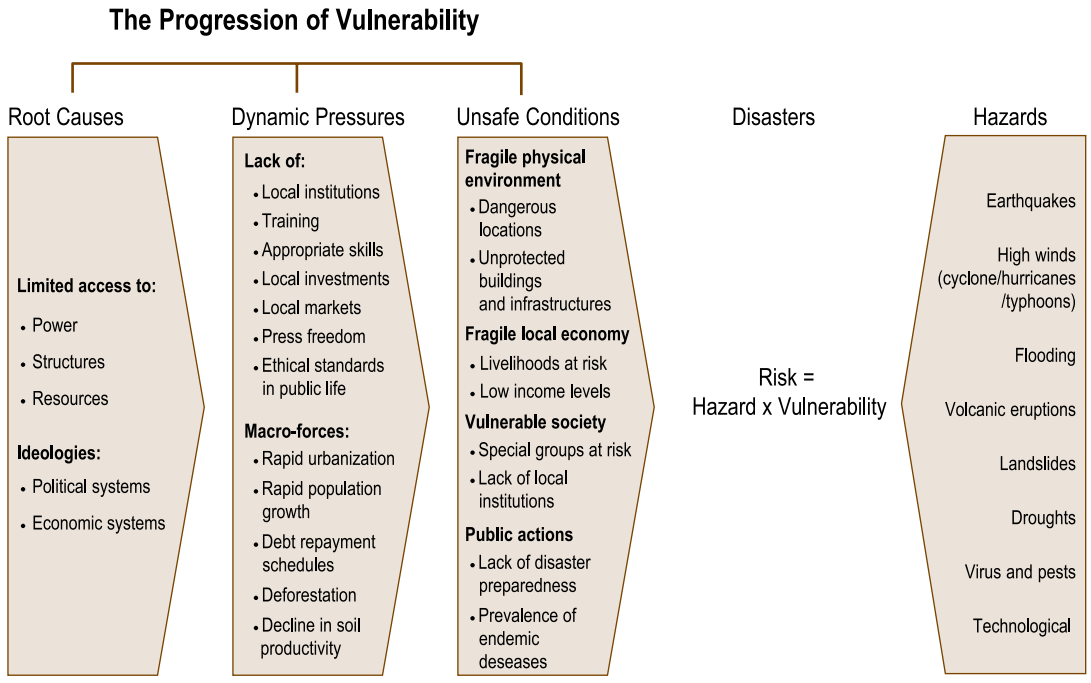
Good practices to reduce pastoralists' vulnerability in Ethiopia and Kenya are introduced in Annex 3.

Other resources for gathering information on vulnerable populations, particularly in regard to famine, include programmes such as the Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS), the World Food Programme's Vulnerability Analysis and Mapping (VAM) system and the UN Food and Agriculture Organization's food security system.

FIVIMS are networks of national information systems that assemble, analyse, and disseminate data on food insecurity and vulnerability. Their objectives are to raise awareness about food security issues, improve the quality of food security related data and analysis, facilitate integration of complementary information, promote better understanding of users' needs and better use of information, and improve access to information through networking and sharing.

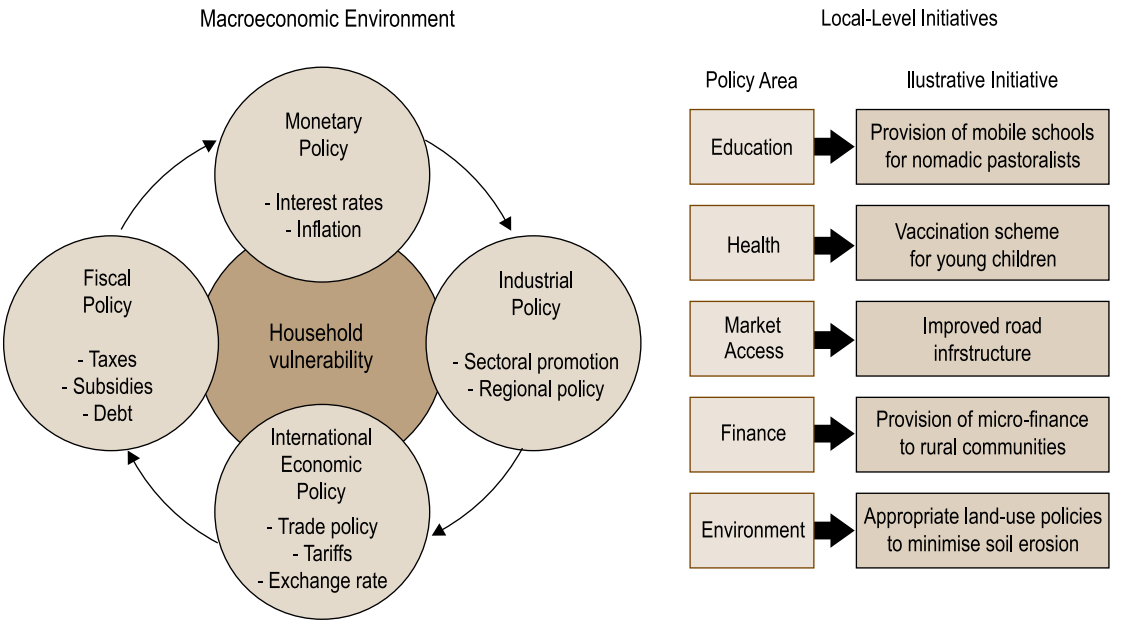
VAM uses a wide array of technological sources and analytical methods: satellite imagery and

Figure 13: Risk results from a combination of hazard occurrence and vulnerability to the hazard



Source: Adapted from Blaikie et al., 1994

Figure 14:
Micro and macro linkages for analyzing household vulnerability



Source: Drylands Development Centre, UNDP, 2007

Box 10:
West Asia: Drought vulnerability analysis

Seeing a need for more research on water development and drought, the United Nations Economic and Social Commission for Western Asia undertook studies from 2004 to 2005 to better understand drought vulnerability in West Asia. The researchers developed three case studies (i.e., Jordan, Syria, and Yemen) to investigate drought vulnerabilities and how countries in the region are currently mitigating and managing drought risk.

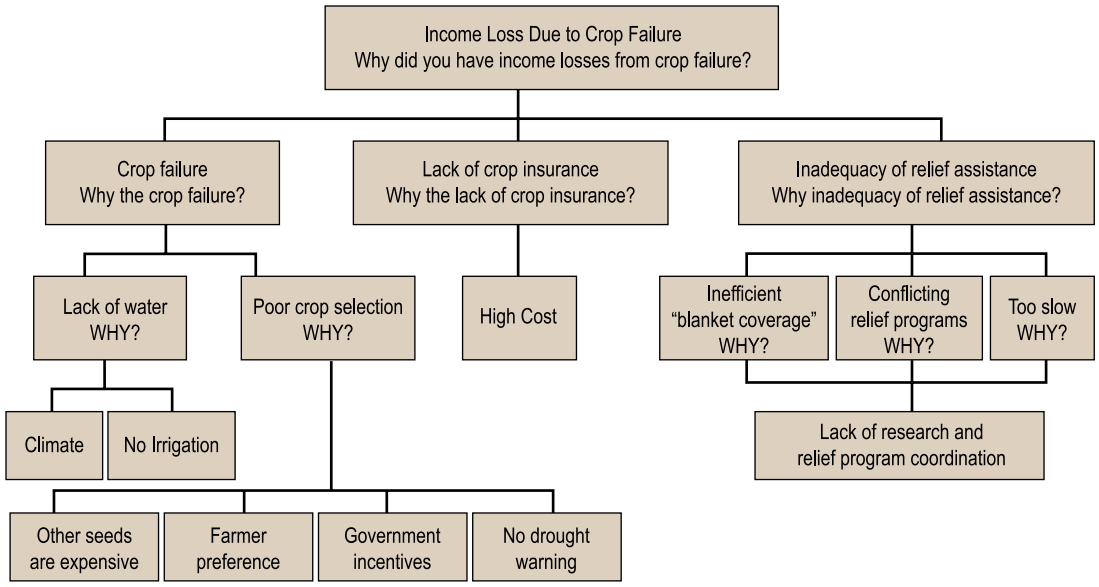
Climatic, water resource, agricultural, environmental and socio-economic vulnerabilities; drought early warning systems; and mitigation strategies were investigated in each country. Although a good deal of information was obtained during the study, researchers found that there is a general lack of understanding and awareness of drought and its impacts in West Asia and that this type of research should be continued throughout the region.

Source: UNESCWA (2005), Water Development Report 1: Vulnerability of the Region to Socio-Economic Drought.

spatial analysis, monitoring of food prices in local markets, exhaustive household surveys, and discussions with members of poor and food-insecure households to understand the nature of food insecurity and the risks to livelihoods. VAM monitors and analyses emerging food security problems, and help WFP's decision making at key points in the design and management of emergency and development programmes. VAM works in close collaboration with many partners worldwide, including governments, other UN agencies (such as FAO, UNICEF, WHO), local and international NGOs, universities and the private sector. These partnerships ensure a shared understanding of food security problems and common priorities for action.

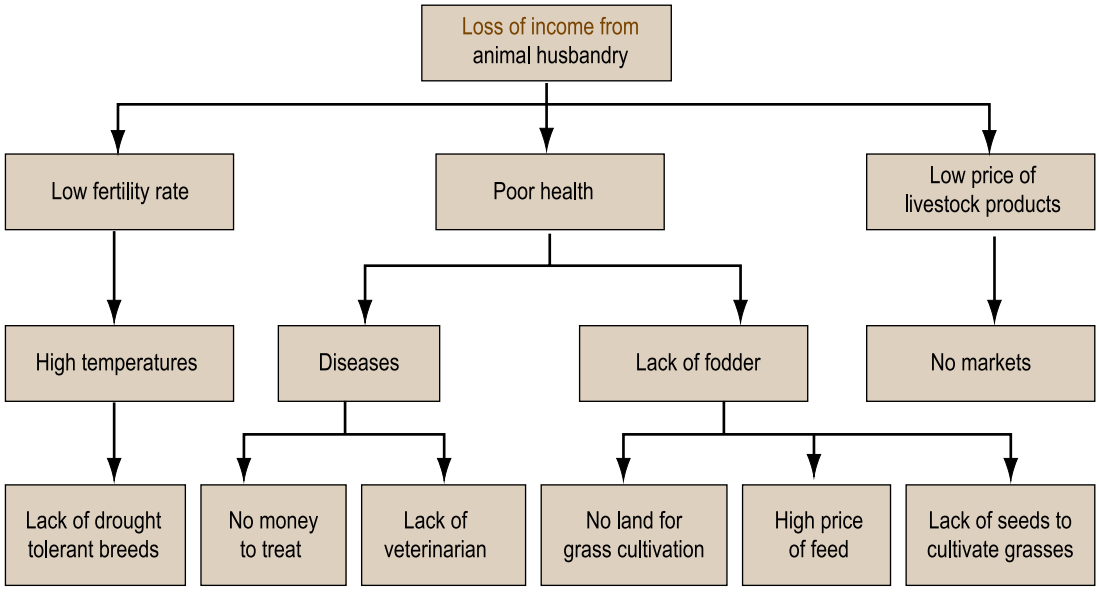
Another example is the UN Food and Agriculture Organization, which also supplies food security statistics and maps, such as a map of the percentage of undernourished population by country around the world (Figure 17). Gathering and sharing this type of information is essential for analyzing drought vulnerabilities and helping decision makers target mitigation actions that will help address the real causes of drought impacts.

Figure 15:
An example of a simplified agricultural impact tree diagram



Source: National Drought Mitigation Center, USA

Figure 16:
An example of an impact tree diagram for animal husbandry



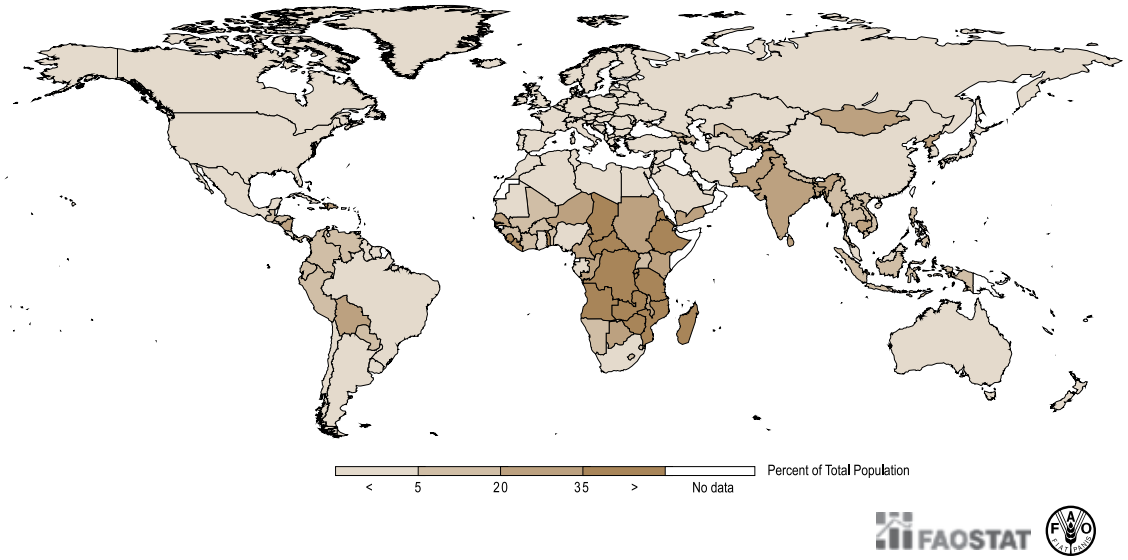
Source: Oxfam in Viet Nam and Graduate School of Global Environmental Studies of Kyoto University, Japan, 2007, Drought-Management Considerations for Climate- Change Adaptation: Focus on the Mekong Region

4.2.3 Enhancing risk assessment methodology and applications

Risk assessment methodologies, maps and standards should continue to be tested and modified to meet the needs of stakeholders. They should also be required as part of national and local planning strategies. Institutionalizing the processes will help ensure they are carried out as administrations and initiatives change over time.

In order to enhance risk assessment efforts, it is recommended that researchers and planning entities support the development of common methodologies for defining and assessing risks, thereby encouraging the identification and

Figure 17:
Percentage of undernourished population, by country, 2003-2005



Source: UN Food and Agriculture Organization at http://faostat.fao.org/site/563/default.aspx

adoption of best international practices. This includes the adoption of drought hazard and vulnerability indicators and using metrics most relevant to decision makers and clients (e.g., identifying the agricultural drought hazard rather than simply the climate hazard).

In addition, researchers and practitioners should develop, update periodically and disseminate risk maps and related information on drought exposure and vulnerability, with special emphasis on those populations most at risk. Institutions must also cooperate regionally and internationally, as appropriate, to assess and monitor regional and transboundary hazards and vulnerabilities and exchange relevant information.

4.2.4 Drought monitoring and early warning

Drought is typically a slow-onset phenomenon, which means that it is often possible to provide early warning of an emerging drought. Such information allows for a shift from reactive to proactive hazard management and represents a change in focus from disaster recovery to disaster prevention.

Because there is no single definition for drought, its onset and termination are difficult to determine. We can, however, identify various indicators of drought specific to sectors or water uses, and tracking these indicators provides us with a crucial means of monitoring and providing early drought warnings.

The UNISDR Platform for the Promotion of Early Warning completed a global survey of early warning systems in 2006. The survey found that early warning systems for drought are more complex than those for other hydro-meteorological hazards and are, consequently, relatively less developed globally (see http://www.unisdr.org/ppew/). They are heavily reliant on monitoring observed patterns of monthly and seasonal rainfall, streamflow, groundwater levels, snowpack and other parameters and the use of historical and statistical data. The study also stressed the importance of "people-centred" early warning systems, i.e., systems that are focused on reaching the people affected and providing them with meaningful information that they can act on.

Global Circulation Models (GCMs) and associated statistical ensemble methods are being routinely used to provide predictions of upcoming climate anomalies and offer promise for increasingly useful

forecasts of the onset, severity and duration of drought for large geographic regions on monthly and seasonal timescales. Requirements for early warning range from a few weeks to several months.

For example, Eastern African countries have developed drought early warning systems capable of integrating information from various sources and providing warnings of the imminent onset of drought. In Africa, regional centres such as the IGAD Climate Prediction and Applications Centre (ICPAC) and the Drought Monitoring Centre (DMC) in Harare, supported by the World Meteorological Organization and Economic Commissions, and the Sahara and Sahelian Observatory (OSS), provide current data, develop climate outlooks and issue warnings to national meteorological and hydrological services.

Figures 18 and 19 illustrate selected climate- and drought-related products produced by ICPAC (www.icpac.net). The products depict cumulative rainfall deviations from the mean for Mombasa, Kenya; a regional climate outlook map; and a map illustrating the food security outlook for the countries in the Greater Horn of Africa, respectively.

ICPAC organizes regional climate outlook forums comprising national, regional, and international experts to review conditions and develop climate outlooks. User representatives from different sectors often participate in the forums. Such forums are also organized in other regions of the world.

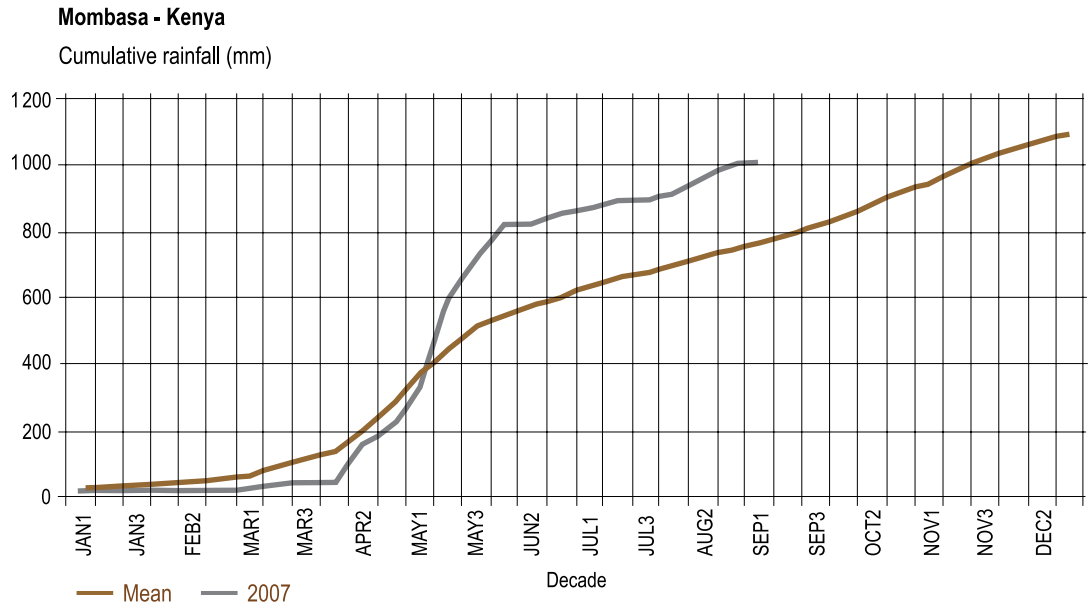
As discussed in the 2006 World Meteorological Organization document "Drought monitoring and early warning: concepts, progress, and future challenges" (http://www.wmo.int/pages/publications/showcase/index_en_old.html), drought monitoring systems have also been developed in countries such as China, South Africa, Portugal, Australia, and the United States, as well as a collaborative North American drought monitoring system between Canada, the United States and Mexico. Each of these countries has developed unique monitoring systems to suit their needs and capacities. China relies heavily on the Standardized Precipitation Index to monitor drought occurrence, Portugal utilizes the Palmer Drought Severity Index and Australia quantifies precipitation percentiles.

In some developing countries, an outcome of drought, and sometimes of other weather hazards, is the risk of famine or extreme food insecurity. For example, early warning systems for food security in many African developing countries make use of information from the major international food security monitoring systems. The FAO Global Information and Early Warning System on Food and Agriculture (GIEWS) is the most globally complete system, but other systems, including the USAID-sponsored Famine Early Warning System (FEWS NET) and DevInfo, developed by UNICEF and implemented through the UN Country Teams, are also important. FEWS NET is mainly focused on Africa (see Figure 20), where the majority of food security warning systems operate, but it also covers parts of central Asia, Central America, and the Caribbean.

FAO/GIEWS was developed after the world food crisis of the early 1970s, and has become the worldwide network for providing information on food production and security. The network has expanded to 115 governments, 61 NGOs and various other trade, research and media organizations worldwide. GIEWS Workstation Information Management provides 1) an integrated database of multidisciplinary, standardized and harmonized data, 2) data analysis tools including maps, tables and charting tools, and 3) a peer-to-peer data exchange system linking all nodes in the GIEWS Workstation Network (see Figure 21).

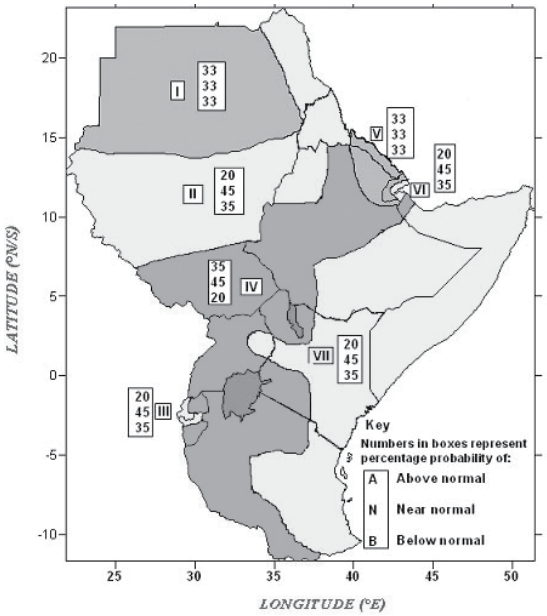
The GIEWS Workstation installed at the country level, with the support from the European Commission, uses open-source technology to avoid license constraints and enable free distribution. Training, data collection and the development of supplementary tools are part of the GIEWS Workstation "package". The GIEWS Workstation's modular structure is based on its flexibility and adaptability to the different needs of users and changing needs over time. Participation and feedback from the users are also important for updating the system. Access to high-quality and timely information and the ability to derive

Figure 18:
Example: Cumulative rainfall over parts of Kenya



Source: ICPAC at www.icpac.net

Figure 19:
Example of Climate Outlook Product of Seasonal Forecast for the Greater Horn of Africa (September-December 2007)



Source: ICPAC at www.icpac.net/Forecasts/GHACOF20/cof20_statement.html

Zone I: Climatology is indicated over northern Sudan.

Zone II: Increased likelihood of near normal to belownormal rainfall over central and northeastern Sudan; northwestern Ethiopia; and much of Eritrea.

Zone III: Increased likelihood of near normal to below normal rainfall over western Rwanda and northern Burundi.

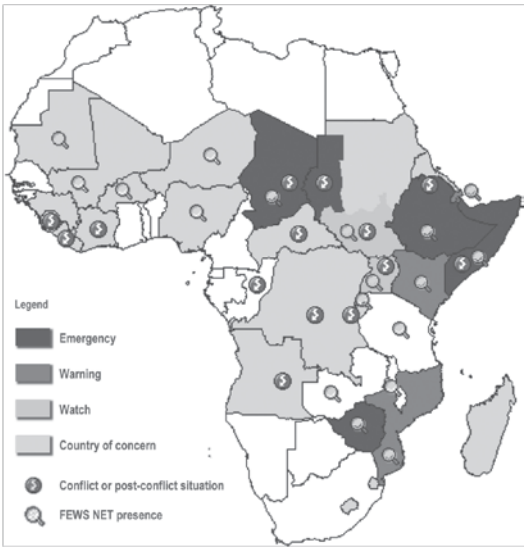
Zone IV: Increased likelihood of near normal to above normal rainfall over southern Sudan; western, central and parts of northern Ethiopia; extreme northwestern Somalia; northwestern and southwestern Kenya; much of Uganda; central and eastern Rwanda; central and southern Burundi; as well as northern and western Tanzania.

Zone V: Climatology is indicated over northeastern Ethiopia; southeastern Eritrea and much of Djibouti.

Zone VI: Increased likelihood of near normal to below normal rainfall over eastern Djibouti.

Zone VII: Increased likelihood of near normal to below normal rainfall over much of Somalia; eastern and southern Ethiopia; much of Kenya; eastern Uganda; as well as eastern and central Tanzania.

Figure 20: Example of Food Security Alerts in Sub-Saharan Africa (November-December 2007)



Source: GIEWS Homepage, FAO, http://v4.fews.net/docs/Publications/1001480.pdf

vulnerability and food insecurity indicators from primary and secondary data have contributed to the implementation of efficient response mechanisms to food crises. (http://www.fao.org/giews/english/index.htm)

FEWS was established after the catastrophic famine in Ethiopia in 1985 with a mission to lower the incidence of drought-induced famine by providing timely and accurate information regarding potential famine conditions to decision makers. The system has evolved into FEWS NET, which has continued its focus on mainly improving food security in 22 drought-prone African countries, but it has also helped establish more effective, sustainable, and African-led food security and response planning networks that reduce the vulnerability of the groups at risk.

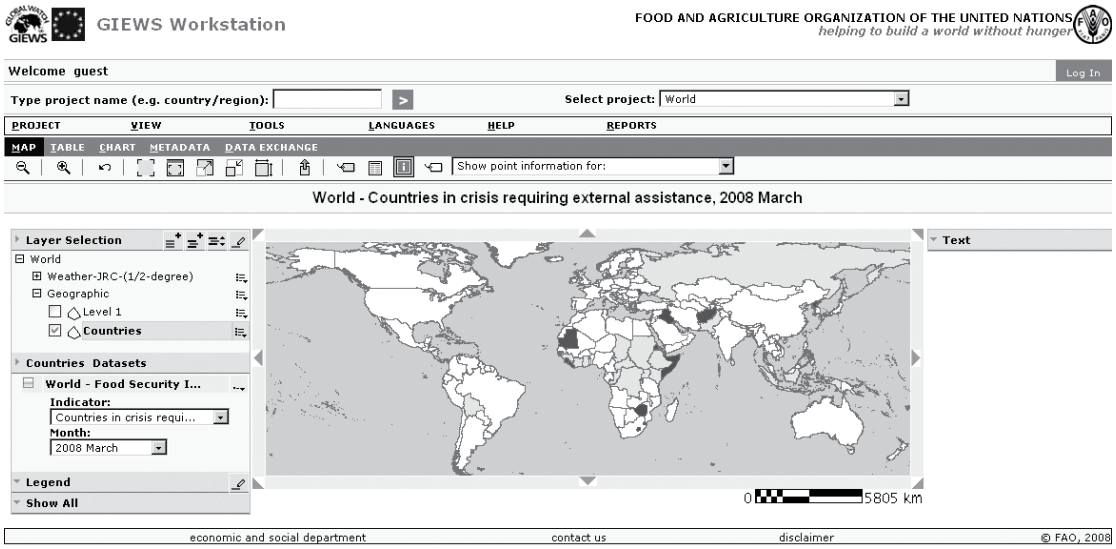
The information, data and analysis needed for FEWS NET have been collected and provided by the U.S. Geological Survey EROS Data Center (USGS/EDC) in cooperation with USAID, the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and Chemonics International Incorporated. The information, which includes satellite data, provides the spatial coverage and temporal frequency necessary for monitoring both vegetation condition and rainfall occurrence throughout the entire African continent. In addition, field representatives in each of the 22 African countries provide the network with ground-based input, make field observations, and monitor regional and country-specific conditions. (http://edcintl.cr.usgs.gov/fewsnet.html)

DevInfo is a desktop and web-enabled tool of a database system that provides a method of organizing, storing, and displaying data in a uniform format to facilitate data sharing at the country level across government departments and UN agencies using the same system. DevInfo has been adapted from UNICEF ChildInfo database technology. It is a useful tool to monitor progress toward the Millennium Development Goals (MDG). DevInfo generates tables, graphs and maps with user-friendly features for MDG related reports and presentations. The integrated database system maintains indicators by time periods and geographic areas. The standard set of indicators (the 48 MDG indicators) cannot be modified. However, at the regional and country levels, database administrators have the option of adding their own sets of local indicators to their databases. (www.devinfo.org)

From the standpoint of user accessibility to underlying original data collections and enhancing the capacity of end-users to handle such geo-information, the International Institute for Geo-Information Science and Earth Observation (ITC), Netherlands, analysed several early warning web portals which provide information related to food security on multiple hazards simultaneously. Examples of such web portals include the above-mentioned FEWS NET of USAID, ReliefWeb of OCHA (http://www.reliefweb.int/), the Climate Data Library of the International Research Institute for Climate and Society of Columbia University (IRI), New York, (http://iridl.ldeo.columbia.edu/), and the University Network for Disaster Risk Reduction in Africa (UNEDRA) of ITC (www.itc.nl/unu/dgim/unedra/default.asp).

As explained previously, FEWS NET combines the best available technology with state-of-the-art remote-sensing satellite imagery sourced

Figure 21:
GIEWS Workstation home page



Source: GIEWS Homepage, FAO, http://www.fao.org/giews/workstation/page.jspx

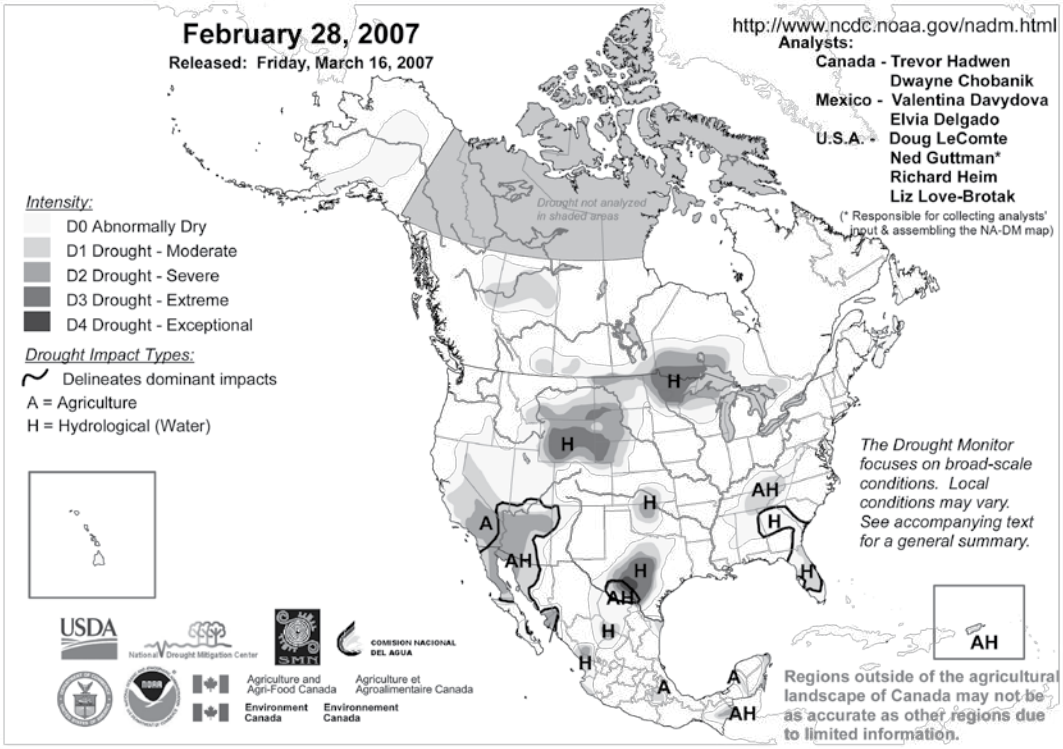
from NOAA, NASA, and USGS. FEWS NET recently started to incorporate livelihood zones as the basis on which to overlay and analyse remote sensed environmental hazard products to account for vulnerability and coping capacity of local communities. Working toward a holistic approach to risk assessment, FEWS NET has also started to incorporate warnings on other hazards that can deepen a food insecurity crisis, such as locust plagues.

ITC points out that, unfortunately, underlying data collections are not yet available for download at FEWS NET. Such access would give the user the option to question and verify the messages of their bulletins, to improve possible shortcomings in the underlying methodologies, or to combine it with other data collections to achieve more holistic systems approach. However, this is less feasible as it assumes desktop-based remote-sensing and Geographic Information System (GIS) skills, which the average humanitarian or emergency worker may not have.

In contrast, the Climate Data Library of IRI offers the same data collections as FEWS NET, but supports a much broader variety of file formats and Internet protocols. This allows selected clients to access their data collections remotely without the need for binary downloading them to the local desktop first. The Climate Data Library contains over 300 datasets from a variety of earth science disciplines and climate-related topics, including drought monitoring and food security related hazards. As an example, the Desert Locust Information Service (DLIS), as part of the FAO, collaborates with IRI in providing products to estimate favourable ecological conditions in the Desert Locust recession area. Various clients can remotely access these and other data collections by their Internet protocol support through so-called Application Protocols Interfaces (API). A similar approach is adopted by UNEDRA, which falls under "Capacity Building for Disaster Geo-Information Management (DGIM)", a task performed by ITC as an associated institution of the United Nations University (UNU).

Taking an integrated approach, the United States Drought Monitor (USDM) and the North American Drought Monitor (NADM) utilize multiple climate indices and indicators to assess drought conditions (e.g., Palmer Drought Severity Index, Standardized Precipitation Index, stream flow, satellite-derived vegetation health, soil moisture, Keetch-Byram Drought Index, reservoir levels, Surface Water Supply Index, river basin snow water equivalent, and pasture and range conditions). To ensure the accuracy of regional drought depictions on the USDM, a growing network of

Figure 22:
The North American Drought Monitor



Source: National Drought Mitigation Center, University of Nebraska-Lincoln, USA, U.S. Department of Agriculture, National Oceanic and Atmospheric Administration, Agriculture and Agrifood Canada, Meteorological Service of Canada, and National Meteorological Service of Mexico (see www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/index.html).

more than 240 experts across the United States has an opportunity to comment on the map via a web-based list serve before its release each week. India uses a similar network of experts to monitor drought conditions during the year.

The NADM in Figure 22 shows drought conditions across North America in February 2007 (NADM). NOAA's Climate Prediction Center also provides a monthly drought outlook across the United States, illustrating regions where drought is expected to linger, become more serious, or degrade. These services form a part of the National Integrated Drought Information System (NIDIS) of the United States. NIDIS launched a new U.S. Drought Portal website in 2007 (http://www.drought.gov).

For any drought prone areas where inaccessibility prevents effective drought monitoring, a radar soil moisture detection method could be one solution. Radar instruments on satellites can see through clouds and can be operated day and night. They can monitor changes in water content in soil, vegetation and snow, detect when the earth surface is frozen, and map inundation patterns. Therefore, radar satellites are ideally suited for monitoring hydrological processes over land. Using this technology, the Vienna University of Technology (TU WIEN) in cooperation with the European Space Agency (ESA) and the University of Kwazulu Natal issues a periodical bulletin called "SHARE Bulletin" on soil moisture. The bulletin describes soil moisture conditions over the SADC (South African Development Community) region in monthly averages using active microwave remote sensing. An experimental use of the same dataset over East Africa (Somalia in particular) has just started as collaboration between Vienna University of Technology (Prof. Wolfgang Wagner group, http://www.ipf.tuwien.ac.at/radar/index.php) and

Box 11
India: Collaborative drought monitoring and utilizing existing resources

In India, the Crop Weather Watch Group (within the Federal Ministry of Agriculture) evaluates information and data furnished by Indian and other agencies to determine the likely effects of meteorological and other environmental parameters on agriculture. The group meets every Monday during the rainy season (June to September) and the frequency of meetings increases during drought events. The group is derived of representatives from several different sectors, and utilizes several different communication nodes to relay drought monitoring information from the field to decision makers.

Composition and role of CWWG of the Ministry of Agriculture, Government of India.

Partners	Tasks
Additional Secretary, Ministry of Agriculture	Chairperson of the Group; promotes overall coordination
Economic & Statistical Adviser, MoA	Report behavior of agro-climatic and market indicators
India Meteorological Department	Rainfall forecast and progress of monsoonal conditions
Central Water Commission	Water-availability monitoring in major reservoirs
Plant Protection Division	Watch pests and diseases outbreak
Crop Specialists	Crop conditions and production
Agricultural input supply divisions	Supply and demand of agricultural inputs
Agricultural extension specialists	Report on field-level farm operations
Ministry of Power	Manage electrical power for groundwater extraction
Indian Council of Agricultural Research	Technical input and contingency planning
National Center for Medium Range Weather Forecast	Provide medium-term forecasts

Details of CWWG monitoring and information management.

P arameters	National-level agencies	State- level agencies	District- level agencies	Field- level agencies	Communication mode
A. Meteorological					
Delay in the onset ofmonsoon	W	W	D	D	Wireless/Fax/Telephone/e-mail
Dry spell during sowing	W	W	D	D	Wireless/Fax/Telephone/e-mail
Dry spells during critical					
crop-growth periods	W	W	D	D	Wireless/Fax/Telephone/e-mail
B. Hydrological					
Water availability in Reservoirs	W	W	D	D	Wireless/Fax/Telephone/ e-mail/ Written reports
Water availability in tanks/ lakes	F	F	F	W	Written reports
Stream flow	F	F	F	W	Written reports
Groundwater level	S	S	S	S	Written reports
Soil moisture deficit	F	F	F	F	Written reports
C. Agricultural					
Delay in sowing	W	W	W	W	Wireless/Fax/Telephone/e-mail
Sown area	W	W	W	W	Wireless/Fax/Telephone/e-mail
Crop vigor	F	F	F	W	Written reports
Change in croppingpattern	W	W	W	W	Wireless/Fax/Telephone/e-mail
Supply and demand of agricultural inputs	W	W	W	W	Wireless/Fax/Telephone/ NICNET

D = Daily; W= Weekly; F= Fortnightly; M= Monthly; S = Seasonal (Pre- and Post-rains)

Source: J.S. Samra, 2004, Review and Analysis of Drought Monitoring, Declaration, and Management in India, Working Paper 84, International Water Management Institute (http://www.iwmi.cgiar.org/Publications/Working_Papers/working/WOR84.pdf)

Box 12:
India: Indigenous drought prediction in the upper north-west Himalayas

Indigenous knowledge still plays an important role in climate and drought forecasting in many regions of the world. Some of the indigenous strategies for predicting rainfall and drought in the upper north-west Himalayas of India are:

- If the "Jonks" (leeches) are immobile on water surfaces, dry weather is predicted, but rainfall is predicted if they move rapidly in upward and downward directions.
- Heavy rainfall is predicted during the coming rainy season if the "Tatihari" bird (lapwing) lays her eggs on the higher portion of the field, but if the eggs are laid in the lower portion of the field then a drought is predicted. If a single egg is laid, there will only be rainfall one out of four months of the rainy season. If two eggs are laid, rainfall will occur for two months and similarly four eggs indicate there will be rainfall during all four months of the rainy season.
- If the "Tillbohara" (dragon flies), which appear generally in the rainy season, are observed to swarm in a large group over the surface of a pond, dry weather is predicted, but early rainfall is predicted by the farmers if they swarm over open dry lands or fields.
- If the "Khejri" tree bears good fruit in a particular year, then farmers predict good rainfall during the next rainy season and, vice versa, less rain is predicted in the event of a poor fruit crop.
- When cloudy days are accompanied by clear nights and the eastern winds blow somewhat strongly, then no rainfall is predicted.

Source: L.R. Verma, 1998, Indigenous technology knowledge for watershed management in upper north-west Himalayas of India, GCP/RAS/161/NET, FAO (UN), Kathmandu, Nepal

the FAO SWALIM project (www.faoswalim.org). (Ref: http://www.ipf.tuwien.ac.at/radar/)

Traditional monitoring and forecasting also remains an important source of climate information in many rural communities. Along with growing appreciation that traditional observations and outlook methods may have scientific validity, there is increased interest in harmonizing traditional and modern scientific methods of climate prediction. An example of indigenous drought prediction in the upper north-west Himalayas of India is given in Box 12. Studies have also been initiated in some countries, such as Zimbabwe and Kenya, to gain further understanding of traditional forecasting.

4.2.5 Enhancing drought monitoring and early warning capacities

Drought monitoring and early warning systems will be enhanced if planners and scientists work together to promote the development of systems that are timely, relevant, understandable, affordable, and people-centred. In order to achieve this goal, it is essential to develop the appropriate social and technological capacity to research and implement programmes to better understand, monitor, and communicate drought occurrences and their related effects.

This includes fostering the ability of national governments and other planning entities to support the development and sustainability of the required infrastructure and scientific, technological, and institutional capacities needed to research, observe, analyse, map and, where possible, forecast natural and related hazards, vulnerabilities, and drought impacts.

It is also essential to support the development and improvement of relevant databases and the promotion of full and open exchange and dissemination of data for assessment, monitoring, and early warning for drought at international, regional, national, and local levels. This includes the development of decision-support models for the dissemination of drought-related information

to end users and appropriate methods for encouraging feedback on climate and drought assessment products, and on other forms of early warning information.

Effectively gathering and sharing this information will require the promotion of institutional development and the skills necessary for effective collaborative research and planning among relevant scientific groups (i.e., physical and social scientists), policymakers, and stakeholders.

Where possible, scientists should also encourage the prudent adoption of climate and forecast information to foster a shift from reactive to proactive management of drought risks. In this regard, changing climate and the associated changing nature of drought pose a serious risk to sustainable development, the environment, and society. Climate change will lead to changes in the dynamics of drought, with associated (but somewhat uncertain) changes in drought hazard and exposure.

Therefore, it is essential that entities begin to compile and analyse, in a consistent manner, information on the occurrence of drought hazards, to enable a better understanding of past and future changes. With this information, planners can begin to research, analyse, and report on long-term changes in drought risk, and in particular those aspects that might increase vulnerabilities and the capacity of authorities and communities to respond to drought. They can also evaluate the potential for incorporating drought risk assessments into national vulnerability and adaptation assessments for climate change.

An example of online drought monitoring is given by the South Asia Drought Monitor (SADM), a project which, until 2004, facilitated information on the web, based on remote sensing data, drought-related indices and GIS. The project aimed at supplying timely information on drought onset, progression and extent. This near-real-time drought monitoring and reporting system covered Afghanistan, Pakistan and western parts of India, and facilitated information at the district or village scales. See Figure 23.

Similarly, a group of European hydrologists has undertaken a European Union supported project to develop a highly consistent modelling framework by integrating three different disciplines, namely water resources, hydrology and climate studies. The integrated project, called WATCH (WATer and global CHange), will evaluate how the global water cycle and in particular droughts respond to future drivers of global change, including greenhouse gas release and land cover change. WATCH can contribute to assessing the uncertainties in the predictions of climate-hydrological-water resources model chains using a combination of model ensembles and observations. (http://www.geo.uio.no/edc/downloads/droughts_and_climate_change_2007.pdf)

In some countries and regions without adequate infrastructure to measure the physical manifestations of drought, such as precipitation, streamflow, or groundwater levels, an early warning system may be based on the effects of drought, such as market fluctuations (increased food prices or cattle sales), health indicators (increase in malnutrition or disease), human or animal migrations, or other social indicators.

Promoting the inclusion of indigenous or local groups and knowledge in drought monitoring and early warning systems is essential for developing appropriate local drought indicators, verifying the occurrence of drought, and communicating the warnings to local populations. For example, the FAO (Food and Agriculture Organization) Near East Regional Office has worked with the Syrian government to develop an early warning system for drought in the Syrian rangelands. This system utilises community members who have been trained to be field monitors to help survey drought indicators on a monthly basis. This information is then compiled into a national drought monitoring database, and monthly drought bulletins have been produced regularly since 2005 in both English and Arabic. (http://www.fao.org.sy/modules.php?op=modload&name=projects&file=viewProjects&idField=23&cat_id=1)

Another example involving local farmers in drought monitoring to enhance national level early

warning systems can be found in Mali's "observing farmers" (see Box 13).

Networks should also continue to be established to support the sharing of basic climate information and early warning systems across borders and regions. For example, the AGRHYMET Centre (a specialized centre of the Permanent Interstate Committee for Drought Control in the Sahel) provides agro-meteorological monitoring services across western Africa in Burkina Faso, Cape Verde, Chad, The Gambia, Guinea Bissau, Mali, Mauritania, Niger and Senegal. In this capacity, the centre monitors a range of conditions such as rainfall amounts and surface water supplies, start of the growing season, crop water requirements, crop pests and diseases, and vegetation stress (www.agrhymet.ne).

The AGRHYMET Centre is also a member of a consortium, along with the African Centre for Meteorological Applications to Development (ACMAD) and the Niger River Basin Authority, which issues forecasts for the July-September cumulative rainfall, two to three months in advance, for the Economic Community of Western African States (ECOWAS) member countries (Figure 24). This type of collaboration and information sharing is essential to create robust and international drought early warning systems.

National and local capacities may need to be enhanced to ensure that early warning information is appropriate for user needs (including those at the community level), and that it is well integrated into policy and decision-making processes and emergency management systems at both the national and local levels. The responsibility for organizing appropriate preparedness and responses to warnings usually rests with national and local disaster management organizations,

Box 13:
Mali: Involvement of local farmers in drought monitoring

The concept of "Paysan Observateur" (observing farmers) was developed within a project aimed at strengthening meteorological services to the rural population, implemented by the National Meteorological Service (DNM) in Mali and launched in 1982 with financial support from Switzerland. The programme offers farmers crucial information about optimal sowing times for different crops in different locations in addition to information regarding potential precipitation during the crop season and potential insect infestations.

DNM collects and analyses information from a number of different sources, including information collected by the farmers themselves through special rain gauges. A local project has been established to produce cheap rain gauges that are sold to the farmers. The participating farmers are trained in using the rain gauges and collection sheets for immediate use as well as for transmission of the daily measurement through a decentralized system to the DNM in Bamako.

Once analysed, the information is communicated to different audiences, such as farmers and decision makers at national and regional levels, and presented in specific communications according to the audiences. Farmers, for instance, receive daily information on the local rural radio in addition to information provided by the rural extension system. The information is highly appreciated by the farmers and it is believed that output has increased by 15 to 25% for farmers using the daily information and advice provided through the rural radio, compared to farmers who do not use the information.

It should also be noted that many women appreciate the weather forecasts to programme some of their income generation activities such as dried mangoes and vegetable production. Moreover, the DNM organizes a number of awareness-raisingactivities for different audiences, such as yearly "meteorological days" for the parliamentarians, and the various DNM early warning systems now form part of the national budget. The programme was integrated into the national budget after the third phase of the Swiss project came to an end in 2004.

Source: The text above is from "Drought and Vulnerability – A review of context, capacity and appropriate interventions with respect to drought and the problem of acute malnutrition in the Sahel Region of West Africa", L. Poulsen, M. Michael, N. Pearson, 2007

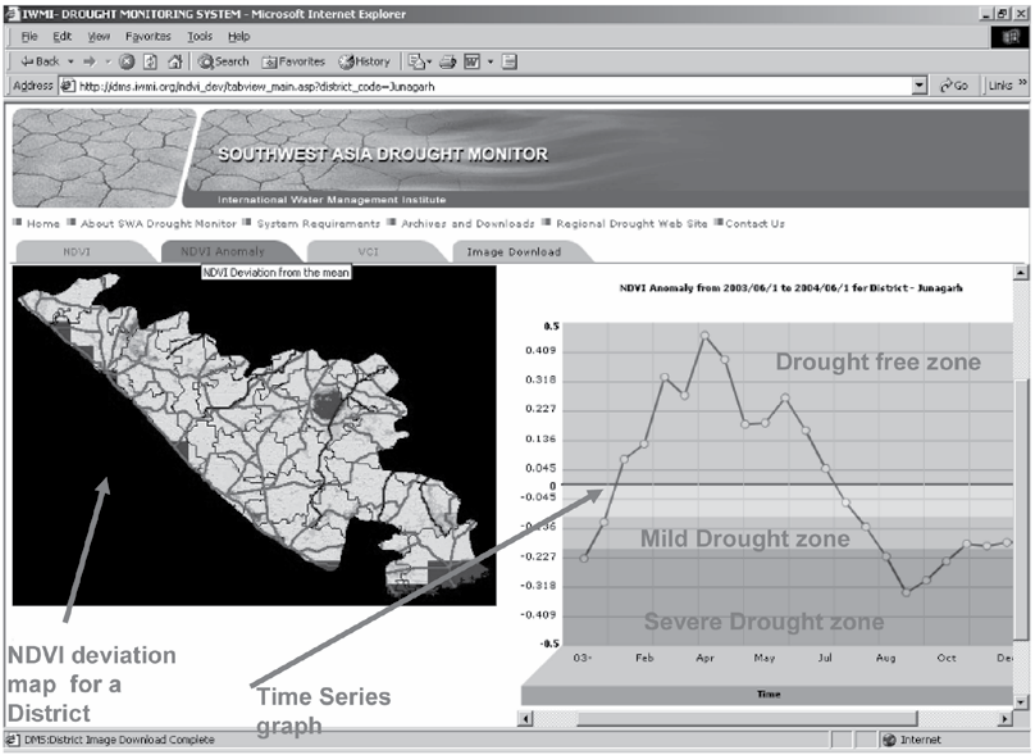


Figure 23: South-West Asia Drought Monitor, example of on-line drought monitoring report at a district/ village scale with Normalized Difference Vegetation Index (NDVI) and time series of drought anomalies, date 2004.

Source: National Drought Mitigation Center, U.S. Department of Agriculture, National Oceanic and Atmospheric Administration, Agriculture and Agrifood Canada, Meteorological Service of Canada, and National Meteorological Service of Mexico

but it also requires interaction with national and regional forecast institutions. A good practice in establishing drought early warning system for decision-makers in Botswana is indicated in Annex 3.

In developing countries, emergency response agencies, committees, and organizations, as well as NGOs and UN agencies, can play significant roles in capacity development (see the website of the Capacity for Disaster Reduction Initiative at http://www.unisdr.org/cadri/index.html). These groups seek to work with relevant national agencies to coordinate the development of technical capacities for monitoring, detecting, and warning for a wide range of hazards and their impacts.

These capacities need to be used for drought risk reduction purposes to develop a drought knowledge network where governments, international and regional organizations, experts, and practitioners can exchange information, policies, and practices in a coordinated and systematic way. This network is also important for improving forecast and early warning information.

Augmenting forecast and early warning information with decision support capabilities to provide information on options for reducing vulnerability to drought enhances local coping capacities and provides an important mechanism for reducing drought risk.

Box 14:
Ethiopia: FAO/WFP collaboration on weather-indexed livelihood protection scheme

Ethiopia has had generally favourable weather over the last few growing seasons, with record grain production in 2006/2007, but the country in general, and many areas in particular, remains vulnerable to crop failure from extended dry spells, or even drought. Early warning of impending crop failure is essential to enable the government to take prompt actions to mitigate a disaster or compensate rural households for food and income losses, but response is often delayed by a lack of objective data and evidence.

To overcome this, and provide both a scientific basis for decision making and a response financing mechanism, the Food and Agriculture Organization and the World Food Programme are jointly developing and testing weather-indexed livelihood protection schemes, similar to a partial indemnity insurance policy.

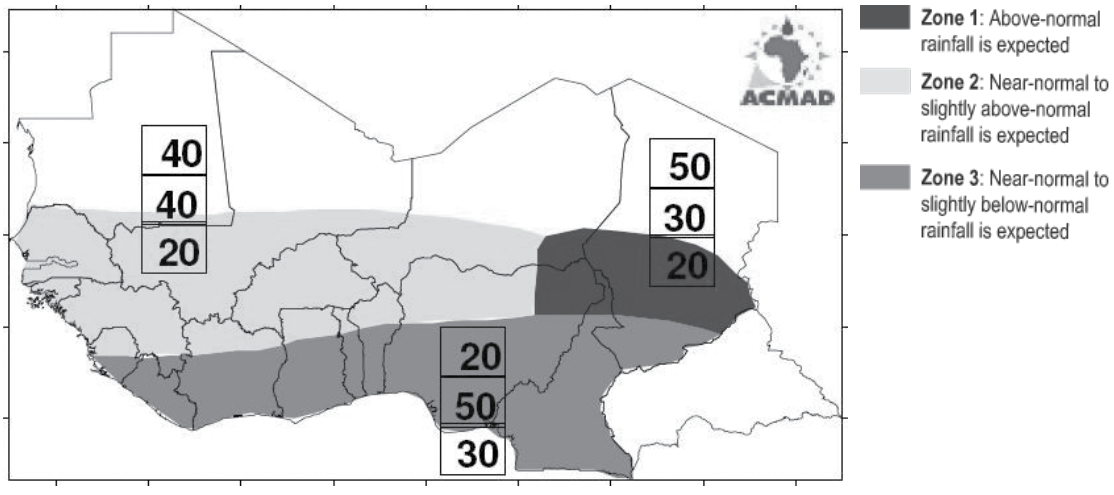
The weather index combines ground station and rainfall estimates with state-of-the-art modeling of water requirements for 13 major crops of Ethiopia. The spatial resolution is fine enough to differentiate between proximate but different ecological and livelihood systems. In combination with household-level data, the model allows one to derive estimates of the impact of drought, in terms of the value of productive assets (e.g., livestock, farm implements, seed) people would have to sell to cope with the disaster. Since the onset of the disaster in the affected areas can be verified by the model, the weather index serves as the objective basis for the release of a partial indemnity insurance payment.

These funds can then be used by WFP and national institutions to provide immediate support to the affected households, and thus prevent the liquidation of critical household assets. If the crop failure is severe or total, additional assistance can then be mobilized through the national Productive Safety Net Programme, an appeal process, or other means.

Once the current prototype is validated, it will provide an objectively verifiable means to establish a very rapid first line of defence against the effects of drought. A software package, which is called LEAP, to support drought-index calculation for ex-ante risk management for Ethiopia is available at the WFP Website (http://vam.wfp.org/LEAP). This software platform, currently only filled with the data of Ethiopia, can be used outside Ethiopia.

Source: Henri Josserand, FAO and Ulrich Hess, WFP, 2007.

Figure 24:
Seasonal forecast for the year 2007 July-August-September cumulative rainfall in Western Africa



Source: African Centre for Meteorological Applications to Development -ACMAD- at www.acmad.ne

4.3 Drought awareness and knowledge management

Related to Priority 3 of the Hyogo Framework for Action: To use knowledge, innovation and education to build a culture of safety and resilience at all levels of society.

Today, the world has a wealth of knowledge and information on disaster risk reduction at its disposal; the key is compiling, collecting, sharing, and using this in a proactive way through awareness-raising and educational initiatives so that people can make informed decisions and take action to best protect themselves and their property and livelihoods from natural hazards.

Guiding principles

In general, drought awareness and knowledge management activities should be guided by the following principles:

1 The effects of drought can be substantially reduced if people are well informed and motivated toward a culture of disaster prevention and resilience,
2 Effective information management and exchange requires strengthening dialogue and networks among disaster researchers, practitioners, and stakeholders in order to foster consistent knowledge collection and meaningful message dissemination,
3 Public awareness programmes should be designed and implemented with a clear understanding of local perspectives and needs, and promote engagement of the media to stimulate a culture of disaster resilience, including resilience to drought and strong community involvement,
4 Education and training are essential for all people in order to reduce local drought risk.

4.3.1 Developing a culture of drought prevention and resilience

There are many challenges to improving the management of droughts.

The first challenge is that drought must be recognized as a natural hazard, not just a natural event, within the natural hazard community of scientists and policymakers. Because of its slow-onset characteristics and lack of structural impacts, it is often disregarded.

This lack of recognition of the importance of drought as a natural hazard by some actors has been an impediment to obtaining adequate financial and research support and, in many instances, an obstacle to building awareness among policymakers at the local, national, regional, and international level. This lack of awareness, in turn, has resulted in an under-appreciation of drought and its far-reaching impacts. It has also perpetuated the process of dealing with drought in a crisis management mode when the knowledge and technology necessary to improve preparedness for and mitigation of impacts is readily available.

The second challenge is to build awareness of drought as a natural part of climate. Climate change is an additional variable to be considered in drought hazard identification, monitoring, mitigation and preparedness.

Drought can occur anywhere, although its features vary from region to region. Defining drought is therefore difficult; it depends on differences in regions, needs, and disciplinary perspectives. Based on the many definitions that have appeared in the literature, for example, drought may be defined in Libya as occurring when annual rainfall is less than 180 mm, but in Bali, drought might be considered to occur after a period of only 6 days without rain. Nonetheless, it is often considered to be a rare and random event, resulting in a lack of emphasis on preparedness and mitigation.

Improved understanding of the different types of drought (see Chapter 2) and the need for multiple

definitions and climatic/water supply indicators that are appropriate to various sectors, applications, and regions is a critical part of this awareness-building process.

The third challenge is to erase misunderstandings about drought and society's capacity to mitigate its effects.

Many people consider drought to be purely a physical phenomenon. This leads to the question, "If drought is a natural event, what control do we have over its occurrence and the impacts that result?" Drought originates from a deficiency of precipitation over an extended period of time. The frequency or probability of occurrence of these deficiencies varies spatially and represents a location's exposure to the occurrence of drought. Some regions have greater exposure than others, and we do not have the capacity to alter that exposure. However, as with other natural hazards, drought has physical, social, and economic components (see Chapter 3).

It is the social factors, in combination with our exposure, that determine risk to society. Some of the social factors that determine our vulnerability are level of development, population growth and its changing distribution, demographic characteristics, demands on water and other natural resources, government policies (sustainable versus unsustainable resource management), technological changes, social behaviour, and trends in environmental awareness and concerns. It is obvious that well-conceived policies, preparedness plans, and mitigation programmes can greatly reduce societal vulnerability and, therefore, the risks associated with drought.

The fourth challenge is to convince policy and other decision makers that investments in mitigation are more cost effective than post-impact assistance or relief programmes.

Evidence from around the world, although limited, illustrates that there is an escalating trend of losses associated with drought in both developing and developed countries. Also, the complexity of impacts is increasing. It seems clear that present investments in preparedness and mitigation will generate large dividends in reducing the impacts of drought.

A growing number of countries are realizing the potential advantages of drought planning. Governments are formulating policies and plans that address many of the deficiencies noted from previous response efforts that were largely reactive. Most of the progress in drought preparedness and mitigation has been made in the past two decades. Although the road ahead will be difficult and the learning curve steep, the potential rewards are numerous.

The crisis management approach of responding to drought has existed for many decades and is engrained in the culture and reflected in the institutions of both developed and developing countries. Movement from crisis to risk management will certainly require a paradigm shift.

In part because of the crisis management approach, those affected by drought have become accustomed to government assistance programmes. In many instances, misguided and misdirected government programmes and policies have promoted the unsustainable use of natural resources. Many governments have come to realize that drought response in the form of emergency assistance programmes that are not linked to changing practices only reinforces poor or unsustainable actions and decreases self-reliance.

These messages also need to be reinforced throughout society. As governments begin to

Box 15:
Essential drought messages

Developing a culture of drought prevention and resilience requires engraining the following messages into society:

1. Drought is a natural hazard that affects a wide range of sectors.
2. Drought is natural part of climate that should be managed.
3. There are proactive measures that can be taken to reduce drought disaster risk.
4. Pre-drought mitigation and preparedness actions are more cost-effective than drought response measures.

adopt risk reduction approaches, they can help formulate educational programmes directed at developing a culture of risk aversion throughout their constituencies. In some cases, this movement has been promoted from the grassroots level when governments have not been responsive to the paradigm shift. People's understanding and skills are essential components of any drought risk reduction strategy and practices. An investment in human resources by increasing individual capabilities across generations is likely to have more lasting value than other investments or measures to reduce risks.

Governments have a responsibility to promote public awareness of natural hazards and risk on a continuous basis and provide mechanisms for the sustainability of such programmes at the local level. They must also support capacity development at the local level for understanding and using drought risk and related information in short- and long-term decision making. As these themes become engrained in society, people will become increasingly responsive to the development and implementation of drought policies and planning, drought risk assessment and early warning systems, educational programmes, and drought risk reduction measures outlined in the framework.

4.3.2 Effective information management and exchange

Enabling effective information management and exchange requires the collection, compilation, and dissemination of relevant knowledge and information on hazards, vulnerabilities, and capacities and linking that knowledge to community drought risk reduction awareness campaigns, programmes, and projects. Interaction between the generators and users of information is essential for developing useful messages and helping to ensure the use of that information.

Specifically, this interaction and networking can help ensure that awareness programmes are designed and implemented with a clear understanding of perspectives and requirements that reflect local conditions and target all sections of society, including decision makers, educators, professionals, members of the public, and individuals living in threatened communities.

In these efforts, it is essential to identify the information users and their particular needs so that programmes, information products, and technologies will be useful and applicable. Different types of messages, locations, and delivery systems are necessary to reach the broad range of target audiences.

These messages must also provide easily understandable information on drought risks and mitigation options, especially to citizens in high-risk areas, to encourage and enable people to take actions to reduce risks and build resilient societies. Involvement of the media is often crucial in this process, and to stimulate a culture of disaster resilience and strong community involvement in sustained public awareness campaigns and public consultations at all levels of society.

Some innovative knowledge and communication networks in Africa are introduced in Box 16 and 17. A good practice of using information technology to assess and manage drought risk in Australia is indicated in Annex 3.

4.3.3 Education and training

Education for disaster risk reduction is an interactive process of mutual learning among people and institutions. It encompasses far more than formal education at schools and universities and in training courses. It involves the use of traditional wisdom and local knowledge to safeguard against natural hazards as well as the active and informed participation of the mass media. The effects of drought can be substantially reduced if policymakers, scientists, media, and the public are well informed and motivated toward a culture of disaster prevention and resilience. This requires sustained efforts to educate all segments of society that are vulnerable to the disastrous effects of drought. Education is a crucial means within society to communicate, motivate, and engage, as much as it is to teach. Awareness about drought risks and dangers needs to start in early

Box 16:
Africa: Southern Africa Drought Technology Network - SADNET

SADNET is a network that brings together development practitioners involved in agriculture to promote indigenous knowledge systems and drought mitigation activities in Southern Africa.

The NGO Southern Alliance for Indigenous Resources (SAFIRE) adopted SADNET as one of its strategies to address livelihood and food security issues for communities in drought-prone areas of Zimbabwe, Zambia, Malawi, and Mozambique through an emphasis on information sharing.

The project is based on the premise that "knowledge is power" and that the vulnerable farmers are in a better position to make informed decisions with regard to their agricultural production and drought mitigation activities if they have a ready supply of relevant and up-to-date information. SADNET facilitates information-sharing among small-scale farmers, NGOs, and community-based organizations in the areas of rural food security, agricultural research, and extension, as well as relating the role of agribusiness in fostering drought-coping strategies.

Collaborating partners include the Canadian International Development Agency (CIDA), Canadian Hunger Foundation (CHF), Care Zambia, Civil Society Network on Agriculture (CISANET), and CARE Mozambique. SADNET was the winner of the 2004 Yeoman's Award for Local Content for Africa.

For example, In Zimbabwe, SADNET has investigated the information needs of various partners; produced ten booklets on drought intervention technologies, two videos, and newsletters; established eight community information resource centres, five of which are connected to internet, satellite radio, and email; and trained more than eight rural communities in sustainable agriculture practices and documentation. The project has resulted in diversified sources of information for local communities, increased and more relevant information from the media, and increased outreached by partners.

Source: Southern Africa Drought Technology Network (www.safireweb.org)

education to create a culture of disaster reduction. The various dimensions of disaster risk within a community can be addressed and continuously reinforced and passed between generations through formal educational programmes and professional training, which is part of knowledge management.

Natural disaster risk reduction education

There are a host of programmes around the world that provide educational programmes on natural hazard risk reduction. For example, the UNISDR and its partners have made disaster risk education and safer school facilities the two key themes of the 2006-2007 World Disaster Reduction Campaign.

The campaign, entitled "Disaster Risk Reduction Begins at School", aims to inform and mobilize governments, communities, and individuals to ensure that disaster risk reduction is fully integrated into school curricula in high-risk countries and that school buildings are built or retrofitted to withstand natural hazards. The campaign's key partners include UNESCO, UNICEF, ActionAid International, the IFRC, and the ISDR's thematic cluster on knowledge and education.

The UNISDR and partners have also created a thematic cluster/platform on knowledge and education. The group identified and examined good practices to reduce disaster risk through education, knowledge, and innovation, including efforts to protect schools from extreme natural events. A comprehensive report was released in July 2006 entitled "Let Our Children Teach Us: A Review of the Role of Education and Knowledge in Disaster Risk Reduction" (http://www.unisdr.org/eng/task%20force/working%20groups/knowledge-education/docs/Let-our-Children-Teach-Us.pdf). The report discusses key elements,

practices, and tools to develop a culture of disaster risk reduction in formal and informal education, and discusses knowledge development, gaps, and opportunities geared toward implementing Priority 3 of the Hyogo Framework for Action.

Several NGOs have also been working on educational programmes and capacity development. For example, Oxfam Great Britain's "Cool Planet" online education module focuses on all aspects of global citizenship, including understanding disasters such as drought and measures that can be taken to reduce societal vulnerability to drought (http://www.oxfam.org.uk/coolplanet/kidsweb/). The education module was developed by the Oxfam Development Education team with close integration of advice from educators in England, Scotland, and Wales. Teachers and students (ages 5-16) in England, Scotland, and Wales are the primary audience of the education module, but it is accessible by any individual who has internet access.

By focusing on images and real world case studies, the "Water for All" portion of the Cool Planet education module integrates water supply statistics and causes and occurrences of water shortages (including drought) with solutions to water shortages that focus on community-led initiatives; it also allows students to develop their own local

Box 17:
Africa: RANET - New technologies for drought communication

The RANET programme is managed by the African Centre of Meteorological Applications for Development (ACMAD) and faculty at the University of Oklahoma, USA.

A discussion between a meteorologist and a nomad in the desert of South-Eastern Algeria led to the development of the RANET system. The meteorologist, Mohammed Boulaya, offered the nomad a gift of a weather radio but the offer was declined. The nomad commented that drought-related information such as rainfall would be useful in tending his flocks but that the radio would be useless and excess baggage once the batteries died.

Inspired by this conversation and the potential that drought monitoring and prediction technologies hold for improving the quality of life in rural Africa, the meteorologist worked with herders and farmers to design the RANET system.

The RANET system relies on sustainable technologies such as Freeplay wind-up radios, the Wantok solar-powered FM radio transmitter, and the WorldSpace Digital Satellite to maintain communications between users.

RANET, named for its innovate linkage of radio and internet, is an international collaboration to make weather, climate, and related information more accessible to remote and resource-poor populations, where broadcast and telecommunications infrastructure is lacking or expensive to operate. RANET undertakes this mission in order to aid day-to-day resource decisions and prepare against natural hazards, including drought.

The programme combines innovative technologies with appropriate applications and partnerships at the community level in order to ensure that the networks it creates serve all of the community's information needs. Community ownership and partnership is the core principle of RANET's sustainability strategy.

Specific RANET activities include awareness development, training, partnership development, pilot activities to demonstrate various community technologies, broadcast management, and development of a dissemination network through partnership and platform development. For the past several years, RANET has developed programmes in a number of African countries. Based on the success of these efforts, the programme began pilot efforts in the Pacific. Similar efforts are planned in South and South-East Asia.

Source: RANET.net (www.ranetproject.net)

Box 18:
UNISDR Biennial Campaigns on Disaster Risk Reduction

The UNISDR organizes biennial campaigns to enhance awareness for disaster risk reduction. The 2006-2007 campaign was devoted to education, and it was launched with UNESCO and UNICEF under the slogan "Disaster Risk Reduction Begins at School".

The 2008-2009 campaign on 'Hospitals Safe from Disasters' was organized with the World Heath Organization (WHO), with support from the World Bank, as a side-event during the World Economic Forum.

The campaign's three main objectives are to better protect the lives of patients, health staff and the public by reinforcing structural resilience of health facilities; to ensure that health facilities and services continue to function in the aftermath of disasters; and to better prepare and train health workers on preparedness plans that will keep health systems operational if natural hazards strike.

At the global launch in Davos, Switzerland, speakers included Under-Secretary-General John Holmes, World Heath Organization ADG Dr Ala Alwan, Princess Zahra Aga Khan, Mary Robinson, Richard Newfarmer of the World Bank, Walter Fust of the Swiss Agency for Development and Cooperation and Walter Ammann of the International Disaster and Risk Conference and Global Risk Forum GRF Davos.

Source: www.unisdr.org

actions. The activity set ends with suggestions for how to effect positive change and celebrate water.

Students can complete the activities online or they can be adapted and presented in a regular classroom setting. Teachers are also able to find professional development resources to gain information and ideas about using case studies in a classroom setting and teaching about controversial and distant issues. Oxfam GB has also assembled an extensive list of additional resources, curricula, and notes for teachers. Grant programmes are offered by Oxfam GB to facilitate education programmes in schools.

Drought risk reduction education

Other programmes focus more directly on drought risk reduction. For example, the National Drought Mitigation Center (NDMC) in the United States has established an Internet clearinghouse for drought information (http://drought.unl.edu). The NDMC provides access to information on drought planning, monitoring, risk and impact assessment, and drought management options. NDMC staff also provide outreach and training around the world on a range of drought-related topics.

The National Oceanic and Atmospheric Administration has also initiated a programme, in collaboration with other U.S. federal agencies and nongovernmental organizations, to establish a "U.S. Drought Portal" for information sharing and easy access to drought-related information (see http://drought.gov). Part of this project will be directed at creating an educational outreach programme on drought awareness and preparedness.

In addition to programmes such as SADNET and RANET, other drought-related educational projects have experimented with new models for integrating risk reduction curricula in rural communities.

One example is a project funded by the United Kingdom Department for International Development (DFID). In this case, researchers from two Brazilian academic institutions (Universidade Federal Rural de Pernambuco and Universidade Federal de Pernambuco) and the University of Birmingham (UK) focused on fostering the sustainable use of rural water resources and the role of environmental education and gender roles in north-east Brazil. In this case, female teachers and male farmers were brought together to develop educational materials for students and community members on rural livelihood, including water conservation and related sustainability issues.

The Million Cisterns programme in north-east Brazil is another example of a programme that combines drought risk reduction actions and education. In this region, rainwater harvesting has become an important measure to mitigate drought. The P1MC, as this programme is referred to, is distinct

Box 19:
Brazil: Sustainable use of water resources and the role of environmental education and gender roles in north-east Brazil

Researchers from the University of Birmingham (UK) and the Universidade Federal Rural de Pernambuco (UFRPE) and Universidade Federal de Pernambuco (UFPE) in Brazil implemented a rural environmental education programme from 2003 to 2005. The programme had a significant impact as it presented a new educational model not found in any school settings in rural Brazil.

The project brought together teachers, most of whom were women with formal training, and farmers, most of whom were men with no formal education. Such integration was very important and gave credibility to the programme because the teachers belong to a group of women who have high status at the community level, and the farmers were well respected.

The programme presented a new educational model that combined theory and practice in a way that recognized traditional knowledge held by farmers, which placed high value on agriculture. An important impact in regard to drought mitigation was that the programme highlighted the relevance of aspects related to rural livelihood and introduced ways for students and community members in general to monitor the availability of water.

Historically, the educational model followed by both rural and urban schools had been heavily modeled on urban life. This has had a very negative impact on rural students, particularly those who inhabit the drought-prone areas of north-east Brazil, as it contributed to out-migration. The main goal of the environmental education programme was to raise the students' awareness about how to mitigate the impacts of drought.

The programme was very successful in introducing measures to mitigate drought effects because it focused on education and therefore had a long-term sustainable impact. The programme showed the importance of involving different partners, such as local community members, teachers, NGOs, international organizations, and government officials, in the implementation of long-term sustainable drought mitigation measures.

Source: Jan van Wonderen and Mott MacDonald, University of Birmingham (UK), UFRPE, and UFPE

from various mitigation measures previously implemented, not only for focusing on the needs of the poor, but for stressing the importance of education as the basis for all its actions.
In such a context, the programme broadens the understanding and the practice of handling the semiarid ecosystem in a sustainable manner.
Considering these factors, it can be said that this is a programme based on long-term mitigation measures, which gives priority to educational actions rather than to technical ones. The local population (women and men) participate in training workshops about water management and also learn how to build cisterns as they take part in the construction process.

The programme, led by a collaboration of local NGOs and government ministries, was initially funded by the World Bank, but has since received funds from the Federation of Banks in Brazil, international NGOs, and other private donations.

These types of innovative educational programmes must continue to be expanded and monitored so that both positive and less-positive lessons in drought risk reduction and knowledge management are documented and shared, thereby fostering a process of continual improvement.

4.4 Reducing underlying factors of drought risk

Related to Priority 4 of the Hyogo Framework for Action: To reduce underlying drought-related risk factors through effective drought mitigation and preparedness measures.

Reducing drought vulnerability requires reducing underlying risk factors by effective environmental and natural resource management, social and economic development practices, and land-use planning and other technical measures. These factors that have an impact on vulnerability to drought need to be reflected in national poverty reduction strategies, development plans, sector development planning and programmes, and environment and natural resource management strategies as well as in post-disaster situations so that effective preparedness and mitigation measures can be considered (see Section 4.5).

Guiding principles

1 Mechanisms should be in place to systematically bring together practitioners in disaster risk reduction (e.g., national platform members) and key institutions involved in environmental management (e.g., adaptation to climate change, desertification and biodiversity).
2 Areas of overlap and synergy should be identified between existing environmental programmes and disaster risk reduction activities.
3 A mechanism for carrying out joint assessments should be institutionalized to integrate disaster risk reduction and environmental protection parameters (e.g., integrated risk-and-environmental-impact assessments).
4 Specific attention should be given to socio-economic high-risk factors such as age, disabilities, social disparities and gender. By focusing on protection of the most vulnerable groups, the impacts of disasters can be reduced.
5 Post-drought recovery planning can incorporate drought risk reduction strategies for the future.
6 Safety nets such as insurance mechanisms for properties as well as microcredit and financing for ensuring minimum livelihood means can accelerate post-drought recovery process

4.4.1 Environmental management and climate change

Environmental degradation such as land degradation, deforestation, desertification and loss of biodiversity has detrimental effects on the local communities in coping with droughts. On the other hand, more sustainable land management, including protecting soils from erosion and eventual desertification through better land-use planning and sustainable farming and ranching practices, helps to reduce people's vulnerability to drought and flood. Maintaining watersheds by avoiding deforestation and diversion of waterways protects water quality and quantity. Better management of water resources and conservation of fragile ecosystems will allow diversification of livelihoods and sustain local economies during and after drought. A good practice for increasing crop resilience to drought through agro-forestry farming in Niger is introduced in Annex 3. Another good practice in Tajikistan focusing on organic fertilizers to combat soil degradation is also found in Annex 3.

Short- and medium-term drought risk reduction efforts could also be combined with the promotion of long-term climate change adaptation measures. Clear identification of climate change related risk, exchanging relevant data and information and leveraging political support and funding can contribute to effective and efficient use of existing resources and maximizing synergy between drought risk reduction and climate change related programmes. An example of a common data set required by environmental managers for monitoring desertification, climate change and biodiversity is shown in Table 2. Some critical basic data can be found in these exercises, which can be used for integrated risk-and-environmental-impact assessments.

Table 2:
Example of a common data set for monitoring desertification, climate change adaptation and biodiversity

Core Data Set Needs	Biodiversity	Desertification	Climate Change Adaptation
Land use (by type)	X	X	X
Vegetation (by type)	X	X	X
Forests (by type, condition, density)	X		X
Forest production and export information	X		X
Forest tenure/land tenure	X	X	
Soils (by type)	X	X	X
Agriculture (by type)	X	X	X
Rice cultivation			X
Fertilizer use			X
Livestock census	X	X	X
Wetlands	X		X
Oceans	X		
Climate (temperature, precipitation, etc.)	X	X	X
Topography (elevation, slope, aspect)	X	X	
Surface hydrology (lakes, rivers, streams)	X	X	
Estimate of areas' risk of desertification		X	
Flora and fauna (species type and density information)	X		
Endangered species habitat	X		
Protected areas (by type and condition)	X		
Human settlements	X	X	X
Indigenous peoples' homelands	X	X	
Population (count and density)	X	X	X
Roads	X	X	X
Other infrastructure (transmission lines, etc.)	X	X	X
Power transmission lines	X		X
Industrial activities	X		X
Power generation facilities (by type, capacity)	X		X

Source: Adapted from Synergies in National Implementation: The Rio Agreements. UNDP

To help developing countries improve their understanding and assessment of impacts, vulnerability and adaptation, and to enhance their decision-making capacity on a sound scientific, technical and socio-economic basis, the five-year "Nairobi Work Programme" on impacts, vulnerability and adaptation to climate change was developed and has been coordinated by the Subsidiary Body of the Scientific and Technological Advice of the UNFCCC. (For details of the programme, history and update, see http://unfccc.int/adaptation/sbsta_agenda_item_adaptation/items/3633.php) IPCC's Fourth Assessment Report (2007) lists possible major drought-related impacts by sector as a result of changes in extreme weather and climate events, and presents various examples of possible adaptation options (Table 3). Many of these climate change adaptation measures can be implemented by strengthening existing drought risk reduction capacities.

The IPCC Fourth Assessment Report projects that drought-affected areas are likely to increase to the mid- to late 21st century, although it does not take into account any changes or developments in adaptive capacity (http://www.ipcc.ch/ipccreports/ar4-syr.htm). Thus, climate change is an important factor to be considered in drought risk analysis. Possible drought-related impacts as a result of climate change are as follows:

- Agriculture, forestry and ecosystems - land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire
- Water resources - more widespread water stress
- Human health - increased risk of food and water shortage; increased risk of malnutrition; increased risk of water-and food-borne diseases
- Industry, settlement and society - water shortage for settlements, industry and societies; reduced hydropower generation potentials: potential for population migration

The thirteenth session (COP13) of the Conference of the Parties to the UNFCCC, held in Bali, Indonesia, in December 2007, adopted the "Bali Action Plan", which reiterates the need to consider disaster reduction strategies for enhanced action on adaptation. In order to enable climate-change resilient development and reduce vulnerability, the Plan gives due consideration to the urgent and immediate needs of developing countries, including the needs of countries in Africa affected by drought, desertification and floods. (see http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf)

Various international, regional and national agencies have been supporting specific field level initiatives to establish an integrated approach to managing climate risks at national and local levels. For example, a project implemented by FAO targets enhancing drought risk management by incorporating climate variability and change (see Section 4.5).

The 2009 Global Assessment Report on Disaster Risk Reduction (available at http://www.unisdr.org) focuses on the challenges of risk and poverty in a changing climate by highlighting the importance of investing today for a safer tomorrow. The Report identifies disaster risk, analyses its causes and effects, shows that these causes can be addressed and recommends means to do so. The central message of the Report is that reducing disaster risk can provide a vehicle to reduce poverty, safeguard development and adapt to climate change, with beneficial effects on broader global stability and sustainability.

Table 3:
Examples of climate change adaptation options in water, agriculture and human health sectors

Sector	Adaptation option/strategy	Underlying policy framework	Key constrains and opportunities to implementation (normal font= constrains; bold=opportunities)
Water	Expanded rainwater harvesting; water storage and conservations techniques; water re-use; desalination; water-use and irrigation efficiency.	National water policies and integrated water resources management; water-related hazards management	Financial, human resources and physical barriers; integrated water resources management; synergies with other sectors
Agriculture	Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection thought tree planting	R&D policies; institutional reform; land tenure and land reform; training capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits	Technological & financial constrains; access to new varieties; markets; longer growing season in higher latitudes; revenues from 'new' products
Human health	Heat-health action plan; emergency medical services; improved climate-sensitive disease surveillance and control; safe water and improved sanitation	Public and health policies that recognize climate risk; strengthened health services; regional and international cooperation	Limits to human tolerance (vulnerability groups); knowledge limitations; financial capacity; upgraded health services; improved quality of life

Source: Adapted from Fourth Assessment Report "Climate Change 2007", Synthesis Report, Summary for Policymakers, Intergovernmental Panel on Climate Change, 2007, http://www.ipcc.ch/ipccreports/ar4-syr.htm

4.4.2 Socio-economic factors, consideration of vulnerable groups and gender

In addition to the environmental factor, social and economic development practices also greatly affect the resilience of vulnerable communities to drought. The vulnerability of impoverished communities to disasters is increased by marginalization due to physical ability, caste, age, race, ethnicity and gender. In relation to drought risk reduction, governments may consider programmes to increase the resilience of the poor through asset enhancement, diversification of livelihoods, social protection, safety nets and empowerment of the most vulnerable groups, including women.

Gender is a core factor in disaster risk and in the implementation of disaster risk reduction. Women and men are not equally at risk from disasters, and therefore gender shapes the capacities and resources of individuals to minimize harm, adapt to hazards and respond to disasters. Past disasters have shown that low-income women and those who are marginalized due to marital status, physical ability, age, social stigma or caste are especially disadvantaged. At the grass roots level, on the other hand, women are often well positioned to manage risk because of their roles as both users and managers of environmental resources, as economic providers, and as caregivers and community workers. For these reasons it is necessary to identify and use gender-differentiated information, to ensure that risk reduction strategies are correctly targeted to the most vulnerable groups and are effectively implemented through the roles of both women and men.

The roles which women have played in the face of drought in north-east Brazil are described in Box 20. The active role of the women in Kenya in the Green Belt Movement is described in Box 21. The role of female teachers in environmental education in north-east Brazil is also introduced in Section 4.3.3.

Box 20:
Brazil: Role of women in the face of drought

A research study during the late 1990s highlighted how rural women faced with the challenges of drought became involved in a process to obtain new knowledge and change their livelihoods.

Droughts periodically affect an impoverished semi-arid region of north-east Brazil. Because of a lack of political support, the needs of women in the region had not been effectively reflected in the local drought mitigation measures. As a result, women either migrated to cities to seek jobs or remained in the drought-struck rural region. However, drought disasters also provided local women with some opportunities to become involved in mitigation measures. The study reviewed how the women, who stayed to cope with droughts, successfully organized self-help action groups with the support of local and international NGOs.

The NGOs provided practical training to the women left in the region after their husbands migrated to cities in search of jobs. As a result, these women started to discuss their problems, and gained skills for income-generating activities such as sewing, lace making and artcrafts. In addition, as these women became more motivated and more active in economic and political activities, their activities also attracted the attention of policymakers.

Source: De Melo Branco, Adélia, 2000, Editora Universitária João Pessoa, "Women of the Drought: Struggle and visibility in face of a disaster situation"

Box 21:
Kenya: Green Belt Movement

The Green Belt Movement (GBM) of Kenya exemplifies an organization that fosters local-based efforts to create a more sustainable environment that will be more resilient to the effects of drought. The programme creates a culture of resilience by encouraging women and men in rural areas to plant and nurture native trees.

Established in the mid-1970s, GBM is credited with planting more than 30 million trees and is now expanding to other African countries. Its founder, Wangari Maathai, won the Nobel Peace Prize in 2004.

The idea came to her as she observed the effects of commercial agriculture on people in villages: it reduced their food choices because they had less firewood for cooking; it de-emphasized traditional, unprocessed foods in the diet; there was more erosion and soils were less fertile; and there were fewer springs so women had to walk farther for water. There was also less wildlife, clean air, and shade.

The result was greater vulnerability to drought, malnourishment, famine, and death. Maathai taught women to collect seeds of indigenous trees from their immediate surroundings and to nurture them using whatever resources were at hand. GBM paid the women a token amount for each seedling that survived. With each tree planted, she asked them to repeat words affirming the need to roll back encroaching desertification. GBM organizers conducted a variety of environmental education and awareness activities for its “foresters without diplomas”, and made a point to listen to people in their native languages as they shared traditional knowledge from their particular areas.

This example demonstrates how one programme aimed at planting trees has grown to meet broader needs of local communities, such as increasing re-forestation, increasing food security, empowering women, and providing for environmental education and leadership capacity development.

Source: Greenbelt Movement, www.greenbeltmovement.org

4.5 Effective drought mitigation and preparedness measures

Related to Priority 5 of the Hyogo Framework for Action: To strengthen disaster preparedness at all levels of society.

The goal of drought mitigation and preparedness is to reduce drought vulnerability and foster drought-resilient societies. "Mitigation" can be defined as "the lessening or limitation of the adverse impacts of hazards and related disasters" (see Annex 1). It should be noted that in the context of climate change policy, "mitigation" is defined differently, being the term used for the reduction of greenhouse gas emissions that are the source of climate change.

"Preparedness" is defined as "the knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions".

Before drought, mitigation actions can be implemented to build resilience into an enterprise or system so it will be less affected when drought eventually occurs. Some mitigation actions can require relatively small changes in our lives while others may require the re-evaluation and modification of more basic elements of our livelihoods and production systems. An important mitigation measure is the development of drought preparedness and contingency plans that detail specific measures to be taken by individuals or responsible agencies both before and during drought. Effective drought mitigation and preparedness planning are based on established policies and institutional capacity (Section 4.1), sound drought risk identification and early warning (Section 4.2), and drought awareness and knowledge management (Section 4.3), while this chapter focuses more on the selection of specific actions that will be implemented in the plans.

Drought impacts and losses can be substantially reduced if authorities, individuals, and communities are well-prepared, ready to act, and equipped with the knowledge and capacities for effective drought management. It should be recognized that mitigation and preparedness have a greater impact on reducing the scale and effects of drought disasters than ad-hoc emergency response measures.

Guiding principles

1 Prevention, mitigation and preparedness are central components of disaster risk reduction, and are more important than relying solely on ad-hoc emergency response measures.
2 Dialogue, exchange of information, and coordination are needed between disaster risk reduction, development and emergency management actors.
3 The selection of appropriate drought risk reduction (prevention, mitigation and preparedness) measures requires many considerations, such as integrated environmental and natural resource management, social and economic development, land use planning opportunities, and climate change adaptations.

Box 22:
Definitions: Mitigation and preparedness

"Mitigation" can be defined as 'the lessening or limitation of the adverse impacts of hazards and related disasters".

"Preparedness" can be defined as "the knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions".

Source: UNISDR Terminology on Disaster Risk Reduction (2009), http://www.unisdr.org/eng/library/UNISDR-terminology-2009-eng.pdf

4 A combination of top-down and bottom-up approaches is required for development and implementation of effective mitigation and preparedness measures.
5 Institutional capacity, coordinated mechanisms, identification of local needs and indigenous knowledge are required to implement effective mitigation and preparedness strategies.
6 Monitoring and early warning are key elements of disaster risk reduction and must be closely linked to other risk reduction actions.
7 Drought risk reduction (prevention, mitigation and preparedness) requires a long-term commitment of resources.

4.5.1 Considerations and methodologies in selecting drought mitigation and preparedness measures

There are currently a limited number of tested strategies available for identifying appropriate drought risk reduction measures. Nevertheless, the topics presented in this section should be generally considered when identifying drought mitigation and preparedness measures.

Dialogue, exchange of information, coordination, and common understanding among different actors are necessary. Experience has shown that a critical feature of effective risk reduction (prevention, mitigation and preparedness) is the extent to which different actors and entities operate in a coordinated and timely manner by avoiding gaps, duplication of effort, and parallel activities and structures. This is especially vital given the increasing number of organizations involved in disaster risk reduction, related separately with development, environment and humanitarian sectors.

Common understanding of roles, responsibilities, spheres of activities, and accountability needs to be developed, clearly established and adhered to.

Different political, cultural and socio-economic environments necessitate institutional arrangements, including coordination mechanisms that are appropriate to a particular context. Exchange of information is crucial to coordinate activities and actions for drought risk reduction (prevention, mitigation and preparedness).

Effective drought risk management requires a combination of measures, related with prevention, mitigation and preparedness for response. Drought response or relief measures often result in immediate effects on people's lives and livelihoods. For example, direct food and cash distribution saves lives and benefits livelihoods in the short term. However, these efforts can also create dependency and other new vulnerabilities and may not reduce underlying drought risk factors and vulnerabilities. Therefore, the same affected individuals may experience similar or more extreme conditions the next time a drought occurs. Although drought relief is an important safety net and is often politically appealing, it should not be the primary focus in drought risk reduction.

The selection of risk management options must be evaluated in the context of constraints and issues. Some constraints could include time, financial and personnel resources, geography, feasibility, the level and nature of development and vulnerability, the attitudes and desires of the affected communities and landowners, legalities, public acceptance, and liability. They must also take into account social factors such as gender, age, and other social and economic capacities. Women, children, the elderly, the poor and the disable are especially vulnerable to the effects of drought. Special consideration must be given to these populations and to those livelihoods least able to cope with drought.

Risk reduction measures, including prevention, mitigation and preparedness actions, should complement those of other programmes focusing on public health, economic development, education, environmental management, and adaptation to climate change. For example, when appropriate, integrating drought risk reduction planning into the health sector can pay long-term dividends. In this regard, planners can promote activities that assist the health sector in monitoring the health impacts of drought and develop their capacity to help prevent, mitigate and prepare for drought negative impacts. This includes fostering food security and livelihood diversification to

ensure the resilience of communities to drought and other hazards that can weaken agriculture-based livelihoods.

In regard to *economic development*, planners should promote diversified income options for populations in high-risk areas to reduce their vulnerability to drought, and ensure that their income and assets are not undermined by development processes that increase their vulnerability. These efforts should parallel those that promote the development of innovative financial instruments and risk-sharing mechanisms, particularly insurance against drought.

For example, the innovative market-based solutions proposed by the Commodity Risk Management Group of the World Bank include index-based weather insurance and price risk insurance linked to credit (see www.iwmi.cgiar.org/drw/images/ ADDF2_report.doc). The World Bank and WFP have jointly investigated the possibility of a more comprehensive ex-ante risk management strategy involving an expanded risk financing facility that moves beyond commercial insurance. See also a case study of Ethiopia about weather-indexed livelihood protection scheme (Box 14).

A combination of resilience-building actions and safety nets for exceptional circumstances provides a balanced approach to drought risk reduction.

In recent years, sustainability has also been increasingly stressed as essential for creating more resilient systems and reducing the effects of natural hazards. Therefore, planners should encourage the sustainable use and management of ecosystems, including better land-use planning and development activities to reduce drought risk. This includes mainstreaming drought risk considerations into planning procedures for major development projects such as the creation of settlements, urban growth projects, and building and water supply regulations and management.

Overall, drought risk reduction strategies must be realistic, as well as socially and environmentally compatible. This means that the specific activities in the drought risk reduction strategies must take place on a scale that is meaningful to those who must act, whether at the national, regional, or local level. In choosing the appropriate actions, stakeholders may want to ask some of the following questions:

- Will the action equitably address the needs of affected individuals and groups?
- What are the cost/benefit ratios for the identified actions?
- Which actions do stakeholders consider feasible and appropriate?
- Which actions are sensitive to the local environ¬ment (i.e., sustainable practices)?
- Do the actions address the right combination of causes to adequately reduce the relevant impact or vulnerability?
- Do the actions address short- and long-term solu¬tions?

As mentioned earlier in Section 4.2.1, several international documents have been developed to assist planners in choosing appropriate drought risk reduction strategies. For example, the National Drought Mitigation Center, USA, has developed the "How to Reduce Drought Risk Guide" (http://drought.unl.edu/plan/handbook/risk.pdf), and worked with FAO Near East Regional Office to produce the "Near East Drought Planning Manual". Scientists from Cyprus, Greece, Italy, Morocco, Spain, and Tunisia have also developed Drought Management Guidelines for Mediterranean countries that discuss the selection of drought risk reduction strategies (see http://www.iamz.ciheam.org/medroplan/).

Other examples of efforts to identify and implement drought risk reduction actions from national to local levels are introduced below.

Case Study from Vietnam:
Selecting policy options to reduce drought vulnerability for climate change adaptation, Hanoi

The Oxfam in Viet Nam and Graduate School of Global Environmental Studies of Kyoto University, Japan, conducted a study in 2007 on the impacts of recurring droughts on the livelihoods of the rural communities in the most drought-prone areas in Ninh Thuan province, Viet Nam. The study

Box 23:
India: National and state level drought contingency plans

In India, during the severe drought of 2000, the Government of India set up a Group of Secretaries to develop a comprehensive contingency plan. Several sector-wise contingency plans, covering such areas as foodgrains availability, drinking water, fodder, health and nutrition for residents, wage employment, health management of livestock, seasonal crop management, post-drought agriculture rehabilitation and management of ground and surface water, were developed by the respective concerned departments. A detailed assessment of the drought situation revealed that Gujarat and Rajasthan were the worst affected among the eleven States affected by the drought. As it is primarily the States that declare the drought in India, and the contingency plans had to be implemented at the State level, the nodal agency, the Department of Agriculture and Cooperation, asked the State Governments of Gujarat and Rajasthan to submit their respective contingency plans to complement the sector-wise contingency plans formulated at the national level.

The State Government of Gujarat prepared a contingency plan for water harvesting and water conservation measures. The State Government's initiative, "Sardar Patel Participatory Water Conservation Project", had earmarked sufficient funds from the budgetary provisions for construction of dams, check dams, percolation tanks, etc., in the scarcity-hit districts of the Saurashtra and Kutch regions. These public oriented works encouraged large scale participation of the residents, with 60% of the total cost born by the beneficiaries. The National Bank for Agriculture and Rural Development (NABARD) sanctioned financial assistance for Water Conservation and Ground Water Recharge Works.

The State Government of Rajasthan also prepared a contingency plan for water harvesting and water conservation measures. The Irrigation Department executed 1,870 water conservation works during 1999-2000 which helped conserve moisture in the field. In addition, the contingency plan showed various schemes implemented by the Watershed Department. Deepening of a large number of wells had been carried out in 1999 as part of scarcity relief measures. Farmers were using these wells for life saving irrigation wherever necessary. The State Government was equipped with 125,000 sprinklers to meet the requirement for water in the dry spells. In the case of heavy rain in the later part of the monsoon season, the State had the potential to take up crops such as gram, rape and mustard with residual/conserved moisture.

Although many of these activities were implemented as part of drought contingency (response) efforts, some of them (e.g., the construction of dams and tanks, and implementation of water harvesting and conservation projects) also have the potential for decreasing the vulnerability of affected populations to future drought.

assessed drought vulnerability by examining the perceptions of local communities and government officials. Drought impacts and root causes in a range of livelihood sectors such as agriculture, animal husbandry and fisheries were identified. Based on the findings of the study, a national forum was organized in Hanoi in May 2007, to consider various policy options for adaptation to drought in the context of climate change. In the forum, the following policy options were suggested to overcome community vulnerability to drought. The forum also suggested specific roles for various institutions in the country, and proposed establishing dedicated "Drought Management Boards" at the community level.

Communities

- Strengthen community organization by establishing or building on social institutions like village Self-Help Groups (SHGs), women's groups, and village water sub-committees.
- Set up a commune seed bank / food credit coupon system.
- Establish 'Village emergency funds'.
- Develop an understanding that the drought may be a recurring phenomenon and that communities should prepare themselves to minimise the impact.
- Promote better forest management and the avoidance of forest fires.

Agriculture

- Develop drought-resistant crop varieties.
- Provide training in dry-season cropping techniques.
- Ensure that appropriate crop seeds are in place before the rains.
- Develop village seed banks with seeds of traditional and improved drought-resistant crops/varieties.
- Provide training in economical water use.
- Subsidise/facilitate supplies of seeds/irrigation equipment.
- Establish field schools and mobile libraries for farmers.
- Provide meteorological forecasts and corresponding advice on cultivation.
- Improve soil-moisture management.
- Reduce run-off / increase rainwater infiltration by planting barriers such as vetiver, lemon grass, and agave.
- Increase fertility and water-holding capacity of the soil through addition of organic manures and green manures.
- Introduce proper land-use planning as per the land-capability classification system.
- Promote mulching practices so that the limited available soil moisture is saved during critical stages of crop growth.

Livelihood strategies

- Support and protect livelihoods and livelihood diversification (carpentry, petty shops, handicraft, etc.), so that people have a safety net to rely on during all stages of drought.
- Establish/strengthen micro-credit systems.

Domestic water use:

- Encourage rainwater harvesting (e.g. roof-top rainwater harvesting).
- Install water pumps/wells.
- Promote 'home-made', cheap, and water-efficient drip irrigation for vegetable gardens.

Health

- Provide training in first aid (e.g., treating diarrhoea and respiratory diseases).
- Promote public health by raising awareness of health and hygiene issues.
  • Raise awareness of nutrition and home gardening.
  • Improve access to clean water.
  • Provide hygiene kits and teach women how to use them.

Animal husbandry

- Store rice, paddy husk, and other crop residues in barns for use during scarcity.
- Grow seasonal grasses/perennial fodder trees in community forests, fallow lands, and permanent pastures.
- Recommend that farmers avoid burning crop residues in the field and use them instead as animal feed by treating them appropriately.
- Establish fodder banks at community/household level.
- Improve the quality and productivity of the existing livestock population, either through artificial insemination or other breeding practices or by replacing them with exotic breeds.
- Preserve endangered productive and drought-resistant local animal breeds.
- Promote the rearing of goats, sheep, and dry ducks in areas where feed and water are scarce.
- Construct rainwater-harvesting structures (mini-ponds, tanks).

Case Study from Tajikistan:
Identification of drought mitigation actions

From 2004 to 2005, the Canadian International Development Agency, World Bank, and national stakeholders in Central Asia and the Caucasus investigated potential drought mitigation actions that could be implemented to reduce drought risk in the region (see http://www.worldbank.org/eca/drought).

As a result of this process, planners in Tajikistan proposed a wide range of mitigation strategies that could reduce the country's drought risk. These priority actions, listed below, were selected in accordance with their advantages for development, cost-effectiveness, advisability and

reliability, market potential, and social-economic significance, and their potential for reducing unfavourable drought-related impacts in the future.

Policy, Governance and Institution:

- Improvement of RT Law "On legal regime of state of emergency" (1999)
- Development of National Programme of Hydrometeorological Service development in terms of drought forecasts
- Development of state policy at national and regional levels on water resource allocation
- Amending Law on Nature Preservation, taking into account wide development of "dehqan" and private farms, including ecological criteria of land tenure under drought conditions
- Zoning of territory for optimal reforestation with the aim of reducing drought exposure
- Zoning of pastures based on their vulnerability to droughts
- Regulation and optimization of pasture load
- Zoning of the territory based on its vulnerability to SHE and climate changes
- Strengthening of interdepartmental collaboration on drought forecasting and early warning system improvement
- Development of national concept on drought surveys
- Improvement of existing and development of new mechanisms of coordination oriented toward the formation of favourable conditions for the most effective implementation of drought mitigation measures
- In accordance with the regulations of Orhus Convention to improve legislative-normative basis to ease access to documents of different agencies
- Conducting regular meetings on exchange of experience and staff of different groups of population
- Improvement of legislation on procedures of community participation in decision making processes and data access

Scientific and technological:

- Rehabilitation and improvement of current Hydro-meteorological network
- Introduction and expansion of automatic sensors of snow accumulation, air temperature, and intensive precipitations
- Modernization of gathering facilities, processing, analysis, interpretation and operative data dissemination, GIS database development and computer-assisted models of drought's formation and impact
- Development of a programme of water resources study by academy of sciences and SRIs
- Formation of automatic control system and water consumption on the basis of GIS technologies
- Establishment of structures for introducing modern irrigation methods
- Arranging training and seminars and exchange of data with countries that have advanced irrigation technologies and methodologies on drought control
- Establishment of work group to develop projects on optimal location of windbreaks in different districts
- Conducting surveys and approbation of highly productive varieties of wood species
- Conducting agro-meteorological surveys for identification of climate impacts on soils and productivity of agricultural crops
- Establishment and introduction of fast-ripening, disease-resistant, and heat-resistant varieties of high quality cotton
- Improvement of cotton irrigation efficiency on the basis of water saving technologies
- Scientific research on the assessment and forecasting of the impact of climate change on the state and productivity of ecosystems and on the examples of reference sites of nature (i.e., national parks, reserves)
- Improvement of the set of measures on prevention of infectious diseases under drought conditions
- Introduction of modern methods of forecasting and modelling droughts
- Establishment of Scientific Coordinating Board on Droughts
- Implementation of programmes of scientific-technical training and the preparation of highly qualified personnel

Economic:

- Increasing of efficiency of economic mechanisms in water resource management

- Development of differentiated tariffs for water use depending on water delivery costs, priorities of grown crops, etc.
- Introduction of international methods and standards of statistical records of water resources
- Amending a system of remuneration of labour
- Establishment of social insurance fund for combating desertification and droughts
- Change of regime of work and rest to reduce time spent outside under maximal high temperatures
- Poverty liquidation, particularly amongst the most vulnerable droughts groups

Knowledge management, Education

- Timely issue of bulletin with information on droughts
- Creation of website for exchange of data on drought at both national and international levels
- Improvement of the system for continuous education of the population on ecological education
- Adoption of normative-legislative basis for improvement of propaganda of awareness of population on droughts
- Enhancing work of Social Ecological Board
- Establishment of Informational Centre for Drought
- Alteration of educational programmes on ecology that were introduced in all institutes of higher education
- Issue illustrated magazine covering drought issues in Tajikistan and other ecological problems
- Preparation of cycle of TV and radio programmes on drought issues
- Improving access to the Internet

Source: Adapted from M.T. Safarov, A.K. Kayumov, and A.Sh. Khomidov (2006) National Drought Management and Mitigation Plan for Tajikistan, State Hydrometeorology Agency – State Nature and Forestry Protection Committee (http://siteresources.worldbank.org/EXTECAREGTOPRURDEV/Resources/573581-1164120557290/TajikistanDroughtPlan-English.pdf)

Case Study from United States:
Identification of drought mitigation and response actions in Nebraska

In 2004, Nebraska completed a drought planning process that outlined a range of priority mitigation and response actions the state proposed to carry out to reduce the potential impacts associated with drought. Two risk assessment committees were organized to identify these actions: the Agricultural, Natural Resources, and Wildlife Subcommittee and the Municipal Water Supply, Health, and Energy Subcommittee. In this rural, agriculture-dominated state, the majority of their actions were focused on sustainable agricultural practices, public health, and water resources protection. Selected impacts and planned mitigation outlined in the Nebraska Drought Mitigation and Response Plan and response actions are listed below.

Potential impact 1: Reduced range and pasture forage and livestock water results in poor animal health, soil erosion, and possible economic loss to ranchers

Planned actions:

- Encourage the use of range and pasture management techniques such as reduced stocking rates, reserve pastures, rotational grazing, removing competitive plants, and stored feed to improve sustainability of rangelands.
- Before and during drought, use public information programmes and on-site visits to emphasize the importance of rangeland management and planning to equalize stocking rates with available forage and the need for permanent water storage and distribution systems.
- Monitor forage supplies and conditions around the state and facilitate information exchange between interested parties.
- Investigate the needs of economically stressed ranchers who now rely on federal and state grazing leases to sustain their herds. Develop a coordinated plan of action to be taken by land management agencies to provide grazing and/or supplemental feed assistance to lessees.

Investigate changing federal and state grazing regulations during drought.
- Assist ranchers in obtaining supplemental income by connecting them with employment opportunities, and, during drought, by holding job fairs and raising general awareness of job opportunities and ranchers' work skills.

Potential impact 2: Social and physical stress on agricultural producers

Planned actions:

- Develop working partnerships with local ministerial alliances and local health offices to develop social counselling and support programmes.
- Implement and/or maintain farm/crisis telephone hotline(s).
- Use local TV and radio outlets to implement public information programmes directed at reducing drought-induced mental stress and for announcements for hotline numbers and mediation services.
- Establish education programmes to increase awareness of dust-related respiratory problems and how proper land management can improve air quality.
- Communicate with state medical allergy and asthma experts to develop recommendations for treating and mitigating dust-related health problems.

Potential impact 3: Because of drought, many public water supply systems experience potable water demand problems

Planned actions:

- Emphasize, and evaluate, long- and short-term drought contingency plans for all systems.
- Emphasize indoor and outdoor water conservation measures.
- Maintain a list of "problem systems" with a history of or potential for drought-related problems.
- Develop programmes and educate the public on the potential uses of wastewater.

Box 24:
United States: Drought mitigation planning, Indian Hopi Nation

The Hopi Nation, an American Indian group in the south-western United States, developed a list of short- and long-term drought mitigation and response actions for each impact sector by following the 10-Step Drought Planning Process developed by the NDMC, University of Nebraska and the NDMC's risk assessment methodology. As part of the process, the tribe conducted a thorough impact and vulnerability analysis to identify sectors of concern. Based on this analysis, they then identified mitigation and response actions to address the vulnerabilities.

For example, to mitigate range and livestock losses, the plan suggests that range management plans be completed for each range unit. To facilitate rotations and proper use of grazing lands, the Hopi range management plan also includes fencing and water development projects. Water availability in these units will be improved through a combination of rehabilitating surface water impoundments, additional wells at key locations, improved water distribution from the supply point to multiple stock watering troughs, and other conjunctive uses. The Hopi planners hope these mitigation actions will decrease the vulnerability of the range and livestock economic sector.

In addition to identifying mitigation actions that will reduce the tribe's drought risk, the Hopi drought plan is unique in that it identifies the responsible agencies, provides a timeline to complete the actions, and proposes a cost estimate for these actions. For example, a cost of $12 million is estimated to upgrade the water supply systems of 12 tribal villages by improving pumping capacity, storage tank size, and pipe capacity. The tribe plans to seek funding for these actions through a variety of agencies and sources while enhancing water conservation at the same time.

Source: Developing a Drought Plan: The Hopi Nation, National Drought Mitigation Center, University of Nebraska-Lincoln, USA at http://drought.unl.edu/plan/HopiPlan.htm.

- Develop partnerships with utility companies and others who can help distribute drought-related information.

Source: Nebraska Drought Mitigation and Response Plan, Nebraska Climate Assessment and Response Committee, 2000, at http://carc.agr.ne.gov/docs/NebraskaDrought.pdf

4.5.2 Implementing drought mitigation and preparedness measures

Although it is essential to identify potential risk reduction measures, including prevention, mitigation and preparedness, effective drought risk reduction can only be achieved if the actions are implemented in a coordinated manner. Promoting a culture of drought risk reduction is necessary to overcome the barriers in implementing short- and long-term measures needed to more effectively reduce drought risk. There are several strategies that help formulate this culture and increase the likelihood of implementation:

Demonstrate long-term benefits of prevention, mitigation and preparedness

As discussed previously, cost is one factor in implementing effective drought risk reduction measures. The development and implementation of effective prevention, mitigation and preparedness policies and measures often requires long-term financial and institutional investments. Many countries are beginning to realize that the long-term benefits of more proactive prevention, mitigation and preparedness measures bring greater rates of return, although they may take longer to be realized.

In order to illustrate this concept, it is essential to evaluate the cost effectiveness of drought risk reduction measures in comparison to a focus on drought response and relief measures. Demonstrating long-term costs and benefits will help in promoting the effective investment of resources into risk reduction strategies. Drought is a natural part of climate that should not be ignored during times of plenty. While it is impossible to prevent or mitigate drought as natural hazard, it is possible and desirable to prevent, mitigate and prepare for the negative impacts of the natural hazard on lives and livelihoods, by avoiding or reducing the human, social, economic and environmental vulnerability that enhance the risk.

Demonstrate the effectiveness of prevention, mitigation and preparedness

Not only should the costs and benefits involved in drought risk reduction be assessed, but also the effectiveness of the measures themselves. It is essential to identify and demonstrate effective approaches and opportunities for prevention, mitigation and preparedness, including case studies to show examples of good as well as weak policies. Policymakers, scientists, media and the public often need to see "actions-at-work" in order to foster buy-in to similar efforts. Good practices of replacing conventional farming methods with innovative and more sustainable farming and irrigation methods in Jamaica and Nepal are introduced in Annex 3.

Incorporate prevention, mitigation and preparedness into drought response and relief efforts

Although droughts can be disastrous to people and their livelihoods, they also create a "window of opportunity" to develop capacities that reduce risk in the long term, including the sharing of expertise, knowledge, lessons learned and capacity development. To make the best of a poor situation, resources may even be pre-positioned to maximize the utilization of these opportunities when they occur. Long-term drought risk reduction activities should be incorporated into drought response and recovery processes while political will is strong and drought is in the minds and hearts of those affected.

For example, the Spanish Red Cross, Salvadorian Red Cross Society, Inter-American Institute for Cooperation in Agriculture and El Salvador Post-Harvest Coordinating Unit responded to drought conditions from 1998 to 2001 in El Salvador by establishing the Drought Response

and Mitigation Project. This programme focused both on providing immediate drought relief and implementing alternative farming techniques to increase local long-term sustainability (see the case study of El Salvador in this Chapter).

Foster collaboration and community ownership

The implementation of drought risk reduction measures will also be enhanced by developing specific mechanisms to engage the active participation and ownership of relevant stakeholders in drought risk reduction, in particular building on the spirit of volunteerism and community and personal responsibility.

This entails fostering collaborative efforts and information sharing between sectors and partners from governmental, non-governmental, and local entities, including the establishment of public-private partnerships to better engage the private sector in drought risk reduction activities.

The private sector should be encouraged to foster a culture of disaster reduction, putting greater emphasis on and allocating resources to pre-drought activities such as risk assessments and early warning systems. Drought is a complex phenomenon that affects a wide range of groups and sectors. Addressing drought in a holistic manner requires that stakeholders coordinate their efforts to maximize effectiveness and minimize redundancy and competing goals. A case study on the groundwater dam is introduced in Box 25. Another good practice of enabling communities to develop and implement drought risk reduction strategies in Pakistan is introduced in Annex 3.

Inventory and develop capacities to mitigate drought

Many governmental and local entities may not have the capacity or resources to identify and support community-based mitigation measures. Efforts may be required to develop the capacity of these entities to more fully explore and implement prevention, mitigation and preparedness for response strategies. This includes the ability to develop inventories of national capacities to identify, assess and implement prevention, mitigation and preparedness measures.

The ability to assess and incorporate local indigenous knowledge and capacities into drought risk reduction strategies is also essential in order to develop and implement equitable and community-based solutions. Planning at all levels should be collaborative and inclusive. As gaps in capacity are identified, resources and expertise should be targeted to meet these needs. Appropriate long-term investment of financial and technical resources into capacity development and drought mitigation and preparedness activities will be required to sustain these efforts. A good practice of developing local plans for combating water shortage based on traditional knowledge in India is indicated in Annex 3.

Formalize drought risk reduction responsibilities

Drought risk reduction measures and actions (prevention, mitigation and preparedness for response) are more likely to be carried out if they are required by national, regional and local development plans and if agencies or individuals are given the responsibility for their implementation. For example, as discussed in Section 4.2, it is essential that drought risk management policies emphasize risk (hazard and vulnerability) assessments, monitoring, early warning and other risk reduction measures, as explained in the Hyogo Framework (HFA).

Early warning information should be linked to actions that can be taken to reduce the negative effects of drought. For example, a drought plan may specify actions to be undertaken during normal times, during the early stages of drought, during drought, and in the drought-recovery period. The plan will also identify the entities responsible for carrying out each action. The implementation of the designated actions may be recommended or legalized depending on the situation, but it tends to foster a sense of responsibility in either case.

Examples of linking early warning indicators and other prevention, mitigation and preparedness

Box 25:
Groundwater dam built by a community – a solution to water scarcity

One possible solution to water scarcity during the dry season: the groundwater dam. Groundwater dams store water underground, rather than on the surface. Water that is stored in the soil does not evaporate like ponds and streams. It is clean and healthy - parasites will not contaminate underground water. The key is to find ways to capture wet season rainfall underground. There are many ways to do this, both traditional and modern; but whatever method is used, the principle is the same: slow down the flow of water as it runs downhill.

The groundwater dam requires a fair amount of labour to complete, but the technology is not difficult, and the rewards are considerable. However, each region will have its own traditional solutions, based on its own unique needs for water, its soil structure, its climate, and its social structure.

A conversation with an African villager describing the implementation of a groundwater dam can be found on the website of the Developing Countries Farm Radio Network (www.farmradio.org/english/radio-scripts/71-9script_en.asp). The radio network provides various materials to radio broadcasters in 39 African countries.

Source: Dr. Chris Reij http://www.farmradio.org/english/radio-scripts/71-9script_en.asp

actions is provided by several U.S.A. states (e.g., Arizona, Georgia, Hawaii and New Mexico) and American Indian tribes that have recently developed drought mitigation plans, including linking drought indicators with specific drought mitigation and response actions to be carried out by responsible agencies. The state drought plans outlining these linkages can be seen at drought.unl.edu/plan/stateplans.htm. The drought plan for the Navajo Nation can be viewed at (http://drought.unl.edu/plan/Navajo_drought_pln2003.pdf).

Allocate resources for drought risk reduction
Drought is a significant natural hazard that is a catalyst for a wide variety of severe consequences for humans, their livelihoods and the environment. Reducing the risk of this threat requires a long-term commitment of human, technical and financial resources.

Governments, the private sector and other stakeholders need to consider drought as a significant natural hazard and allocate the appropriate resources to reduce drought risk. Many studies have shown that investing in natural hazard preparedness and vulnerability reduction strategies is more cost-effective than relying solely on response activities.

Hence, any investment in drought risk reduction (prevention, mitigation and preparedness) measures to reduce the effects of drought is a profitable investment. Governments and other stakeholders should allocate adequate funds in their budgets for meaningful drought risk reduction efforts.

A good practice of improving livestock markets to reduce drought disaster risk in Kenya is indicated in Annex 3.

Case Study from India:
Indo-German Watershed Development Programme: Integrating sustainable development and drought risk reduction

An example of the integration of sustainable development and drought risk reduction is the Indian government's development of the Indo-German Watershed Development Programme between 1992 and 2001, coordinated by the Watershed Organization Trust (WOTR) and the National Bank for Agriculture and Rural Development.

Darewadi village and the surrounding area in the Ahmednagar district of Maharashtra state in India was faced with near-complete desertification, limited agricultural production, and the seasonal migration of villagers to find work. In response to situations such as this one in Darewadi, the

Indian government developed the Indo-German Watershed Development Programme between 1992 and 2001, coordinated by the Watershed Organization Trust (WOTR) and the National Bank for Agriculture and Rural Development (NABARD).

Restoration activities such as tree and grassland planting and a switch to more sustainable crops were coupled with community-led pilot projects to promote soil and water conservation (e.g., education, water harvesting, and irrigation techniques) over a 5-year time span. The projects were carried out on both privately owned and publicly held land. Communities were considered eligible for participation in the programme if they were considered to be drought-affected, the land-ownership within the region was relatively equally distributed, and their geographical position within a watershed was conducive to the restoration activities.

The communities also had to agree to a ban on tree cutting and grazing in areas where the restoration activities were to take place and provide voluntary labour equal to 15-20% of the project's total costs. The restoration activities and pilot projects were carried out by community members after receiving technical and organizational training and economic assistance from WOTR. An unpaid Village Watershed Committee, appointed by the Village Assembly, oversaw the implementation of the projects, monitored the grazing and tree cutting bans, organized labour and wages, and imposed fines on any violators.

The Indo-German Watershed Programme was widely successful throughout regions of India. It was particularly successful in Darewadi, where after 5 years of the restoration activities, 65% of the trees and grasses that were planted on 395 hectares of previously denuded terrain and grazing biomass increased by 170%. Crops such as maize, wheat, and other vegetables were sustainably grown. Irrigated land increased from 197 to 342 hectares. The project's funding ceased in 2001 but Darewadi continued to experience a rise in the water table, grazing biomass, and amount of land under irrigation.

The seasonal migration of villagers also ceased as a result of stabilized agricultural production and wages. Importantly, the community members also

Box 26:
Kenya: Combining pastoralist drought preparedness and mitigation

Pastoralists in Garba Tulla in Isiolo District in Kenya are testing different ways of collecting water fees. People in the District are highly reliable on livestock keeping for their livelihood and therefore water availability for livestock is of crucial importance to them. The people of Garba Tulla are experimenting with different ways of collecting water fees. Users can either pay fees according to how many animals of each species they water, or they pay a flat rate per boma (enclosure). Smallholders have displayed a preference for the first option, whereas the big livestock keepers prefer the second. The means of payment also differs. The first group generally pays directly in cash and the other group may pay on a monthly basis.

The communities are generally able to collect the fees and bank them in Isiolo. They have contact with the Water Department in Isiolo for repairs on boreholes. The operations of this community initiative are overseen by the Deedha council, a traditional decision-making institution.

The fee collection and management system stimulates community organization and leads to quick responses when water supplies break down. Interestingly, it appears to be easier to collect fees during times of drought-related stress. Other options for watering animals may not be available during those periods.

Pastoralists in Garba Tulla have become accustomed to paying for this basic service, and the communities continue to explore which form of payment for watering livestock is most suitable.

Source: IIRR, Cordaid and Acacia Consultants, 2004, Drought Cycle Management: a Toolkit for the drylands of the Greater Horn.

gained leadership, technical and organizational skills, and unity among community members.

Source: World Resources 2005 at http://www.grida.no/wrr/047.htm

Case Study from Asia:
FAO projects on promoting livelihood adaptation to climate change in drought prone areas

Examples of drought risk reduction approaches with a strong emphasis on livelihoods include two FAO projects. The projects implemented in China and Mongolia under FAO's Technical Cooperation Programme (TCP) promote coordinated pastoral risk management strategies. Further, another example of a livelihood-focused drought risk management project in the context of climate variability and change has been also implemented by FAO in Bangladesh.

In Qinghai Province, China, one of the five largest pastoral regions in the country, the FAO project aims to reduce the regular animal losses of pastoral herders caused by recurrent natural hazards such as severe snow storms and spring droughts, and to enhance their own capacities to prevent such disasters. The project also contributes to the overall improvement of herders' future livelihoods, reduced environmental degradation and an increased capacity for risk prevention and management at local and provincial levels. (http://www.fao.org/sd/dim_in3/in3_060701_en.htm)

In Mongolia, risk management strategies were operational before its transition to market economy, but have completely collapsed under the free market economy since 1990. The FAO project assists the government in preparing risk management plans with particular emphasis on herding, the country's important livelihood system, for selected pilot provinces prone to catastrophic snow storms in winter and droughts in summer. Key components of the plans are field-tested so that the successful ones can be demonstrated and duplicated widely in the country.

In the north-western region of Bangladesh, the Comprehensive Disaster Management Programme of the Government of Bangladesh, in partnership with FAO, has implemented a project, "Improved Adaptive Capacity to Climate Change for Sustainable Livelihoods in the Agriculture Sector – Community Based Adaptation in Action", designed to promote livelihood adaptation and reduce vulnerability to climate change, particularly among women and poor communities that have the lowest capacity to adapt.

Source: Stephan Baas, FAO

Case Study from El Salvador:
Example of integrating drought response and mitigation

Subsistence farmers, especially in eastern El Salvador, suffered from sporadic rainfall between 1998 and 2001. Many crops in 62 municipalities were devastated by drought, with losses of up to 80% of the crops and 38% of farmers' incomes.

Box 27:
Africa: Innovative market-based solutions for drought risk reduction

At the 2nd African Drought Risk and Development Forum in Nairobi in 2006, the Commodity Risk Management Group of the World Bank put forward innovative market-based solutions to improve responses to drought. Index-based weather insurance and price risk insurance linked to credit are two proposed drought risk management options that are financially viable.

According to the World Bank, Malawi farmers have started to purchase weather insurance contracts and, following the drought of 2005, the government has used futures market price risk management as a way of hedging the potential cost of importing emergency food relief.

There is a need to shift from the typical ex-post to an ex-ante response, so that agencies are not always operating with high costs. The market for these instruments is developing quickly, thus the need to be aware of them and experiment with unconventional options.

Source: Session 2: Innovative Market-Based Solutions, 2nd African Drought Risk and Development Forum, Nairobi, Kenya (www.iwmi.cgiar.org/drw/images/ADDF2_report.doc)

The Drought Response and Mitigation Project was developed by the Spanish Red Cross, Salvadorian Red Cross Society, Inter-American Institute for Cooperation in Agriculture, and El Salvador Post-Harvest Coordinating Unit to reduce drought impacts by providing immediate food aid, assisting with the technical aspects of diversification and marketing of crops, increasing family income, enriching daily diets, reforesting lands with fruit trees, and conserving soil to ameliorate environmental conditions. Those most in need began a programme of agricultural recovery in which they received a farm kit containing tools to plant their crops. Emphasis was placed on sustainable agricultural techniques, organic fertilizers, and irrigation systems for small plots. Training and technical assistance was provided to increase production and assist with storing and marketing crops.

Approximately 300 families, or 1,500 people, were helped through this project and became better able to farm more effectively and efficiently. About 75% of those involved in the project were women, who took on a greater role of leadership and decision making in the communities. Children learned that there is an alternative to migrating away from their communities for employment. Crops could be grown in the summer with the help of irrigation systems. Organizations witnessed the rewards of addressing drought vulnerability through long-term strategies. Those helped by the project have continued to practice the new methods they learned.

Box 28:
Ethiopia: Cost effectiveness of livestock feeding support during drought

A livelihoods-based drought response in pastoralist areas could protect key livestock assets and support rapid rebuilding of herds after drought. Research by the Pastoralist Livelihoods Initiative, a joint initiative by USAID and Feinstein International Center, U.S.A., conducted in three areas (Afar, Borana and Somali) of Ethiopia, aimed to quantify different causes of livestock mortality during normal and drought years. The research found that most of the excess livestock mortality in drought years is mainly caused by starvation, not by disease. The research also found that, if given a choice, pastoralists invest more heavily in feed than veterinary care during drought.

A hypothetical analysis of feed, transport, operational and administration costs for delivering 2000 quintals (1 quintal is equivalent to 100 kilograms) of concentrate feed to Afar region indicates a cost of US$19/quintal, or a total cost of US$37,694.

- Sheep and goats - assuming a ration of 250g concentrate/day, 2000 quintals would support 8890 sheep and goats for three months. The cost of replacing these animals through a restocking project would be US$246,397, or 6.5 times more expensive than supplementary feeding.

- Cattle – assuming a ration of 1kg concentrate/day, 2000 quintals would support 2223 adult cattle for three months. The cost of replacing these animals through restocking would be US$ 530,000, or 14 times the cost of feeding.

The above-mentioned analysis shows that, in Afar region, restocking sheep and goats costs around 6.5 times more than supplementary feeding. Restocking cattle costs 14 times more than feeding. In other words, supporting livestock feeding during drought is likely to be much more cost effective than investing the same financial resources in veterinary care in this region. These findings may help decision makers to choose specific drought response measures.

Source: Feinstein International Center, Tufts University, U.S.A.

4.5.3 Tracking progress

Planners should develop performance indicators and institute a monitoring process to measure progress in drought risk identification, impact assessment, awareness and knowledge through engagement with the social science community and stakeholders, and further engage in effective risk reduction measures.

Often, drought monitoring and management is under the authority of physical scientists and policymakers. Social scientists and NGOs provide an important link to stakeholders that are ultimately affected by drought and benefit from risk reduction efforts. They are also the experts in social capacity development and policy analysis, who are needed to implement and review risk assessment methodologies.

Monitoring and evaluating the effects of risk assessment programmes requires an extensive review of on-the-ground projects, the development of case studies, and discussions with a wide range of stakeholders affected by drought at national, local and community levels. At the national level, Article 26 of the UNCCD provides the basis for developing countries experiencing serious drought and/or desertification to conduct regular monitoring, periodic review and reporting about their progress. The latest guidelines or help guide for preparing a national report are available at www.unccd.int/cop/officialdocs/cric5/pdf/inf3eng.pdf. Its key indicators are presented in Section 4.1.

Benchmarks or milestones should be developed for determining "success" in risk reduction to determine if measures are working. Benchmarks should include methods of evaluation for different scales and sectors with both qualitative and quantitative measures. Potential examples include:

- Use of agricultural monitoring data to analyse the reduction in drought impacts on crop production due to early warning information
- An increase in the establishment of institutions with a specific mandate for drought risk reduction
- An increase in the development and use of early warning systems and contingency plans
- Demonstrations and piloting of new technologies for resource conservation in selected drought-prone areas

The UNISDR publication "Indicators of Progress: Guidance on Measuring the Reduction of Disaster Risks and the Implementation of the Hyogo Framework for Action" provides key components, procedures and basic indicators to monitor progress in measures taken at different levels for overall disaster risk reduction. (www.unisdr.org/eng/about_isdr/isdr-publications/15-indicator-of-progress/Indicators_of_Progress_HFA.pdf). The proposed basic indicators for each of the HFA five priority areas are shown in Table 4. Various additional indicators and specific indicators to monitor progress in achieving the MDGs are also presented in these guidelines. Suitable indicators could be selected and used for the review of drought risk reduction.

Table 4:
Proposed indicators for monitoring the implementation of the Hyogo Framework for Action

Priority for Action	Recommended Indicators
1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation	• National institutional and legal frameworks for disaster risk reduction exist with decentralized responsibilities and capacities at all levels. • Dedicated and adequate resources are available to implement disaster risk reduction plans at all administrative levels. • Community participation and decentralization is ensured through the delegation of authority and resources to local levels. • A national multi-sectoral platform for disaster risk reduction is functioning.
2: Identify, assess and monitor disaster risks and enhance early warning	• National and local risk assessments based on hazard data and vulnerability information are available and include risk assessments for key sectors. • Systems are in place to monitor, archive and disseminate data on key hazards and vulnerabilities. • Early warning systems are in place for all major hazards, with outreach to communities. • National and local risk assessments take account of regional/ trans-boundary risks, with a view to regional cooperation on risk reduction.
3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels	• Relevant information on disasters is available and accessible at all levels, to all stakeholders (through networks, development of information sharing system). • School curricula, educational material and relevant training include risk reduction and recovery concepts and practices. • Research methods and tools for multi-risk assessments and cost benefit analysis are developed and strengthened. • Countrywide public awareness strategy exists to stimulate a culture of disaster resilience, with outreach to urban and rural communities.
4: Reduce the underlying risk factors	• Disaster risk reduction is an integral objective of environment-related policies and plans, including for land use, natural resource management and climate change adaptation. • Social development policies and plans are being implemented to reduce the vulnerability of populations most at risk. • Economic and productive sectoral policies and plans have been implemented to reduce the vulnerability of economic activities. • Planning and management of human settlements incorporate disaster risk reduction elements, including enforcement of building codes. • Disaster risk reduction measures are integrated into post-disaster recovery and rehabilitation processes. • Procedures are in place to assess disaster risk impacts of all major development projects, especially infrastructure.
5: Strengthen disaster preparedness for effective response at all levels.	• Strong policy, technical and institutional capacities and mechanisms for disaster management, with a disaster risk reduction perspective, are in place. • Disaster preparedness plans and contingency plans are in place at all administrative levels, and regular training drills and rehearsals are held to test and develop disaster response programmes. • Financial reserves and contingency mechanisms are in place to enable effective response and recovery when required. • Procedures are in place to exchange relevant information during disasters and to undertake post-event reviews.

Source: UNISDR, Indicators of Progress: Guidance on Measuring the Reduction of Disaster Risks and the Implementation of the Hyogo Framework for Action, http://www.unisdr.org/eng/about_isdr/isdr-publications/15-indicator-of-progress/Indicators_of_Progress_HFA.pdf

Chapter 5

Networks and mechanisms related to Drought Risk Reduction

The adoption of the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA) has given impetus to disaster reduction activities worldwide, including drought risk reduction. Governments, UN agencies, and regional organizations have already embarked on redefining national plans and strategies and in setting up promotional campaigns and institutional plans for further action. Summary information on the Hyogo Framework can be found in Annex 5.

The Hyogo Framework outlines five priorities for action to reduce global drought risk and the tasks required by states, regional and international organizations in collaboration with civil society and other stakeholders to achieve the priorities. This partnership of collaborators, which includes Governments, UN and non UN organizations, is referred to as the ISDR system (see http://www.preventionweb.net/english/hyogo/isdr/), and its main role is to provide coordination and assistance in the promotion and implementation of the priorities for action.

The main elements of a drought risk reduction framework, presented in the previous chapters, are in line with the priorities of the Hyogo Framework, namely i) policy and governance, ii) drought risk identification and early warning, iii) awareness and education, iv) reducing underlying factors of drought risk, and v) mitigation and preparedness, as well as cross-cutting issues.

Chapter 5 provides information on existing networks and mechanisms and makes further recommendations to develop a global network on drought risk reduction. The aim is to foster a collaborative "drought community", the implementation of drought risk reduction practices, and the acquisition of resources to carry out these activities. Similar "thematic platforms" exist within the ISDR system for other disaster risk reduction topics such as early warning, disaster recovery, capacity building and education.

This chapter also stresses the importance of knowledge sharing and networking, with reference to the discussions and outcomes of the Third Africa Drought Adaptation Forum jointly hosted by UNISDR and UNDP Drylands Development Centre in Addis Ababa, Ethiopia, from 17 to 19 September 2008. Drought vulnerability is especially high in Africa and a great deal of discussion has taken place about the potential for reducing drought risk, which will benefit Africa and other regions dealing with similar situations.

5.1 Mapping of mechanisms and institutions related to drought risk reduction

Lessons from developing and developed countries demonstrate that drought results in significant impacts, regardless of level of development, although the character of these impacts will differ profoundly, based on the level of vulnerability. As a result of increasing concern over escalating drought impacts and society's inability to effectively respond to these events, the most drought-prone countries are now placing greater emphasis on the creation or strengthening of policies and plans that emphasize the principles of risk management.

Numerous efforts are underway at international, regional, national, and local levels to address the challenges of building greater resilience to episodes of severe drought. These efforts include drought monitoring, prediction, early warning and disaster preparedness programmes sponsored by a wide array of organizations, such as those shown in Figure 25.

The importance of a holistic approach linking disaster risk reduction with environmental protection and sustainable development was

stressed in the Yokohama Strategy and Plan of Action for a Safer World adopted in May 1994 (http://www.unisdr.org/eng/about_isdr/bd-yokohama-strat-eng.htm). The importance of the linkage between such disciplines and mainstreaming disaster risk reduction into sustainable development was reiterated in the Hyogo Framework adopted in January 2005.

It is crucial to link the knowledge, expertise and activities of various institutions working in each specialised thematic area related to drought. The institutions listed in Annex 2 have expertise in each area or combined areas of environment, meteorology, hydrology, climate change, water resources management, sustainable agriculture and forestry practices, food security, health, gender and education, or have a much wider mandate of humanitarian and emergency relief, poverty reduction, sustainable economic development and regional inter-governmental cooperation.

Box 29:
Two-Prong Approach for Drought Risk Reduction

- Implementing practical, real-world drought risk reduction activities
- Establishing regional networks to share knowledge and expertise

Annex 2 provides brief descriptive information on missions, goals and activities of the organizations, institutions, centres and networks involved in drought risk reduction. The directory contains governmental and non-governmental organizations, national and regional organizations, bilateral and multilateral development agencies and financing mechanisms. The directory includes major international institutions supporting drought-related disaster risk reduction activities in Africa. The list also includes specific regional institutions that facilitate the development and implementation of sub-regional action programmes under the framework of the UNCCD as well as institutions engaged in climate change adaptation related activities within the framework of the UNFCCC.

Although many more national and local agencies are undertaking significant drought-related work, this document only contains limited information about national and local-level work. The main focus of this chapter is to provide analysis of the current drought risk reduction paradigm and to propose partnerships at global and regional levels. Strengthening national and local level institutions, centres and networks for drought risk reduction can be considered as part of the ongoing and future capacity building activities of various ISDR system partners.

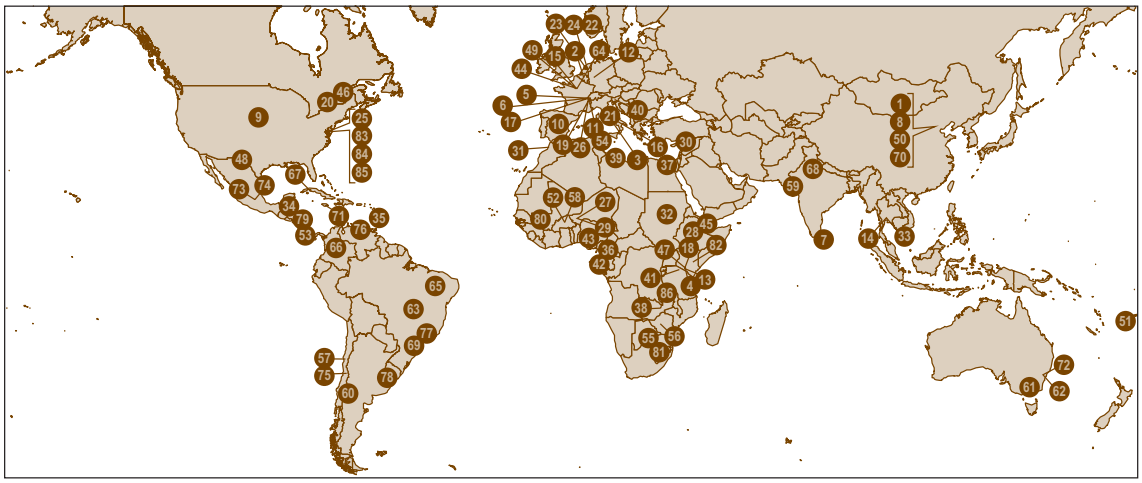
In addition to the development agencies, financial institutions and mechanisms listed in Annex 2, which provide financial assistance for drought risk reduction related activities, the World Bank launched its initiative, the Global Facility for Disaster Reduction and Recovery (GFDRR) in 2006. The GFDRR is an initiative to help governments, especially in the most vulnerable developing countries, implement measures to reduce disaster risks and integrate risk reduction strategies in development processes.

The Facility includes a partnership with the UNISDR to develop a supporting array of regional and international capacities and information resources (www.unisdr.org/partner-wb-isdr). This type of partnership and programme will be valuable for supporting and coordinating drought risk reduction activities around the world.

In 2006, the UNISDR and the National Drought Mitigation Center (NDMC), University of Nebraska-Lincoln, USA, signed a Memorandum of Understanding. The joint effort will promote coordination, networking, exchanging expertise, developing policies and identifying simple and affordable technologies, tools and good practices for drought risk reduction. The UNISDR and the NDMC have since been working in partnership with key U.N. agencies, national agencies, NGOs, and appropriate regional and national institutions with the goal of strengthening their institutional capacity to cope with future episodes of drought and to promote the development of regional drought networks.

In addition, current collaboration with the UN Office for the Coordination of Humanitarian Affairs (OCHA) through its Emergency Preparedness

Figure 25:
Mapping of key organizations, institutions, centres and networks working on drought issues around the world



Some of the key institutions and networks

1. International Center for Drought Risk Reduction (ICDRR), Beijing, China
2. European Commission Humanitarian Office (ECHO)
3. Food and Agriculture Organization of the United Nations (FAO)
4. Intergovernmental Authority on Development - Climate Prediction and Applications Centre (IGAD-ICPAC)
5. International Committee of the Red Cross (ICRC)
6. International Federation of Red Crossand Red Crescent Societies (IFRC)
7. International Water Management Institute (IWMI)
8. National Disaster Reduction Center of China
9. National Drought Mitigation Center (NDMC), University of Nebraska-Lincoln
10. Spanish International Cooperation Agency (AECI)
11. United Nations Children's Fund (UNICEF) - Office of Emergency Programmes
12. United Nations Convention to Combat Desertification (UNCCD)
13. United Nations Development Programme - Drylands Development Centre (UNDP DDC)
14. United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
15. United Nations Educational, Scientific and Cultural Organization (UNESCO)
16. United Nations International Fund for Agricultural Development (IFAD)
17. United Nations International Strategy for Disaster Reduction (UN/ISDR)
18. UN/ISDR Africa Regional Unit
19. United Nations Office for the Coordination of Humanitarian Affairs (OCHA)
20. United Nations University - International Network on Water, Environment and Health (UNU-INWEH)
21. United Nations World Food Programme (WFP)
22. University of Oslo
23. Vrije University, Amsterdam
24. Wageningen University
25. World Bank
26. World Meteorological Organization (WMO)

Regional level (excluding the institutions already mentioned)

27. African Centre of Meteorological Application for Development (ACMAD)
28. African Union (Organization of African Unity)
29. AGRHYMET Regional Centre
30. Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)
31. Arab Maghreb Union (UMA)
32. Arab Organization for Agricultural Development (AOAD)
33. Asian Disaster Preparedness Center (ADPC)
34. Caribbean Community (CARICOM) Climate Change Centre
35. Caribbean Environmental Health Institute (SEHI)
36. Central Africa Forests Commission (COMIFAC)
37. Centre for Environment and Development for Arab Region and Europe (CEDARE)
38. Common Market for Eastern and Southern Africa (COMESA)
39. Community of Sahel-Saharan States (CEN-SAD)
40. Drought Management Center for South-Eastern Europe (DMCSEE)
41. East African Community (EAC)
42. Economic Community of Central African States (ECCAS)
43. Economic Community of West African States (ECOWAS)
44. European Space Agency (ESA)
45. Intergovernmental Authority on Development (IGAD)
46. Institut de l'Energie et de l'Environnement de la Francophonie (IEPF)
47. Institute for Meteorological Training and Research / Regional Training Centre (IMTR/RTC)
48. International Boundary and Water Commission
49. International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM)
50. International Center for Drought Risk Reduction (ICDRR)
51. Pacific Islands Applied Geoscience Commission (SOPAC)
52. Permanent Interstate Committee for Drought Control in the Sahel (CILSS)
53. Regional Committee on Hydraulic Resources
54. Sahara and Sahel Observatory (OSS)
55. Southern African Development Community (SADC)
56. South African Development Community (SADC), Drought Monitoring Centre (DMC)
57. Water Center for Arid and Semi-Arid Zones in Latin America and The Caribbean (CAZALA)
58. West African Economic and Monetary Union

National level (excluding the institutions already mentioned)

59. All India Disaster Mitigation Institute
60. Argentine Institute for Arid Zones Research (IADIZA)
61. Australian Bureau of Meteorology
62. Australian Bureau of Rural Sciences
63. Brazilian Agricultural Research Corporation (Embrapa)
64. Bureau de Recherches Géologiques et Minières (BRGM)
65. Ceara State Foundation for Meteorology and Hydrology (FUNCEME)
66. Colombian Hydrology, Meteorology and Environmental Studies Institute (IDEAM)
67. Cuban Meteorology Institute
68. India Council of Agricultural Research (ICAR)
69. Institute of Agronomy at Campinas (IAC)
70. China Meteorological Administration
71. Jamaica Office of Disaster Preparedness and Emergency Management (ODPEM)
72. Land and Water Australia
73. Mexico National Drought Research Center
74. Mexico National Water Commission (CNA)
75. Ministry of Agriculture and CONAF (National Forestry Corporation)
76. Ministry of Environment and Natural Resources
77. National Institute for Space Research (INPE), São José dos Campos, Brazil
78. National Institute of Farming Technology of Argentina (INTA)
79. Nicaraguan Institute for Territorial Studies (INETER)
80. SAHEL Institute (INSAH)
81. South African Weather Service
82. Turkana Drought Contingency Planning Unit (TDCPU)
83. United States Department of Agriculture (USDA)
84. United States Geological Survey (USGS) Reston, Virginia, United States
85. United States National Oceanic and Atmospheric Administration's (NOAA)
86. Zambia Department of Meteorology

Note that only agency headquarters are shown in some cases. The map summarizes key organizations, institutions, centres and networks working on drought-related issues. For more information, please consult Annex 2.

Box 30:
The Global Facility for Disaster Reduction and Recovery (GFDRR)

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a partnership of Australia, Canada, Denmark, European Commission, Finland, France, Germany, Italy, Japan, Luxembourg, Norway, Spain, Sweden, Switzerland, United Kingdom, UNISDR, USAID and the World Bank to reduce disaster losses by mainstreaming disaster risk reduction in national development strategies and plans and to support the implementation of the Hyogo Framework (HFA).

The GFDRR provides low- and middle-income countries with financial assistance for development projects and programmes, including those for drought risk reduction that enhance local capacities for disaster prevention and emergency preparedness. The GFDRR grants support disaster risk assessments, development of risk mitigation policies and strategies, preparation of disaster prevention projects and additional financing for recovery.

The GFDRR has three windows of financing to achieve its objectives at global, regional and country levels. Track I supports an annual joint work programme of the ISDR system through the UNISDR to enhance global and regional advocacy, partnerships, and knowledge management in disaster risk reduction. Track II supports countries' efforts in mainstreaming disaster reduction and enhances investments in risk reduction and risk transfer mechanisms. Track III supports activities to strengthen mobilization of international assistance for disaster recovery and to accelerate recovery operations.

Source: UNISDR, http://www.unisdr.org/eng/partner-netw/wb-isdr/wb-isdr.htm

Section and Regional Offices is creating another important venue for risk reduction activities. OCHA is mandated to coordinate humanitarian response during disasters, policy development, and humanitarian advocacy. Enhancing drought risk preparedness reduces the impact of drought and allows communities and regions to recover more quickly during the post-drought period.

OCHA, in collaboration with UNDP and UNISDR, is undertaking a study in selected countries in East, Central and Southern Africa to review recent trends in slow-onset disasters such as drought to recommend how to respond to such disasters effectively.

An important inter-agency mechanism for coordination, policy development and decision making for humanitarian assistance is the Inter-Agency Standing Committee (IASC). The IASC was established in June 1992 in response to United Nations General Assembly Resolution 46/182 on the strengthening of humanitarian assistance. The IASC has developed a "cluster" system for preparedness and response to disasters including droughts by involving key UN and non-UN humanitarian partners. The UN partners leading the clusters include FAO, OCHA, UNDP, UNICEF, UNHCR, WFP and WHO. A large number of NGOs are represented in the IASC, through three NGO coalitions, namely: the International Council of Voluntary Agencies (ICVA), the Steering Committee for Humanitarian Response (SCHR) and the American Council for Voluntary International Action (InterAction), (see www.humanitarianinfo.org/iasc/content/default.asp).

5.2 Progress on the development of regional networks

Mobilizing funding and expertise to implement local and national risk reduction activities, programmes and pilot projects is critical for reducing drought risk and providing examples for others to follow. The coordination of these initiatives and sharing of knowledge could be increased by the creation or enhancement of regional drought preparedness networks.

Many drought risk reduction initiatives focus on Africa, owing to its high levels of poverty, human insecurity, and life-threatening vulnerability to drought. The Nairobi-based UNDP Drylands Development Center (DDC) and the UNISDR Regional Office in Africa have agreed to work with selected regional drought monitoring centres in the identification and implementation of drought risk reduction activities in Africa, as described later in this chapter.

In addition to Africa, the concept of regional networks on drought risk reduction has been discussed in other drought-prone regions in the Mediterranean, Near East, South-Eastern Europe, Asia and the Pacific, South America and North America.

The development of regional networks has been a challenging process because of overlapping political jurisdictions, differences in the profiles of participants and policy issues in each region, varying degrees of interest among potential regional participants, and different implementation timelines. These factors have resulted in the creation of dispersed regional networks, such as those illustrated in Figure 26.

As a result, efforts to organize regional networks have been rather slow, and still have not been as successful as desired. Indeed, the Secretary General's Report for the sixteenth session of the Commission on Sustainable Development notes that "though there is increasing recognition of the crucial role that systems and networks for drought monitoring, early warning, and drought impact and assessment can play in drought mitigation, in many drought affected countries and regions, such systems and networks are not available, or where they are available, often do not effectively operate" (http://www.un.org/esa/sustdev/csd/csd16/documents/sgreport_6.pdf).

Additional work is needed to strengthen existing regional networks and develop new networks to fill the gaps and coordinate the exchange of information and expertise between them. The UNISDR and its partners in the ISDR system have already undertaken various discussions to reach out to, and work with, a wide range of relevant stakeholders in order to foster the implementation of risk reduction activities. These discussions with a number of governments and institutions are expected to result in the identification and designation of possible regional collaborative centres for monitoring and managing drought-related risks.

The following section presents some of the progress being made in establishing regional networks around the world.

Sub-Saharan Africa: The UN System's support for Africa, through the New Partnership for Africa's Development (NEPAD), which has been operationalized at global, regional, sub-regional and country levels. Drought-related disaster risk reduction has been part of this UN System support.

Following the endorsement of the seventh meeting of the ISDR Inter-Agency Task Force on Disaster Reduction in April 2003 on the proposal of a global drought risk reduction network, the UNDP Drylands Development Centre (DDC), the UNDP Bureau for Crisis Prevention and Recovery (BCPR) and the UNISDR Africa Regional Unit started to work with the regional drought monitoring centres in the development of a regional network for Sub-Saharan Africa.

This work resulted in the creation of the African Drought Risk and Development Network (www.droughtnet.org), which has been operated by

Box 31:
Key messages resulting from the Third African Drought Adaptation Forum held in Addis Ababa in September 2008

1. Better coordination and communication will be needed among development organizations, governmental bodies, Community Based Organizations (CBOs), NGOs and practitioners.
2. Despite some progress made in the area of adaptation, more focus should be placed on policy-level changes in order to face the issues ahead.
3. The reasons for why some of the drought-related initiatives have not been working well should be explored.
4. Responses to drought emergencies need to be quicker.
5. Appropriate indicators (early warning) should be examined and in place in order to determine a drought.
6. Alternative ways to network and share information need to be sought.
7. Focus should be placed on innovative approaches to drought risk and climate change adaptation, as well as incorporating indigenous knowledge.
8. Alternative ways need to be explored to help maintain dryland populations' livelihoods.
9. More collaboration is needed between drought management practitioners and national governments.
10. Current differences in terminology and concepts of drought need to be clearly defined.

the UNDP's DDC. The network aims to promote the development of coordinated drought risk reduction strategies.

Since 2005, UNDP/DDC and UNISDR have organised three *African Drought and Development Forums* as part of the Africa Drought Risk and Development Network. These meetings have concentrated on setting up mechanisms to change the paradigm for drought management in Africa from crisis to risk management. These forums are expected to provide further stimulus to the sub-regional networks.

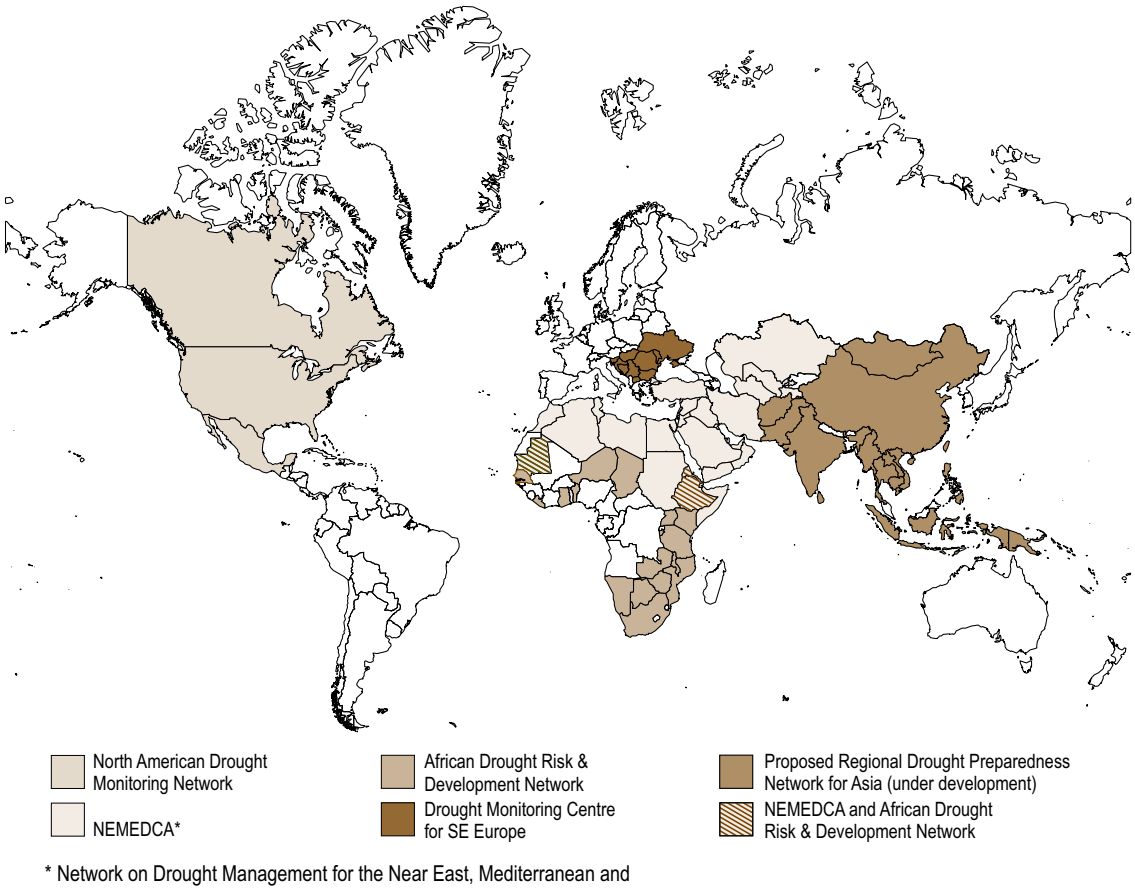
The most recent meeting, the *Third African Drought Adaptation Forum,* was convened in Addis Ababa, Ethiopia, September 2008, hosted by the Economic Commission for Africa (UNECA). It brought together some 80 policymakers from governments, UN and non UN organizations, donor agencies, as well as experts and practitioners to exchange criteria, information and practices on how to adapt to the increasing threat of drought and climate change in the drylands of Africa.

The identified good practices are compiled in Annex 3. Several key themes and messages emerged, as a result of the presentation and rich discussions. Box 31 summarise the ten key messages that will help shape the future of the Forum and the African Drought Risk & Development Network efforts to address issues related to climate change and drought risk continue.

Within the framework of its mandate, the UN Economic Commission for Africa (UN/ECA) is increasing the emphasis of its work on climate change, a considerable emerging challenge that threatens to derail progress in achieving the Millennium Development Goals and sustainable development in Africa. Indeed, projected impacts of climate change in Africa include increases in droughts, floods and other extreme events, which would exacerbate the stress on water resources, agriculture, food security, human health, and infrastructure, and thereby constrain development. Such threats are compounded by the low adaptive capacity of the continent, which features some of the poorest regions of the world that will likely be disproportionately affected by the adverse effects of climate change.

To address the related challenge, ECA has been working with other regional institutions, within the framework of the Joint Secretariat of the African Union Commission (AUC), UN/ECA and the African Development Bank (AfDB), to develop an appropriate climate change response policy and intervention agenda for the Africa region. In this regard the African Climate Policy Centre (ACPC) is being established and the ClimDev-Africa Programme has been developed. The overall goal of these two initiatives is to contribute to poverty reduction through successful mitigation and adaptation to climate change in Africa and to improve the capacity of African countries to participate effectively in multilateral climate negotiation. (Sources: http://www.uneca.org/eca_

Figure 26:
Map of some drought risk reduction networks around the world



Note: this map is not meant to represent all drought-related networks around the world. It shows representative networks that could potentially become part of a global drought preparedness network. (Source: National Drought Mitigation Center, University of Nebraska-Lincoln, USA).

resources/Publications/books/drought/index.htm, and The African Drought Risk and Development Network Newsletter, UNDP DDC, November 2008)

Other sub-regional African drought-related networks have also been tested, such as the Southern African Drought Technology Network (SADNET). These networks enhance collaborative possibilities within the region (more information about SADNET is available in Box 16, Chapter 4).

Mediterranean/Near East/Central Asia Region: The UN Food and Agriculture Organization (FAO), International Center for Agricultural Research in the Dry Areas (ICARDA), and International Center for Advanced Mediterranean Agronomic Studies (CIHEAM) launched the NEMEDCA drought preparedness network for the Near East, Mediterranean, and Central Asian countries in 2002. This collaboration with funding by the European Commission has also resulted in a regional drought planning guide for the Mediterranean region (southern Europe and North Africa), referred to as MEDROPLAN (www.iamz.ciheam.org/medroplan). More information about the MEDROPLAN guidelines is available in Box 7, Chapter 4.

FAO has also funded technical cooperation projects in Iran, Syria, and Jordan to develop national drought strategies with the goal of developing a regional drought management centre. FAO and the National Drought Mitigation Center, USA, have prepared a report on drought-related activities in the Near East Region and developed a drought planning manual (see the Land and Water publications section at http://www.fao.org/world/Regional/RNE/).

South-Eastern Europe/Central Asia: Following a process organised by the UNCCD Secretariat

in cooperation with the World Meteorological Organization (WMO), Slovenia has been selected by eleven countries from South-Eastern Europe to host the Drought Management Center for South-Eastern Europe in the context of the UNCCD (DMCSEE). The DMCSEE's goal is to serve as an operational centre for drought preparedness, monitoring and management, aiming to support a wide range of end users. (http://www.unccd.int/regional/centraleu/meetings/meetings.php)

Drawing on the experience of DMCSEE, the UNCCD Secretariat and the Organization for Security and Co-operation in Europe (OSCE) are supporting all five Central Asian countries in establishing a Drought Management Centre in Central Asia in the context of the UNCCD (DMCCA) in cooperation with WMO (http://www.unccd.int/regional/asia/meetings/meetings.php).

Asia and the Pacific: The concept of creating a regional network for drought preparedness (evolving towards risk reduction) was presented at the UN/DESA-UN/ESCAP-USA/NOAA Interregional Symposium on Water-Related Disaster Reduction and Response in Bangkok, Thailand, in August 2001. Since then, ESCAP, UNDP, WMO, the UNISDR, the Asian Disaster Preparedness Center (ADPC) and the USA/NDMC have discussed the development of a network for Asia and the Pacific Islands and received letters of support from most participating countries, and they are actively seeking funding for organization of the network.

The concept of a regional drought preparedness (evolving towards risk reduction) network has also been discussed with the Australian Bureau of Resource Sciences (BRS) and the Bureau of Meteorology. BRS is interested in providing technical support for this network, especially in the Asian and Pacific Island regions. BRS is the primary organization in Australia providing support for their national drought policy. The next step is to better define a role for Australia in support of this regional drought networking effort.

In April 2007, the International Center for Drought Risk Reduction (ICDRR) was established in Beijing by the Government of China in collaboration with UNISDR to monitor and assess drought risk across Asia, develop knowledge and capacities for drought mitigation and promote cooperation between China and other Asian countries on drought relief.

South America: The concept of a regional network for South America was originally discussed with the Institute of Agronomy at Campinas and National Institute for Space Research (INPE), Brazil. The goal was to help regional organizations take leadership in organizing efforts to develop a network on drought risk reduction. Although there has been general agreement on the importance of establishing a network of this type, progress has been limited. Considerable work is yet to be done in identifying the principal regional and national member institutions, organizing a network, and seeking funding sources.

North America: The Prairie Farm Rehabilitation Administration/Agriculture Canada has agreed to work with the National Drought Mitigation Center, University of Nebraska-Lincoln, USA, to organize a North American regional network. Potential areas of collaboration are still being identified. The Institute of Ecology in Xalapa, Mexico, and the Mexican National Water Commission (CNA) will also be approached to determine their interest in participating in this network. These partners already cooperate in creating the North American Drought Monitor, so expansion of this network would be complementary (more information on the North American Drought Monitor is available in Figure 22, Chapter 4).

5.3 Need for a global drought risk reduction network

Vulnerability to drought depends on a multitude of factors, including cultural and socio-economic factors, technology, government policies, people and livelihood vulnerability and environment and natural resources management. Many drought-related activities have been accomplished in a sectoral manner, with limited sharing of knowledge and experiences. As more technologies, tools, and methodologies become available, drought-prone countries will benefit from them and subsequently strengthen their knowledge. The importance of sharing information and experience has become paramount to future advances in drought risk reduction management.

There is a need to establish a strategy to shift from current perceptions to integrated drought risk reduction management. As described in the preceding sections, the strategy should be based on a new approach that is more focused on the human dimensions of drought and proactive risk reduction measures, including vulnerability analysis, risk assessment and implementation of activities at the local, national and regional levels. Reducing risk, rather than only getting prepared, needs to become a higher priority for governments, as explained in the Hyogo Framework, including strong awareness-raising, educational, training and other capacity development actions, undertaken as a matter of priority in national development policies and plans

To accomplish this strategy shift, the report of the ISDR Ad-Hoc Discussion Group on Drought in April 2003, Drought: Living with Risk: An Integrated Approach to Reducing Societal Vulnerability to Drought (www.unisdr.org/eng/task%20force/tf-adhoc/droughts/WGD-doc1.pdf), identified the key issues associated with drought risk reduction, and recommended the development of a global network. Such a network would not duplicate the work of regional or sub-regional networks, but would strengthen and complement activities and capacity development and provide a forum for interregional exchange of ideas, technology and experiences. The report and proposal were subsequently presented to and endorsed by the seventh meeting of the Inter-Agency Task Force on Disaster Reduction in April 2003 (http://www.unisdr.org/eng/task%20force/tf-meetigns/7th%20TF%20mtg/TF-7_report.doc).

In line with the above-mentioned criteria, the present document proposes a "Global Drought Risk Reduction Network" relying mainly on internet and regional forums (e.g., e-workshops) for linking institutions within and between regions to enhance knowledge and communication exchange for more effective policy guidance at all levels. This virtual global network aims to foster the exchange of information to document and support the implementation of practical, real-world drought risk reduction activities and provide better technical assistance to governments and other organizations working on reducing risk and vulnerability to drought.

The Global Drought Risk Reduction Network can provide an opportunity for nations and regions to share experiences and lessons learned (successes and failures) through a virtual network of regional networks. The Network will assist in identifying drought risk reduction policies and measures, including prevention, mitigation and preparedness actions, coordinating global support initiatives, developing guidance information and nurturing the development and strengthening of regional, national and local networks. It will bring together a wide range of natural and social scientists and practitioners needed to implement the vision of drought risk reduction.

The network will provide a forum for streamlining work on the thematic area of drought risk reduction, as its resources allow, including advocacy, coordination, networking and partnership development, information provision, inputs to related websites and global and regional reporting processes. It will follow the work with existing mechanisms such as the ones within the framework of relevant MEAs and the specific partnerships on drought resulting from the World

Summit on Sustainable Development (WSSD) and provide linkages between ongoing activities in different parts of the world.

The network could facilitate information on drought risk reduction policies, institutional and legal frameworks, drought risk identification, early warning systems, links to meteorological networks and climate forecast, education material, planning methodologies, and stakeholder involvement, as well as information on impact assessment, training opportunities, mitigation and preparedness measures, emergency response activities, programmes and technologies.

In essence, this global drought network or partnership will enhance current national and regional institutional capacities for drought risk reduction and preparedness by sharing information and knowledge. Complementary activities need to be considered to translate policies and frameworks into practical tools, published in different languages and widely disseminated.

The Global Drought Risk Reduction and Preparedness Network will facilitate the exchange of drought-related information and experiences around the world.

The network's goals relate to the five specific Priorities for Action of the Hyogo Framework in relation to drought, which are:

- Ensuring that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation;
- Identifying, assessing, and monitoring disaster risks and enhancing early warning;
- Using knowledge, innovation, and education to build a culture of safety and resilience at all levels of society;
- Reducing the underlying risks of drought; and
- Strengthening disaster preparedness for effective response at all levels of society.

The ISDR system, comprising governments and international, regional and UN organizations, will continue to seek ways to promote and implement drought risk reduction programmes and knowledge networks to facilitate the implementation of the Hyogo Framework. Although activities will be supported worldwide, the initial emphasis may be placed in Africa, where drought and related factors result in the greatest loss of lives and livelihoods.

Various ISDR system partners and experts working on drought risk reduction have suggested that they could play an initial role in promoting the proposed Global Drought Risk Reduction Network, and provide guidance for improved international coordination, as a core element of a future ISDR thematic platform on drought risk reduction. This group or platform could assist in identifying drought risk reduction priorities, coordinating global support initiatives, developing guidance information, and nurturing regional networks. It should bring together the range of natural and social scientists and practitioners needed to implement the vision of drought risk reduction management proposed in this document.

While the implementation of drought risk reduction activities would continue by partners, such as governments and intergovernmental organizations and international actors, experts, practitioners and UN agencies, such as FAO, IFAD, UNCCD, UNDP, OCHA, WFP, and WMO have been consulted about the proposed partnership for drought risk reduction. An initial Drought Advisory Group would lead the consultation about the feasibility of and resource mobilisation for a global drought risk reduction network and subsequently define an appropriate mechanism, in which regional organizations, key operational partners, experts and practitioners, among others partners, could also participate according to their respective mandates.

The UNISDR could help in promoting and supporting these efforts by the ISDR system partners, through advocacy, information generation, promotion with donor organizations and programmes, coordination of ISDR thematic platforms, and through the encouragement of networks. The regional offices of the UNISDR could actively support related efforts at the regional level.

Working individually, vulnerable countries sub-regions and regions may struggle to develop their drought coping capacities. However, by collectively working through global regional and sub-regional networks and partnerships, they can significantly improve their chances of achieving a substantial reduction in the magnitude of social, economic, environmental, and political impacts associated with drought in the 21st century.

Annexes

KENYA: Reducing pastoralists' vulnerability to drought through public health
Enhancing Water Access, Hygiene Awareness and Local Capacity

Oxfam GB

Annex 1 UNISDR Terminology on Disaster Risk Reduction (2009)

The UNISDR Terminology aims to promote common understanding and common usage of disaster risk reduction concepts and to assist the disaster risk reduction efforts of authorities, practitioners and the public. The previous version "Terminology: Basic terms of disaster risk reduction" was published in "Living with risk: a global review of disaster risk reduction initiatives" in 2004. The following year, the Hyogo Framework for Action 2005-2015 requested the UNISDR secretariat to "update and widely disseminate international standard terminology related to disaster risk reduction, at least in all official United Nations languages, for use in programme and institutions development, operations, research, training curricula and public information programmes".

The 2009 version is the result of a process of ongoing review by the UNISDR and consultations with a broad range of experts and practitioners in various international venues, regional discussions and national settings. The terms are now defined by a single sentence. The comments paragraph associated with each term is not part of the definition, but is provided to give additional context, qualification and explanation. It should be noted that the terms are not necessarily mutually exclusive, and in some cases may have overlapping meanings.

The Terminology has been revised to include words that are central to the contemporary understanding and evolving practice of disaster risk reduction but exclude words that have a common dictionary usage. Also included are a number of emerging new concepts that are not in widespread use but are of growing professional relevance; these terms are marked with a star (*) and their definition may evolve in future. The English version of the 2009 Terminology provides the basis for the preparation of other language versions. Comments and suggestions for future revisions are welcome and should be directed to the ISDR Secretariat isdr@un.org

Acceptable risk

The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.

Comment: In engineering terms, acceptable risk is also used to assess and define the structural and non-structural measures that are needed in order to reduce possible harm to people, property, services and systems to a chosen tolerated level, according to codes or "accepted practice" which are based on known probabilities of hazards and other factors.

Adaptation

The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Comment: This definition addresses the concerns of climate change and is sourced from the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). The broader concept of adaptation also applies to non-climatic factors such as soil erosion or surface subsidence. Adaptation can occur in autonomous fashion, for example through market changes, or as a result of intentional adaptation policies and plans. Many disaster risk reduction measures can directly contribute to better adaptation.

Biological hazard

Process or phenomenon of organic origin or conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Comment: Examples of biological hazards include outbreaks of epidemic diseases, plant or animal contagion, insect or other animal plagues and infestations.

Building code

A set of ordinances or regulations and associated standards intended to control aspects of the design, construction, materials, alteration and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage.

Comment: Building codes can include both technical and functional standards. They should incorporate the lessons of international experience and should be tailored to national and local circumstances. A systematic regime of enforcement is a critical supporting requirement for effective implementation of building codes.

Capacity

The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals.

Comment: Capacity may include infrastructure and physical means, institutions, societal coping abilities, as well as human knowledge, skills and collective attributes such as social relationships, leadership and management. Capacity also may be described as capability. Capacity assessment is a term for the process by which the capacity of a group is reviewed against desired goals, and the capacity gaps are identified for further action.

Capacity Development

The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions.

Comment: Capacity development is a concept that extends the term of capacity building to encompass all aspects of creating and sustaining capacity growth over time. It involves learning and various types of training, but also continuous efforts to develop institutions, political awareness, financial resources, technology systems, and the wider social and cultural enabling environment.

Climate change

(a) The Inter-governmental Panel on Climate Change (IPCC) defines climate change as: "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use".

(b) The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Comment: For disaster risk reduction purposes, either of these definitions may be suitable, depending on the particular context. The UNFCCC definition is the more restricted one as it excludes climate changes attributable to natural causes. The IPCC definition can be paraphrased for popular communications as "A change in the climate that persists for decades or longer, arising from either natural causes or human activity."

Contingency planning

A management process that analyses specific potential events or emerging situations that might threaten society or the environment and establishes arrangements in advance to enable

timely, effective and appropriate responses to such events and situations.

Comment: Contingency planning results in organized and coordinated courses of action with clearly-identified institutional roles and resources, information processes, and operational arrangements for specific actors at times of need. Based on scenarios of possible emergency conditions or disaster events, it allows key actors to envision, anticipate and solve problems that can arise during crises. Contingency planning is an important part of overall preparedness. Contingency plans need to be regularly updated and exercised.

Coping capacity

The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.

Comment: The capacity to cope requires continuing awareness, resources and good management, both in normal times as well as during crises or adverse conditions. Coping capacities contribute to the reduction of disaster risks.

Corrective disaster risk management *

Management activities that address and seek to correct or reduce disaster risks which are already present.

Comment: This concept aims to distinguish between the risks that are already present, and which need to be managed and reduced now, and the prospective risks that may develop in future if risk reduction policies are not put in place. See also Prospective risk management.

Critical facilities

The primary physical structures, technical facilities and systems which are socially, economically or operationally essential to the functioning of a society or community, both in routine circumstances and in the extreme circumstances of an emergency.

Comment: Critical facilities are elements of the infrastructure that support essential services in a society. They include such things as transport systems, air and sea ports, electricity, water and communications systems, hospitals and health clinics, and centres for fire, police and public administration services.

Disaster

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

Comment: Disasters are often described as a result of the combination of: the exposure to a hazard; the conditions of vulnerability that are present; and insufficient capacity or measures to reduce or cope with the potential negative consequences. Disaster impacts may include loss of life, injury, disease and other negative effects on human physical, mental and social well-being, together with damage to property, destruction of assets, loss of services, social and economic disruption and environmental degradation.

Disaster risk

The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.

Comment: The definition of disaster risk reflects the concept of disasters as the outcome of continuously present conditions of risk. Disaster risk comprises different types of potential losses which are often difficult to quantify. Nevertheless, with knowledge of the prevailing hazards and the patterns of population and socio-economic development, disaster risks can be assessed and mapped, in broad terms at least.

Disaster risk management

The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Comment: This term is an extension of the more general term "risk management" to address the specific issue of disaster risks. Disaster risk management aims to avoid, lessen or transfer the adverse effects of hazards through activities and measures for prevention, mitigation and preparedness.

Disaster risk reduction

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.

Comment: A comprehensive approach to reduce disaster risks is set out in the United Nations-endorsed Hyogo Framework for Action, adopted in 2005, whose expected outcome is "The substantial reduction of disaster losses, in lives and the social, economic and environmental assets of communities and countries." The International Strategy for Disaster Reduction (ISDR) system provides a vehicle for cooperation among Governments, organizations and civil society actors to assist in the implementation of the Framework. Note that while the term "disaster reduction" is sometimes used, the term "disaster risk reduction" provides a better recognition of the ongoing nature of disaster risks and the ongoing potential to reduce these risks.

Disaster risk reduction plan *

A document prepared by an authority, sector, organization or enterprise that sets out goals and specific objectives for reducing disaster risks together with related actions to accomplish these objectives.

Comment: Disaster risk reduction plans should be guided by the Hyogo Framework and considered and coordinated within relevant development plans, resource allocations and programme activities. National level plans needs to be specific to each level of administrative responsibility and adapted to the different social and geographical circumstances that are present. The time frame and responsibilities for implementation and the sources of funding should be specified in the plan. Linkages to climate change adaptation plans should be made where possible.

Early warning system

The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Comment: This definition encompasses the range of factors necessary to achieve effective responses to warnings. A people-centred early warning system necessarily comprises four key elements: knowledge of the risks; monitoring, analysis and forecasting of the hazards; communication or dissemination of alerts and warnings; and local capabilities to respond to the warnings received. The expression "end-to-end warning system" is also used to emphasize that warning systems need to span all steps from hazard detection through to community response.

Ecosystem services

The benefits that people and communities obtain from ecosystems.

Comment: This definition is drawn from the Millennium Ecosystem Assessment. The benefits that ecosystems can provide include "regulating services" such as regulation of floods, drought, land degradation and disease, along with "provisioning services" such as food and water, "supporting services" such as soil formation and nutrient cycling, and

"cultural services" such as recreational, spiritual, religious and other non-material benefits. Integrated management of land, water and living resources that promotes conservation and sustainable use provide the basis for maintaining ecosystem services, including those that contribute to reduced disaster risks.

El Niño-Southern Oscillation phenomenon

A complex interaction of the tropical Pacific Ocean and the global atmosphere that results in irregularly occurring episodes of changed ocean and weather patterns in many parts of the world, often with significant impacts over many months, such as altered marine habitats, rainfall changes, floods, droughts, and changes in storm patterns.

Comment: The El Niño part of the El Niño-Southern Oscillation (ENSO) phenomenon refers to the well-above-average ocean temperatures that occur along the coasts of Ecuador, Peru and northern Chile and across the eastern equatorial Pacific Ocean, while La Niña part refers to the opposite circumstances when well-below-average ocean temperatures occur. The Southern Oscillation refers to the accompanying changes in the global air pressure patterns that are associated with the changed weather patterns experienced in different parts of the world.

Emergency management

The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps.

Comment: A crisis or emergency is a threatening condition that requires urgent action. Effective emergency action can avoid the escalation of an event into a disaster. Emergency management involves plans and institutional arrangements to engage and guide the efforts of government, non-government, voluntary and private agencies in comprehensive and coordinated ways to respond to the entire spectrum of emergency needs. The expression "disaster management" is sometimes used instead of emergency management.

Emergency services

The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.

Comment: Emergency services include agencies such as civil protection authorities, police, fire, ambulance, paramedic and emergency medicine services, Red Cross and Red Crescent societies, and specialized emergency units of electricity, transportation, communications and other related services organizations.

Environmental degradation

The reduction of the capacity of the environment to meet social and ecological objectives and needs.

Comment: Degradation of the environment can alter the frequency and intensity of natural hazards and increase the vulnerability of communities. The types of human-induced degradation are varied and include land misuse, soil erosion and loss, desertification, wildland fires, loss of biodiversity, deforestation, mangrove destruction, land, water and air pollution, climate change, sea level rise and ozone depletion.

Environmental impact assessment

Process by which the environmental consequences of a proposed project or programme are evaluated, undertaken as an integral part of planning and decision-making processes with a view to limiting or reducing the adverse impacts of the project or programme.

Comment: Environmental impact assessment is a policy tool that provides evidence and analysis of environmental impacts of activities from conception to decision-making. It is utilized extensively in national programming and project approval processes and for international development assistance projects. Environmental impact assessments should include detailed risk assessments and provide alternatives, solutions or options to deal with identified problems.

Exposure

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Comment: Measures of exposure can include the number of people or types of assets in an area. These can be combined with the specific vulnerability of the exposed elements to any particular hazard to estimate the quantitative risks associated with that hazard in the area of interest.

Extensive risk *

The widespread risk associated with the exposure of dispersed populations to repeated or persistent hazard conditions of low or moderate intensity, often of a highly localized nature, which can lead to debilitating cumulative disaster impacts.

Comment: Extensive risk is mainly a characteristic of rural areas and urban margins where communities are exposed to, and vulnerable to, recurring localised floods, landslides storms or drought. Extensive risk is often associated with poverty, urbanization and environmental degradation. See also "Intensive risk".

Forecast

Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.

Comment: In meteorology a forecast refers to a future condition, whereas a warning refers to a potentially dangerous future condition.

Geological hazard

Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Comment: Geological hazards include internal earth processes, such as earthquakes, volcanic activity and emissions, and related geophysical processes such as mass movements, landslides, rockslides, surface collapses, and debris or mud flows. Hydrometeorological factors are important contributors to some of these processes. Tsunamis are difficult to categorize; although they are triggered by undersea earthquakes and other geological events, they are essentially an oceanic process that is manifested as a coastal water-related hazard.

Greenhouse gases

Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds.

Comment: This is the definition of the Intergovernmental Panel on Climate Change (IPCC). The main greenhouse gases (GHG) are water vapour, carbon dioxide, nitrous oxide, methane and ozone.

Hazard

A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Comment: The hazards of concern to disaster risk reduction as stated in footnote 3 of the Hyogo Framework are "… hazards of natural origin and related environmental and technological hazards and risks." Such hazards arise from a variety of geological, meteorological, hydrological, oceanic, biological, and technological sources, sometimes acting in combination. In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis.

See other hazard-related terms in the Terminology: Biological hazard; Geological hazard; Hydrometeorological hazard; Natural hazard; Socio-natural hazard; Technological hazard.

Hydrometeorological hazard

Process or phenomenon of atmospheric, hydrological or oceanographic nature that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Comment: Hydrometeorological hazards include tropical cyclones (also known as typhoons and hurricanes), thunderstorms, hailstorms, tornados, blizzards, heavy snowfall, avalanches, coastal storm surges, floods including flash floods, drought, heatwaves and cold spells. Hydrometeorological conditions also can be a factor in other hazards such as landslides, wildland fires, locust plagues, epidemics, and in the transport and dispersal of toxic substances and volcanic eruption material

Intensive risk *

The risk associated with the exposure of large concentrations of people and economic activities to intense hazard events, which can lead to potentially catastrophic disaster impacts involving high mortality and asset loss.

Comment: Intensive risk is mainly a characteristic of large cities or densely populated areas that are not only exposed to intense hazards such as strong earthquakes, active volcanoes, heavy floods, tsunamis, or major storms but also have high levels of vulnerability to these hazards. See also "Extensive risk."

Land-use planning

The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses.

Comment: Land-use planning is an important contributor to sustainable development. It involves studies and mapping; analysis of economic, environmental and hazard data; formulation of alternative land-use decisions; and design of long-range plans for different geographical and administrative scales. Land-use planning can help to mitigate disasters and reduce risks by discouraging settlements and construction of key installations in hazard-prone areas, including consideration of service routes for transport, power, water, sewage and other critical facilities.

Mitigation

The lessening or limitation of the adverse impacts of hazards and related disasters.

Comment: The adverse impacts of hazards often cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions. Mitigation measures encompass engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness. It should be noted that in climate change policy, "mitigation" is defined differently, being the term used for the reduction of greenhouse gas emissions that are the source of climate change.

National platform for disaster

risk reduction A generic term for national mechanisms for coordination and policy guidance on disaster risk reduction that are multi-sectoral and inter-disciplinary in nature, with public, private and civil society participation involving all concerned entities within a country.

Comment: This definition is derived from footnote 10 of the Hyogo Framework. Disaster risk reduction requires the knowledge, capacities and inputs of a wide range of sectors and organizations, including United Nations agencies present at the national level, as appropriate. Most sectors are affected directly or indirectly by disasters and many have specific responsibilities that impinge upon disaster risks. National platforms provide a means to

enhance national action to reduce disaster risks, and they represent the national mechanism for the International Strategy for Disaster Reduction.

Natural hazard

Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Comment: Natural hazards are a sub-set of all hazards. The term is used to describe actual hazard events as well as the latent hazard conditions that may give rise to future events. Natural hazard events can be characterized by their magnitude or intensity, speed of onset, duration, and area of extent. For example, earthquakes have short durations and usually affect a relatively small region, whereas droughts are slow to develop and fade away and often affect large regions. In some cases hazards may be coupled, as in the flood caused by a hurricane or the tsunami that is created by an earthquake.

Preparedness

The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.

Comment: Preparedness action is carried out within the context of disaster risk management and aims to build the capacities needed to efficiently manage all types of emergencies and achieve orderly transitions from response through to sustained recovery. Preparedness is based on a sound analysis of disaster risks and good linkages with early warning systems, and includes such activities as contingency planning, stockpiling of equipment and supplies, the development of arrangements for coordination, evacuation and public information, and associated training and field exercises. These must be supported by formal institutional, legal and budgetary capacities. The related term "readiness" describes the ability to quickly and appropriately respond when required.

Prevention

The outright avoidance of adverse impacts of hazards and related disasters.

Comment: Prevention (i.e. disaster prevention) expresses the concept and intention to completely avoid potential adverse impacts through action taken in advance. Examples include dams or embankments that eliminate flood risks, land-use regulations that do not permit any settlement in high risk zones, and seismic engineering designs that ensure the survival and function of a critical building in any likely earthquake. Very often the complete avoidance of losses is not feasible and the task transforms to that of mitigation. Partly for this reason, the terms prevention and mitigation are sometimes used interchangeably in casual use.

Prospective disaster risk management *

Management activities that address and seek to avoid the development of new or increased disaster risks.

Comment: This concept focuses on addressing risks that may develop in future if risk reduction policies are not put in place, rather than on the risks that are already present and which can be managed and reduced now. See also Corrective disaster risk management.

Public awareness

The extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards.

Comment: Public awareness is a key factor in effective disaster risk reduction. Its development is pursued, for example, through the development and dissemination of information through media and educational channels, the establishment of information centres, networks, and community or participation actions, and advocacy by senior public officials and community leaders.

Recovery

The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.

Comment: The recovery task of rehabilitation and reconstruction begins soon after the emergency phase has ended, and should be based on pre-existing strategies and policies that facilitate clear institutional responsibilities for recovery action and enable public participation. Recovery programmes, coupled with the heightened public awareness and engagement after a disaster, afford a valuable opportunity to develop and implement disaster risk reduction measures and to apply the "build back better" principle.

Residual risk

The risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained.

Comment: The presence of residual risk implies a continuing need to develop and support effective capacities for emergency services, preparedness, response and recovery together with socio-economic policies such as safety nets and risk transfer mechanisms.

Resilience

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Comment: Resilience means the ability to "resile from" or "spring back from" a shock. The resilience of a community in respect to potential hazard events is determined by the degree to which the community has the necessary resources and is capable of organizing itself both prior to and during times of need.

Response

The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Comment: Disaster response is predominantly focused on immediate and short-term needs and is sometimes called "disaster relief". The division between this response stage and the subsequent recovery stage is not clear-cut. Some response actions, such as the supply of temporary housing and water supplies, may extend well into the recovery stage.

Retrofitting

Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards.

Comment: Retrofitting requires consideration of the design and function of the structure, the stresses that the structure may be subject to from particular hazards or hazard scenarios, and the practicality and costs of different retrofitting options. Examples of retrofitting include adding bracing to stiffen walls, reinforcing pillars, adding steel ties between walls and roofs, installing shutters on windows, and improving the protection of important facilities and equipment.

Risk

The combination of the probability of an event and its negative consequences.

Comment: This definition closely follows the definition of the ISO/IEC Guide 73. The word "risk" has two distinctive connotations: in popular usage the emphasis is usually placed on the concept of chance or possibility, such as in "the risk of an accident"; whereas in technical settings the emphasis is usually placed on the consequences, in terms of "potential losses" for some particular cause, place and period. It can be noted that people do not necessarily share the

same perceptions of the significance and underlying causes of different risks.

See other risk-related terms in the Terminology: Acceptable risk; Corrective disaster risk management; Disaster risk; Disaster risk management; Disaster risk reduction; Disaster risk reduction plans; Extensive risk; Intensive risk; Prospective disaster risk management; Residual risk; Risk assessment; Risk management; Risk transfer.

Risk assessment

A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.

Comment: Risk assessments (and associated risk mapping) include: a review of the technical characteristics of hazards such as their location, intensity, frequency and probability; the analysis of exposure and vulnerability including the physical social, health, economic and environmental dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities in respect to likely risk scenarios. This series of activities is sometimes known as a risk analysis process.

Risk management

The systematic approach and practice of managing uncertainty to minimize potential harm and loss.

Comment: Risk management comprises risk assessment and analysis, and the implementation of strategies and specific actions to control, reduce and transfer risks. It is widely practiced by organizations to minimise risk in investment decisions and to address operational risks such as those of business disruption, production failure, environmental damage, social impacts and damage from fire and natural hazards. Risk management is a core issue for sectors such as water supply, energy and agriculture whose production is directly affected by extremes of weather and climate.

Risk transfer

The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a household, community, enterprise or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party.

Comment: Insurance is a well-known form of risk transfer, where coverage of a risk is obtained from an insurer in exchange for ongoing premiums paid to the insurer. Risk transfer can occur informally within family and community networks where there are reciprocal expectations of mutual aid by means of gifts or credit, as well as formally where governments, insurers, multi-lateral banks and other large risk-bearing entities establish mechanisms to help cope with losses in major events. Such mechanisms include insurance and re-insurance contracts, catastrophe bonds, contingent credit facilities and reserve funds, where the costs are covered by premiums, investor contributions, interest rates and past savings, respectively.

Socio-natural hazard *

The phenomenon of increased occurrence of certain geophysical and hydrometeorological hazard events, such as landslides, flooding, land subsidence and drought, that arise from the interaction of natural hazards with overexploited or degraded land and environmental resources.

Comment: This term is used for the circumstances where human activity is increasing the occurrence of certain hazards beyond their natural probabilities. Evidence points to a growing disaster burden from such hazards. Socio-natural hazards can be reduced and avoided through wise management of land and environmental resources.

Structural and non-structural measures

Structural measures: Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve

hazard-resistance and resilience in structures or systems;

Non-structural measures: Any measure not involving physical construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education.

Comment: Common structural measures for disaster risk reduction include dams, flood levies, ocean wave barriers, earthquake-resistant construction, and evacuation shelters. Common non-structural measures include building codes, land use planning laws and their enforcement, research and assessment, information resources, and public awareness programmes. Note that in civil and structural engineering, the term "structural" is used in a more restricted sense to mean just the load-bearing structure, with other parts such as wall cladding and interior fittings being termed non-structural.

Sustainable development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Comment: This definition coined by the 1987 Brundtland Commission is very succinct but it leaves unanswered many questions regarding the meaning of the word development and the social, economic and environmental processes involved. Disaster risk is associated with unsustainable elements of development such as environmental degradation, while conversely disaster risk reduction can contribute to the achievement of sustainable development, through reduced losses and improved development practices.

Technological hazard

A hazard originating from technological or industrial conditions, including accidents, dangerous procedures, infrastructure failures or specific human activities, that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Comment: Examples of technological hazards include industrial pollution, nuclear radiation, toxic wastes, dam failures, transport accidents, factory explosions, fires, and chemical spills. Technological hazards also may arise directly as a result of the impacts of a natural hazard event.

Vulnerability

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

Comment: There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples may include poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard for wise environmental management. Vulnerability varies significantly within a community and over time. This definition identifies vulnerability as a characteristic of the element of interest (community, system or asset) which is independent of its exposure. However, in common use the word is often used more broadly to include the element's exposure.

* Emerging new concepts that are not in widespread use but are of growing professional relevance; the definition of these terms remain to be widely consulted upon and may change in future.

Annex 2 Directory of drought-related organizations

1. United Nations System

Food and Agriculture Organization of the United Nations (FAO)
FAO leads international efforts to defeat hunger. Serving both developed and developing countries, FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information. FAO helps developing countries and countries in transition modernize and improve agriculture, forestry, and fisheries practices and ensure good nutrition for all. Since its founding in 1945, its has focused special attention on developing rural areas, home to 70 percent of the world's poor and hungry people. http://www.fao.org

Global Mechanism
The Global Mechanism (GM) was established under Article 21 of the United Nations Convention to Combat Desertification (UNCCD), and began its operations in October 1997. The original functions of the GM as general broker of funding for the Parties to the UNCCD to implementation the Convention has since evolved. The GM is increasingly specializing in providing a range of financial advisory services in close cooperation with International Finance Institutions (IFIs) and bilateral donors, in particular the World Bank Group, the International Fund for Agricultural Development (IFAD) and the regional development banks.
http://www.global-mechanism.org/

International Fund for Agricultural Development (IFAD)
IFAD's goal is to empower poor rural women and men in developing countries to achieve higher incomes and improved food security. IFAD will ensure that poor rural people have better access to resources, and the skills and organization they need to take advantage of natural resources, improved agricultural technologies, a broad range of financial services, transparent and competitive markets for agricultural inputs and produce, opportunities for rural off-farm employment and enterprise development, and local and national policy and programming processes. http://www.ifad.org

Office of the High Commissioner for Human Rights (OHCHR)
OHCHR, a department of the United Nations Secretariat, is mandated to promote and protect the enjoyment and full realization, by all people, of all rights established in the Charter of the United Nations and in international human rights laws and treaties. The mandate includes preventing human rights violations, securing respect for all human rights, promoting international cooperation to protect human rights, coordinating related activities throughout the United Nations, and strengthening and streamlining the United Nations system in the field of human rights. http://www.ohchr.org/

Office of the United Nations High Commissioner for Refugees (UNHCR)
The agency is mandated to lead and co-ordinate international action to protect refugees and resolve refugee problems worldwide. Its primary purpose is to safeguard the rights and well-being of refugees. It strives to ensure that everyone can exercise the right to seek asylum and find safe refuge in another State, with the option to return home voluntarily, integrate locally or to resettle in a third country. http://www.unhcr.ch/

United Nations Children's Fund (UNICEF)
UNICEF is mandated by the United Nations General Assembly to advocate for the protection of children's rights, to help meet their basic needs and to expand their opportunities to reach their full potential. UNICEF works in 191 countries through country programmes and National Committees.
http://www.unicef.org/

United Nations Convention to Combat Desertification (UNCCD)
The "United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in

Africa" was adopted in Paris on 17 June 1994 and opened for signature there on 14-15 October 1994. It entered into force on 26 December 1996, 90 days after the fiftieth ratification was received. The convention has 193 country parties as of 31 March 2009. http://www.unccd.int

United Nations Country Team (UNCT)
The Secretary-General's reform process initiated in 1997 stressed the need to achieve a greater unity of purpose and coherence in country-level operations of the UN system, highlighting the need to strengthen the UN Country Team (UNCT) System and promoting a more united UN presence at the country level. The UNCT system encompasses all organizations of the United Nations system dealing with operational activities for development and relief, regardless of their formal presence in the country. The UNCT system aims to bring together the different UN agencies to improve the efficiency and effectiveness of operational activities at the country level.

United Nations Development Fund for Women (UNIFEM)
UNIFEM is the women's fund of the United Nations. It provides financial and technical assistance to innovative programmes and strategies to foster women's empowerment and gender equality. http://www.unifem.org/

United Nations Development Group (UNDG)
Chaired by the UNDP Administrator, based in New York, the UNDG provides a framework for greater coherence and cooperation in UN development operations. As most of the UNDG members carry out activities related to disaster reduction, this group represents an opportunity to integrate disaster reduction into sustainable development. http://www.undg.org

United Nations Development Programme (UNDP) http://www.undp.org
UNDP is the UN's global development network, an organization advocating for change and connecting countries to knowledge, experience, and resources to help people build a better life. UNDP's offices are on the ground in 166 countries, working with them on their own solutions to global and national development challenges. As they develop local capacity, they draw on the people of UNDP and our wide range of partners. UNDP has two specialized divisions which deal with disaster risks reduction: Bureau for Crisis Prevention and Recovery (BCPR) http://www.undp.org/bcpr and the Drylands Development Centre (DDC) http://www.undp.org/drylands

United Nations Economic Commission for Africa (ECA), Addis Ababa, Ethiopia
The ECA convenes the UN Regional Consultations Mechanism, a framework for consultations aiming to fast-track programme implementation system-wide by the United Nations. in support to the New Partnership for African Development (NEPAD). The ECA works closely with the Regional Economic Communities. The Food Security and Sustainable Development Sub-programme of ECA aims to strengthen the capacity of member States to design institutional arrangements and implement national policies and programmes that reinforce the linkages within the nexus of food security, population, environment and human settlements in order to achieve sustainable development. http://www.uneca.org/

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok, Thailand
Established in 1947, ESCAP seeks to overcome some of the region's greatest challenges. It carries out work in three main thematic areas: poverty reduction, managing globalization, and tackling emerging social issues. http://www.unescap.org/; http://www.unescap.org/esd/environment

United Nations Economic and Social Council (ECOSOC)
ECOSOC serves as the central forum for discussing international economic and social issues, and for formulating policy recommendations addressed to Member States and the United Nations system. It is responsible for promoting higher standards of living, full employment, and economic and social progress; identifying solutions to international economic, social, and health problems; facilitating international cultural and educational cooperation; and encouraging universal respect for human rights and fundamental freedoms. It

has the power to make or initiate studies and reports on these issues. With its broad mandate the Council's purview extends to over 70 percent of the human and financial resources of the entire UN system. http://www.un.org/docs/ecosoc/

United Nations Educational, Scientific and Cultural Organization (UNESCO)
UNESCO's main objective is to contribute to peace and security in the world by promoting collaboration among nations through education, science, culture, and communication in order to further universal respect for justice, the rule of law, human rights, and fundamental freedoms. http://www.unesco.org

United Nations Environment Programme (UNEP)
UNEP is the voice for the environment in the United Nations system. It is an advocate, educator, catalyst, and facilitator promoting the wise use of the planet's natural assets for sustainable development. http://www.unep.org

United Nations Framework Convention on Climate Change (UNFCCC)
Adopted in 1992, the UNFCCC sets out a framework for action aimed at stabilizing atmospheric concentrations of greenhouse gases at a level that would prevent human-induced actions from leading to "dangerous interference" with the climate system. The UNFCCC entered into force on 21 March 1994. As of 31 March 2008, UNFCCC has 192 Parties, and thirteen meetings of the Conference of the Parties (COP), three meetings of the meeting of the Parties to the Kyoto Protocol (CMP) as well as numerous workshops and meetings of the COP's subsidiary bodies have taken place. http://unfccc.int

United Nations Human Settlements Programme (HABITAT)
The United Nations Human Settlements Programme, UN-HABITAT, is the United Nations agency for human settlements. It is mandated by the UN General Assembly to promote socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all. http://www.unhabitat.org/

United Nations International Strategy for Disaster Reduction (UNISDR)
The mission of the UNISDR is to build disaster resilient communities by promoting increased awareness of the importance of disaster reduction as an integral component of sustainable development, with the goal of reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental disasters. The ISDR system is referred collectively as various international, regional and national bodies, platforms, programmes and mechanisms expressly established to support the implementation of the Hyogo Framework for Action. The secretariat of the UNISDR is located in Geneva, Switzerland. http://www.unisdr.org, http://www.unisdr.org/eng/hfa/docs/Hyogo-framework-for-action-english.pdf

United Nations Office for the Coordination of Humanitarian Affairs (OCHA)
OCHA aims to alleviate human suffering by facilitating international coordination for the effective and efficient delivery of assistance to victims of disasters and complex emergencies. OCHA is led by the Under-Secretary-General for Humanitarian Affairs/Emergency Relief Coordinator. OCHA-Geneva has recently created the Emergency Preparedness Section to promote and strengthen disaster preparedness at all levels, among other activities. OCHA, as a part of the Inter-Agency Standing Committee (IASC), also assists Humanitarian Early Warning Service (HEWS) for natural hazards and socio-political developments worldwide. http://ochaonline.un.org

United Nations University (UNU)
The mission of the UNU is to contribute, through research and capacity building, to efforts to resolve the pressing global problems that are the concern of the United Nations and its Member States. The UNU aims to fulfil its mission by performing four key roles that are based on the mandate given to the University by its Charter: to be an international community of scholars; to form a bridge between the United Nations and the international academic community; to serve as a think-tank for the United Nations system; and to contribute to capacity building, particularly in developing countries. http://www.unu.edu/

United Nations University - International Network on Water, Environment and Health (UNU-INWEH), Hamilton, Canada
The core concern of the UNU-INWEH is the global water crisis. UNU-INWEH's programme is designed to provide applied science and capacity-building initiatives that enable water managers to better address both the root causes and current manifestations of the global water crisis. UNU-INWEH activities serve two core functions: Capacity Development and Directed Science & Policy Bridging. http://www.inweh.unu.edu/inweh/mission.htm

United Nations Volunteers (UNV)
United Nations Volunteers is the United Nations focal point for promoting and harnessing volunteerism for effective development. UNV is a strategic source of knowledge and advice about the role and contribution of volunteerism and the benefits of civic engagement in development programmes. UNV is dedicated to using Volunteerism for Development (V4D) to make distinctive contributions to the effectiveness of development. http://www.unv.org/

World Food Programme of the United Nations (WFP)
WFP is the United Nations' frontline agency in the fight against global hunger. Operations aim to save lives in refugee crises and other emergencies, improve nutrition and quality of life of world's most vulnerable people at critical times in their lives, and enable development by (a) helping people build assets that benefit them directly; (b) promoting the self-reliance of poor people and communities. The WFP specializes in food aid and humanitarian assistance (http://www.wfp.org/english). One of the WFP's key initiatives related to Disaster Risk Reduction is the Vulnerability Analysis and Mapping (VAM) (http://vam.wfp.org/)

World Health Organization (WHO)
The World Health Organization is the United Nations specialized agency for health. WHO's objective is the attainment by all peoples of the highest possible level of health, which is defined as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. http://www.who.org

World Meteorological Organization (WMO)
The World Meteorological Organization is a Specialized Agency of the United Nations. It is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces, and the resulting distribution of water resources. http://www.wmo.ch

2. International institutions, networks and centres

Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Entebbe, Uganda
ASARECA is a non-political organization of the National Agricultural Research Institutes (NARIs) of ten countries: Burundi, D. R. Congo, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania and Uganda. It aims at increasing the efficiency of agricultural research in the region so as to facilitate economic growth, food security and export competitiveness through productive and sustainable agriculture. http://www.asareca.org

Center for Disaster Management (CENDIM), Istanbul, Turkey
CENDIM was established in January 2001 as an interdisciplinary research centre for disaster management. The centre is in strategic partnership with many national and international organizations to develop disaster, engineering, and risk management plans and to facilitate information sharing with governmental, non-governmental, and community based organizations. CENDIM also aims to deploy the synergy of multidisciplinary collaboration by national and international organizations. http://www.cendim.boun.edu.tr/index.html

Center for Research on the Epidemiology of Disasters (CRED), Brussels, Belgium
CRED promotes research, training, and information dissemination on disasters, with a special focus on public health, epidemiology, and structural and socio-economic aspects. It aims to enhance the effectiveness of developing countries' disaster management capabilities as

well as fostering policy-oriented research. http://www.cred.be

Consultative Group on International Agricultural Research (CGIAR)
The Consultative Group on International Agricultural Research (CGIAR) is a strategic alliance of countries, international and regional organizations, and private foundations supporting 15 international agricultural centres that work with national agricultural research systems and civil society organizations including the private sector. The alliance mobilizes agricultural science to reduce poverty, foster human well being, promote agricultural growth and protect the environment. The CGIAR generates global public goods that are available to all. http://www.cgiar.org (includes links to many partner and allied institutions)

Global Water News Watch
Global Water News Watch covers water news from 188 countries. The website is produced by Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA), a National Science Foundation Science and Technology Center at the University of Arizona. http://www.sahra.arizona.edu/newswatch

International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria
Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is one of the 15 Centers strategically located all over the world and supported by the Consultative Group on International Agricultural Research (CGIAR). With its main research station and offices based in Aleppo, ICARDA works through a network of partnerships with national, regional and international institutions, universities, non-governmental organizations and ministries in the developing world; and with advanced research institutes in industrialized countries. http://www.icarda.org

International Center for Tropical Agriculture (CIAT), Cali, Colombia
CIAT's mission is to reduce hunger and poverty in the tropics through collaborative research that improves agricultural productivity and natural resource management. CIAT's research on major agroecosystems has been focused mainly on tropical American hillsides, forest margins, and savannas. In addition, the Center is extending significant work on soils and production systems, agroenterprise development, and land use to mid-altitude areas of eastern Africa and upland environments of Southeast Asia including the work relevant to droughts. (www.ciat.cgiar.org/)

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru India
The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that undertakes innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR). http://www.icrisat.org

International Development Research Centre (IDRC), Ottawa, Canada
The International Development Research Centre (IDRC) is a public corporation created by the Parliament of Canada in 1970 to help developing countries use science and technology to find practical, long-term solutions to the social, economic, and environmental problems they face. Support is directed toward developing an indigenous research capacity to sustain policies and technologies that developing countries need to build healthier, more equitable, and more prosperous societies. http://www.idrc.ca

International Hydrological Programme (IHP)
IHP is UNESCO's international scientific cooperative programme in water research, water resources management, education and capacity-building, and the only broadly-based science programme of the UN system in this area. www.unesco.org/water/ihp/)

International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria
IIASA is a non-governmental research organization located in Austria. The institute conducts inter-

disciplinary scientific studies on environmental, economic, technological, and social issues in the context of human dimensions of global change. IIASA researchers study environmental, economic, technological, and social developments. In doing so, they generate methods and tools useful to both decision makers and the scientific community. The work is based on original state-of-the-art methodology and analytical approaches and links a variety of natural and social science disciplines. http://www.iiasa.ac.at

International Institute for Sustainable Development (IISD), Winnipeg, Canada
Its mission is to champion innovation, enabling societies to live in a sustainable way. It advances policy recommendations on international trade and investment, economic policy, climate change, measurement and indicators, and natural resource management to make development sustainable. By using the Internet it covers and reports on international negotiations and brokers' knowledge gained through collaborative projects with global partners, resulting in more rigorous research, capacity building in developing countries, and a better dialogue between North and South. IISDnet identifies issues, sets goals, and compiles information on sustainable growth. http://www.iisd.org

International Research Institute for Climate and Society (IRI), New York, U.S.A.
The mission of the IRI is to enhance society's capability to understand, anticipate, and manage the impacts of seasonal climate fluctuations, in order to improve human welfare and the environment, especially in developing countries. http://iri.columbia.edu

Natural Hazards Research and Applications Information Center, University of Colorado, Boulder, U.S.A.
The Center is a national and international clearinghouse that provides information on natural hazards and human adjustments to these risks. The Center's prime goal is to increase communication among hazard and disaster researchers and individuals, agencies, and organizations actively working to reduce disaster damage and suffering. The Natural Hazards Center carries out its mission in four principal areas: information dissemination, an annual workshop, research, and library services. http://www.colorado.edu/hazards

ProVention Consortium
The mission of the ProVention Consortium is "to help developing countries build sustainable and successful economies and to reduce the human suffering that too often results from natural and technological catastrophes". It is a global coalition of governments, international organizations, academic institutions, the private sector, and civil society organizations aimed at reducing disaster impacts in developing countries, and established by the World Bank in 2000. Since 2003, its secretariat has been hosted by the International Federation of Red Cross and Red Crescent Societies. http://www.proventionconsortium.org

World Agroforestry Centre (ICRAF), Nairobi, Kenya
The World Agroforestry Centre (ICRAF) founded in 1978, has promoted growing trees on farms, using innovative science for development to transform lives and landscapes. ICRAF's research focuses are on four global themes; land and people; environmental services; strengthening institutions; and trees and markets. The Centre has regional centres throughout the developing world in more than 20 countries across Africa, Asia and South America. http://www.worldagroforestry.org

3. Regional institutions, networks and organizations

African Centre of Meteorological Application for Development (ACMAD), Niamey, Niger
ACMAD is the Weather and Climate Centre with African continental competence. ACMAD has been operational in Niamey since 1992. ACMAD is composed of 53 Member States, the 53 countries of the "Africa" continent. http://www.acmad.ne

African Union (Organization of African Unity), Addis Ababa, Ethiopia
The AU, which has 53 member states, promotes accelerated socio-economic integration of the

continent, which will lead to greater unity and solidarity between African countries and peoples. The Strategic framework document of the New Partnership for Africa's Development (NEPAD) arises from a mandate given to the five initiating Heads of State (Algeria, Egypt, Nigeria, Senegal, South Africa) by the OAU to develop an integrated socio-economic development framework for Africa. http://www.africa-union.org, http://www.nepad.org

AGRHYMET Regional Centre (Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationne Institute), Niamey, Niger
Created in 1974, AGRHYMET is a specialized hydro-meteorological institute of the Permanent Interstate Committee for Drought Control in the Sahel (CILSS). http://www.agrhymet.ne

Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria
The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), established in 1968, is a specialized Arab organization working within the framework of the League of Arab States with the objective of unifying the Arab efforts which aim to develop the scientific agricultural research in the arid and semi-arid areas, help in the exchange of information and experiences and make use of the scientific progress and the modern agricultural techniques in order to increase the agricultural production. http://www.acsad.org/

Arab Maghreb Union (UMA), Rabat, Morocco
The Arab Maghreb Union (UMA), established in 1989, is a sub-regional intergovernmental organization which, among other activities, assists North African countries to implement activities regarding droughts and land degradation. The UMA's members include Algeria, Lybia, Mauritania, Morocco and Tunisia. UMA has been the leading institution for the formulation and implementation of the UNCCD's Sub-Regional Action Programme for the Maghreb Region. http://www.maghrebarabe.org/en/

Arab Organization for Agricultural Development (AOAD), Khartoum, Sudan
AOAD was established based on the approval of the League of Arab States in March 1970. The overall objective of the AOAD is to identify and develop linkages between Arab countries, and coordinate all agricultural and agriculture-related activities amongst them. http://www.aoad.org/about_en.htm

Asian Disaster Preparedness Center (ADPC), Bangkok, Thailand
ADPC is a regional resource Center established in 1986 dedicated to disaster reduction for safer communities and sustainable development in Asia and the Pacific. It is recognized as an important focal point for promoting disaster awareness and developing capabilities to foster institutionalized disaster management and mitigation policies. http://www.adpc.ait.ac.th

Association of Southeast Asian Nations (ASEAN) Experts Group on Disaster Management (AEGDM)
ASEAN cooperation on natural and man-made disasters is coordinated by AEGDM which was established in 1976 and meets regularly to discuss and share experiences of the region's disaster management and mitigation activities. http://www.adpc.ait.ac.th/pdr-sea/newsletter/issue3/pdr-update.html

Caribbean Community (CARICOM) Climate Change Centre, Belmopan, Belize
The mission of the Climate Change Centre is to support the people of the Caribbean as they address the impact of climate variability and change on all aspects of economic development through the provision of timely forecasts and analyses of potentially hazardous impacts of both natural and man-induced climatic changes on the environment, and the development of special programmes with create opportunities for sustainable development. http://caribbeanclimate.bz

Caribbean Environmental Health Institute (SEHI), Castries, Saint Lucia
CEHI has 16 Members States and has dedicated to finding cost effective solutions to environmental health problems in the Caribbean region. CEHI is currently involved in a number of projects which approach the issue of environmental management in the Caribbean as multi-faceted and multi-disciplinary. Some of these projects focus on

capacity building for sustainable land management within the framework of implementing the UNCCD. The Institute has also recognized the importance of developing partnerships in pursuing its goals. http://www.cehi.org.lc/

Central Africa Forests Commission (Commission des Forêts d'Afrique Centrale) (COMIFAC), Yaounde, Cameroon
COMIFAC is an authority of orientation, decision and coordination of the sub-regional actions and initiatives regarding conservation and sustainable management of the forest ecosystems for Central Africa. COMIFAC, in collaboration with the Communauté Economique des Etats de l'Afrique Centrale (CEEAC) has developed UNCCD's Sub-Regional Action Programme and Resouce Mobilisation Strategy for Central Africa in 2007. http://www.comifac.org/

Central European Disaster Prevention Forum (CEUDIP)
This Forum was established in 1999 by decision of the Central European Committees for the International Decade for Natural Disaster Reduction of the United Nations (IDNDR). This was done in order to continue the efforts initiated during the Decade by the countries of Central Europe (Czech Republic, Germany, Hungary, Poland and Slovakia) in activities requiring collaboration of neighbouring countries in all types of disasters, in particular in floods on rivers which are shared by these countries. The main focus was on early warning, but other important issues are being mutually considered, including the media's role, disaster prevention, and mitigation and legislation on states of emergency. http://www.unisdr.org/europe/eu-partners/partner-eu.html

Centre for Environment and Development for Arab Region and Europe (CEDARE), Cairo, Egypt
The CEDARE was established in 1992 as an international inter-governmental organization in response to the convention adopted by the Council of Arab Ministers Responsible For the Environment(CAMRE). Its priority areas include water resources management; land resources management; knowledge management; and trade, investment and the environment. http://www.cedare.int/

Common Market for Eastern and Southern Africa (COMESA), Lusaka, Zambia
COMESA is one of the main Regional Economic Communities in Africa. Its mission is to endeavor to achieve sustainable economic and social progress in all member states through increased cooperation and integration in all fields of development.
The attainment of full integration and the implementation of complete COMESA mandate under the COMESA Treaty is viewed as a long term objective. In the short to medium term, the emphasis in programme focus will be trade development and investment, specifically, the elimination of impediments to trade and investment. http://www.comesa.int/index_html/view

Community of Sahel-Saharan States (CEN-SAD), Tripoli, Libya
The CEN-SAD is a regional economic community which has an observer status in the United Nation. Its main objectives are: the establishment of an economic union; the removal of the restrictions hampering economic integration of the member states; the promotion of external trade through an investment policy in the member States; the increase of means of transport and communications and execution of common projects; the same right, advantages and obligations to the signatory countries; and the harmonization of educational, pedagogical, scientific and cultural systems of the various cycles of education. http://www.cen-sad.org/

Drought Management Center for South-Eastern Europe (DMCSEE), Ljubljana
Slovenia
The World Meteorological Organization, the Secretariat of the United Nations Convention to Combat Desertification (UNCCD), and eleven countries from south-eastern Europe have agreed to create this Center to be based in Slovenia. The DMCSEE is to serve as an operational centre for south-eastern Europe for drought preparedness, monitoring, and management.
http://www.dmcsee.org/

East African Community (EAC), Arusha, Tanzania.
The EAC is the regional intergovernmental organization of the Republics of Burundi, Kenya,

Rwanda, Uganda and the United Republic of Tanzania. The EAC aims at widening and deepening co-operation among the Partner States in, among others, political, economic and social fields for their mutual benefit. To this extent the EAC countries established a Customs Union in 2005 and are working towards the establishment of a Common Market by 2010, subsequently a Monetary Union by 2012 and ultimately a Political Federation of the East African States. http://www.eac.int

Economic Community of Central African States (ECCAS), Libreville, Gabon
ECCAS aims to achieve collective autonomy, raise the standard of living of its populations and maintain economic stability through harmonious cooperation. Its ultimate goal is to establish a Central African Common Market.
http://www.ceeac-eccas.org/

Economic Community of West African States (ECOWAS), Abuja, Nigeria
ECOWAS is a regional group of fifteen countries, founded in 1975. Its mission is to promote economic integration in all fields of economic activity, particularly industry, transport, telecommunications, energy, agriculture, natural resources, commerce, monetary and financial questions, social and cultural matters. http://www.ecowas.int/

European Drought Centre (EDC)
The European Drought Centre (EDC) is a virtual centre of European drought research and drought management organizations to promote collaboration and capacity building between scientists and the user community. The long term objective of the Center is to enhance European cooperation in order to mitigate the impacts of droughts on society, economy, and the environment. http://www.geo.uio.no/edc

European Space Agency (ESA), Paris, France
Following the contact with the UNCCD Annex IV countries at the COP6 of the UNCCD in Havana, Cuba in 2003, ESA has launched DesertWatch project which involves the development of a desertification monitoring system for the northern shores of the Mediterranean Sea in support of responsible regional and national authorities.
http://www.esa.int

Institut de l'Energie et de l'Environnement de la Francophonie (IEPF), Québec, Canada
IEPF is a subsidiary body of the Organization internationale de la Francophonie. IEPF's mission is to initiate and support capacity building initiatives at the national level and to promote partnerships in the fields of Energy and Environment. IEPF's four priority areas are; training for environment and energy professionals; specialized information and communication products; field pilot projects; and promoting partnerships. http://www.iepf.org/

Institute for Meteorological Training and Research / Regional Training Centre (IMTR/RTC), Nairobi, Kenya
Institute for Meteorological Training and Research (IMTR) is a branch of the Kenya Meteorological Department (KMD) under the Ministry of Transport charged with the responsibility of training personnel in meteorology, hydrology and related geo-sciences in the country and the Anglophone countries in Africa. Since 1965, it has functioned as Regional Meteorological Training Centre (RMTC) for the Anglophone Africa as designated by WMO.
http://www.meteo.go.ke/imtr/

Inter-American Water Resources Network (IWRN)
Recognizing the need to strengthen water resources management, the mission of the Inter-American Water Resources Network is to build and strengthen water resources partnerships between nations, organizations, and individuals that transcend disciplines, political boundaries, and language barriers; promote education and the open exchange of information and technical expertise; and enhance communication, cooperation, collaboration, and financial commitment to the implementation of integrated water and land resources management within the context of environmental and economic sustainability in the Americas. http://www.iwrn.net

Inter-American Water Resources Network – Brazil (Rede Interamericana de Recursos Hídricos-Brazil (RIRH)
RIRH is one of the IWRN regional nodes. It has headquarters in Brazil, and is responsible not only to gather the information about water resources in Brazil, but also for the translations into portuguese

about the main topics of other Nodes. This Node is the only Portuguese-based information system in the IWRN. http://brasil.rirh.net/noticia_vista.php?id=99

Intergovernmental Authority on Development (IGAD), Djibouti, Djibouti
IGAD in Eastern Africa was created in 1996 to supersede the Intergovernmental Authority on Drought and Development (IGADD) which was founded in 1986 for development and drought control in the region. IGAD has developed CCD's Sub-Regional Action Programme to enhance partnership for the IGAD member countries (Djibouti, Ethiopia, Eritrea, Kenya, Somalia, Sudan and Uganda). http://www.igad.org

Intergovernmental Authority on Development - Climate Prediction and Applications Centre (ICPAC) Nairobi, Kenya
The mission of the ICPAC, formerly Drought Monitoring Centre - Nairobi (DMCN), is to improve the technical capacity of producers and users of climatic information; develop an improved, proactive, timely, broad-based system of information and product dissemination and feedback; and expand the knowledge base within the sub-region in order to facilitate informed decision making. http://www.icpac.net

International Boundary and Water Commission
Established in 1889, the International Boundary and Water Commission (IBWC) has responsibility for applying the boundary and water treaties between the United States and Mexico and settling differences that may arise out of these treaties. The IBWC is an international body composed of the United States Section and the Mexican Section, each headed by an Engineer-Commissioner appointed by his/her respective president.
The United States Section of the International Boundary and Water Commission (USIBWC) is headquartered in El Paso, Texas. http://www.ibwc.state.gov

International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), Paris, France
CIHEAM's three main focus areas of work are to propagate a common scientific culture for the food and agriculture sector, to work in cooperative networks with national agricultural education and research institutions, and to provide a Mediterranean forum where governments can discuss prospects for food and agriculture. CIHEAM pursues its threefold mission of training, research and cooperation through four Mediterranean Agronomic Institutes (MAIs) of Bari, Chania, Montpellier and Zaragoza. Its General Secretariat is located in Paris, France. http://www.ciheam.org/uk/index.php

International Center for Drought Risk Reduction (ICDRR), Beijing, China
The Center was launched in April 2007 under the partnership between the Government of China and the UNISDR secretariat. The ICDRR aims to mitigate people's vulnerability to drought. The ICDRR will focus on international and inter-regional cooperation and collaboration in drought risk reduction, using space technology and other means to monitor and assess drought risks across Asia. The initiative will also concentrate on building databases and a knowledge pool, developing applied technology and enhancing capacity building and public awareness on drought risks and ways to reduce drought risks. ICDRR's website in both Chinese and English is currently under construction. http://www.unisdr.org/eng/public_aware/highlights/2007/ISDR-highlight-May%202007.pdf

International Water Management Institute (IWMI), Colombo, Sri Lanka
IWMI is a non-profit scientific organization funded by the Consultative Group on International Agricultural Research (CGIAR). IWMI's research agenda is organized around four priority themes covering key issues relating to land, water, livelihoods, health, and environment. The Institute concentrates on water and related land management challenges faced by poor rural communities. It also maintains the IWMI Drought Network and Information Center and the South Asia Drought Monitor (SADM). http://www.iwmi.cgiar.org
http://www.iwmi.cgiar.org/drw/info/default.asp?PG=HOME http://dms.iwmi.org/about_swa_dm.asp

North American Drought Monitor
The North America Drought Monitor (NA-DM) is a cooperative effort between drought experts in Canada, Mexico and the United States to monitor drought across the continent on an ongoing basis. Drought monitoring has become an integral part of drought planning, preparedness, and mitigation efforts at the national, regional, and local levels. http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/index.html

Pacific Islands Applied Geoscience Commission (SOPAC), Suva, Fiji
SOPAC is an inter-governmental, regional organization dedicated to providing services to promote sustainable development in the countries it serves. Its work focuses on providing assistance to its member countries in three key programme areas: Ocean and Islands Programme, Community Lifelines Programme and Community Risk Programme. http://www.sopac.org/tiki/tiki-index.php

Permanent Interstate Committee for Drought Control in the Sahel (Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel) (CILSS), Ouagadougou, Burkina Faso
Its mission is to be involved in the research of food security and to combat the effects of drought and desertification for better ecological stability. http://www.cilssnet.org

Regional Committee on Hydraulic Resources (Comité Regional de Recursos Hidráulicos) (CRRH), San José, Costa Rica
CRRH is a technical intergovernmental organization specialized in meteorology and hydrology n Central America region (Belize, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama). As a technical agency of SICA (Central America Integration System (SICA), CRRH specializes on climate and water, keeping track of demand and supply of water resources. http://www.aguayclima.com/clima/inicio.htm

Sahara and Sahel Observatory (Observatoire du Sahara et du Sahel) (OSS), Tunis, Tunisia
OSS, an independent international organization founded in 1992, aims at improving early warning and monitoring systems for agriculture, food security and drought in the Sahara and Sahel regions of North, West and East Africa. Its main objective is to give impetus to the combat against desertification and the mitigation of drought by providing countries and organizations with a forum to share experiences and harmonize the ways in which data is collected and processed to feed into decision-support tools. Today, OSS has 22 member countries, and also works in partnership with some countries in Europe and North America, regional and sub-regional organizations as well as the United Nations system and the Civil Society. http://www.oss-online.org/

Southern African Development Community (SADC), Gaborone, Botswana
SADC was established in 1992 by transforming former Southern African Development Coordination Conference (SADCC) to achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the people of Southern Africa and support the socially disadvantaged through regional integration. SADC's Environment and Land Management Sector (ELMS) Coordination Unit has been mandated to oversee the implementation of the UNCCD in the sub-region. SADC facilitated the formulation of CCD's Sub-Regional Action Programme for Southern Africa. http://www.sadc.int/

Southern African Development Community (SADC), Drought Monitoring Centre (DMC), Harare, Zimbabwe
The main objective of the SADC DMC is to carry out climate monitoring and prediction for early warning and mitigation of adverse impacts of extreme climatic events on agricultural production, food security, water resources, energy, and health among other socio-economic sectors. Since the centre's inception, it has played an important role in providing the sub-region with weather and climate advisories and more importantly, timely early warnings on droughts, floods and other extreme climate related events. http://www.dmc.co.zw

Water Center for Arid and Semi-Arid Zones in Latin America and The Caribbean (Centro de Aguas para las Zonas Aridas de America Latina) (CAZALA), La Serena, Chile
CAZALAC promotes training, education, scientific

research and technological initiatives in the arid and semi-arid zones in the Latin America and the Caribbean region to strengthen technical, social, and educational development of the region with respect to the use and improved management of water resources and to increase the role of communities in the development of a water culture. http://www.cazalac.org

West African Economic and Monetary Union (Union Economique et Monétaire Ouest Africaine) (UEMOA), Ouagadougou, Burkina Faso
UEMOA was created by Treaty in 1994 by seven West African countries namely Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal and Togo. In 1997, Guinea-Bissau became the eighth member. UEMOA has been involved in the formulation of UNCCD's Sub-Regional Action Programme for West Africa through its two affiliated institutions, Communauté Economique des Etats de l'Afrique de l'Ouest (CEDEAO) and Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS). http://www.uemoa.int/

4. Country-based organizations

All India Disaster Mitigation Institute, Ahmedabad, India
All India Disaster Mitigation Institute (AIDMI), India, is a community-based action research, action planning, and action advocacy nongovernmental organization. It promotes adoption and practice of disaster mitigation through: partnership with the poorest within disaster vulnerable communities; integrating water, food, habitat, and livelihood security; capacity building of multiple humanitarian stakeholders; synergy between traditional and modern risk reduction strategies; capturing and disseminating lessons and innovative ideas; promoting use of humanitarian standards in disaster response; and providing timely and targeted relief in a sustainable manner. http://www.southasiadisasters.net

Argentine Institute for Arid Zones Research (Instituto de Zonas Aridas) (IADIZA), Mendoza, Argentina
IADIZA, a research institute of the National University of Cuyo in Mendoza, aims to undertake thematic research in barren zones on conservation and use of natural resources oriented to the sustainable development. It also promotes raising social awareness on the use of natural resources, production systems improvement of the conditions of life by enhancing participation of the community in the management of renewable natural resources. http://www.cricyt.edu.ar/iadiza

Australian Bureau of Meteorology, Melbourne, Australia
The Australian Bureau of Meteorology is the National Meteorological Authority for Australia. The role of the Bureau is to observe and understand Australian weather and climate and provide meteorological, hydrological and oceanographic services in support of Australia's national needs and international obligations. The Bureau's product, SILO website offers data and information for drought monitoring for land and agriculture. http://www.bom.gov.au/silo/products/Drought.shtml

Australian Bureau of Rural Sciences, Canberra, Australia
Agriculture is one of the most technically and scientifically adventurous sectors in the economy. Science is a key contributor to the prosperity and sustainability of Australia's rural industries and communities. BRS provides the scientific advice that delivers better decisions by government and better outcomes for rural industries and communities. http://www.daffa.gov.au/brs

Beijing Climate Center of China Meteorological Administration (CMA), Beijing, China
Drought monitoring from China's capital city. BCC's goal is to propose climate research and development projects and coordinate with other Regional Climate Centers (RCCs); to formulate plans for studies of climate variability, predictability, and impact in the region; to develop consistent practices to handle conflicting information in the region; to develop validation procedures relating to seasonal-to-interannual forecasting products and enhance co-ordination with other RCCs; to develop regional models, methods of downscaling, and interpretation of global forecast products; to undertake

application research; to assist development and application of specific products for various users; and to study the economic value of climate information. http://bcc.cma.gov.cn/Website/index.php?ChannelID=3

Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária) (Embrapa), Brasilia, Brazil
The Brazilian Agricultural Research Corporation's mission is to provide feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer. Embrapa researches and spreads knowledge in remote sensing and digital cartography for agriculture and the environment in Brazil. http://www.embrapa.br/

Bureau de Recherches Géologiques et Minières (BRGM), Paris, France
Established in 1959, its activities on risks cover seismic risk, landslides, drought, volcanic risk, and pollution. http://www.brgm.fr

Canadian Climate Impacts and Adaptation Research Network, Canada
C-CIARN is a national network that facilitates the generation of new climate change knowledge by bringing researchers together with decision makers from industry, governments, and non-government organizations to address key issues. http://www.c-ciarn.ca/index_e.html

Ceara State Foundation for Meteorology and Hydrology (Fundação Cearense de Meteorologia e Recursos Hídricos) (FUNCEME), Ceara, Brazil
The mission of the FUNCEME is to conduct intensive and specialized studies on meteorology, water resources and environmental resources, to supply knowledge and information for the rational risk management of semi-arid areas, and to collaborate for the sustainable development of north-eastern Brazil. This site helps monitor climate and environment in northern Brazil. http://www.funceme.br

Colombian Hydrology, Meteorology and Environmental Studies Institute (Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia) (IDEAM), Bogotá, Colombia
IDEAM was established by the Colombian government to carry out technical and scientific activities to support the national environmental policy framework, or Environmental National System (Sina), which provides general directions and norms for activities, resources, programmes and institutions to integrate environmental principles. IDEAM provides data and environmental information and undertake research to support decision-making relevant to environmental policy. http://www.ideam.gov.co

Cuban Meteorology Institute (Instituto Meteorologia de Cuba), Havana, Cuba
In collaboration with the UNCCD secretariat and UNEP, the Instituto Meteorologia de Cuba hosts specific website to facilitate exchange and dissemination of the information on droughts, desertification and national action programmes for the implementation of the UNCCD in the Latin America and the Caribbean region. http://www.medioambiente.cu/deselac/

Drought Watch, Canada
This is a monitoring site by the Canadian agriculture department with the goal of providing timely information on the impacts of climatic variability on water supply and agriculture and promoting practices that reduce drought vulnerability and improve management during a drought. http://www.agr.gc.ca/pfra/drought/default.htm

India Council of Agricultural Research (ICAR), New Delhi, India
The Union Minister of Agriculture is the President of the ICAR. Its principal officer is the Director-General. He is also the Secretary to the Government of India in the Department of Agricultural Research and Education (DARE). The General Body, the supreme authority of the ICAR, is headed by the Minister of Agriculture, Government of India. Its members include the Minister of Agriculture, Animal Husbandry and Fisheries, and senior officers of the various state governments, representatives of the parliament, the agro-industries, scientific organizations, and farmers. http://www.icar.org.in/

Institute of Agronomy at Campinas (Instituto Agronômico de Campinas) (IAC), Campinas, Brazil
The Instituto Agronômico de Campinas (IAC) is a public research and development institution of the Agência Paulista de Tecnologia dos Agronegócios (São Paulo Agency of Agrobusiness Technology) under the Secretariat of Agriculture of the state of São Paulo. The IAC's mission is to generate and transfer science and technology for the agricultural business aiming at optimizing the systems of vegetal production, economic development and environmental quality.
http://www.iac.sp.gov.br/

International Center for Drought Risk Reduction (ICDRR), Beijing, China
The International Center for Drought Risk Reduction was established in Beijing on April 2007 under the auspices of the UNISDR. The main functions of the ICDRR are to monitor and assess drought risk across Asia, develop knowledge and capacities for drought mitigation, promote information sharing and public awareness to reduce drought impacts, and enhance cooperation between China and other Asian countries on drought relief.

Jamaica Office of Disaster Preparedness and Emergency Management (ODPEM), Kingston, Jamaica
ODPEM is committed to taking pro-active and timely measures to prevent or reduce the impact of hazards in Jamaica, its people, natural resources and economy through its trained and professional staff, the use of appropriate technology and collaborative efforts with national, regional and international agencies. http://www.odpem.org.jm

Land and Water Australia, Canberra, Australia
This organization of the Government of Australia is devoted to investing in and managing research and development to underpin sustainable resource use and management. Land and Water Australia aims to generate the uniquely Australian knowledge needed to improve Australian farming systems and consequent profitability, improve the way our natural resources are managed for sustainability, inform large public investments in natural capital, and help governments balance competing demands on natural resources and rural landscapes. http://www.lwa.gov.au

Long Paddock, Queensland, Australia
The Long Paddock website is provided by the Queensland Government. It supplies decision-support information services to help clients better manage climatic risks and opportunities, particularly those associated with the El Niño - Southern Oscillation (ENSO) phenomenon. http://www.longpaddock.qld.gov.au

Mexico National Drought Research Center (The Centro de Investigaciones Sobre la Sequia), Mexico
Mexico's Centro de Investigaciones Sobre la Sequía (National Drought Research Center) is housed at the institute of Ecology in Chihuahua, Mexico [in Spanish] http://www.sequia.edu.mx

Mexico National Water Commission (La Comisión Nacional del Agua) (CNA), Mexico
The CAN is a national water authority. Its mission is to administer and preserve national water with the participation of the society and to achieve sustainable use of the resource. http://www.cna.gob.mx/conagua/Default.aspx

Ministry of Agriculture (Ministerio de Agricultura) and National Forestry Corporation (CONAF), Santiago, Chile
The mission of the National Forest Corporation (CONAF) is to contribute to the development of the country through the conservation of the patrimony and the sustainable use of the forest ecosystems. CONAF has provided tentative secretariat for the development of UNCCD's Sub-regional Action Programme for American Puna region. http://www.minagri.gob.cl/noticias/detallenoticia.php?noticia=650 and www.conaf.cl

Ministry of Environment and Natural Resources (Ministerio del Ambiente y de los Recursos Naturale), Caracas, Venezuela
Ministry of Environment and Natural Resources of the Government of Venezuela, which oversees droughts and desertification related matters, works closely in partnership with the UNCCD secretariat and other Parties to the Convention. www.marn.gov.ve

National Disaster Reduction Center of China (NDRCC), Beijing, China
The NDRCC was re-organized in 2003 as the national integrated platform for disaster information sharing. Director-general, Department of Disaster and Social Relief of Ministry of Civil Affairs, works concurrently as the director of National Center. Most of the staffs at the NDRCC are the specialist in the scientific field. http://www.unisdr.org/wcdr/thematic-sessions/presentations/session3-6/ndrcc-mr-zhenyao.pdf

National Drought Mitigation Center (NDMC), University of Nebraska-Lincoln, United States
Based at the University of Nebraska-Lincoln in the United States, the NDMC works to reduce societal vulnerability to drought through better monitoring and preparedness. The NDMC has also previously been the home of the International Drought Information Center (IDIC). The NDMC produces the Drought Monitor (drought.unl.edu/dm) in cooperation with federal, state, and academic partners. http://drought.unl.edu/

National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais) (INPE), São José dos Campos, Brazil
INPE's mission is to promote and undertake studies, scientific researches, technological development and human resources capacitation, in the fields of space and atmosphere sciences, space applications, meteorology, and space engineering and technology, as well as in related domains, in accordance with the policies and guidelines set forth by the Science and Technology Ministry of the Government of Brazil. http://www.inpe.br

National Institute of Farming Technology of Argentina (Instituto Nacional de Tecnología Agropecuaria de Argentina) (INTA)
INTA is a public institution in Argentina. INTA's mission is to carry out and foster actions addressing the innovation of agricultural and livestock, agro-food and agro-industrial sectors to contribute to the competitiveness of agro-industrial chains, environmental health and sustainability of productive systems, social equity and territorial development, through research, technological development and extension. http://www.inta.gov.ar

Nicaraguan Institute for Territorial Studies (Instituto Nicaraguense de Estudios Territoriales) (INETER), Managua, Nicaragua
INETER is the technical and scientific body of the state. It provides its services to the entire population in such areas as basic information, projects and studies of the environment that contribute to socio-economic development and the lowering of vulnerability to natural disasters, and continuously tracking dangerous natural phenomena. http://www.ineter.gob.ni

SAHEL Institute (INSAH), Bamako, Mali
INSAH, a specialized institution of CILSS, provides food security in a balanced ecological environment; coordinates, harmonizes, and promotes scientific and technical research and training; and disseminates scientific and technical information on issues related to drought control, desertification management, and population. http://www.insah.org/index.html

South African Weather Service, Pretoria, South Africa
The vision of the South African Weather Service is to be a world-class meteorological organization that contributes to the sustainable development of South Africa and beyond. Their mission is to collect, process, and provide meteorological and climatological products and services for the public good and commercial use of all South Africans and beyond. http://www.weathersa.co.za

Southern Alliance for Indigenous Resources (SAFIRE), Zimbabwe
The Southern Alliance for Indigenous Resources (SAFIRE) is a Zimbabwean non-Governmental organization (NGO) which has been operational since 1994. It sponsors the Southern Africa Drought Technology Network (SADNET) between Zimbabwe, Zambia, Malawi, and Mozambique. http://www.safireweb.org

Turkana Drought Contingency Planning Unit (TDCPU), Turkana, Kenya
The Early Warning System of Turkana was set up in 1987. It operates at the sub-national level, for the district of Turkana in the northern part of Kenya. It is run by local government, by the TDCPU. It provides information on how early warning data

can be translated and communicated to decision makers.

United States Department of Agriculture (USDA), Washington, D.C., United States
The USDA provides weather and climate publications and supports programmes such as the Foreign Agricultural Service, World Agricultural Outlook Board, and the Joint Agricultural Weather Facility.
http://www.usda.gov/oce/weather/pubs/index.htm http://www.fas.usda.gov/ http://www.usda.gov.oce/commodity/index.htm
http://www.usda.gov/oce/weather/index.htm

United States Geological Survey (USGS) WaterWatch
The USGS is a scientific agency within the United States federal government. They play a crucial role in monitoring and evaluating the nation's surface and ground water resources. http://water.usgs.gov/waterwatch

United States National Climatic Data Center (NCDC)
The NCDC is the world's largest archive of weather data. They develop both national and global datasets that have been used by both government and the private sector to maximize the resources provided by our climate and minimize the risks of climate variability and weather extremes. http://www.ncdc.noaa.gov/oa/about/ncdcwelcome.html

United States National Oceanic and Atmospheric Administration - Cooperative Institute for Research in Environmental Sciences Climate Diagnostics Center (CDC)
CDC identifies the nature and causes of climate variations on time scales ranging from a month to centuries, thus enabling prediction of climate variations on these time scales. The CDC provides several resources. http://www.cdc.noaa.gov

United States National Oceanic and Atmospheric Administration's (NOAA) Drought Information Center
The Drought Information Center is a compilation of various NOAA websites and information on drought and climate conditions. It provides breaking news, including current drought assessments of various kinds, monthly roundups, and considerable background information; and links to websites with information about drought.
http://www.drought.noaa.gov

University of Oslo, Department of Geosciences, Oslo, Norway
The Department is the country's strongest educational and research environment in the geosciences. The researchers cover a large spectrum of topics within natural geography, geology, geophysics, hydrology, meteorology and oceanography. http://www.geo.uio.no/english/

University Wageningen, Wageningen, Netherlands
Wageningen University is the leading European university in the Life Sciences. Researchers and students focus on the fields of nutrition, health, nature and the living environment. The University's Centre for Water and Climate has been engaged in the activities related to drought risk reduction.
http://www.wageningenuniversiteit.nl

Vrije University, Center for International Cooperation, Amsterdam, Netherlands
CIS, among other thematic areas, supports projects and programmes on natural resource management with the focus on the role of farmer innovators in sustainable resource management and on linking these local innovators with extension workers and researchers.
http://www.cis.vu.nl/home/index.cfm

Zambia Department of Meteorology
The Zambia Department of Meteorology offers a series of weather forecasts and analyses from Zambia and farther afield, and relevant to Zambia or the region. http://www.zamnet.zm/siteindex/Links/weather.html

5. Development agencies and financing mechanisms

African Development Bank Group (AfDB)
The ADB is a multilateral development bank whose shareholders include 53 African countries (regional member countries—RMCs) and 24 non-African

countries from the Americas, Asia, and Europe (non-regional member countries—non-RMCs). It was established in 1964, with its headquarters in Abidjan, Côte d'Ivoire, and officially began operations in 1967. http://www.afdb.org

Asian Development Bank (ADB)
ADB's vision is a region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their citizens. ADB's main instruments for providing help to its developing member countries are: policy dialogue, loans, technical assistance, grants, guarantees, and equity investments. http://www.adb.org

Belgium/ Directorate-General for Development Cooperation
Africa in general and Central Africa in particular are a key priority for Belgian foreign policy. Belgium works to promote peace and stability, respect for democracy and human rights, development cooperation, including health, education and agriculture and food security, and economic reconstruction. Belgium encourages regional cooperation via the African Union and regional organizations, and supports the NEPAD objectives. It is involved in the Europe-Africa dialogue and promotes the interests of African countries within international bodies. Belgium focuses specifically on civil society in Africa and on NGOs, and provides them with considerable financial support.

Canadian International Development Agency (CIDA)
In its support to Africa, Canada aims to focus on five key areas of intervention that are highly relevant to the African environment and to reaching the Millennium Development Goals; namely governance; health (including HIV/AIDS prevention and control); basic education; private sector development; and environmental sustainability.

Central Emergency Response Fund (CERF)
The Central Emergency Response Fund (CERF) is a stand-by fund established by the United Nations to enable more timely and reliable humanitarian assistance to those affected by natural disasters and armed conflicts. It is a tool created by the United Nations to pre-position funding for humanitarian action. http://cerf.un.org

European Commission Humanitarian Office (ECHO)
The European Union's mandate to ECHO (Regulation (CE) n° 1257/96) is to provide emergency assistance and relief to the victims of natural disasters or armed conflict outside the European Union. The aid is intended to go directly to those in distress, irrespective of race, religion or political convictions. ECHO's task is to ensure goods and services get to crisis zones fast. Goods may include essential supplies, specific foodstuffs, medical equipment, medicines and fuel. Services may include medical teams, water purification teams and logistical support. Goods and services reach disaster areas via ECHO partners. http://ec.europa.eu/echo/index_en.htm

French Ministry of Foreign and European Affairs
The goals of French aid are to reduce poverty and social disparities. France has multi-year strategies in the seven priority sectors identified within the framework of the Millennium agreement: education, water and sanitation, health and the fight against AIDS, agriculture and food security, infrastructure development in sub-Saharan Africa, protection of the environment and biodiversity, and private sector development. Geographically, Africa constitutes the top priority for French cooperation, accounting for nearly 2/3 of its bilateral aid. http://www.diplomatie.gouv.fr/en/ministry_158/publications_2288/international-cooperation-and-development_2289/french-international-cooperation-2005_2651/strategy-for-action_3035.html

German Agency for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit) (GTZ)
GTZ is a federal enterprise of the Government of Germany for international cooperation and sustainable development with worldwide operations. Its programmes include; conservation and management of natural resources, including biodiversity and forest management; food security; improvement of water supply; agricultural development; and support for environment policy. GTZ provides support for the Conférence des

Ministères en charge des Forêts d'Afrique Centrale – Central Africa Forests Commission (COMIFAC) and to the Regional SADC Programme for Sustainable Forest Management. http://www.gtz.de

Global Environment Facility (GEF)
The GEF is a financial mechanism for implementing the international conventions on biodiversity, climate change, and persistent organic pollutants. The GEF is also a financial mechanism for the UN Convention to Combat Desertification. The GEF provides grants to developing countries and countries with economies in transition for projects related to the above-mentioned focal areas. The GEF projects can be implemented by ten agencies and financial institutions including UNDP, UNEP and the World Bank. http://www.gefweb.org/

Global Facility for Disaster Risk Reduction (GFDRR)
The GFDRR is an initiative to assist governments, especially in most vulnerable developing countries, to implement measures to reduce disaster risks and to integrate risk reduction strategies in development processes. The World Bank launched this new initiative in partnership with the UNISDR secretariat in 2006. Detailed information is available in Chapter V of this document. http://www.unisdr.org/eng/partner-netw/wb-isdr/wb-isdr.htm

Global Mechanism
See the section of the United Nations system in this Annex.

Inter-American Development Bank (IADB), Washington DC, United States of America
The IADB is the oldest and largest regional multilateral development institution. It was established in December 1959 to help accelerate economic and social development in Latin America and the Caribbean. http://www.iadb.org

International Fund for Agricultural Development (IFAD)
See the section of the United Nations system in this Annex.

Islamic Development Bank (IDB)
The Islamic Development Bank was established in 1973 to foster the economic development and social progress of member countries and Muslim communities individually as well as jointly in accordance with the principles of Shari'ah i.e., Islamic Law. The membership of the Bank consists of 56 countries as of May 2007. http://www.isdb.org/irj/portal/anonymous

Japan International Cooperation Agency (JICA)
Japan's development assistance supports, among others, formulation of agricultural policies, agricultural experiment and research, dissemination of agricultural techniques and training for agricultural promoters. Japan also supports strengthening linkage between rural areas and cities, through development of local and feeder roads, agricultural markets, and local industries by improving rural life and self-reliance based on the notion of human security. In October 2008, the new Japan International Cooperation Agency (JICA) will be inaugurated and will implement the three aid instruments – technical assistance, loan aid and grant aid – in an integrated manner. http://www.mofa.go.jp/policy/oda/index.html, http://www.jica.go.jp/english/

Ministry of Foreign Affairs, Italy
Italy's development assistance supports, among others, participation to combat famine in the world and nutritional assistance interventions for development through bilateral and multilateral initiatives. These contribution includes the Food Security Special Fund of FAO, emergency programmes with WFP and financial contribution to IFAD concerning the rural development. http://www.esteri.it/MAE/EN/Politica_Estera/Cooperaz_Sviluppo/

Ministry of Foreign Affairs of Denmark
The goal of Denmark's development assistance is to help the poor by providing critical investments in education and health, infrastructure plus support for the development of a private sector as an engine for growth. Special emphasis is put on the effort to promote the respect for human rights and poverty reduction for women and their participation in the development process. The Danish aid has focused on a selected number of developing countries (so-called programme countries) that work with efficient, long-term national strategies for poverty

reduction. http://www.um.dk/en/menu/DevelopmentPolicy/DanishDevelopmentPolicy/DanishDevelopmentPolicy

Netherlands Directorate-General of Development Cooperation (DGIS)
The development policy of the Netherlands promotes, among others, agriculture, trade and the environment. http://www.minbuza.nl/en/developmentcooperation

Norwegian Agency for Development Cooperation (NORAD)
The five main goals of Norwegian development cooperation are: to combat poverty and promote greater social and economic development; to contribute towards promoting peace, democracy and human rights; to promote responsible management and utilisation of the global environment and biological diversity; to contribute towards preventing hardship and alleviating distress arising from conflicts and natural disasters; and to contribute towards promoting equal rights and opportunities for women and men in all areas of society. http://www.norad.no/

Spanish Agency for International Cooperation (La Agencia Española de Cooperación Internacional) (AECI)
AECI's objectives are: to foment economic growth; to contribute to the social, cultural, institutional and political progress in developing countries, specifically those with historical or cultural ties to Spain; to assure the co-ordination of development policies with developed countries, especially within the area of the European Union; to encourage cultural and scientific cooperation with developing countries; and to promote and develop cultural and scientific relations with other countries concerning the Ministry of Foreign Affairs and Cooperation. http://www.aecid.es/

Swedish international development cooperation Agency (SIDA)
The eight main elements that characterize the goals and emphasis of Swedish development cooperation are: democracy and good governance; respect for human rights; gender equality; sustainable use of natural resources and environmental protection; economic growth; social development and security; conflict management and security; and common global resources. http://www.sida.se/sida/jsp/sida.jsp?d=121&language=en_US

TerrAfrica
TerrAfrica is a partnership that aims to address land degradation by scaling up harmonized support for effective and efficient country-driven Sustainable Land Management (SLM) practices in Sub-Saharan African countries. Currently, TerrAfrica partners include African governments, NEPAD, regional and sub-regional organizations, the UNCCD Secretariat, the UNCCD Global Mechanism (GM), the World Bank, GEF, IFAD, FAO, UNDP, UNEP, AfDB as well as multilateral organizations including the European Commission, bilateral donors, civil society and scientific organizations. TerrAfrica does not exist to fund SLM projects. Instead, by removing the bottlenecks which are currently preventing the scaling up and mainstreaming of nationally-driven SLM strategies, TerrAfrica aims to help mobilize existing resources to catalyze additional investment. http://www.terrafrica.org/

United Nations Development Programme (UNDP)
See the section of the United Nations system in this Annex.

United States Agency for International Development (USAID)
USAID supports long-term and equitable economic growth and advances U.S. foreign policy objectives by supporting economic growth, agriculture and trade; global health; and democracy, conflict prevention and humanitarian assistance. USAID provides assistance in five regions of the world, Sub-Saharan Africa, Asia, Latin America and the Caribbean, Europe and Eurasia, and the Middle East. http://www.usaid.gov/

World Bank Group
The World Bank is one of the world's largest sources of development assistance. The group consists of five closely associated institutions, owned by 185 member countries that carry ultimate decision-making power: the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA),

International Finance Corporation, Multilateral Investment Guarantee Agency and International Centre for Settlement of Investment Disputes. Each institution plays a distinct role towards the Bank's overarching vision of global poverty reduction and the improvement of living standards. The Bank has recently launched the Global Facility for Disaster Reduction and Recovery (GFDRR) with the UNISDR to support drought risk reduction globally. http://www.worldbank.org, http://www.unisdr.org/partner-wb-isdr

6. International Non-governmental Organizations (NGOs)

Action Against Hunger, U.S.A.
Action Against Hunger / Action Contre la Faim (ACF) is an international network committed to saving the lives of malnourished children and their families while ensuring access to safe water and sustainable solutions to hunger. Its areas of work include agriculture and food production, food security, nutrition, and disaster and emergency relief. http://www.actionagainsthunger.org/

ActionAid International, Johannesburg, South Africa
ActionAid is an international anti-poverty agency whose aim is to fight poverty worldwide. It is helping over 13 million of the world's poorest and most disadvantaged people in 42 countries in Africa, Americas, Asia and Europe. Its areas of work include agriculture, disaster and emergency relief. http://www.actionaid.org/

Africare, U.S.A.
Africare is a leading nonprofit organization, specializing in helping Africa by helping alleviate hunger, building water wells, treating childhood diseases, and supporting social empowerment.. http://www.africare.org/

CARE International
CARE is a leading humanitarian organization fighting global poverty. Non-political and non-sectarian, CARE operates in more than 65 countries in Africa, Asia, Latin America, the Middle East and Eastern Europe, reaching more than 50 million people in poor communities. Its areas of work include agriculture and food production, natural resources, nutrition, water and emergency relief. http://www.careinternational.org/

Catholic Relief Services, U.S. A.
The mission of the Catholic Relief Services is "to assist impoverished and disadvantaged people overseas, working in the spirit of Catholic Social Teaching to promote the sacredness of human life and the dignity of the human person". Its areas of work include agriculture, food production and food security. http://crs.org/

Christian Children's Fund
The Fund works in Asia, Africa, Latin America and Eastern Europe. Its areas of work include agriculture and food production, nutrition and emergency relief.
http://www.christianchildrensfund.org/

Concern Worldwide
Concern Worldwide is a non-governmental, international, humanitarian organization dedicated to the reduction of suffering and working towards the ultimate elimination of extreme poverty in the world's poorest countries. http://www.concern.net/

InterAction
InterAction is the largest coalition of U.S.-based international nongovernmental organizations (NGOs) focused on the world's poor and most vulnerable people. Collectively, InterAction's more than 165 members work in every developing country. Members meet people halfway in expanding opportunities and supporting gender equality in education, health care, agriculture, small business, and other areas. http://www.interaction.org/

International Council of Voluntary Agencies (ICVA)
ICVA is a global network of over 70 member agencies around the world that brings together humanitarian and human rights NGOs as an advocacy alliance for humanitarian action. Focusing on humanitarian and refugee policy issues, ICVA draws upon the work of its members at the field level and brings their experiences to international decision-making forums. ICVA provides a means for the collective body of its members to work

together to effect change, and also assists members to improve their own work through access to initiatives and tools that help to increase quality and accountability. http://www.icva.ch/

International Committee of the Red Cross (ICRC)
The International Committee of the Red Cross (ICRC) is an international humanitarian organization whose exclusively humanitarian mission is to protect the lives and dignity of victims of war and internal violence and to provide them with assistance. It directs and coordinates the international relief activities in situations of conflict, and endeavours to prevent suffering by promoting and strengthening humanitarian law and universal humanitarian principles. http://www.icrc.org/

International Federation of Red Cross and Red Crescent Societies (IFRC)
Readiness to reduce the impact of disasters is central to the work of the International Federation and its member Red Cross and Red Crescent Societies around the world. This is carried out alongside work to help National Societies respond to the consequences of disasters at local, national and international levels. http://www.ifrc.org

Islamic Relief, U.K.
Islamic Relief (IR) is a U.K.-based independent non-governmental organization and an international relief and development charity, which aims to alleviate the suffering of the world's poorest people. Its areas of work include livelihood support, disaster response and post-disaster recovery. http://www.islamic-relief.com/

Lutheran World Federation, Sweden
The Lutheran World Federation (LWF) is a global communion of Christian churches in the Lutheran tradition. Founded in 1947 in Lund, Sweden, the LWF now has 140 member churches in 78 countries all over the world, and provides humanitarian assistance for disaster response. http://www.lutheranworld.org/

Médecins sans Frontière (MSF), Geneva, Switzerland
MSF is an independent humanitarian medical aid agency. http://www.msf.org/

OIC International, U.S.A.
OIC International (OICI) is a non-profit organization headquartered in the United States. Its areas of work include agriculture and food Production, and livelihood support. OICI is currently engaged in 13 active projects throughout Africa. http://www.oicinternational.org/

OXFAM
Oxfam International is a confederation of 13 organizations working together with over 3,000 partners in more than 100 countries to find lasting solutions to poverty and injustice. Its areas of work include Agriculture and Food Production, livelihood support, water resources management, disaster response and post-disaster recovery. http://www.oxfam.org/en/

Save the Children, U.S.A.
Save the Children is the leading independent organization creating real and lasting change for children in need in the United States and around the world. It is a member of the International Save the Children Alliance, comprising 28 national Save the Children organizations working in more than 110 countries to ensure the well-being of children. Its areas of work include disaster response, post-disaster recovery and livelihood support. http://www.savethechildren.org/

Steering Committee for Humanitarian Response (SCHR)
SCHR, created in 1972, is an alliance for voluntary action of currently eight major international humanitarian organizations and networks including Care International, Caritas Internationalis, the International Committee of the Red Cross, the International Federation of Red Cross and Red Crescent Societies, International Save the Children Alliance, Lutheran World Federation, Oxfam, and World Council of Churches. http://www.humanitarianinfo.org/iasc/content/about/schr.asp

World Vision, U.S.A.
World Vision is a Christian relief and development organization dedicated to helping children and their communities worldwide reach their full potential by tackling the causes of poverty. Its areas of work include agriculture and food production. http://www.worldvision.org/

Annex 3 Examples of Drought Risk Reduction Good Practices

AUSTRALIA
Using information technology to assess and manage drought risk

The National Agricultural Monitoring System: A public Web Site for Drought Impact Assessments

Bureau of Rural Sciences
Department of Agriculture Fisheries & Forestry, Australia

Abstract

Parts of Australia have been in severe drought since 2002. As at April 2009, 44 per cent of agricultural land in Australia is drought declared. As a result, farm production has been reduced across most of southern Australia and farm incomes have fallen, placing many farming families under significant financial and emotional stress. The National Agricultural Monitoring System uses information technology to manage a variety of data needed by its many users to assess and respond to drought risk.

This web site hosts a wealth of datasets and analyses from a variety of sources on rainfall, temperature, water, vegetation growth, production, and economic performance of farm enterprises. NAMS streamlines the drought relief application and assessment process, and serves as a preparedness and risk management tool for Australian agricultural stakeholders. Today, farmers, governments, industry groups and scientists use NAMS to help manage short and long-term drought risks.

The Initiative

The National Agricultural Monitoring System (NAMS) is an initiative that grew out of Australia's National Drought Policy that was implemented in 1992. Agricultural ministers across Australia requested a tool to better identify communities affected by drought so that drought relief programs could be delivered more efficiently and fairly to farmers in need. The development of NAMS began in April 2005. The project had two key objectives:

1. improve the efficiency and transparency of the drought application and assessment process
2. provide better support for drought preparedness and risk management.

The development of NAMS involved extensive consultation and collaboration with major stakeholder groups, including representatives from the federal, state and territory governments, agricultural producers, industry groups and scientific research organizations. The development process was governed by a steering committee whose members were appointed by state and federal governments. Members of the steering committee included climate scientists and representatives from the Australian, state and territory departments of agriculture. This committee established two advisory groups; one responsible for the scientific content of the site and one responsible for linkages into agricultural industry bodies. The two committees recommended appropriate data and analyses for use in the system. These committees continue to oversee the quality, accuracy and presentation of the information today.

NAMS was developed as a public website containing information on climate, production and economic conditions to help manage drought risk. Australian industry bodies, producers, researchers, government institutions and the general public can query any of the available analyses for more than 600 regions within Australia. Analyses are available for a number of spatial divisions, including country, state, region and river basins. NAMS is jointly funded by Australian, state and territory agriculture and primary industry government departments. Over 30 organizations[1] provide climate and production data that is updated on a regular basis for agricultural regions within Australia.

Today, NAMS is accessed by a wide range of users, including producers, researchers and governments, to generate regional and national analyses and reports on production, climate, irrigation, water availability and economic productivity.

Impacts and Results

Currently all drought assistance applications in Australia are prepared using NAMS. It supports the assessment and delivery of government assistance measures to drought-affected farm families and small businesses in regions experiencing severe drought. Its uptake as a risk management tool is still expanding.

The implementation of NAMS as a tool to assist in streamlining the drought assistance process has resulted in many benefits for stakeholders across Australia.

1. NAMS has reduced the time and resources needed to compile information supporting drought assistance applications.
2. A standardised application template, developed after extensive consultation, is used by all applicants to provide consistent information, enabling an efficient and transparent assessment process.
3. NAMS has lead to a reduction of delays in the delivery of regional drought assistance.
4. Targeted support can be delivered to regions before the primary impact of a drought is experienced, reducing the environmental, social and economic impacts.
5. NAMS provides a scientifically sound, publicly available assessment framework for drought assistance applications.

NAMS has met its main objective of effectively streamlining the drought assessment and application process.

A Good Practice

NAMS serves as a good example of how Information Technology can be used by a variety of stakeholders to assess drought risk. Historically, managers of production systems have used agro-meteorological information to make farming systems more resilient to variable climates. However, this information is not typically available to decision makers in a user-friendly format. By harnessing the power of the Internet, NAMS enables the Australian government to make consistent and fair decisions about drought support. NAMS serves as a 'one-stop-shop' for Australian farmers seeking drought-related information to help them manage climate variability as a business risk.

NAMS also promotes self-reliance and encourages producers and other stakeholders to be proactive in drought risk management before the full impact of a major drought is experienced. This assistance can avert significant environmental damage by helping producers prepare for, and manage, the inevitable impact of drought.

Droughts are a recurring natural phenomenon in Australian agriculture. Better adaptive strategies improve the long-term sustainability of farming enterprises. NAMS can assist agricultural producers manage climate variability since it provides relevant and up-to-date information on historical, current and emerging climatic and agricultural conditions.

Collaboration and cooperation among the many stakeholders greatly contributed to the success of NAMS. The extensive consultation process during the development stage ensured that the tool had strong support from its key users, including the state and territory governments as well as industry and producers. This process also ensured that NAMS would be valuable and relevant across a wide range of agricultural industries in Australia. NAMS users have not identified any major failures since its release. A range of improvements based on user and industry feedback has been implemented to make the system more user-friendly.

The Challenges

The development and implementation of NAMS had many significant challenges. The two main challenges were:

1. Sourcing relevant data
   Baseline climatic data for Australia was readily available from the Australian Government Bureau of Meteorology but compiling many of the other data sets was very resource intensive. The criteria for inclusion of data sets in NAMS was stringent and included nation-wide coherent coverage, peer review of data and model outputs, ease of interpretation and real time updates. Data on water availability and

usage for irrigated agriculture as well as actual economic and production data were difficult to source under these criteria. It was important that the custodians of the included data sets were supportive of the intended use.

2. Technology development
   An off-the-shelf software solution that provided the required combination of database, analysis engine, mapping interface and automated report generation was not available. NAMS developers designed an innovative web interface that integrated spatial, temporal and point-based data at various scales using a range of commercial and open source software. While this process was resource intensive, it was completed within tight deadlines set by stakeholder expectations. User acceptance testing was undertaken and used to make modifications during the development stage.

Lessons Learned

The following are the key lessons learned from the initiative:

1. the development of NAMS shows that a reliable, integrated and publicly available information system can be developed to streamline the delivery of drought assistance programs and that such a system can gain the support of different levels of government and be used to implement drought policy outcomes
2. different stakeholders have different roles in assessing, managing and responding to drought risks and different needs when it comes to information. Engaging the key stakeholders and rationalising their conflicting needs was an important step in project development; gaining their support for NAMS was important for its success
3. the composition of the steering committee was critical. High level stakeholder representation on the NAMS Steering Committee gave the project legitimacy. The NAMS Steering Committee Chair provided sustained commitment from all stakeholder groups which helped to maintain the momentum of the project
4. advisory groups from science, industry and government were established to disseminate user-information on NAMS to the broad community. This provided support and user acceptance
5. over the last three years NAMS has been subject to three independent reviews assessing the governance structure, technical infrastructure and delivery against original objectives. All three reviews were positive of the achievements and helped to continually improve the system.

Potential for Replication

This initiative is replicable in parts of the world that has well developed telecommunications infrastructure and high levels of Internet access for potential users, and a range of established, relevant data sets.

Components of the NAMS tool have already been used in a variety of online projects providing essential data on natural resource management and social themes for Australia.

For more information, please contact: Bureau of Rural Sciences (info@brs.gov.au; nams@nams.gov.au), National Agricultural Monitoring System web site: www.nams.gov.au.

BOTSWANA
Monitoring drought risk to provide timely relief and save lives

The Botswana Drought Early Warning System

The Government of Botswana

Abstract

Botswana is a landlocked southern African state with common borders with Zimbabwe, South Africa, Namibia and Zambia. Being an arid and mainly desert country where rainfall is generally low and erratic, the country is consistently under threat of drought.

Realizing that drought is a recurrent phenomenon that requires planning ahead of its occurrence, the Botswana Government established institutions in relevant government ministries to deal with various aspects of drought management. And aware that a functioning early warning system is critical in disaster-prone countries, the Government

formally established a Drought Early Warning System (EWS) in 1984 to enhance drought preparedness, mitigation and response. The EWS relies on a variety of data and indicators related to human nutrition, agriculture, rainfall and climate to assess drought risk.

The resulting drought risk assessments are used to produce monthly and annual reports. The reports are then used by government decision makers to monitor the situation and, when appropriate, formally declare drought. Once drought is declared, food relief is delivered to affected communities within days - with all ministries and local authorities mobilized to assist.

In a nutshell, the Drought EWS enables the Government to act quickly to reduce the impact of drought. Since the implementation of the EWS, Botswana has suffered no human loss due to drought. The EWS is also credited with saving the Government and individual households money by minimizing economic losses.

The Initiative

The Republic of Botswana is a landlocked southern African state with common borders with South Africa, Zimbabwe, Zambia and Namibia. It is an arid, mainly desert and drought-prone country receiving an average of only 500 mm rainfall per annum. As the Botswana government realized that drought was a recurrent phenomenon and that responding to it had to be planned far ahead of its occurrence, institutions were set up in relevant ministries to deal with various aspects of drought management. During drought periods, all ministries and local authorities are mobilized to assist in relief programmes.

Foreign assistance was secured in the past for drought relief, but increasingly the needs are met by mobilizing domestic funds. A number of organizations, including UN agencies, provide funds to assist the Government where relevant projects are not adequately provided for in the National Development Plan.

Aware that a functioning early warning system is critical in disaster-prone countries, the Government formally established a Drought Early Warning System (EWS) in 1984 - after a series of droughts - to enhance drought preparedness, mitigation and response. The EWS relies on a variety of data and indicators related to human nutrition, agriculture, rainfall and climate to assess drought risk. The resulting drought risk assessments are used to produce monthly and annual reports. These reports are then used by government decision makers to monitor the situation and, when appropriate, make the decision to formally declare drought. Once drought is declared by the President of the Republic, food relief is delivered to affected communities within days.

The development of Botswana's Early Warning System began in the 1970s. At that time, the Government hired consultants to evaluate the country's drought situation and develop methodologies to assess drought risk. Today, the EWS is entirely managed and funded by the Government of Botswana. It involves a number of government ministries, including the Department of Meteorological Services, the Department of Wildlife and National Parks, the Department of Forestry and Range Resources, the Department of Crop Production, and the Department of Local Government (Development Planning).

The main aim of the EWS is to provide a timely situational analysis on the country's vulnerability to drought, which informs government decisions regarding food security and the formal declaration of drought.

The specific objectives of the Botswana EWS include:

- Providing monthly rangeland conditions and the associated conditions of wildlife and livestock.
- Estimating the level of malnutrition for children under the age of five and school-going children categorized into total, moderate and severe malnutrition.
- Gathering information on school attendance rates, children's body growth failure and food ration coverage (of school feeding programmes) for school-going children.
- Providing monthly meteorological data/ weather conditions (especially temporal and spatial rainfall patterns).

- Providing the monthly status of the human water supply in urban areas, rural villages and settlements.

As part of the EWS process, drought assessments collecting agro-meteorological data are conducted across the country every month by local authorities from relevant government departments. These assessments are submitted to the National Early Warning Technical Committee, the National Disaster Management Committee and the Rural Development Council.

Once a year towards the end of each growing season, all the monthly assessments are analyzed by the National Early Warning Technical Committee to assess drought risk for the country as a whole. Findings are submitted to the Cabinet usually some time in March. The Cabinet then drafts recommendations to the President on whether a drought should be declared or not.

The methodologies rely primarily on data gathered through remote sensing systems of the Southern African Development Community (SADC), an inter-governmental body established to further cooperation and integration among 15 southern African states. The remote sensing systems are located in Drought Monitoring Centres (DMCs) in Nairobi (Kenya) and Harare (Zimbabwe). They provide SPOT Satellite vegetation data which is converted to Normalized Difference Vegetation Index (NDVI) for every decade of the month. The resulting thematic maps indicate vegetation greenness after every 10 day period and these are easily accessible to member countries who can then correlate the images with field grazing condition data in order to validate the observed changes in the satellite images. Grazing condition is collected by the different District offices in the form of biomass per hectare (kg/ha). This includes noting vegetation type at each sampling point and collection of herbaceous samples to determine their green and dry weights. A record is also made of the livestock forage value of the herbaceous layer found at each sample point. The results from the sample point can then be extrapolated to the entire assessment area. This collected data is then validated with field data by local authorities.
The Botswana EWS also uses other relevant methodologies that have been developed by various international organizations. The UN Food and Agricultural Organization (FAO) methodologies are used to estimate crop yields. UNICEF and the World Health Organization (WHO) methodologies are used to assess the population's nutritional status. Range condition assessments are done using country field assessment methodologies. Range condition refers to a measure of the existing productivity of forage of rangeland (land on which native vegetation is predominantly composed of grasses, forbs, or shrubs suitable for grazing or browsing by livestock and wildlife) relative to what that rangeland is naturally capable of producing. Field assessment techniques were developed by the Land Utilization Division in the Ministry of Agriculture and are documented in the Range Management Handbook for Botswana (Hendzel L., 1981). Field assessment prescribed include methodologies on how to gather grazing condition field data (methods for laying out transects, collection of grass samples in order to determine green and dry weight of herbaceous layers) and how to calculate grazing capacity of a given locality.

Impacts and Results

The Botswana ESW has greatly reduced the impacts of drought by incorporating real-time information into the drought management and mitigation processes. The EWS has helped the Governmen t implement effective drought response programmes to communities at risk. These programmes include the provision of subsidies such as free seeds, two meals a day for school-going children, livestock subsidies through a reduction in feed prices and food rations for destitute persons. There is also a programme to monitor borehole and dam water levels and quality. These mitigation measures are only offered during drought years except for mitigation measures targeting school children and destitute persons which are continuous irrespective of whether it is a drought year or not.

When the Government declares drought, food baskets are provided to affected communities. As a result, communities across Botswana are cushioned against the impacts of drought and food security improves at household level.

A Good Practice

A drought EWS is always considered a good practice because it allows for a shift from reactive to proactive hazard management and response. A EWS represents a change in focus from disaster recovery to disaster reduction.

The Botswana EWS has managed to save lives by providing timely technical information needed to assess the country's drought risk and mobilize drought response efforts. The Government can use the information gathered to distribute appropriate resources, both financial and human, to affected areas. If necessary, the Government can also ask the international community for assistance.

The EWS has improved the speed and efficiency of the Government's response to drought situations. The EWS minimizes human and economic losses and ensures that relief efforts are targeted specifically to those in need.

The Challenges

Drought mitigation initiatives are expensive to develop and manage. Currently, there is a shortage of expertise in the implementation of drought mitigation measures in Botswana. This is particularly true for identification of drought mitigation projects which requires through identification of vulnerable groups, project formulation in terms of type of projects to undertake, accurate estimation costs for such project and expertise in project management. Currently, drought coordinators at district level are in charge of several projects taking place in several settlements and villages simultaneously. Project monitoring is often a challenge due to shortage of transport, difficult terrains (in some instances) and so on which often results in poor project supervision.

Adequate funding for drought relief projects is always a challenge as there are often many projects submitted for funding whereas national budget allocation might not be enough to cater for all of them. This often results in project prioritization which often reduces overall beneficiaries of the program – especially for Labour-based public works program where people are engaged for a wage. Due to capacity constraints described in the paragraph above, there is often late completion of projects which leads to cost overruns when costs for project materials rises due to other factors such as inflation, global economic crisis.

Lessons Learned

The main key lessens learned are:

1. Regularly gathered data and information related to drought risk is extremely useful for decision making processes. Vulnerable groups of people should be categorized in advance so that assistance is provided to those who are most in need.
2. Exchange of information between drought-prone countries is helpful. Collaboration on capacity building among countries and regional and international organizations, such as the UNDP Drylands Development Centre (DDC) and the International Centre for Drought Risk Reduction (ICDRR), should be improved. This can include continuous sharing of data amongst countries in order to identify best practices and promising innovations as well as lessons learned in drought mitigation measures by participating countries that can be adopted by others. This will be important in spreading knowledge faster so that finite resources will have maximum impact. Collaboration can be important in strategic networking for information sharing (i.e. helping others to solve problems, produce knowledge collaboratively, drawing external sources of knowledge etc).
3. Mitigation measures should be prioritized to ensure that the most effective initiatives are selected. The project implementation process needs to be improved to manage resources more efficiently. There should also be provision of human resources and time with an adequate provision of financial resources. It was indicated that there is a need for national sustainable development frameworks for understanding linkages between drylands and socio-economic development. There is a need to develop communication strategy for all the important stakeholders in drought risk management, plan their participation in risk management, ensure availability of finance to implement all the risk management strategies/plans, monitor and evaluate effectiveness of the process as well as revision and adjustment of all plans and these should then be integrated into the institutional culture.

Potential for Replication

The Botswana EWS is easy to replicate because most of the drought risk reduction methods used have been well documented (e.g. methods to determine food basket requirements, conduct range assessment, assess nutritional status and status of water supply).

Countries wanting to develop their own EWS should reach out to countries like Botswana that have established a EWS and can share relevant experiences and documentation. More experienced countries can also offer advice on how developed methodologies can be adapted to suit another country's needs.

Economically, however, there might be restrictions in terms of funds available to implement a drought EWS. It is also important to have a stable political system so that all the intended recipients can benefit from the initiatives. This is because in most politically unstable countries, access to Government programs is often used a tool to punish dissidents to the Government of the day especially the Opposition. Only those individuals or communities who are pro-Government are most likely to benefit more from any risk management projects proposed by the government of the day. Project funding and implementation can also be a challenge as there will a high possibility of project disruption due to wars, limited funding and movement of people.

For more information, please contact:
Kealeboga S. Kemoreile (kskemoreile@gov.bw)

ETHIOPIA
Accelerated livestock marketing to boost household income of pastoralists during drought

Commercial Livestock Destocking as a Drought Response

Save the Children/US

Abstract

Recurrent drought has a major impact on the vulnerability of Ethiopian pastoralists. It typically results in large livestock losses, reduced market prices and decreased household food security. A severe drought hit Ethiopia in 2006, during the first six months of which cattle prices decreased from 138 to 50 US dollars per head. The cattle prices were expected to continue falling as their conditions worsened. Many cattle were also likely to eventually die from lack of pasture and water. Save the Children/US, an international NGO, rapidly launched an accelerated livestock marketing initiative in the southern district of Moyale, near the Ethiopia-Kenya border.

The initiative also known as commercial destocking, enabled pastoralists to receive cash in exchange for some of their animals, many of which were likely to die as drought conditions worsened. The pastoralists then used this money to purchase food for their families and hay and feed for their remaining livestock. An estimated 20,000 cattle valued at 1.01 million US dollars were sold. Some 5,400 households – about 30,000 people - participated in the initiative. Each household received, on average, 184 US dollars from the sale of cattle.

The pastoralists saw clear advantages of destocking over food aid and traditional relief efforts. Still better, the households involved became more resilient to drought.

The Initiative

A severe drought affected Ethiopia in 2006. During the drought, Save the Children/US, an international NGO, implemented a commercial destocking initiative in the southern district of Moyale, near the Ethiopia-Kenya border. The initiative, which aimed to lessen the impact of drought, was supported by a two-year programme known as the Pastoralist Livelihoods Initiative (PLI). Funded by USAID the PLI, which was already under way at the time, was implemented by a consortium of NGOs with the goal of "mitigating the impact of drought and other shocks for pastoralists in Ethiopia through improved livestock-based relief and development". Alongside the destocking initiative, Save the Children/US has also piloted a number of livestock-based drought responses through the PLI including emergency animal health, supplementary feeding and redistribution of livestock among pastoral families after the onset of rains.

Save the Children/US worked alongside the Ethiopian Ministry of Agriculture and Rural Development and livestock traders to develop and implement the destocking initiative. To raise awareness about the initiative among livestock traders, the Ministry's Marketing Department held a meeting for traders involved in supplying livestock to local and export markets. The meeting was held in the capital, Addis Ababa, and attended by over 40 traders. The Marketing Department and Save the Children/US also organized a familiarization trip so the traders could visit drought-affected areas. In the end, only two traders decided to purchase the cattle. After purchasing over 6,000 cattle, each trader became eligible for an interest-free loan of 25,000 US dollars to help bridge a short-term gap in capital flow during the drought.

Between 5 and 25 February, the traders purchased 6,292 male cattle. Many of the purchased cattle were highly emaciated. The two traders also influenced other commercial livestock traders to buy animals from the area. An additional 3,778 cattle were sold as a result, bringing total cattle purchases in February and March 2006 to 10,915. In total, some 20,000 livestock were removed from Moyale District during the 2006 drought. The onset of rains led to the recovery of livestock prices and the end of the emergency intervention in April 2006.

Impacts and Results

Despite the rapid design and implementation of the destocking initiative, and the involvement of only two traders, results were impressive. Some 5,400 households, or an estimated 30,000 people, benefited from the destocking initiative. Those households that were involved in the initiative received cash payments at an important time when they needed to be able to buy food and other household requirements and therefore became more resilient to the impact of drought.
Months after the initiative ended, an impact assessment developed by Tufts University (USA) was conducted in 114 households that participated in the destocking initiative. The purpose was to assess the initiative's impact. It emerged that:

1. Destocking provided more than 50 per cent of household income during the drought. This income was used in very rational ways, mainly to meet immediate household needs and to protect assets. Up to 79 per cent of the money procured through destocking was used to buy local goods or services. This highlights the resulting support given to local markets, which is required for post-drought recovery.
2. Destocking was considered to be the most useful intervention by participants.
3. A benefit-cost estimation comparing the cash benefits to pastoral households to the costs incurred by the implementing agency showed a benefit-cost ratio of 41:1.
4. All of the people who participated in the destocking initiative were able to buy their own food with the money obtained from destocking. They no longer had to wait for food aid, as they did during previous droughts.
5. Participants saw clear advantages of destocking over food aid. They explained that money from destocking could be used to buy other things besides food, such as medicines and clothes. Food aid was perceived as the second most important intervention to help people cope with the effects of drought.

A Good Practice

The development of the commercial destocking intervention started shortly after the PLI programme commenced in late 2005. At that time, it was evident that a major drought was evolving in parts of southern Ethiopia. Cattle prices had fallen significantly and the condition of cattle herds was worsening. Save the Children/US proposed that a commercial destocking intervention, based on linking private livestock traders and drought-affected pastoral communities, be implemented. Commercial destocking as a drought response involves the exchange of drought-affected livestock for cash. Pastoralists must have access to a market where they can sell their livestock. With the money they receive for their animals, pastoralists can buy food for their families, invest the money in maintaining the core herd or pay for other household expenses.

Commercial destocking is a good practice because it provides pastoralists with cash from animals that are likely to die if left in the herd. Pastoralists typically use the cash they receive for their animals

wisely. Most often they buy food and invest in their remaining livestock.

The Ethiopia destocking initiative maximized the value of the drought-affected cattle. As part of the destocking process, animals were taken out of the pastoralist system, moved to feedlots and eventually exported, thus securing valuable foreign exchange.

During the drought, 54 per cent of household income was derived from the sale of animals. This amount was significantly higher than any other source of income. This amounted to approximately 184 US dollars per household, and therefore represented a substantial injection of cash. Overall, the initiative provided a strong return on investment.

The Challenges

Save the Children/US initially sought to cover five districts but traders opted to focus only on Moyale District. Their main reason for this reduced coverage was the appalling conditions of the roads in the other districts. To reduce transaction costs, it was decided to limit activities to the vicinity of the main asphalt road. This shows how poor infrastructure in pastoralist areas hinders market-led development. This also makes destocking initiatives feasible for only relatively accessible communities.

Initially, pastoralists did not believe that the traders would buy thin cattle for higher-than-current market prices. After some initial purchases were made, this scepticism disappeared and the pastoralists began taking their animals to the traders to sell.

Frequent customs and taxation points exist along the roads between drought-affected areas and holding areas for the animals. These fees added extra costs to the initiative. It is recommended that these payments should be temporarily suspended during drought periods.

Finally, the limited number of holding grounds proved to be a constraint. In some cases, livestock in Moyale District become too thin and unfit for transport. Under these circumstances, it would have been helpful if traders had a small number of holding facilities in pastoralist areas where livestock could be fed until they recover sufficiently to be transported. Also, when large numbers of animals need to be destocked, traders require additional feedlot capacity. The regional government need to allocate additional holding grounds and feedlots at the onset of drought to facilitate the purchase and feeding of large numbers of livestock.

Lessons Learned

1. Destocking can usefully supplement and in some cases replace traditional relief efforts. Livelihood-based approaches to relief programming in pastoral areas, such as destocking, can usefully supplement typical emergency relief responses and can be implemented more quickly. However, it is important to note that livelihood-based programmes require the pre-existence of livestock services and markets.
2. Pastoralists are very willing to sell during drought. Based on the case study, policymakers need to question the myth that pastoralists refuse to sell their animals during drought. Not only do pastoralists sell their livestock, but they also use the income in entirely logical ways to satisfy their immediate food needs and to protect their remaining livestock assets.
3. Consider destocking in early phases of drought. Destocking should be considered at the earliest possible time, even before the official declaration of a drought. The 2006 destocking intervention was designed in a short amount of time and with limited prior experience or expertise. Although assessments of the results show the benefits of the initiative, destocking was implemented rather late in the drought. Drought was declared in November 2005, whereas destocking took place in March 2006. As previously noted, the price of cattle dropped substantially from October 2005 to March 2006. If destocking had taken place in January 2006, it is likely that pastoralists would have received twice the amount for their cattle. This indicates that better contingency planning and preparation of traders are needed for future droughts.

Potential for Replication

Commercial destocking can be practiced in a range of different contexts such as the Horn of Africa region, which experiences drought, and the mountain pastures of central Asia, which experience heavy snowfall that renders fodder unavailable. The viability of the initiative will largely depend on the state of the region's livestock market - the stronger the livestock marketing system, the easier it will absorb the sudden increase in livestock numbers.

Destocking is already practiced in northern Kenya (both commercial and slaughter destocking) and it is clearly practiced in other pastoral areas in times of drought with and without the support of humanitarian aid agencies. In theory, it can serve as a useful intervention in any pastoral area, but carrying out destocking in very remote regions with poor infrastructure may prove to be difficult. With rising fuel prices, the expenses associated with destocking will inevitably increase, thereby negatively impacting the financial benefits of the practice.

It is important to give full consideration to market opportunities before commencing a commercial destocking programme. If export markets are closed, for example, as a result of Rift Valley fever or foot-and-mouth disease, the domestic market must be strong enough to absorb the additional livestock. If export markets are closed and domestic markets are weak, consideration should be given to the more expensive option of slaughter destocking. In the future, Save the Children/US plans to link commercial destocking to a second drought intervention – the provision of supplementary feed. It is anticipated that supplementary feeding interventions will be more financially sustainable than destocking alone.

For more information, please contact:
drian Cullis (Acullis@savechildren.org.et)

INDIA
Combating water shortage, soil erosion through community action

Using Rainwater Cisterns to Collect Drinking Water, and Rainwater Bunds to Prevent Soil Erosion

Tearfund (in partnership with Discipleship Centre)

Abstract

Drought-related risk is greater than other hazards in the State of Rajasthan, northwestern India. In the southwestern part of Jodhpur, the second largest city, local communities generally have few water reserves, small land plots and farming practices relying on expensive fertilizers and irrigation. Yet, water shortage has increased. Also, much like the rest of Rajasthan, the area has isolated communities with degraded lands and few job opportunities, which prompt many to migrate to other towns and states.

In September 2005, Indian NGO "Discipleship Centre", a local partner of international NGO Tearfund, initiated a drought risk reduction project involving actions such as capacity building and the construction of rainwater cisterns and bunds. To ensure that risk resilience is owned and implemented directly where the impact is greatest - among grassroots communities, participatory assessments of disaster risk (PADRs) were carried out with many vulnerable communities.

The project sought to demonstrate the key role played by local NGOs not only in drought risk reduction awareness and social mobilization, but also as vehicles of communication and information. In addition, the focus was not on the drought resilience practices – which are not new – but on the risk assessment process which ensures that the right measures are chosen, owned and implemented by the community and for the community.

The project helped the targeted communities develop their own local plans to reduce the impact of recurring drought. The plans include building rainwater cisterns and raised bunds to increase yields and prevent soil erosion. As a result, migration was reduced, a basic diet provided, and livestock fed and watered.

The wider impact has been to develop the confidence and self-assurance of the communities. They negotiated their own government entitlements and raised awareness on the issues they were facing. They also convinced government officials to replicate some of their initiatives. Last but not least, the project had a positive impact beyond drought resilience. The trust and knowledge developed helped to start challenging some social norms and structures that perpetuated vulnerability, especially for low-caste communities and women: men and women from different castes had the opportunity to meet and work together, enjoying equal treatment and collective decision making.

The Initiative

The project, launched in September 2005, is part of a global project being implemented in Malawi, Afghanistan, Bangladesh and India with funding from DFID (Department for International Development, UK).

The global project seeks to identify and develop good practices in disaster resilience at community level. This is achieved mainly through developing the capacity of national and local NGOs which, in turn, work with local communities in developing their awareness and skills. Central to the global project is the role of advocacy at community, regional and national levels to ensure that disaster resilience concepts are understood, supported and systematically sustained in policy development and in conjunction with institutional awareness and implementation.

The site of the Indian project is the southwestern part Jodhpur, the second largest city in the State of Rajasthan (northwestern India) where drought-related risk is greater than other hazards. Local communities in Rajasthan generally have few water reserves, small plots of land, and their farming practices depend on expensive fertilizers and irrigation. Much like the rest of Rajasthan, the project area has isolated communities with degraded lands and few job opportunities. Water shortage became more common and migration to other towns and states increased.

International NGO Tearfund partnered with Indian NGO Discipleship Centre (DC) which has extensive experience in both community-based development and disaster response in India, along with a good rapport and reputation with both communities and local government authorities in Rajasthan. DC identified 10 isolated and vulnerable villages with approximately 200-500 people per community to get capacity building support. The support included a Participatory Assessment of Disaster Risk (PADR): Tearfund's own vulnerability and capacity assessment for grassroots risk analysis. While there was a special emphasis on identifying the most vulnerable within the communities (such as single-parent households and those with disabilities), disaster management plans were made for a community as a whole.

Central to the Indian part of the project was the objective of generating community-based ownership to manage the impact of potential hazards, in this instance drought. With this came a special emphasis on participatory methodology to identity risks and solutions from the communities' perspective – so that marginalized people living below the poverty line could become resilient to drought. A parallel objective was to utilise government entitlements to help the communities attain and maintain resilience, as well as influencing the development of local policy through community rights and decentralized mechanisms, such as the right to meet with local government decision makers to present their issues and debate funding solutions.

Project activities were organized around three areas of work: community advocacy work, rainwater cisterns, and bunds.

1. Advocacy work. The goal of the community advocacy work was to help local communities to assess the risks of future droughts and consider how they could develop their response capacity. This involved DC staff conducting a series of participatory assessments of disaster risk (PADRs) with community members using basic participatory risk assessment (PRA) tools. The main mechanism for developing, implementing and reviewing the community plans for drought risk reduction activities was the Village Development Committee (VDC). Thiscommittee

provides the first opportunity for men and women of different castes to meet together to make decisions. If no formal village structure existed prior to the PADR, then the PADR process itself would generate this structure through community voting or appointing village members to serve on the committee.

2. Building rainwater cisterns. Shortage of drinking water was one of the major concerns raised during the assessment process. There has been increasing erratic rainfall in Rajasthan over the past 5-10 years. This means the communities expectations of where and when they have rainfall have not been met, and thus managing their water supplies have become more difficult. As ground water levels had fallen considerably, the Indian government opposed building more tube wells. Therefore, some of the VDCs made the decision to build rainwater cisterns. These are concrete structures about 3-4 meters wide and 4 meters deep. They are located in places where good run off is known to occur at the bottom of a shallow concave pit with run off channels flowing into them. During the rainy season, channels that run into the cistern collect rainwater. Each cistern can store up to 40,000 litres and is shared by up to three families. When full, the cistern can supply drinking water to the three families all year round. It can also be used to store water brought in by tankers in times of drought.
3. Building bunds. Another idea that DC staff discussed with VDC members was to restore traditional practices that had been abandoned or forgotten. One of these was to conserve water by making bunds. A bund is an earth wall, one to two metres high, that is built around a field following the local contour lines. A large ditch is then dug out in front of the bund to help capture runoff and maintain moisture within the field. The bund not only helps prevent soil erosion caused by wind and rain, it also holds water in the soil by preventing rainwater from flowing away.

Impacts and Results

The targeted communities developed their own local plans to reduce the impact of recurring drought. These plans included building rainwater cisterns and raised bunds on surrounding farmland to increase yields. This in turn reduced migration, provided a basic diet, and ensured that livestock was fed and watered.

The wider impact has been to develop the confidence and self-assurance of the communities: they negotiated their own government entitlements and raised awareness on the issues they were facing; they also convinced government officials to replicate some of their initiatives.

The PADR had some other positive impacts beyond drought resilience. After living in the villages for a period of time, DC staff members developed trust and knowledge and could start challenging gently some social norms and structures that perpetuated vulnerability especially for low-caste communities and women. The DC staff felt that VDCs could be one of the first opportunities for men and women from different castes to meet and work together. This was accepted and everyone had the opportunity to be treated equally and make decisions.

Slowly but surely, the DC staff helped the VDC members to gain confidence by sharing ideas from other parts of India. Their confidence also increased as they became aware of their rights and entitlements and the strength of their position to receive support. Different meetings between the VDCs and local government resulted in a series of actions ranging from increased schooling facilities to provision of alternative work opportunities. The increased level of confidence was apparent after DC provided training and materials to help one community build a sample cistern. Motivated by their fresh awareness and understanding, the VDC decided to take their cause to their local government meeting. DC staff helped the VDC to make a formal application and provided advice on how to present their case in the meeting. Both male and female members of the VDC attended and the women were highly motivated by their new ability to represent their own cause. Following this application, the local government promised to build another 10 cisterns for the village.

The completion of bunds - which have increased crop yields - has had some positive social impact.

For example, residents in one village were mobilized by the VDC to dig a bund around the field of a local widow. The widow by then could not survive on produce from her land: she had to work in a stone quarry and bring her children with her because nobody else could look after them, which means the children ended up leaving their school and working in the stone quarry themselves. To build the bund, 30 men worked for 20 days for 60 rupees a day, with DC paying them on a cash-for-work basis. After the bund was completed, the widow's yield of millet doubled in the first year. Now she can stay at home, her children have returned to school, and others in the village and beyond are discussing how they can develop bunds for their own fields.

A Good Practice

This project is considered a good practice because: (1) It emphasizes the importance of community ownership; (2) It uses indigenous resources and knowledge; and (3) It increases trust and self-confidence among community members.

On this third point, DC clearly took its time to establish strong relationship and rapport with the villages. As a result, the villages became not only open to new learning but also willing to have some of their social norms challenged, particularly in relation to gender and caste.

Also, DC sought to understand more from other NGOs across India, striving to learn about other practices that could be shared with targeted communities. It aligned with academic institutions and government departments so that it could share with them indigenous low-cost practices identified by the villages, and so that it could be the first to understand technologies or policies that were coming into place.

Last but not least, the project is a good practice because it has had an impact beyond its overall purpose that is drought resilience. As mentioned earlier, it helped to challenge "gently" some social norms and structures that perpetuated vulnerability, especially for low-caste communities and women, offering men and women from different castes the opportunity to meet and work together.

The Challenges

A main challenge faced by the project was to communicate clearly the basic principles of disaster and drought risk reduction. There was a need to present disaster risk reduction (DRR) as a development practice, to move away from associating the word "disaster" with humanitarian response. And if this was not done properly, there would be expectations of quick project delivery and impact, whereas in reality resilience needs to be an attitude. Resilience is about seeing all village development through the lens of vulnerability and disaster impact reduction.

Another challenge was to ensure that the assessments were accurate and led to the right actions. The selected risk reduction activities had to be well thought through. Wrong choice of material or the confined nature of an assessment could result in the collapse of a cistern or in groundwater being drained from an important field. This means that agriculturalists and water engineers had to be involved.

Lessons Learned

1. Local or national NGOs help as vital facilitators and vehicles of communication. In this project, DC was a networker, disseminated new information and promoted better understanding of policies until the VDCs could organize themselves into coalitions or align themselves with other information providers that could help them revise their village development plans. This is especially important in the context of climate change and the need for early warning information to reach isolated communities.
2. Winning the trust and acceptance of the community is of utmost importance. Doing so obviously takes more time but the outcome is more rewarding. Indeed, too rapid risk assessments can result in poor planning and, at worst, increased vulnerability and/or disaster risk. Also, they do not help to build project ownership and sustainability. It is to be noted that a balance must be stricken between these constraints and timely project completion and funding before the next disaster arrives. Realistically, there is a need for trial-and-error experience from several drought events to

understand what truly defines sustainable resilience for each individual community. To build relationships and win the trust of community members, the DC staff stayed several nights in the villages. The resulting deep background knowledge of the community and the difficulties it faced assisted DC staff in developing plans and discussing possible solutions to reduce risk, building largely on the skills, resources and abilities available within the communities, while also identifying areas that required advocacy beyond the village boundaries.

3. Decentralized national budgets can provide good opportunities for local communities. The VDCs gained confidence quickly as their advocacy efforts often received a comparatively fast response. This was because the local government had the powers and funding to support these applications without referring to higher authorities. As a result, the local government was also exposed to the good practice that was going on within their communities and saw it in its interests to support these initiatives to prevent any potential demands for relief in any future drought situation.

Potential for Replication

This project has a high potential for replication. There was nothing new in the methods used to reduce drought risk in this case study. They were already in use in other parts of India or were forgotten traditional practices. The key was DC's ability to network and observe what was going on elsewhere in India and bring that knowledge back to Rajasthan.

Implementing the project in other countries may require different approaches but the value of building strong relationships with communities before starting work is replicable in any other context. The only difference perhaps is that India's tradition of grassroots political awareness and engagement makes social mobilization and advocacy easier, which may not be the case in some other countries.

For more information, please contact:
Oenone Chadburn (oenone.chadburn@tearfund.org)

JAMAICA
From open-field farming to more sustainable practices

Greenhouse Technology and Rainwater Harvesting

Christiana Potato Growers Cooperative Association

Abstract

Jamaica has a bimodal rainfall pattern: the country experiences two peak rainfall seasons and two dry spells. The risk of drought is often very high during the dry spells. Past droughts have wilted crops, drained reservoirs and devastated farmers. The traditional farming method of clearing hillside forests to create open-field farming systems heightens Jamaica's vulnerability to drought by causing forest loss, soil erosion and decreasing soils' capacity to store water.

The community-based organization "Christiana Potato Growers Cooperative Association" began working with farmers in central Jamaica in 2007 to implement a number of sustainable farming practices that would help them better cope with dry spells. One key practice implemented was greenhouse technology. Greenhouse technology lengthens the growing season and decreases the need for open-field farming. As a result, productivity increases and food security is improved year-round.

The initiative has achieved promising results and clearly demonstrates how greenhouse technology can be an important component of a community's strategy to manage the risk of drought.

The Initiative

For decades, the traditional Jamaican farming method of clearing hillside forests to open up more land for the planting of crops has contributed to the loss of forest and ongoing soil erosion. This clearing actually makes the farms less resilient to drought and crop failure by decreasing the land's ability to retain water. The water storage capacity of soils is critical for crops in Jamaica where the majority of farmland is entirely rain-fed.

Recently, there has been a movement to encourage and enable farmers to move away from traditional farming methods and adopt practices that are

more sustainable. From December 2007 to March 2009, the community-base organization Christiana Potato Growers Cooperative Association (CPGCA) worked with farmers in the parish of Manchester to grow crops in sustainable greenhouse systems.

The initiative used a type of greenhouse called high tunnel houses (HTHs). The HTHs have many benefits. They provide ideal conditions for crop cultivation all year round and offer some protection to crops from pests, diseases and weather-related hazards. In addition, if greenhouse production is carried out correctly, crops can remain at a consistently high level of quality and yields can be substantially greater than what could be produced in an open field. Among the crops grown during the initiative were sweet peppers, cucumbers, tomatoes, strawberries, cantaloupes, and cauliflower.

Greenhouse technology uses several sustainable and environmentally friendly practices. Plants are raised in grow bags and in other cases hydroponics is used. This greatly reduces the need for soil. For this initiative, the grow bags were filled with coconut husks, an effective soil substitute. No soil was used in the grow bags; this was decided based on a learning by doing exercise. Firstly crops were grown directly in the soil but the built up of salts affected the subsequent crops hence a move was made to grow bags totally devoid of soil.

Soluble fertilizers are mixed with the water at all times, and used to supply all the nutrient plants. A container was placed underneath each grow bag to collect any water that did not get absorbed. This water containing valuable nutrients was then recycled and fed to the plants again.

To supply the plants with a consistent supply of water, CPGCA incorporated an innovative drip irrigation system into their HTH greenhouse system. First, rainwater was collected in three manmade plastic-lined ponds; these ponds are below the ground level of the HTHs. The harvested rainwater from the plastic-lined ponds drained into a larger concrete catchment pond situated below. The water was then sent to a water tank sitting at an elevation of 80 feet using a solar-powered pump that is operated on demand. The abundance of sunlight guaranteed up to 12 hours of pumping daily, usually between 6:00 a.m. and 6 p.m. Finally, the water in the tank travels through a pipe via gravity to a total of eight (8) the HTH greenhouses with a total coverage of 47,000 square feet. The water pressure in the pipe is 30 pounds per square inch, which is more than adequate for the compensated drippers used by the irrigation system. All the houses share a common main line to which the water for each house is regulated by a hydraulic valve. The valve gets the signal from a timer that sends a 24 volt dc current to open the valve for 4 minutes (each hour). Each house has 5 beds with one 16mm hose that runs for the length of the bed. Drippers that deliver at a rate of 3.8 litre per hour, are plugged into the 16 mm hose. Then a two way adaptor supplies the water through 4mm micro tubes to drip pegs near the base of each plant. In addition to working with farmers to implement the greenhouse farming system, CPGCA hired a marketing officer and other staff to help farmers market and distribute their produce.

This sustainable farming initiative involved a number of organizations at different levels. Twelve community-based groups helped to implement the farming practices. Ten farmers, including four females, participated. The Manchester Parish Development Committee, which includes various community stakeholders who work to advance a "bottom-up" approach to sustainable development planning for Manchester, provided substantial assistance and guidance. The project was funded through a variety of sources including: The Global Environment Facility's (GEF) Small Grant Programme (30,000 US dollars), the Private Sector Development Programme (21,600 US dollars), CPGCA (13,000 US dollars), the Development Bank of Jamaica (5,633 US dollars) and the Jamaica Business Development Centre (2,900 US dollars).

Impacts and Results

1. Improved yields: Crops yields can be up to three times above that of normal open field agriculture. Crops grow much faster, individual vegetables and fruits are considerably larger, are of a higher quality, more pest resistant, and have longer shelf lives. Additionally the HTH uses 5-10 times less land to produce the same amount of crops.

2. Given protected environment, and the ability to simulate growing conditions in the HTH, crop growing season can be extended well beyond the normal length of open field agriculture. In some cases, crops can be produced all year round. There is less dependence on (uncertain) rainfall and given greater guarantees for crop success there is more stable income for farmers, and more reliable supply to markets.
3. The need for hillside open-field farming and the negative effects associated with it have been reduced. As a result, there is less soil erosion, land slippage, species loss and habitat fragmentation.
4. Greenhouse technology required less manual labour to manage production; it uses considerably smaller inputs of fertilizers and other inorganic inputs. The need for weeding is non-existent and as such total labour and capital costs are significantly lower. A number of female workers have also been able to each manage one HTH on their own, as farming is reduced to tending to plants without intensive manual labour. The ability to earn a sustainable livelihood without over-exerting oneself has thus attracted a number of young people to the farming practice.
5. Additionally, the use of greenhouse technology has increased awareness of the problems of associated with traditional farming among farmers in Manchester. Many farmers that still rely on open-field farming have made efforts to make their practices more sustainable and resilient to drought. For example, farmers are diversifying their crops and planting trees to improve percolation and water conservation. Many farmers are also planting crops in continuous mounds along contours. This practice creates barriers that prevent water runoff and keep the root zone wet for longer periods between dry spells.

A Good Practice

The use of greenhouse technology combined with a solar-powered irrigation system shows great potential to improve Jamaica's food security during times of dryness. The supply of vegetables grown in greenhouses is much more consistent than those grown in open fields. Greenhouse technology also reduces the need to clear more hillsides for open-field farming, which has many negative impacts on the environment. When a farmer chooses to use greenhouse technology over the traditional farming method, more trees are left standing, more habitats for species are left intact and less soil erosion occurs.

Greenhouse technology significantly reduces the quality and amount of land required for farming. Greenhouses on marginal lands can be very productive since plants are grown in grow bags using a soil substitute or with hydroponics. Greenhouse farming does not require a lot of land in order to be profitable.

Once the greenhouse system is established, it relies mostly on renewable resources – sunlight, rain and coconut husks. This makes the farming practice extremely sustainable in the long-term. The use of renewable energy (solar energy, bio-gas and bio-fuels) also ensures that water is continually supplied at the correct pressure to crops even when power grid is disrupted. This saves on energy cost, promotes the inclusion of solar panels as a source of clean, renewable energy and simultaneously reducing the levels of greenhouse gas emissions. The reliance on renewable energy provides an innovative solution for coping with increasing electricity costs. Re-using fertilizer further reduces the costs.

Combining a rainfall harvesting and storage system with a drip irrigation system is a commonsense way of minimizing and managing drought risks. Traditional open-field crops are at risk of failure during periods of extreme dryness and heavy rainfall. However, the irrigation system used by this initiative effectively and efficiently manages Jamaica's unpredictable and variant rainfall pattern and makes it possible for crops to thrive.

The Challenges

Start-up costs for greenhouse farming are currently high compared to those for traditional farming. Most of the capital needed is required to purchase equipment and to conduct experimental research to establish best practices. To implement this initiative, it was necessary to seek funding from external sources – mainly groups with an interest in sustainable development.

Due to the high costs and lack of easily accessible funding, this initiative was implemented on a relatively small-scale. Sustainable farming is not a national priority for Jamaica at the moment. Only two per cent of the country's national annual budget is allocated to agriculture. The initiative could have been implemented on a larger scale, but this was not possible due to lack of funds.

Lessons Learned

The key lessons learned are:

1. Plants perform much better when irrigated with fresh rainwater, which lacks added minerals and salts, than they do when watered with well or municipal water.
2. Drip irrigation significantly conserves water and minimizes water waste by feeding each plant directly. Therefore, a small quantity of water can feed several plants.
3. Water wastage can be completely eliminated quite easily. The grow bags, are placed on slopes (a couple of degrees) which allows 15 to 30 percent water to drain from the bags, preventing a build-up of salts in the bag. Further water is collected at the end of the bed, preventing the fertilizers leaching into the soil and underground water. The water can then be recycled and reused.
4. The initiative should be simultaneously implemented on one major farm (the mother farm) and on smaller farms in adjoining communities. In our case, thirteen other farmers within an 8 kilometer radius of our farmers resource centre now have their own greenhouses adopting various aspects of the technology. Interestingly enough, on a recent visit the Inter-American Development Bank (IDB) expressed interest in what they saw and hopefully will help in providing access to capital. The lack of capital is a major deterrent to young (interested) people that have no collateral to offer financial institutions. If capital is availed this could notably increase buy-in and accelerate greenhouse technology adoption by other farmers.

Potential for Replication

Prospects for replication elsewhere seem very good. In countries with warm climates, it is necessary to use greenhouses at higher elevations to avoid heat build-up which reduces plant performance. Several other areas of Jamaica, where there are abundant arable lands with elevations of 1000 feet above sea level, are suitable for greenhouse technology.

To be successful, the selected area must also receive adequately high rainfall levels if it will use an irrigation system that relies solely on harvested rainwater. In areas where rainfall is low, smaller houses can be built, with ponds of corresponding sizes. In such cases, the farmer could anticipate using about 2 litres of water per plant per day. Otherwise, higher elevations with lower rates of evapotransipration can be used. In these cases, the need for irrigation will be slightly reduced.
The initiative is currently being implemented in other parishes in Central Jamaica. Four other farmers in Central Jamaica have followed the example of CPGCA's initiative. A number of similar initiatives funded by the GEF SGP are also underway, including Santoy Farmers Cooperative in Hanover, (Western Jamaica).

For more information, please contact:
Dale Rankine (Dale.rankine@undp.org)

KENYA
Reducing pastoralists' vulnerability to drought through public health

Enhancing Water Access, Hygiene Awareness and Local Capacity

Oxfam GB

Abstract

Wajir, in northeastern Kenya, is one of the country's poorest districts. Situated in arid and semi-arid lands, it has long dry spells and short rainy seasons. Its people, who traditionally are nomadic pastoralists, were in the past able to cope with dry periods by temporarily relocating to areas where there is water. But such a lifestyle has been made more difficult by population growth and an increase in the frequency of drought. So, over the last 10 years, more and more people have shifted to livelihoods that do not rely on livestock. However, as poverty has increased in the area, the ability to cope with drought is extremely low.

Wajir District also experiences recurrent flood episodes that damage its already old and inadequate water infrastructure. The flooding results in poor sanitation around water access points, which put the population at an increased risk of disease epidemics, particularly cholera. In July 2007, Oxfam GB (Great Britain), an international NGO, implemented a public health project in water-stressed communities in Wajir to improve their situation. Oxfam GB worked with local water authorities and members of the community to expand the number of water access points, build the capacity of local water authorities, and raise public awareness about the importance of personal hygiene.

The project enhanced the communities' ability to manage water resources during times of water scarcity on their own, with fewer interventions from external relief agencies. The project helped to increase resilience to drought among the target communities.

The Initiative

From July 2007 to February 2008, Oxfam GB (Great Britain), an international NGO, implemented a public health project in the drought and flood-prone pastoral region of Wajir District in northeastern Kenya. The project was conducted in eight villages in five divisions. The targeted villages all had challenges with water availability, chronic food insecurity and malnutrition. The total population of the villages was approximately 35,000. Oxfam GB also worked with local water authorities to increase their capacity to deal with drought.

The main objective of the project was to reduce the vulnerability of pastoralists to drought by improving access to water, hygiene awareness and sanitation facilities, as water infrastructure is old and inadequate in the district.

Oxfam GB worked closely with community members and agencies that shared an interest in water access and quality. This included members of pastoral associations, water user associations (WUAs) and school management committees, as well as representatives from the District Water Office and two local NGOs - the Wajir-South Development Association and the Arid Lands Development Focus. The requirement to work in particular with the WUAs was based on their role in ensuring equitable access to water for all users dependent on a particular water source. Most usually these are permanent sources – deep boreholes where water pumped is driven by diesel fuelled generators. In times of stress the costs to maintain these systems and access water for both people and livestock – which requires users' contributions – increases and puts all parties under considerable strain. The intensity of use of these sources as surface water sources diminish leads to additional costs (running the systems) and for additional maintenance and repair as demand increases.

One main focus of the project was to improve access to water in the targeted villages. To that effect, Oxfam GB installed additional water access points in the villages. The new water access points primarily used low technology methods such as hand pumps and water pans. The designs also included sustainable and locally appropriate material, including locally made bio-sand and solar-powered pumps.

The new water access points were designed to counter hazards and withstand periods of extreme weather. For example, new shallow wells were made with covers to avoid flooding and silting during floods. The additional water points also reduce people's reliance on boreholes, which often fail during drought because of overuse. Indeed, humans and livestock rely mostly on boreholes to obtain water in times of drought. The boreholes operate 18 to 24 hours each day and often break down because of overuse. Relief agencies are relied upon to make the needed repairs. During severe droughts, water is transported to communities by tanker truck.

The other main focus of the project was to raise awareness about necessary sanitation practices in the villages. Hygiene promotion efforts were implemented in schools, targeting children and teachers. Some of the topics covered included: the benefits of improved sanitation; the relationship between hygiene practices and disease; and the importance of hygiene practices in times of drought and heavy rains. Oxfam improved the

sanitation facilities in the targeted schools to ensure compliance with Government standards (1 per 15 girls, 1 per 30 boys) and supported their safe use and maintenance through the promotional activities. Uptake of messages resulted in improved hygiene practices.

Oxfam GB also devoted some attention to improving the capacity of local water authorities to cope with periods of water scarcity. Oxfam GB held workshops for water user association (WUA) members to build skills in different areas eg the election of officials, basic technical maintenance skills and scheduling and record keeping to improve the management of income and expenditure. After each workshop, Oxfam GB made a follow-up visit to monitor how well the teachings were being applied in real life. Oxfam GB also developed a score sheet to gauge WAU performance so WUAs could keep track of their strengths, weaknesses and improvements over time.

Oxfam GB determined that WUAs had to become more capable of making profits during non-drought periods. The additional funds collected in times of good water supply can be used in times of water scarcity. The funds can also be used to build the WUAs' capacity through accessing new resources and skills. These measures should make the WUAs more self-sufficient and capable of operating effectively during drought periods without external assistance. It is important to note that most WUAs have systems that exempt the poorest in the villages from user fees.

For the sake of accountability, the project also helped community members to know their water-related rights as well as the roles and responsibilities of the different water authorities. For example, Oxfam GB raised people's understanding of the obligations of the District Water Office, particularly in times of drought and flood.

Impacts and Results

The main impact of the project was that it provided some 35,000 people with improved access to reliable water sources. This ensures that more people and livestock have access to water for longer periods during droughts, thereby making them more resilient.

The newer water access points installed are more durable and less susceptible to flood damage than the older ones. Therefore, they are likely to function during times of heavy rain and dryness.
The additional water points also improved the quality of life for the village residents, particularly the women and children who are responsible for collecting water. Now, they can devote more time to development activities such as selling goods and schooling, which can lead them out of extreme poverty.

The targeted populations also showed an increased understanding of the importance of good personal hygiene and sanitation practices. More people became aware of the relationship between sanitation, disease and nutrition. It is expected that the increased hygiene awareness will lead to improved sanitation practices. As a result, the villages' susceptibility to water-borne diseases, including cholera which is a leading cause of morbidity and child mortality in the district, should decrease.

At the end of the project, WUA score sheets revealed that all eight WUAs Oxfam worked with were operating more effectively and were closer to operating in a sustainable manner, even during drought periods. Overall, the score sheets showed significant improvements in the capabilities of WUAs.

A Good Practice

The project can be called a good practice because:

1. It is cost-effective and aimed for sustainability. Focusing on local capacity building and locally sustainable water supply sources is a relatively cheap initiative compared to those that promote borehole construction. Also, greater local capacity helps to reduce the cost of humanitarian interventions in the long run.
2. It seeks to reduce vulnerability, especially in times of extreme stress. The initiative enhanced the villagers' ability to manage water resources in times of water scarcity on their own, with fewer interventions from relief agencies.
3. It is result-oriented. In a relatively short period of time (some six months), it managed to provide some 35,000 people and their livestock with improved access to reliable water sources.

4. It was participatory and helped organize communities better through water user associations (WUAs).
5. It helped to reduce epidemic risk and increased drought resilience among the target communities.

The Challenges

The main challenges faced by the project were:

- Culture of dependency. The WUAs and communities had come to rely on relief interventions by NGOs and other agencies. Breaking this dependency culture was a major challenge. The practice of relief organizations replacing hardware and providing relief funds during drought may actually contribute to this culture and undermine long-term efforts to improve the WUAs' management capability. Worse, it may even reward WUAs that have poor management practices. Emergency relief organizations should work with WUAs to fill gaps in the provision of services. One possible solution is to implement a cost-sharing strategy that is based on maintenance costs instead of automatically covering all drought-related costs.
- Poor government capacity. Another challenge encountered was the poor capacity of government agencies, particularly the District Water Offices. Unfortunately, as WUAs become stronger and more capable, they will likely remain dependent on Oxfam GB for supervision and support since the District Water Offices are unable to take on this role. In future projects, more work should be done to build government capacity concurrently with that of WUAs.

Lessons Learned

Key lessons learned from this project are:

1. Assume disasters will occur. Projects in disaster-prone areas should be designed and implemented assuming recurrent shocks will occur. For example, infrastructure should be designed to withstand the impacts of floods and droughts.
2. Cooperation among all stakeholders is key. Building the capacity of WUAs must include local users and representatives from formal water authorities. All stakeholders have a role to play in proper water management and must work together. Sustainable and self-sufficient WUAs can only exist when community members hold them to account from below and when strong linkages are created with relevant government authorities.

Potential for Replication

This initiative has high potential for replication. However, it is important to note that effective support to local water authorities is a long-term process that is beyond the time scale of most humanitarian projects.

For more information, please contact: Helen Bushell (hbushell@oxfam.org.uk), Brian McSorley (bmcsorley@oxfam.org.uk), Josphat Singano (jsingano@oxfam.org.uk) or Mutuku Muema (mmuema@oxfam.org.uk)

KENYA
Improving livestock markets to reduce drought disaster risk

Ensuring Decent Livestock Price

Oxfam GB

Abstract

Turkana in northern Kenya is one of the country's poorest and undeveloped districts. It is situated in arid and semi-arid lands characterized by periods of low rainfall. Some 87 per cent of rural dwellers in the district live below the poverty line and are unable to meet their food needs. The economy in Turkana is based on pastoralism, where people raise and sell livestock to earn income. In recent years, severe droughts and a deadly livestock disease led to a ban on goat trade and decimated goat herds.

Over the last 10 years, pastoralists have become less capable of dealing with the impact of drought. Traditionally, they searched for better food and water sources in other areas. However, population growth, along with an increase in the frequency and duration of drought, has made extensive livestock husbandry more difficult. When the pastoralists sold some of their livestock to obtain food, buyers typically undervalued the animals. There was a need for a more sustainable livestock marketing system.

In October 2005, Oxfam GB (Great Britain), an international NGO, began working with local pastoralists in Turkana to establish the desired livestock marketing system. After the project began, the district experienced drought and a livestock epidemic disease. In the light of this, the project focused on how to make the population more resilient to drought and livestock disease. The project activities sought to improve the livestock market system, support livelihood diversification for women, and develop an intervention system for the livestock sector to help it cope with periods of extreme stress.

At the end of the project in January 2008, four livestock markets were established, which have helped many pastoralists to sell their animals at decent market prices, especially in times of drought. As the project encouraged livestock buyers to participate in the new markets, both livestock prices and supply grew. The quality of animals has also increased because of the newly introduced veterinarian services and emergency vaccination campaigns. Finally, the situation of many impoverished women has improved as more of them could sell goods and make an income. In a nutshell, the target populations are now more prepared to cope with drought, livestock epidemic and other crises.

The Initiative

In October 2005, Oxfam GB (Great Britain), an international NGO, began working with local pastoralists in Turkana District, northern Kenya, to establish a more sustainable livestock marketing system. Such a marketing system had become a must as livestock buyers undervalued the pastoralists' animals. This is because the pastoralists, who had become less capable of dealing with the impact of drought over the previous 10 years, had to sell their livestock on the buyers' own terms to obtain food. They had become less capable of dealing with the impact of drought because they could no longer search for better food and water sources in other areas – as a result of population growth and an increase in the frequency and duration of drought.

It is to be noted that Turkana District, one of Kenya's poorest and undeveloped districts, is situated in arid and semi-arid lands characterized by low rainfall periods. Some 87 per cent of its rural dwellers live below the poverty line and are unable to meet their food needs, mainly as a result of low-fertility soil, low and highly variable rainfall, geographic isolation, low population density and poor infrastructure. Severe droughts occurred in recent years. And in 2006, goat herds were hit by a deadly livestock epidemic disease known as peste des petits ruminants[2] (PPR). The PPR outbreak was a major blow to the district residents, most of whom are pastoralists who raise and sell livestock to earn income: the disease not only led to a ban on goat sales but also decimated goat herds.

The epidemic, and a major drought, occurred after the Oxfam GB project began. Then the project shifted its focus on making the population more resilient to drought and livestock disease. The project's activities addressed three issues: (1) improving the livestock market system; (2) supporting livelihood diversification for women; and (3) developing an intervention system for the livestock sector to help it cope with periods of extreme stress.

From October 2005 to January 2008, Oxfam GB worked with pastoralists in four divisions of northeast Turkana to implement a project aimed at making the livestock marketing system more sustainable and equitable. Prior to the project interventions, market integration was poor and pastoralists traded animals with individual traders. Due to a lack of competition, animal buyers were able to demand very low prices for animals. Oxfam GB identified this poor marketing system as a key factor undermining the viability of pastoral livelihoods. Pastoralists must be able to sell animals at a reasonable rate, even during times of drought. This principle is a key coping mechanism for pastoralists.

The project's overall objective, to build a more sustainable marketing system, was intentionally articulated in general terms to allow for maximum flexibility. As mentioned earlier, the region experienced a major drought shortly after the project began. Then, just as herds were beginning to recover, an outbreak of the viral PPR disease infected goat herds. Medicines and vaccinations to

treat the PPR were not widely available at the time. As a result, goat herds were decimated. Along with losing many of their goats, the pastoralists had to deal with strict market restrictions.

These crises led the project staff to focus their efforts on market-related areas that would help Turkana become more resilient to disasters such as droughts and livestock epidemics. As the project unfolded, three specific objectives developed. The following is a brief overview of each objective along with the activities implemented to achieve it:
Actively involve local livestock sector stakeholders in major livestock interventions and in making improvements to the livestock markets. Oxfam GB worked with pastoralists from all four divisions. They also worked with the District Veterinarian Office, the District Livestock Marketing Council and Livestock Management Associations (LMAs)
The organization of the Livestock bodies at the national, district and community levels were established after the collapse of the Livestock Marketing Councils, which were coordinated by the then Ministry of Livestock in early 90s. The collapse of this institution served directly to threaten livestock production and marketing in the pastoral areas of Kenya. In 1999, the pastoral interest groups, that included pastoral communities' representation from the Northern Kenya, lobbied the government to establish livestock structures to coordinate livestock marketing activities in the pastoral districts in the country classified as Arid and Semi-Arid Lands (ASAL). The Kenya Livestock Marketing Council (KLMC) headquartered at the national level was formed to coordinate the work of the various District Livestock Marketing Councils (DLMC) formed in the 22 ASAL districts. The DLMC coordinates directly the work of the Livestock Marketing Associations (LMAs) established at the grassroots level.

LMAs are members of the respective DLMCs, and they actively participate in the activities of the DLMC such as elections, trainings and donations. The DLMC are bonifide members of the Kenya Livestock Marketing Council at the national level.

1. Much attention was given to LMAs, which serve as a valuable link between pastoralists and formal livestock authorities. Oxfam GB provided training and support to four LMAs in remote locations to help them develop new livestock markets and sale yards. The creation of new sale yards and LMAs were necessary to give rural pastoralists a place to sell their animals at decent market prices. Oxfam GB also trained LMAs so they could provide veterinarian services during emergency vaccination campaigns and on market days when animals are sold.
2. Plan and implement effective interventions in the livestock sector during critical times. This general and flexible objective took into consideration the fact that interventions need to change in response to circumstances. For example, drought conditions require a shift from restocking to destocking and an epidemic may necessitate the implementation of a vaccine campaign. Oxfam GB worked with the pastoralists, LMAs and local authorities to build their capacity to react quickly and effectively when faced with a crisis. The core activities conducted to achieve this objective included:
   - Establishing an internal early warning monitoring system to collect information that can be used when making programme decisions.
   - Developing internal contingency plans to realign programmes and secure funding.
   - Improving coordination mechanisms.

   Turkana district already has a contingency plan, dating back to 2000-2001. This plans required review and updating to be compatible with the current emerging context in the district, as well as adequate resources (contingency funds and available and appropriately trained human resources). Oxfam was supported this review, with an all-inclusive approach, to develop a comprehensive, realistic and applicable contingency plan. However, the PPR outbreak, as well as the possibility of the district being hit by another livestock disease outbreak called Rift Valley Fever (RVF), provided the grounds for improving the coordination and the involvement of the district stakeholders in common response.
   All efforts related to emergency preparedness and responses were concentrated on planning and preparedness to respond to livestock diseases. An ad hoc PPR coordination group was established in January 2007 to respondto

this situation, including government and administration representatives (Veterinary Services from the MoLFD[3], ALRMP) and NGOs (LWF, Oxfam GB, Practical Action, VSF-B, World Vision[4]) whether traditionally involved in the livestock sector or not. This coordination group related with all other stakeholders in the district who demonstrated a willingness to support this effort, mainly the livestock market structures (DLMC and LMAs[5]) and the local CAHWs[6].
The active involvement of the livestock market structures, especially in North-East Turkana, has been possible as a result of the livestock marketing project, and to the flexibility granted by the donor to adapt the objectives and activities to the changing situation. The PPR coordination group is an example of good practice, with most of the participants pooling resources to be used in the most effective way for the livestock vaccination and treatment exercise. Those resources included staff support, veterinary and refrigeration equipment, drugs and vaccines and transport facilitation for the vaccination teams.

3. Identify and support market opportunities for livelihood diversification. Oxfam GB supported over 15 women's groups by providing them with business training and loans to help them establish livestock trading cooperatives. Initially, the aim was to create more local traders and buyers of livestock, and thereby increase demand and market prices. However, part way through the training programme, the PPR outbreak occurred and forced Oxfam GB to consider non-livestock market activities. To ensure that the business training provided did not go to waste, Oxfam GB worked with the women to help them develop alternative businesses, such as wholesale fuel and cement trading.

Impacts and Results

Overall, the project reduced the population's vulnerability to drought. The livestock marketing system is now more efficient and more capable of responding effectively to disaster events. The LMAs have proved to be critical in mobilizing pastoralists to coordinate livestock interventions. Four new livestock markets in rural communities are now open and are trading regularly. Pastoralists are now able to use the markets as herd management tools. For instance, when drought hit the district after the project had began, an emergency destocking intervention was implemented, targeting up to 7,500 households. Meat from the sale of livestock was distributed to approximately 41,000 people. With a total of 15,000 shoats destocked, the 7,500 producer households each received a compensatory payment per animal of Ksh800 (approx $11). Weak animals were targeted and done so as a means also of protecting the core breeding herd.

Many pastoralists living in remote communities are now making a more viable livelihood. The creation of four new sale yards in remote locations helps the pastoralists sell their animals at decent market prices. The new markets enable them to realize the value of their animals when they consider selling them. This information is particularly valuable to sellers during the onset of drought. The project also has encouraged several new buyers to participate in the new markets. As a result, both livestock prices and supply grew. This trend should ensure that the markets continue to grow and become permanent and sustainable features of the local economies.

The quality of the animals offered at markets has also increased because of veterinarian services provided by the Livestock Management Associations (LMAs). Market-day veterinarian services and emergency vaccination campaigns have led to healthier animals with greater value. The higher prices obtained for the animals result in more income for the pastoralists. As part of their duties, the LMAs also monitor the animals for any infectious diseases that may require emergency interventions. This service helps to keep the quality of animals high and ensures that gains from any restocking initiatives are sustainable in the long term.

The LMAs now function independently and profitably. They are recognized as key stakeholders in the area and have gained further legitimacy from pastoralists. The LMAs have given pastoralists access to information and a degree of organization that previously had been absent.

Finally, the situation of many impoverished women has improved. More women are now selling goods

and making an income. Over 300 women, who had little or no income before the project, benefited from the livelihood diversification activities.

A Good Practice

This initiative can be considered a good practice because:

1. It addresses both disaster resilience and poverty reduction among the most vulnerable. Still better, it boosts disaster resilience through poverty reduction - by enhancing people's livelihoods.
2. It focuses on people's livelihoods, which also helps motivate people's participation and self-reliance and is conducive to sustainability.
3. It recognizes the centrality of livestock to pastoral livelihoods and the pastoralists' need to secure fair prices for their animals in times of drought. The livestock marketing system being used actually increased the pastoralists' vulnerability to drought, livestock epidemic and other crises. Oxfam GB had consulted all pastoral stakeholders and taken actions to improve market coordinating mechanisms.
4. Its overall objective was articulated in general terms and such a flexible approach allowed for unexpected interventions and changes to the project plan in response to extreme circumstances. As a result, the initiative could take on a disaster risk reduction (DRR) focus after its launch.
5. It recognizes the benefits of livelihood diversification. The PPR disease outbreak showed that people could not rely solely on animal trading for income. Diversifying income through non-livestock activities is a key component of a poverty reduction strategy for pastoralists: it can act as a buffer or alternative income in the event of a severe drought or an epidemic.
6. It also addresses gender issues through the inclusion of some of the poorest women in the livelihood diversification activities.

The Challenges

The main challenges for the initiative were:

- Initial lack of legitimacy for the Livestock Management Associations (LMAs). During the initial phase of the project, LMAs were not viewed positively by pastoralists.
- Ineffective District Livestock Marketing Council. The District Livestock Marketing Council was disorganized and unable to fully carry out its role. This was due to internal problems that Oxfam GB could do little to address.
- Unsupportive District Veterinarian Offices. District Veterinarian Offices were weak and not always interested or able to support LMAs in a consistent manner over the long term. The creation of new sub-districts within Turkana District during the project resulted in new District Veterinarian Offices staff and gave Oxfam GB an opportunity to re-engage with these offices.

Lessons Learned

Key lessons learned from this project are:

1. A flexible overall approach is most effective in disaster-prone areas. Projects should be designed and implemented assuming recurrent shocks will occur. A general objective to undertake "effective interventions" (i.e. whatever is considered appropriate given the stage of the disaster cycle) should always be considered. This usually includes the development or review of contingency plans internally with key stakeholders. With this approach, the project could quickly expand, using pre-prepared plans to support destocking or emergency animal health interventions.
2. LMAs are vital to a sustainable livestock marketing system. The LMAs proved to be extremely valuable in both long-term development and emergency response. The roles of the LMAs in humanitarian emergency response, particularly running emergency vaccination campaigns, enabled them to quickly gain legitimacy and respect with the pastoralists they serve. This emergency response role greatly improved their organizational skills and relationships with government departments and other established agencies. This role needs to be made more explicit in their constitutions.
3. The role of LMAs needs to expand. LMAs require ongoing support to become fully institutionalized and sustainable. This cannot be achieved within the time frame of most humanitarian projects. Members of LMAs

earn income from livestock sales on market days; however, they do not earn enough this way to fully sustain them. There is a need to expand their activities in order to increase their income and credibility. An obvious area would be to use them to provide additional animal health services. For example, they could serve as community animal health workers or as veterinarian pharmacists.

Potential for Replication

There is some potential for replication. Obviously, the extent to which this model can be replicated will depend upon existing market structures. The support of existing LMAs and the creation of new ones was a critical step in creating local market structures that previously did not exist. However, effective support to LMAs is a long-term process. It is important that agencies supporting such organizations involved in this work recognize the amount of time and level of commitment required. Improving emergency preparedness and response capabilities can only be achieved by establishing sustainable and credible local institutions.

For more information, please contact:
Helen Bushell (hbushell@oxfam.org), Claudie Meyers (cmeyers@oxfam.org.uk) or Christopher Ekuwom (cekuwom@oxfam.org.uk)

NEPAL
Improving small-scale dryland agriculture through micro-irrigation

Boosting Poor Households' Crop Production with Drip and Sprinkler Irrigation

Manahari Development Institute – Nepal (MDI-Nepal)

Abstract

Nearly 40 per cent of Nepal's 24 million citizens, who are mostly farmers, live in absolute poverty, earning less than a US dollar per day. Among the poorest are the Chepangs who are considered as the most marginalized and resource-poor group. Living in remote sloping hills, the indigenous Chepangs mainly practice "shifting agriculture"[7], using traditional farming methods. Water scarcity severely affects their crop production in their tiny land holdings, providing food security for no more than three months.

Yet, Nepal's hills and mountains have comparative advantage for production of off-season vegetables. But for this to succeed, lack of dry-season irrigation must be overcome. As environmental considerations and lack of viable water sources, in the hill landscape, generally prevent the development of canal irrigation systems, the only alternative is to integrate small water sources and micro-irrigation technologies such as drip and sprinkler systems.

In July 2004, a Nepalese NGO, the "Manahari Development Institute - Nepal" (MDI–Nepal), initiated a project to reduce the Chepangs' vulnerability to annual dry spells. The Project sought to increase the Chepangs' food and income security through increased crop production based on micro-irrigation. Small seasonal/perennial springs, streams or rainwater were tapped, using water-saving drips, micro sprinkler systems and low-cost water storage tanks. Also, conventional drinking water systems were modified.
Thanks to the Project, total income from irrigated vegetable crops has increased by 162 per cent compared to income earned from traditional non-irrigated crops. With only 635 litres of water during spring and 520 litres during winter, a family can harvest vegetables worth 91 US dollars per year from a tiny 96-square-metre land plot. The Chepangs' income and food security have improved. They are now more resilient to annual dry spells.

The Initiative

Some 70 km away from the city of Kathmandu live the most impoverished upland indigenous tribes in Makawanpur District. Known as Chepangs, they are regarded as the most marginalized and resource-poor group in Nepal. They mainly practice shifting agriculture and use traditional farming methods. They live in remote sloping hills and their tiny land holdings provide food security for no more than three months.

The region's agricultural system is predominantly rain-fed and considered high risk because of erratic rainfall. There is a good amount of rainfall (some

1,993 mm/year) but most of the rains occur during the May-October monsoon season and the heavy rains often trigger landslides. Conversely, the November-April period is considered to be a water-deficit one, during which dryness and poor soil and water conservation lead to severe water scarcity - which affects crop production negatively.

In June 2004, a Nepalese NGO known as "Manahari Development Institute - Nepal" (MDI–Nepal) initiated a project to improve the Chepangs' living conditions. The Project's main objective was to provide food and income security to the disadvantaged poor by improving the productivity of dryland agriculture. Disadvantaged women from tribal and indigenous communities were specifically targeted.

Initially, the project methodology involved establishing 28 plastic-covered water harvesting tanks covering some 37 hectares. However, water delivery from the tanks to the main fields proved to be extremely difficult because there was no appropriate conveyance system. As a local Makawanpur NGO, the "Integrated Village Development Services", was at that time installing a drip irrigation system for another project, MDI-Nepal realized that the drip irrigation system suited the Chepangs' project. Consequently, to improve water delivery to the main fields, MDI-Nepal modified the plans for its project by connecting the drip irrigation system to existing water harvesting ponds.

The resulting irrigation system used for the project is a micro-irrigation, multi-use water system. Lack of dry-season irrigation is the greatest constraint faced by small landholder farmers in the production of high-value horticultural crops in Nepal's hills and plains. Small seasonal/perennial springs, streams or rainwater serve as potential sources for irrigation in the hills. These sources were tapped at an affordable price, using water-saving drips, micro sprinkler systems and low-cost water storage tanks.

Drip and sprinkler irrigation is typically a "micro-irrigation" system that carefully uses a combination of available water sources and maximized water use efficiency. Water is collected in water harvesting ponds built with either a plastic liner or cement. The plastic-covered water harvesting tanks are about five times cheaper than those built with cement. However, farmers seem to prefer tanks made from a combination of cement and soil because of their intermediate cost and long durability.

In dry areas, conventional drinking water systems are also modified to meet the water needs of the community for both drinking and irrigation purposes. In this system, water is collected in a reservoir tank; drinking water is then channelled through a separate pipeline and connected to different tap stands in the settlements. Overflow water is collected in another collection tank and is further channelled through off-takes (water distribution points) built in different locations throughout agricultural fields. Drip or sprinkler systems are connected to the off-takes to deliver water to the crops. In areas where water supply is sufficient, sprinklers or drips can also be directly connected to drinking water taps. In this case, two outlets may be used in the same tap stands for convenience.

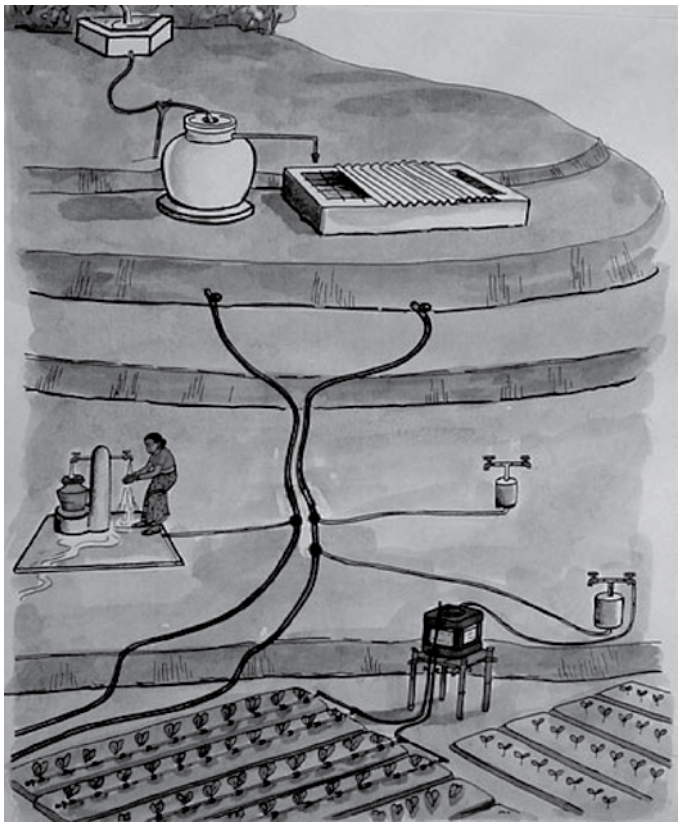
Drip irrigation technology delivers water directly to plants through plastic tubes connected to the water tank with minimal water loss. Different sizes of drip systems are available that can deliver water in a range of sizes. The smallest-size drip, designed to support a field 96 square metres in size, is widely used in the cultivation of vegetable crops. In areas with appropriate vertical height, a head sprinkler system is used for irrigating vegetable crops. Since recently, this system has also been used to irrigate fruit crops like banana and pineapples grown in shifting cultivation areas.

The Project is continuing except in some areas where repair and maintenance in drip accessories is observed as problem. There is also new expansion (40 schemes) in other areas with multi-use water system (MUS))

Impacts and Results

The irrigation systems were installed in 131 households from 15 villages. Vegetable crops using the drip system covered a total land area of eight hectares. Thanks to the Project, the impoverished

A typical sketch map of multi-use water system for drinking and irrigation purposes



Legend

1. Source intake
2. Reservoir tank (RVT-1) for drinking water purpose
3. Reservoir tank (RVT-2) for irrigation purpose (overflow water from RVT 1 is collected in this RVT-2)
4. Off-take (water distribution point): a drip or sprinkler system is connected at this point for delivery of water to the crop field.
5. Drip irrigation system

farmers saw a large increase in their cash income. Records show that the farmers produced annually a total of 571 metric tons of vegetables that were sold for 836,760 rupees (12,000 US dollars). This amounts to an average of 6,387 rupees (91 US dollars) per household per year. Total income from the sale of irrigated vegetable crops saw an increase of 162 per cent compared to income earned from traditional non-irrigated crops like maize and millet.

Such a tremendous increase in crop production has made the impoverished, marginalized and resource-poor Chepangs less vulnerable to food insecurity and more resilient to dry spells.

A Good Practice

The Project can be considered a good practice because:

1. It lays emphasis on proper management of scarce water resources. The project takes into consideration of all available local water sources (perennial, seasonal, waste water), including rainfall, to maximize efficiency use. Such an approach is relevant even to areas where water is not that scarce.
2. It matches the needs and resources of the targeted groups. The project considers micro-irrigation for both fruits and vegetables in the dry area. Using just 635 litres of water during spring and 520 litres during winter, a family is able to harvest vegetables worth 6,387 rupees (91 US dollars) per year from a tiny 96- square-metre parcel of land, using drip and sprinkler systems.
3. It promotes a system with multiple benefits. In addition to the ability to generate more income for the poor in dry areas, the micro-irrigation system used offers many benefits. Among other things, it helps to produce and sell off-season vegetables substantially with just a small quantity of water. It is also mobile and can be used in different locations, which helps to expand easily the size of cultivated areas.
4. It was gender-sensitive. The Project's main objective was to provide food and income security to the disadvantaged poor by improving the productivity of their dryland

agriculture. In overall 80% women from disadvantaged community were involved into the project.

5. It addresses the problems of both poverty and food insecurity and vulnerability to dry spells among most vulnerable groups. The Chepangs are an impoverished, marginalized and resource-poor indigenous group. Thanks to the Project, they increased their cash income from vegetable crops by 162 per cent - compared to income from traditional non-irrigated crops. This made them less vulnerable to food insecurity and more resilient to dry spells.

The Challenges

Producing off-season vegetables proved to be a challenging task that requires technical skills and knowledge. Initially, some of the farmers failed to produce good harvests primarily because they lacked the necessary technical know-how. However, this was eventually solved with rigorous training and support from the Project's technical staff.

The Chepangs' low levels of literacy and remote locations were also difficult at times. Not only did these issues necessitate a different approach to training and communication, they also required more time and preparations - which translate into higher costs.

Lessons Learned

Lessons have been learned from the Project, including the following:

1. Initiatives based on acute local needs generally have more chances to succeed. The Project's point of departure was scarce water which severely affected crop production among resource-poor people.
2. Rigorous training and support can help instil technical know-how in remote communities with low levels of literacy.
3. With some outside support and resources, impoverished and marginalized indigenous people are able to implement technology-driven initiatives.
4. With the same support and resources, they can also improve their quality of life and increase their self-reliance.
5. Little is sometimes needed to help highly vulnerable groups create capital and use it efficiently to reduce their own vulnerability to natural hazards.

Potential for Replication

The hills and mountains of Nepal have comparative advantage for production of off-season vegetables. However, lack of dry season irrigation is one major constraint for its success. Lack of viable water sources as well as environmental considerations in the hilly landscape prevent the development of canal irrigation systems. In this context, the only opportunity is using and integrating small water sources and micro-irrigation technologies such as drip and sprinkler systems. On the other hand, experience from the micro-irrigation and water system development project indicates substantial income generation, particularly through vegetable cultivation and sales. It results from all the above that replicating the Project seems to have wider scope particularly in uplands with scarce water and people practising subsistence agriculture.

Of the total 2.6 million ha of agricultural land in Nepal, nearly one million ha is upland (bari) and 80 per cent of this bari agricultural land lies in the hills. With similar socio-economic, cultural and physical environments and a strong income generation component, the Project is replicable or scaleable in a larger geographical area in Nepal.

The shifting cultivation practice is very common in various parts of the neighbouring areas of the project district. The bio-physical and socio-economic conditions of these areas closely match with the proposed project sites. Eastern Himalayan region encompassing Nepal, India, Bhutan, Bangladesh, Myanmar and South China are other potential places to scaling up of the technology as shifting cultivation in the slope lands is widely practiced in these regions too.

For more information, please contact:
Khop Narayan Shrestha (mdi@ntc.net.np)

NIGER
Increasing crop resilience to drought through agroforestry farming

The Benefits of Growing Australian Acacia Trees in African Farms

World Vision Australia and Serving in Mission[8]

Abstract

Drought often leads to crop failure and famine in Africa's semi-arid regions. As typical farming practices used in these regions rely on a narrow range of annual crops and tend to clear land of all trees - which lead to lack of biodiversity and the removal of essential ground cover, crop failure is more likely and farmers' vulnerability to drought increases.

In 2005, after working many years with farmers in Niger to help make communities and crops more resilient to drought, the faith-based organization "Serving in Mission"(SIM) developed an integrated farming system known as the "Farmer Managed Agroforestry Farming System" (FMAFS). The System incorporates agroforestry and environmental restoration to maximize biodiversity and regenerate indigenous trees. It is an agro-pastoral forestry system that uses a wide range of annual and perennial, and indigenous and exotic plant species, typically Australian acacia species which thrive in semi-arid lands.

Currently, there are 483 FMAFS farms in 25 villages in Niger, which directly benefit over 4,000 people. The FMAFS itself is still in its infancy, but it already has provided farmers with many tangible benefits, including an additional food source, firewood, crop protection and crop resilience, and alternate income. The farmers are ensured a minimum harvest of varied products in any given year. Soil fertility is built and degraded lands restored without relying on expensive and sometimes environmentally harmful chemicals. The System has contributed to natural regeneration of indigenous trees. And it is affordable and accessible to the poorest farmers. In a nutshell, the FMAFS has helped improve sustainability and reduce drought disaster risk.

The Initiative

Drought can have devastating effects in Africa's semi-arid regions. Drought often leads to crop failure and famine. Typical farming practices used in Africa, such as reliance on a narrow range of annual crops and clearing land of all trees, lead to lack of biodiversity and removes essential ground cover. These two factors make crop failure more likely and increase farmers' vulnerability to drought.

Working with farmers in Niger for many years, the faith-based organization "Serving in Mission" (SIM) has developed an integrated farming system known as "Farmer Managed Agroforestry Farming System" (FMAFS). The System seeks to make communities and crops more resilient to drought, incorporating agroforestry and environmental restoration to maximize biodiversity, improve food security and regenerate indigenous trees.

Devised by SIM staff member Peter Cunningham in 2005, the FMAFS is an alley-cropping, agro-pastoral forestry system that uses a wide range of annual and perennial as well as indigenous and exotic plant species. The practice typically uses Australian acacia species which thrive in semi-arid lands, and provide the farmer with many benefits, including an additional food source, firewood and crop protection.

The FMAFS is currently being implemented in dozens of villages in Niger. It builds upon work started in 1984 on natural regeneration of indigenous trees and on research on edible seeded acacias commenced in 1986. The FMAFS addresses two features typical of African farming systems that increase the risk of crop failure during times of drought:

1. Lack of biodiversity. African farming systems are usually dominated by a narrow range of annual crop species. Farmers frequently rely on a single annual crop such as maize, millet or sorghum, which is grown in a high risk environment. If this crop is damaged through drought, pests or other adverse factors, subsistence farmers have little to fall back on and famine can ensue.
2. Absence of ground cover and low soil organic matter content. African farming methods commonly practiced involve the complete removal or destruction of crop residue through burning. Regular turning of the soil under hot tropical conditions hastens the loss of organic

matter. In highly degraded environments, where there is a shortage of fire wood and fodder, crop residues are removed from fields for use as cooking fuel or for animal fodder. With no mulch covering the soil, heavy rain causes high levels of water runoff and soil erosion, high evaporation and low water infiltration.

The FMAFS incorporates a wide range of plant species - annual and perennial, and indigenous and exotic - to reduce crop vulnerability. Farmers use the FMAFS as a basic farming model and adapt it according to their circumstances. Based on their resources and needs, farmers determine the actual layout, number and types of indigenous and exotic trees used, and the crops planted. Different exotic trees can be used; however, the following discussion of the FMAFS is based on a major recommendation to implementers to use Australian acacias as the exotic tree species.

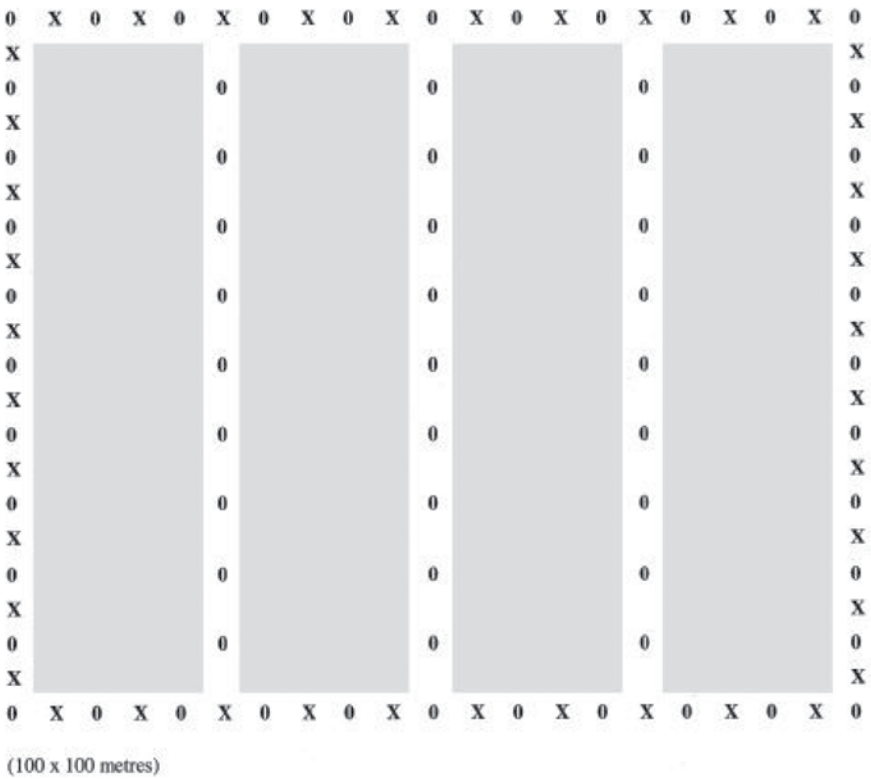
The FMAFS typically introduces a range of Australian acacia trees (Acacia colei, A. torulosa, A. tumida, A. elachantha) which thrive under Africa's semi-arid conditions and produce edible seeds and timber.

SIM has undertaken development activities and built relationships in the region for over 20 years. SIM's close liaison with farmers helped project staff to understand their needs and the root causes of crop failure in Niger. To support implementation of the FMAFS in villages, SIM provided farmers with training in person and over the radio, demonstrations, field visits, and the general assistance of field staff and volunteers. SIM also facilitated the opening up of a small market for acacia seeds, which greatly boosted farmers' interest in the FMAFS.

World Vision Australia is supporting this work through promotion, co-funding research on the impact of Farmer Managed Natural Regeneration, and funding acacia market analysis and the development of a nutrient dense acacia biscuit. <http://www.worldvision.com.au/>

Impact and Results

Currently, there are 483 FMAFS farms in 25 villages in Niger, which directly benefit over 4,000 people. While the FMAFS itself is still in its infancy, many benefits have been observed so far.



The Farmer Manage Agroforestry Farming System, one hectare model. 0=Acacia colei (68) , X= Acacia torulosa (40): Total acacia trees 107 per ha. Trees on boundary are 5m apart. Trees within the farm are 10m apart. Rows of trees are 25m apart. Rows of trees are planted across the prevailing wind direction. Shaded are: FMNR with 40 to 120 trees per ha per ha and annual/perennial crops in rotation.

Crop yields and income generation under the FMAFS greatly exceed those under traditional farming systems. Farmers and communities practicing the FMAFS now have alternate income sources from the sale of firewood and acacia seed during drought. They also have the option of eating acacia seed and feeding it to their livestock. The FMAFS increases the resilience of crops to adverse conditions. In 2005, farmers faced drought and locusts and it was found that farmers practicing natural regeneration methods were much better off than those relying solely on annual crops, most of which were devastated.

Grain stocks (e.g. millet and sorghum) also last longer in villages that grow acacias because of the following reasons: (1) acacias are high in protein and filling, so less volume of food is consumed; (2) acacia flour is often mixed with flour of other traditional grains and, as a result, grain stocks last longer.

In addition, the FMAFS has contributed to natural regeneration of indigenous trees in Niger. In 1980, most farmland in Southern Niger was cleared of trees and other non-crop vegetation, making crops very vulnerable to pest attacks and the harsh climate. Today it is not unusual for farms to be stocked with 40 to 150 indigenous trees per hectare.

A Good Practice

As mentioned earlier, the FMAFS typically introduces a range of Australian acacia trees (Acacia colei, A. torulosa, A. tumida, A. elachantha) which thrive under Africa's semi-arid conditions and produce edible seeds and timber. The acacias are planted along farm borders and in rows within the farm. The acacias provide firewood, timber, mulch and food for humans and animals, while contributing to environmental restoration and crop protection. The acacias also help to restore indigenous trees that have been negatively impacted by environmental conditions and inadequate farming practices. Annual cash crops such as millet, sorghum, peanuts, cowpeas and sesame can then be planted in rotation between the tree rows.

The FMAFS initiative is considered to be a good practice because it offers farmers a holistic and comprehensive approach to improving sustainability and reducing drought disaster risk. Biodiversity, healthy soil and healthy ecosystem functions are crucial for resilient farming systems. Single-focus approaches, which address annual crop issues alone, are not robust enough to withstand the complex and multiple environmental stressors experienced in marginal tropical and sub-tropical locations.

Farmers in Africa often face challenges such as drought, insect attack and disease. These can potentially devastate a farmer and leave him or her with no harvest. However, farmers using the FMAFS are ensured a minimum harvest of varied products in any given year, because of the wide range of biodiversity employed in the System even in the face of challenges.

The FMAFS also builds soil fertility and restores degraded lands without relying upon expensive and sometimes environmentally harmful agricultural chemicals. The FMAFS is affordable and accessible to the poorest farmers and while exotic species are used in the FMAFS, indigenous vegetation forms the foundation of this farming approach.

Last but not least, the FMAFS has helped to bring about a much needed paradigm shift in farmers' thinking. Traditionally, farmers saw themselves primarily as millet farmers and viewed trees as weeds. The FMAFS helped farmers to broaden their definition of farming and accept agroforestry. The FMAFS project introduced a robust, resilient farming system that restores ecosystem functions. It replaces a farming system that was environmentally destructive and extremely vulnerable to multiple challenges, including drought.

The Challenges

The main challenges have been:

- Farmers have been slow to move away from annual crop farming to agroforestry. Acceptance of agro-forestry has taken over a decade. A main obstacle was that farmers viewed trees as weeds and nuisances.
- Tree ownership policy also compounded the negative relationship between farmers and trees. When the FMAFS project began, all trees were owned by the state. In 2004, the Niger

Government moved a step closer to allowing for private ownership of trees thanks to advocacy efforts by donor community stakeholders. Private tree ownership will greatly boost farmer confidence to plant and protect trees.

- Farmers sometimes have specific fears or concerns about trees and are reluctant to leave them in their fields. These fears need to be addressed thoroughly. Sometimes this takes years of work, other times not. When the reasons for not wanting trees on farms are understood, then appropriate measures can be taken. For example, there may be a legitimate fear that somebody else will steal the tree, that annual food crops will suffer or that trees will bring about conflicts with nomadic herders. When understood, these fears can be addressed appropriately.
- The population of Niger has also been slow to adopt acacia seed as a food source. Despite all the benefits, demand for the seed has been low. The recent opening up of a small acacia market has resulted in increased demand.

Lessons Learned

The key lessons learned from the initiative are:

1. Winning farmers' trust is crucial. Close working relations between SIM staff and farmers in Niger contributed to the success of the FMAFS. The FMAFS builds on over 20 years of SIM development activities in the region, which created a great deal of trust. SIM staff liaised closely with farmers to understand their needs and the root causes of crop failure in Niger. When the System was implemented, SIM staff continued to work closely with farmers and persevered even in the face of setbacks, misunderstandings and rejection.
2. Support services facilitate adoption. The farmers' adoption of the System was facilitated by commonly accepted practices such as regular consultations with SIM staff in person and via radio, training programmes, demonstrations, field visits, and the use of field staff and volunteers living in the villages.
3. New market generates interest. Opening up of a small market for acacia seed and wood, in conjunction with FMAFS implementation, greatly boosted farmers' interest in the FMAFS.
4. Farmer-to-farmer communication is key Exchange visits and fostering dialogue among farmers is very important.
5. National laws may need to be changed. National policies on land and tree ownership may discourage or prevent farmers from taking steps to improve their farms and farming systems. If this is the case, the first action taken should be advocating for favourable laws.
6. Treat the FMAFS as a set of guiding principles. The FMAFS should not be seen as a strict blueprint that farmers must adhere to but rather a system with flexibility. A certain layout or combination of species does not have to be used. It is critical to examine the situation, listen to farmers' needs and special circumstances, and be prepared to adapt the FMAFS.

Potential for Replication

Now that a working model has been implemented and tested, the FMAFS will be much easier to replicate in other areas. Ease of replication depends on a number of factors, including:

- Farmers' perception of their needs. Farmers need to recognize that their current farming system is not meeting their needs and to understand the many benefits of FMAFS and be willing to change their traditional approaches.
- Skill and understanding of change agents. The change agent plays a special role in helping people to understand their actual situation and to be willing to try new ideas. The change agent can greatly help or hinder adoption of new techniques. Empathy, persistence, patience, skill and flexibility are key attributes. Those who implement FMAFS in their farms need training in tree planting, management, harvesting and processing of Acacia seed and an understanding of how to capture the range of benefits and products from the FMAFS. Key farmers with good FMAFS farms themselves can be powerful examples and adoption motivators for other farmers.
- Collaboration/endorsement of government stakeholders. Affordable sources of good quality crop seed for planting is required from government agencies and partner NGO's. Access to research results and understanding of their implementation at the farm level will help adoption and replication of improved

components of the FMAFS. Where possible NGOs should collaborate with government extension services in promotion of FMAFS. Government endorsement can go a long way in giving credibility to new farming systems such as FMAFS.

- Existence of favourable natural resource policies. Farmer ownership of trees and their natural resources is vital to encourage their investment in a new farming system. Government agencies and policies need to support and promote the farming systems.
- The presence of coppicing tree stumps on farmers fields. FMNR is based on the regeneration of shoots/branches from tree stumps. Many tree species in semi-arid regions of Africa have this growth/survival system and the stumps of trees are still present in many agricultural areas.

For more information, please contact:
Tony Rinaudo (Tony.rinaudo@worldvision.com.au and Peter Cunningham, peter.cunningham@sim.org)

PAKISTAN
Enabling communities to develop, implement risk reduction strategies

Empowering Citizens to Come Together to Mitigate Risk and Build Resilience

Taraqee Foundation[9]
(in partnership with National Engineering Services Pakistan - NESPAK)

Abstract

The 1998-2004 drought swept through the whole of Pakistan, affecting severely almost 50 per cent of the country's districts and over 15 million people living below the poverty line. The most severely affected region was the western province of Balochistan, especially the Rodh Malazai union council[10]. In this area, where agriculture and livestock are the main sources of income, the groundwater table fell so sharply that water shortage hit some 90 per cent of the population. Over 60 per cent of orchards were badly damaged. Drinking water had to be transported with water tankers from faraway places.

To cope with the drought, the community began migrating or selling their languishing livestock much below the market prices. Some members of the community spent their savings to prevent their orchards from drying up and their animals from dying - with water purchased and transported from faraway places. The area's annual income fell from 80 million to 10 million rupees.

In July 2003, a project known as "Rodh Malazai Pilot Project" (RMPP) was initiated, with funding from a countrywide Drought Mitigation and Preparedness Programme launched, in 2002, by the Pakistan Poverty Alleviation Fund (PPAF). The Project sought to minimize drought risk by both developing infrastructures and empowering the community. Practical solutions were applied in a participatory manner, including building dams, water channels, reservoirs, flood protection walls, and rehabilitating or improving wells and other infrastructures. Maximum use was made of local resources and skills through the establishment of community organizations and a task force, all involved in decision making.

The Project enabled the community to develop good practices and strategies. Rainwater is now conserved and used efficiently. Better agriculture and irrigation practices are being adopted. Livelihood has been diversified and the community stopped relying solely on agriculture and livestock. Community organizations and a task force now exist to resolve drought-related issues. More importantly, the community now acknowledges that drought is a recurring phenomenon rather than a surprise.

In summary, the impact of drought has been reduced considerably in Rodh Malazai: the community is now more resilient. Meanwhile, the Project currently is being replicated all over Pakistan in communities which share similar conditions with Rodh Malazai.

The Initiative

The 1998-2004 drought in Pakistan affected severely the residents of Rodh Malazai Union Council in Balochistan Province (western Pakistan). The union council is inhabited by a population of 14,319 that live in some six mouza (sub-units):

Yusaf Kach, Mullazai, Shudan, Pani Shakh, Kodak and Harchand. The population relies on livestock and crops such as apricots, peaches and apricots. Their area is rugged, very dry and situated at an elevation much higher than the rest of Pakistan. Due to the area's dryness, people use a unique, centuries-old way of gathering water, known as karez. In the karez method, underground tunnels are built to collect subsoil water at the foot of hills through gravitational pull. The water is then either transported to fields and villages through underground vertical shafts or drawn out at the site where it has been collected.

Before the 1998-2004 drought set in, the main source of water was the perennial Toghai Nullah stream supplied by melting snow from the mountains. The secondary source of water - for drinking and irrigation purposes - was groundwater that was collected using karez dug wells, dug-cum-bore wells and borewells. After the drought, the Toghai Nullah stream completely dried up and people became dependent on the wells and karez and earthen reservoirs - which also started to dry up. The groundwater table eventually fell below 700 feet (2.13 m) and water became extremely scarce. Water shortage hit some 90 per cent of the population and some 70 apple orchards dried up. Drinking water had to be transported with water tankers from faraway places.

To cope with the drought, the affected community began migrating. A section of the community spent their savings to prevent their orchards from drying up and their animals from dying. They bought water from faraway places, transported it with water tankers, and watered their plants and animals. People started selling their animals to buy food and medicine. The annual income of the region fell from 80 million to 10 million rupees. The population was on the verge of a calamity. Out of necessity, they sought out alternative ways of earning a living, such as doing manual labour for nearby construction projects.

In 2002, a countrywide drought mitigation and preparedness programme was launched by the Pakistan Poverty Alleviation Fund (PPAF). One project that received funding under the Programme was the Rodh Malazai Pilot Project (RMPP). Initiated in July 2003, the RMPP sought to mitigate the effects of the prolonged drought and to prepare communities to deal with similar situations with enhanced capacity and proactive measures.

The Project was led by Taraqee Foundation with funding from the Pakistan Poverty Alleviation Fund (PPAF) and the World Bank. The National Engineering Services Pakistan (NESPAK) provided consultants to carry out its feasibility and design study.

The project was implemented by engineers from the Taraqee Foundation who worked closely with local social mobilizers, social organizers, contractors, field staff and other members of the community. Some 50 community organizations and a task force were formed to help implement the project. The task force comprised representatives from the Taraqee Foundation, an elected representative from each mouza (sub-unit), selected representatives from local authorities and the nazim (mayor) and naib nazim (deputy mayor) of the union council.

The defining principle of the Project was: fulfilling the needs of the communities in terms of infrastructure facilities while generating a range of social development activities. The sequential steps included identification of small physical infrastructure schemes, and formation, organization and training of village community organizations.

The main goals were to: (1) Strengthen the capacity of local communities to plan, develop and manage their own drought response strategies; and (2) Provide the communities with the decision-aiding facilities needed to access pertinent information on the management and conservation of vital natural resources such as soil, water and vegetation.

Several infrastructure development projects were carried out. The projects focused mainly on: dams (delay action dams and check dams); water channel/course lining; karez rehabilitation; drinking water schemes; improvement of dug wells; reservoir construction (concrete construction

of earthen reservoirs); flood protection walls; spate irrigation; gravity pipeline; and sprinkler/bubble irrigation system.

Many supporting activities were implemented to get all community members involved in drought mitigation and preparedness. Residents were prompted to adopt good irrigation practices and to view water as a precious resource. Land retrieval and watershed management were introduced to reclaim land that could be lost to flooding. Steps for capacity development, communication and social mobilization were taken. A series of training sessions, workshops and exposure visits were organized, aimed at increasing people's capacity and preparedness to deal with future droughts and minimize drought impact.

The "communication and mobilization" activities aimed to create community awareness and ownership of the natural resources and promote the concepts of self-help and sustainability - through BBC (British Broadcasting Corporation) material, documentaries and community dialogues. Much of the working of the initial project has been completed, there are subsidiary project under way.
Impacts and Results

1. The Project has enabled the community to develop good practices and strategies to conserve water resources. Rainwater is now conserved and used efficiently. The effects of drought have been considerably reduced.
2. Better agriculture and irrigation practices are being adopted.
3. Livelihood has been diversified and the community is not relying solely on agriculture and livestock. As a result, the impact of any future drought should not be as severe as the last one.
4. Community organizations and a task force with democratically elected representatives now exist to resolve drought-related issues with the well-being of all residents in mind. The Project brought all residents closer together by helping them to develop a shared vision. Individual differences and disagreements that were apparent at the start of the Project had greatly diminished near the end.
5. The community now acknowledges that drought is a recurring phenomenon rather than a surprise. This change in thinking has led its members to devise strategies to withstand future dry spells. They acquired Knowledge on all the basic concepts of making things work from scratch to carrying out full-fledged projects. Efforts were made to diversify their knowledge and provide them with alternative livelihoods to increase their drought resilience.

Key successes of the Project include: the creation of the task force and 50 community organizations; completion of 160 infrastructure projects; the development of 42 drinking water supply schemes and 100 agriculture schemes; completion of 10 flood protection and land reclamation projects; and the construction of eight delay action dams.

A Good Practice

The Rodh Malazai Pilot Project (RMPP) is considered a good practice because:

1. It uses the dual strategy of developing both the infrastructure and the community to minimize drought risk. Steps for capacity development, communication and social mobilization were taken. Training, workshops and exposure visits were held to boost people's capacity and drought preparedness.
2. It focuses on practical solutions that reduce the impact of drought: dams, water channel, karez rehabilitation, improved wells, reservoir construction, flood protection walls, gravity pipeline, etc.
3. It is participatory: some 50 community organizations and a task force were formed. The task force comprised local elected leaders and representatives of the community, local authorities and the project implementer. All the structures above were involved in decision making.
4. It makes maximum use of local resources and skills: the engineers involved worked closely with local social mobilizers, social organizers, contractors, field staff and other members of the community.
5. It seeks to create community awareness of and ownership of natural resources and promote the concepts of self-help and sustainability.
6. It is currently being replicated in other areas of the country.

The Challenges

The Project was faced with the following challenges:

- Rivalry among tribes hampered work as sometimes access roads were blocked, or electricity transmission lines were not allowed to pass through one tribe's land. These issues caused delays as they required inter-community negotiations facilitated by the task force.
- Financing proved to be very problematic. Community organizations faced problems in opening bank accounts for the schemes. As a result, cash transactions were delayed by up to a month. The local community also faced problems in getting the computerized national identity cards required to open a bank account.
- Low levels of illiteracy also presented specific challenges and made the Project generally more difficult to implement. The community organizations faced problems with record maintenance and lacked technical knowledge.
- Accessibility was a major problem. The geographical location of the Project is an area with rough terrain, with little or no infrastructure. The region also has harsh winter weather that reduces the amount of time available for work.

Lessons Learned

The following lessons have been learned from the Project:

1. It is important to teach both mitigation and preparedness to community members. This helped them acquire a comprehensive understanding of drought risk, which in turn makes the adoption of strategies - such as water conservation and developing assets - easier.
2. The concept of community ownership of projects needs to be promoted. The project promoted the concept of that all community members should have a sense of ownership of the RMPP. The project staff encouraged everyone to identify with the Project, participate and feel invested in its final outcome. Community members participated in the decision-making process and contributed financially and manually.
3. Task force formation is an ideal practice to get community elders and others involved. It also makes conflict resolution easier in conflict-prone communities.

Potential for Replication

Being a "pilot project", the RMPP was designed specifically for replication. The rural/tribal set-up of the some communities in Pakistan may pose additional challenges, but task force formation and intensive social mobilization can make community acceptance easier. So, as earlier mentioned, the Project already is currently being replicated all over Pakistan in communities which share the same way of life with the people of Rodh Malazai.

On whether the Project can be replicated in other countries, it can be used as a template or model for a national-level drought management strategy, particularly because of its comprehensive approach. It is to be noted, however, that the Project generally suits hilly areas and needs to be readjusted if it is implemented in plain areas. Last but not least, the Project can be replicated with ease when sufficient funding is available.

Meanwhile, many components of the Project can be replicated on their own. Water conservation and other strategies can be easily replicated anywhere else. And the practices and strategies undertaken in community mobilization and organization can be replicated in regions with strong cultural and traditional values.

For more information, please contact:
Amjad Rashid (amjadrshd@yahoo.com),
Syed Naseebullah (Naseeb.agha@gmail.com)

TAJIKISTAN
Combating soil degradation with hard-saved organic fertilizers

Efficient Use of Energy Resources to Sustain Agricultural Production in Semi-Arid Areas

Welthungerhilfe

Abstract

Tajikistan is a mountainous landlocked country in Central Asia. From 1924 to 1991, the country was part of the Soviet Union and the population had access to large amounts of highly subsidized

agricultural inputs and fuel sources. However, after the country's independence, many rural dwellers could not buy expensive agricultural inputs or fuel regularly. They rely mostly on locally available resources - which are often used in a highly inefficient and wasteful manner.

Baljuvon and Temurmalik districts, in southern Khatlon Province, are among the country's poorest regions. Their populations are mainly engaged in subsistence agriculture and extensive animal breeding. Even though the two districts are in semi-arid lands, their key water-related problem is not unavailability of precipitation but its uneven distribution. Water cycles are severely imbalanced, with substantial amounts of precipitation and water runoff in winter/spring and pronounced water scarcity during the long, hot and dry summer period.

This, as well as prolonged application of merely exploitative land management practices, have contributed to drastic reduction of soil humus content and poor water infiltration and retention capacity. As a result, agricultural harvests have declined, often preventing farmers from recovering their investment. Yet, large quantities of organic fertilizers are available in the region in the form of animal dung. The problem is that animal dung is generally used by families as fuel material at household level.

To break the vicious cycle between decreasing soil fertility and deteriorating agricultural yields, German development NGO Welthungerhilfe in February 2007 launched with financial support from EC TACIS Programme a project entitled "Integrated Rural Development in the Kyzylsu Watershed Area" in Baljuvon and Temurmalik districts. The project is among other seeking to raise resource use efficiency at household and farm levels so that larger quantities of organic fertilizers could be used on agricultural plots to increase the soil humus content. A second EC TACIS supported Welthungerhilfe project was launched in neighbouring areas in January 2008, a project called "Strengthening the Self-Reliance of Rural Communities through Integrated Natural Resource Management".

The two projects, which are currently working in more than 75 villages, introduced simple but effective modifications to make cook stoves, bread baking equipment and winter heating facilities more efficient. Additionally house insulation techniques are promoted by the project. The low-cost modifications have reduced fuel consumption by at least 50 per cent. Even resource-poor farm households can return substantially larger amounts of animal dung back to their agricultural plots.

Already during the first year of project implementation, farmers who applied more organic fertilizers on their plots noticed clearly the positive effects in terms of plant development, drought resistance and yields. Even though 2008 was again a very dry year - where many farmers almost completely failed to obtain harvests, those who applied larger amounts of organic fertilizers on their land obtained at least reasonable harvests. They halted soil degradation and increased soil fertility with the hard-saved organic fertilizers. In short, they reduced the risk of drought-related crop failure and its negative impact on rural livelihoods.

The Initiative

As mentioned above (see "Abstract"), the two EC TACIS supported Welthungerhilfe rural development projects, initiated in February 2007 and January 2008 respectively, are under way in over 75 villages in the southern province of Khatlon. The province has a continental climate with precipitation from autumn to spring and a hot, dry summer period lasting up to six months. Over 95 per cent of the land in the semi-arid region consists of degraded rain-fed land.

One major goal of both projects is to help the local population raise their living standards by improving the management of remaining deteriorated natural resources. Both projects follow an integrated approach that links various activities at household and farm levels to better manage local resources. To improve agricultural production, a special emphasis is put on reducing soil erosion, increasing water retention, diversifying cropping patterns and rehabilitating the soil's organic matter content. These activities are complemented by actions at household level to improve domestic energy efficiency, which would reduce the use of animal dung as fuel source. Indeed, the local

people's cooking, bread baking and heating facilities are all highly energy inefficient and contribute each to some 30 per cent of household energy consumption. The poorest families use almost 100 per cent of animal dung as fuel material, due to lack of viable alternatives. Annual consumption of dry animal dung as fuel can reach more than 20 tons per family.

To achieve their goals, the two projects focus on the following three elements:

1. Supporting rural development by linking the search for low-cost technological improvements at household and farm levels. Initially, Welthungerhilfe conducted a thorough analysis of cultural habits and environmental and socioeconomic conditions in the areas covered. After identifying the dimension and importance of wasteful energy use at household level, several small follow-up studies were conducted to better understand local energy consumption patterns.
   In a next step, Tajikistan-based NGO SEEDS (Social Enterprise and Ecological Development Systems) was contracted to make first designs for simple, low-cost options to raise energy efficiency, in particular for cook stoves and winter heating systems. The designs were tested in the houses of a small number of rural families. The families worked together with the project staff and a local craftsman to further refine and adjust the innovative designs to better suit local conditions. Apart from saving approximately 50 per cent of fuel material - due to improved air flow, the modified cook stoves have a much cleaner fire.
   More and more women are recognizing the advantages of the introduced innovation and are eager to get involved in the projects. Training events organized by Welthungerhilfe cover the importance of animal dung for farming and include practical demonstrations about how to modify cook stoves. To make the cook stoves much more efficient, simple adjustments are applied to optimize air flow and concentrate the fire where it is mostly needed - underneath the pot. In addition, a simple metal sheet is used to close the front part of the stove during the burning process. The modification of a cook stove normally does not take more than 30 minutes and it is easy to learn by local women who are experienced in working with clay.
   A number of enthusiastic women have acquired advanced skills and are now acting as trainers themselves, educating other rural women about energy efficiency and proper resource management.
   Regarding the improvement of local winter heating systems, the production of so called "heat exchangers" as well as the promotion of low cost house insulation techniques are as well basically simple processes. However, they require a certain level of craftsman's skills. So the project is closely cooperating with and supporting interested local personnel with relevant professional background and experience.
2. Enhancing local people's self-reliance. Rather than adopting sophisticated options to improve energy efficiency, which might be very efficient but expensive and difficult to replicate in local conditions, the projects focus on developing and promoting low-cost innovations that are affordable even to resource-poor farm households. The developed innovations can produce tangible, positive results for agricultural production even long time after the end of the projects.
   By paying emphasis on more careful and efficient utilization of local resources, the innovations help to address some of the most important underlying root causes of low agricultural production in the semi-arid areas and at the same time contribute to reduce dependency on ever more expensive external agricultural inputs.
   Rather than using a lot of financial resources, the projects apply a working approach which requires a good portion of empathy and inspiration to develop together with active community member suitable ideas for sustainable improvements. The two projects purposely chose not to concentrate too much on conventional needs assessments - where local populations often tend to fall back into a position of self-complacency and paternalism rather than focus, right from the beginning, on identifying and developing existing self-help potentials. Indeed, to develop lasting

improvements, helping people broaden their views for existing development potentials is often more important than the creation/ promotion of certain technical innovations itself.

Lastly, to enhance the general sense of responsibility and ownership, Welthungerhilfe generally expects significant own contributions from the target population to different project activities. Nothing is given to them for free.

3. Supporting active networking and information exchange. The projects disseminate information and tools related to proper resource management as widely as possible within the target populations. Farmer-to-farmer exchange visits play a very important role for Welthungerhilfe promotional activities. Here farmers are brought in contact with innovative farmers who, for example, have been applying large amounts of organic fertilizers for a number of years with significant success, and who have the ability to motivate others to follow their example.

   In addition, the projects use existing information-sharing platforms and facilitate self-initiated events to sensitize other organizations for the importance of creating and applying more integrated approaches.

Impact and Results

The two projects have had the following impacts and results:

1. Community awareness of the importance of and potential offered by more careful use of local resources has increased. More and more local farmers understand the need for soil rehabilitation measures and the crucial importance of soil humus content for reducing drought-related crop failure in their semi-arid region.
2. Even though soil rehabilitation is a very complex process that normally takes many years, farmers who applied the recommended energy saving and soil rehabilitation measures already noticed substantial positive changes during the first year. Soil quality improved in terms of nutrient availability, water infiltration and water retention, and prospects for successful agricultural activities have increased. Already after the first application of larger amounts of organic fertilizers, the farmers experienced better harvests for wheat and achieved reasonable harvests in their vegetable gardens - where most neighbours who applied commonly used techniques failed. If such a positive trend spreads, the resilience of rural families and entire communities to drought will increase further.
3. More and more rural households use fuel-saving techniques and return more animal dung back to their agricultural plots. Some 1,000 households are using improved cook stoves and 300 houses have been insulated with significant contributions from house owners. In addition, more and more families are shifting to joint bread baking and the use of "heat exchangers" for more efficient winter heating systems. The technical innovations reduce rural women's and youths' workload regarding fire material collection; they also help to reduce indoor pollution.
4. Already at the current stage, these achievements represent the past decades' most successful comprehensive energy-saving campaign for rural areas not only in Tajikistan but in Central Asia as a whole.
5. The innovations not only spread to neighbouring villages which are not directly targeted by the projects; they also have raised interest in other regions of the country and in neighbouring countries such as Kyrgyzstan and Afghanistan. To fine-tune the profile of their own future activities, a larger number of organizations involved in rural development are acquiring ideas from the two Welthungerhilfe projects.

A Good Practice

The two initiatives can be described as good practices for the following reasons:

1. A holistic and integrated approach has been chosen. It assesses conditions prevailing in project areas in a comprehensive way, not overestimating but also not underestimating existing potentials for enhancing local development through more careful utilization of local resources. For both projects, a thorough assessment has been conducted regarding strong linkages between predominant wasteful energy use at household level and advancing

natural resource deterioration. The projects do not subscribe to a still common misperception that lasting improvements, in semi-arid areas affected by severe soil degradation and occasional droughts, are secured mainly by the application of chemical fertilizers and improved seeds. Instead, an integrated format has been developed, linking various activities addressing wasteful use of energy resources at household level as a crucial element to assure that more animal dung is used as organic fertilizers in the future - to reduce soil erosion and increase soil humus content. The latter is of particular importance as organic material has the potential to substantially improve both soil fertility and water infiltration and water storage capacity. One metric ton of dried organic material has the capacity to store around the same amount of water, which is of special importance in drought-prone areas.

2. The focus is on low-cost, sustainable techniques. Being aware of existing financial constraints among the local populations, the projects concentrate on promoting low-cost techniques which even resource-poor families can afford. Families can easily continue applying the Welthungerhilfe innovations after the end of the projects. This is preferable to spending large parts of project funds on expensive agricultural inputs that may quickly become unaffordable after the end of the projects. In this context, efficient and simple options to improve the use of natural resources can also be seen as a way to optimize the use of available project funds. And to further enhance the impact of projects interventions, initiatives were launched to support information sharing with many other development organizations.
3. The projects recognize people's tendency to resist change and constructively deal with this. "Change" often starts with a few innovative community members who are ready to try out something new. The projects attach high importance to thorough pre-testing of proposed modifications on the houses of families receptive to the idea. Promotional activities are initiated only after the innovative designs have been further adjusted and refined. Even when promoting simple, low-cost techniques, especially in the beginning, sufficient follow-up activities are extremely important to detect at an early stage possible weaknesses which then need to be addressed quickly.

The Challenges

Resistance to change. Even though substantial progress has been made, implementing both projects has been affected by reluctance from most of the people to implement changes. Resistance to change is a common phenomenon and people initially stick to their old habits even when innovations are developed in their own local context and offer many visible benefits. The projects' approach to promoting the use of organic manure rather than chemical fertilizer was a big change from what the people had heard from many other professionals (agronomists, local authorities, development project staff). Many of these professionals and local people still firmly believe in chemical fertilizers and improved seeds even though they have experienced many crop failures by just relying on this approach. Frequent free distribution of agricultural inputs and other materials in the project areas. This continues to affect the development of Welthungerhilfe project activities. Where lots of free distributions occur, people's disposition to make own contributions generally decreases. Furthermore, the ongoing free distribution of agricultural inputs and other materials undermines local self-help capacity, delaying the process of necessary adjustments of farming systems and contributing to inefficient use of project resources.

Lessons Learned

Key lessons learned from the two projects are:

1. Efforts to improve resource use efficiency in poor communities are rewarding. There is significant potential to improve natural resource management among rural dwellers commonly referred to as marginalized or resource poor. Even in resource-poor communities, people end up embracing, participating actively and contributing significantly when they see the benefits of the innovations that have been developed and implemented.
2. A holistic approach is necessary. In rural areas, the use of local resources at household and

farm levels is often deeply interrelated. When seeking to improve resource management, it is worth having a close look at the relationship and connections between the two domains.

3. Involvement of women leaders at community level is crucial. Close cooperation with rural women is vital to project success. Women tend to be particularly affected by the direct and indirect impacts of advancing natural resource deterioration. In many cases, women demonstrate a higher degree of interest in and commitment to the search for improvements. In societies with strong hierarchical structures like in Tajikistan, it is even more important to actively integrate women leaders into community promotional activities. Women leaders' involvement helps to build confidence in other women that the proposed innovations are supported by their leaders and that applying the innovations therefore is socially accepted.
4. Low-cost methods are highly effective. Putting emphasis and efforts on the promotion of low-cost energy efficiency options and solutions at the household level can contribute greatly to soil rehabilitation. Additionally, the limited project funds were used more effectively and benefited more members of the target populations.

Potential for Replication

To develop a specific working method, projects always have to carefully analyze the existing situation in project areas. From that point of view, there is no easy way of replicating what has been developed in one project to another. However, there are some general considerations that can make the desired replication easier:

1. Wasteful use of scarce energy resources at household level is common in many semi-arid regions as well as in other climatic zones. Therefore, linking resource use efficiency at household and farm levels with agriculture production is widely applicable in various local contexts.
2. The projects' focus on promoting simple, cost-efficient innovative technology and practices is widely applicable in other regions and countries.
3. A few years ago, it could be difficult to easily obtain funds for developing and spreading efficient, low-cost options for enhancing resource use efficiency. But now that an international financial crisis is impacting negatively on the prices of energy, food and other items, which makes resource-poor households even more vulnerable, there is renewed interest in funding down-to-earth practices.
4. Increasing economic pressure and fuel scarcity can become a strong incentive for rural communities to improve resource use efficiency. Many projects and institutions are looking for viable options to assist them in a sustainable way.

The process of scaling up the Welthungerhilfe innovations in other parts of Tajikistan and neighbouring countries has already been initiated and is expected to be further strengthened in the future.

Despite some achieved progress, the developing of a suitable integrated approach for sustainable natural resource management in the region still needs to be considered as "work-in-progress". For instance, the ongoing project activities were recently complemented by the development and promotion of low-cost rain water retention structures which offer another huge potential for more careful and productive use of available resources by the local population.

For more information, please contact:
Mr Frank Löwen (floewen@gmx.de)

References

1 Data contributors to the NAMS include Australian Bureau of Agricultural and Resource Economics, Australian Bureau of Statistics, Australian National Committee on Irrigation and Drainage, Australian National University, Bureau of Meteorology, Bureau of Rural Sciences, Canegrowers, Commonwealth Scientific and Industrial Research Organization (CSIRO), Cotton Australia Limited, Dairy Australia, Department for Natural Resources (New South Wales), Department of Agriculture and Food (Western Australia), Department of Land Information (Western Australia), Department of Natural Resources and Water (Queensland), Department of Natural Resources Environment and the Arts (Northern Territory), Department of Primary Industries and Fisheries (Queensland), Department of Primary Industries and Resources (South Australia), Department of Primary Industries and Water (Tasmania), Department of Primary Industries (New South Wales), Department of Sustainability and Environment (Victoria), Department of Water Land and Biodiversity Conservation (South Australia), Department of Water (Western Australia), Environmental Resources Information Network, Geoscience Australia, Goulbourn-Murray Water (Victoria), Grampians Wimmera Mallee Water (Victoria), National Land and Water Resources Audit, National Water Commission, Rural Lands Protection Boards, Southern Rural Water (Victoria), SunRice and SunWater (Queensland).

2 Peste des petits ruminants (a French term) is also known as pseudorinderpest of small ruminants, pest of small ruminants, goat plague, pest of sheep and goats, kata, stomatitis-pneumoenteritis syndrome, contagious pustular stomatitis and pneumoenteritis complex. It is an acute or subacute viral disease of sheep and especially of goats, characterized by sudden fever, nasal discharge, congestion of conjunctiva, bronchopneumonia, necrotic stomatitis and diarrhoea… There is a breed-linked predisposition in goats… The disease is transmitted through direct contact between animals… (Source: European Commission, DG Health and Consumer Protection)

3 MoLFD: Ministry of Livestock and Fisheries Development

4 LWF: Lutheran World Federation
VSF-B: Vétérinaires Sans Frontières - Belgique, Veterinary without borders – Belgium

5 DLMC: District Livestock Market Council
LMA: Livestock Market Association

6 CAHW: Community Animal Health Worker

7 Shifting agriculture is a system of cultivation that preserves soil fertility by plot (field) rotation, as distinct from crop rotation. In shifting agriculture, a land plot is cleared (for instance through slash-and-burn) and cultivated for a short period, then it is abandoned and allowed to revert to its natural vegetation while the cultivator moves on to another plot. Shifting agriculture has frequently been attacked in principle because it degrades the fertility of forestlands of tropical regions.

8 The SIM project 'Sowing Seeds of Change in the Sahel' is made possible by donations through SIMaid (the aid arm of SIM Australia), SIM Canada, SIM USA and other SIM offices. <http://www.sim.org/>

9 Taraqee Foundation is a national-level Pakistani NGO working for poverty alleviation. It operates in two provinces, including Balochistan Province.

10 A "union council" or "village council" in Pakistan is an elected local government body consisting of 21 councillors and headed by a nazim (equivalent to a mayor) and a naib nazim (deputy mayor). Union councils are the primary governmental institutions and are the fifth tier of government: above them are the tehsil (a district subdivision), the district, the province and the Federal Government. The territory covered by a village council usually comprises a large village and surrounding areas, often including nearby small villages. The term "union council" may be used for localities that are part of cities.

Annex 4: Key information, good practices and challenges to illustrate the proposed drought risk reduction framework, results of the 3rd African Drought Adaptation Forum, 17-19 September 2008, Addis Ababa, Ethiopia

Key principles suggested in "Drought Risk Reduction – Framework and Practices"	Feedback from the Participants on key principles (Corresponding elements and key principles)	Existing good practices (Corresponding elements and key principles)	Challenges/Gaps/Needs (Corresponding elements and key principles)
1. Policies and Governance for drought risk reduction			
1) Political commitment, strong institutional and appropriate governance for mainstreaming drought risk reduction into disaster risk reduction and sustainable development 2) A bottom-up approach, community participation and decentralization 3) Capacity building and knowledge development 4) Drought policies with a clear set of principles or operating guidelines 5) Drought policies and plans emphasizing mitigation and preparedness rather than solely emergency relief	(1-1) Importance of improving infrastructure, general development. (1-1) Importance of policy integration: Drought, flood, economic development should not be stand-alone. (1-1 through 1-8) Each country should have a policy and strategy on drought management including vulnerability and risk assessment, coping mechanisms, action plans and funding. (1-1, 1-4) Importance of the integration and linkage of various strategies and frameworks for DRR, CC, CCD etc (e.g. Joint implementation of UNFCCC National Adaptation Programmes of Action (NAPAs) and UNCCD National Action Programmes (NAPs) and DRR strategies). Leverage funding for DRR based on these strategies. (1-2) Importance of community participation in elaboration of development plans.	(1-1) Botswana has well structured institutional arrangements - National Early Warning Technical Committee (N. E. W. T. C.) linking the Office of the President, Cabinet, rural development councils and district level drought committees (1-1) Botswana/Ethiopia/Kenya: Government provides contingency funding in the case of drought although more focus is placed on emergency response to drought (1-1, 1-2) Ethiopia: legal status for pastoralists association (1-1) Iraq Kurdistan Regional Government has coordination mechanism for transboundary water allocations. (1-1, 1-4) Kenya: Many policy initiatives exist on DRR with complementarily. Development of a master plan with inter-ministerial dialogue and coordination. Kenya as a model for working on drylands issue beyond DRR. (1-1, 1-2, 1-6) Lesotho: Government set up a ministry mandated to mainstream soil conservation, afforestation etc. DRR is being built into educational curriculum. A national platform for DRR has been launched and is now finding ways to decentralize it to local authorities. Disaster Management Authority undertakes annual vulnerability assessments that are meant to inform both decision making and development programming.	(1-1) How to link the drought strategy into the national development planning process is a challenge. (1-1) Burkina Faso/Kenya: Need for more coordination between different ministries (e.g. agriculture, water etc) (1-1) Morocco/Lesotho: Many sectoral strategies with sectoral mainstreaming, but weak integration of drought and climate change. Need policies to link all the separate initiatives. (1-1) Appropriate resource allocation is needed (1-2) Need for a national coordinating mechanism that embraces both government as well as civil society. Some countries with problem of top down planning. (1-2) Namibia/Ethiopia: Structures could include departments of disaster prevention and with linkages down to community levels at risk. (1-3) Kenya: Needs for coherent support. In order to cross-sectorally mainstream drought risk reduction, it is necessary to get other line ministries on board and securing investment of national and decentralization budget. Political will, financial support and constituency consultation and buy-in is needed.

6) Drought monitoring, risk assessment, and the identification of appropriate risk reduction measures 7) Policy mechanisms to ensure the implementation of drought risk reduction strategies 8) Sound development of long-term investment in mitigation and preparedness measures	(1-2) Local systems (e.g. associations) (1-3, 3-4) Technical assistance and training (1-3, 3-4) Using extension services to educate on appropriate crops for capacity building. (1-6) Change in practices to be driven by policies (e.g. irrigation) (1-6, 1-7) How much will drought preparedness information influence actual decisions (i.e., do political considerations override information and indicators?)	(1-1) Mali: Programme for sustainable land management, which touches on many environment problems and coordination, and is presented as part of the investment strategy, thus ensuring mainstreaming. Centre of Disaster Management is in place as a mechanism for implementing national, regional and local plans for DRR including plans for economic development and natural resource management at local level. Coordination body (e.g. Min. of Environment) meets quarterly with line ministries and donors. (1-1, 1-4) Morocco: Integrating the various strategic frameworks (e.g. NAPA) and capitalizing on political receptivity to mainstream drought risk reduction into planning processes, using the Hyogo Framework (1-1) Mozambique: National Institute for Calamities Management; DRR working group of donors, monthly meetings with Min. of Environment and presentation of NAPA etc. leading to alignment by donors. (1-1, 1-4) Niger: The government focuses on poorest. National initiative for a common forum exists for investment in rural development, food security, and anti-desertification with 13 signatories. Common coordination. Mechanism for concerted action. A fund exists in which all donors join. Prime Minister's office assembles all ministries, FAO, donors, private sector investors, etc. (e.g. if issue relates to pastoralism, "Dispositive National pour la Prevention et Alimentaire : Accord Cadre" is invoked.) (1-1, 1-7) Uganda: Integrate DRR into local planning processes (1-1, 1-3) UN ECA: Mainstreaming drought risk reduction into development policy (Climdev programme, African Climate Policy Centre) (1-2) Togo: Engagement of communities and relevant systems and institutions in the development and updating of the policy and plans.	(1-3) Morocco: Looking for technical assistance and expertise. (1-6) Need for promotion of the Total Economic Valuation (TEV) of pastoralism conceptual framework, to inform national policy, to change mind-sets towards, and investment in drylands. TEV is composed of four "values" with which to assess the total economic value of pastoralism to a national economy. This is needed to assess the value of pastoralism that goes beyond conventional economic criteria, to provide fresh insights into its contribution to poverty reduction, sustainable environmental management and the economic development of dryland areas of East Africa in the context of increasing climate uncertainty. (1-7) Mali: DRR and climate change adaptation are not reflected in practical fashion into policy and sectors and decentralized level. (1-7) Niger: Need to address land use planning as one of the tools to benefit the natural environment (1-8) Botswana, Ethiopia, Kenya: Government provides contingency funding in the case of drought but it still focuses more on emergency response to drought

		(1-3) Kenya: Work with scientific cadre (Least Developed Countries Expert Group), GEF adaptation programme, NAPAs alignment. Fellowships available. The government capitalizes upon scientific elements of other resources on international agenda – Food Crisis Funds, biofuels, etc. (1-5, 1-6) Ethiopia: Crop weather insurance (1-5, 1-6) South Africa: Weather-triggered disaster response (1-6) Syria: Moving from flood irrigation method to drip irrigation, funds allocated under government budget and provide subsidies as an incentive. (1-7) Morocco: Capitalizing decentralization process for disaster risk reduction. Develop and reinforce tools and skills for decentralization. (1-7) South Africa: A comprehensive "Green Paper on Disaster Management" is used down to local level via local authorities	
2. Drought risk identification, impact assessment and early warning			
1) Managing drought risk with clear understanding of hazard, vulnerability and related factors in space and time 2) Strengthening individual, community, institutional, and national capacities to reduce vulnerability 3) Impact assessment for drought risk identification and to target vulnerable groups and sectors	(2-1, 2-3) Drought risk identification and vulnerability assessment (definition and application) (2-1, 2-3, 4-7) Drought risk mapping including baseline of resilience and mapping of livelihoods and economic issues (local to national). Broader vulnerabilities e.g. health, economic (crop and livestock production, power generation) and specific vulnerable groups (e.g. women and children). (2-2) Importance of increasing systemic capacities as national priorities	(2-1, 2-3) Lesotho: Annual vulnerability assessment to inform Cabinet on the most vulnerable population and for national investments/budget. Political sensitiveness exists (e.g. situation similar to Zimbabwe, Zambia and Kenya). (2-1, 2-3) Niger: Niger links to Sahelian AGRYMET/CILSS approach to concerted identification of vulnerable zones, planning a workshop on this to identify priority early responses in the Sahel countries (2-2, 2-4) ICPAC: Climate Outlook Forum (e.g. DMC in Botswana, AGRHYMET in Niger) brings in media (reporters) to witness the scientists' discussions and report in public media – brings in meteorologists from 10 countries, and stakeholders for various sectors incl. agriculture, health (malaria), energy (hydropower), to develop strategies as to how to respond, prepare, warn, etc.	(2-1) Necessity for multi-sectoral, integrated approach (2-1, 2-3) Lesotho: Looking at multiple hazards (incl. overlapping hazards, risks of slow-onset and rapid-onset risks, different space and time etc.) is needed. (2-2, 2-4) The role of communities and traditional knowledge in defining, characterizing and responding has been overlooked. (2-3) Lack of common impact indicators and common monitoring measures. which are needed for cross-country comparisons. (2-3) Namibia has disconnection between the drought assessment (agriculture) and the implementation of action (disaster agency).

4) Drought monitoring and early warning systems in risk identification, impact assessment, and knowledge management 5) Coping with changing climate and the associated changing nature of drought	(2-3, 4-7) Impact assessment including the impact of cross-border or second country actions and global issues such as subsidies (2-3, 2-4, 3-2) Development of appropriate and standardized indicators. Utilization of local knowledge and practices and their linkage to indicators (2-4) Importance of effective observation systems for drought monitoring, prediction and application of early warning (2-4) Community level is important as a first point of early warning. Need to have real time data also at national level to be operation. Should be clear criteria on when a drought is to be declared. (2-4) Climatological systems (e.g. regional drought monitoring and national services) (2-4, 2-5) Climate data/ products are an important input to early warning on drought.	(2-2) Morocco: planning international forum on oasis management in March 2009. UNDP DDC is supporting. (2-3, 2-4) Botswana: The periodic district level assessment contributes to a national level drought assessment report. . (2-3) Ethiopia: Community identified the risk and there are also specific risk assessment carried twice per year (2-3) Morocco leaves out detailed statistics, and focuses on livelihoods indicators. (2-3) Togo: Programme in Togo carries out risk assessment and shares info with other ministries. (2-4) Somalia: Food and nutrition security monitoring (e.g. FAO Food Security Analysis Unit (FSAU) (2-4) Togo has early warning system at local level which responds to national level. (2-5) UNCCD secretariat has sessions with special focus on CC. (2-5, 3-3, 3-4) UNDP is piloting initiative to adaptation strategies in four countries under “coping with drought” brand.	(2-3, 4-7) Need for analysing different scales from local impact to national economy, and at cross-border and global levels (2-3, 2-4) FEWSNET attempts to assemble multi-hazard data and information but not well linked to national and regional institutions, and sustainability would be an issue. The data collection system uses common format at national level. It is not clear how this reporting system can include all risks and priorities in the local and regional levels (e.g. poverty map, food security etc). (2-4) Unavailability of data/information and how to synthesize them is a problem for early warning. (2-4) Duplication and inconsistency in multiple reports regarding national, regional forecasts on drought and weather. (2-4) Need for clear response to assessment results, immediate and subsequent policies etc.
3. Drought awareness and knowledge management			
1) Well informed and motivated community toward a culture of disaster prevention and resilience to reduce effects of drought	(3-1) Planning before the event – identification of pertinent networks and coordination. (3-1, 3-3) Communication strategy is essential as part of the national strategy.	(3-1, 3-3) Togo has strategy to strengthen capacity at national level. (3-1, 3-2) Capacity building networks (e.g. Cap-Net) (3-2) UNDP, UNISDR: African Drought Risk and Development Network	(3-2, 3-3) Need for sharing and two-way movement of knowledge/ feedback. (3-2) Alliance of partners from different layers (e.g. central, local and private sector) needed. Unclear areas include who manages the network of networks, what/who is in the networks, levels of data/networks (e.g. national and/or regional) and at which level synthesis will take place (e.g. between technical and traditional knowledge).

2) Well informed and motivated community toward a culture of disaster prevention and resilience to reduce effects of drought 3) Effective information management and exchange with strong dialogue and networks among disaster researchers, practitioners, and stakeholders 4) Public awareness programmes with a clear understanding of local perspectives and needs, and engagement of media 5) Education and training in order to reduce local drought risk	(3-1, 3-2) Knowledge sharing is essential for drought management and to reduce vulnerability, and can best be achieved through networking. (3-2) Knowledge flow involves the process to generate, identify/capture, structure, disseminate and share linked to education and awareness. (3-2) Develop evidence-based knowledge, arguments & communications tools on CC, drought & desertification to use for audiences at different levels. (3-2) Public/private partnership in investments in DRR interventions. (2-4, 3-2) Utilization of local knowledge and practices, link to indicators, Incorporate indigenous knowledge in dissemination of information. (3-3) Development of appropriate tools (e.g. exchange of experiences, awareness- raising). (3-3) Appropriate awareness-raising has to be audience-specific and demand driven. (3-3) Role of media for awareness-raising (3-3, 3-4) Tailor made capacity development with relevant ministries and for communities to turn information into action.	(3-2) UNEP's Development Platform for the Horn of Africa (DEPHA): DEPHA collects data sets to support countries in Horn of Africa on indicators in reference to MDGs with vulnerability indicators/ mapping. (3-2) Need to benefit from different analogous initiatives, e.g., TerrAfrica (World Bank). (2-4, 3-3) UNDP: Capture traditional knowledge about signs of drought and to mobilizing preparedness and response. (3-3) Namibia: Advocacy through the media. Drought is slow onset and not so media attractive as floods (3-3) Northern Kenya: Community radio programmes by pastoralists journalists on drought risk reduction and climate change adaptation. (3-3) SADC: Network of climate journalists and technical networks to share climate data/products (3-3) Botswana: Periodic assessment and awareness-raising campaigns for different villages by district committees. (2-5, 3-3, 3-4) UNDP is piloting initiative to adaptation strategies in four countries under "coping with drought" brand. (3-3, 3-4) Emergency response capacity being developed for Iraq Kurdistan Regional Government. (3-4) Ethiopia: Workshop on Transboundary Rangeland Management for Livestock Feed Security, Addis Ababa, mid-November 2008, to better prepare for forage, feed and fodder needs in the event of drought.	(3-2, 3-3) Climate data/products are not reaching out to community. Appropriate communication is needed for different audience. Linking of the climatological and hydrological information to the user community (producers and users, as in the Climate Outlook Forum approach – evidence-based, challenging) (3-2) Need for networking in multiple languages (e.g. DryNet). More open network to engage and benefitting from francophone and lusophone initiatives & expertise. High cost is a hurdle. (3-2) Exchange visits/ study tours are suggested for building skills in partner countries to conduct effective analysis to optimally achieve results (3-2) Develop "peer assist" mechanisms using new virtual collaboration tools to share specific ideas and good practices (e.g. Community of Practice websites) (3-2) Need for forming a group to take on leadership in shaping Action Plan (3-2) Need for online calendar of events (3-2) Need for info on how application of strategies /framework has worked in other places and to showcase concrete successful examples. Benefit will come from transboundary networks. (3-2) Developing accessible info / briefs for local, national audiences (3-3) Need for scenario development (3-3, 4-7) Linking of economic and social impacts to national policy issues (2-5, 3-3, 4-7) Need for clarifying climate data. (3-4) Need for Information at schools level – curriculum.

	(1-3, 3-4) Rural extension services (with identification of appropriate models) for linkages to producers. Using extension services to educate on appropriate crops etc.	(3-4) Northern Kenya: Holistic Planned Grazing & Rangeland Management initiatives and capacity building around the Laikipia Wildlife Forum, Northern Rangelands Trust and Enhanced Livelihoods in the Mandera Triangle (ELMT) project – pilot sites are ready to spread to Ethiopia in the context of participatory community resource management.	(3-4) Showing people alternatives and sharing experiences at local level.
4.Reducing underlying factors of drought risk (e.g. environmental management, climate change, socio-economic factor, consideration of vulnerable groups and gender)			
1) Mechanisms to bring together practitioners and institutions involved in disaster risk reduction, sustainable development and environmental management 2) Identification of areas of overlap and synergy between existing programmes and activities relevant to drought risk reduction. 3) A mechanism for assessment to integrate disaster risk reduction and environmental protection parameters 4) Specific attention to socio-economic high-risk factors such as age, disabilities, social disparities and gender and protection of most vulnerable groups	(4-1. 4-2) Linking drought risk to disaster risk reduction. Optimizing sustainable water use management (e.g. dam utilization, sustainable land use linking their policies. Importance of development, poverty reduction and improving food security (4-3) Any change in practice has to be measured against environmental conditions (e.g. soil etc). (2-3, 4-4) Addressing societal and intra-household inequalities (power relationships), broader vulnerabilities (e.g. health and economic activities such as crop and livestock production and power generation), specific vulnerable groups (e.g. women, children) and impact on specific socio-economic groups. (4-7) Importance of recognizing the cross-cutting, integrated aspects of governance, local development and infrastructure development to reduce vulnerability. Importance of the impact of cross-border or second country actions and global issues such as subsidies, socioeconomic factor and the development of income or loss of income.	(4-2) Kenya: Better water management e.g. Kitui sand dams (4-4) Botswana involves identification of especially vulnerable group (e.g. children under the age 5 and school children) and preparation of special programmes for these targeted groups. (4-6) Diversification of livelihoods and promotion of pro-poor economic growth (aiming to increase resilience). Enhancing infrastructure (e.g. cereal banks) (4-6, 5-1) Role of insurance schemes (e.g. Malawi: Index-based weather insurance by WB, Ethiopia: Weather-indexed livelihood protection scheme by FAO and WFP). (4-7) Application of climate info/products	(2-3, 4-7) Different scales from local impact to national economy and then in to cross-border and global

5) Post-drought recovery planning incorporating drought risk reduction strategies for future 6) Safety net such as insurance mechanisms as well as microcredit and financing for ensuring minimum livelihood means to accelerate post-drought recovery process 7) Specific attention to other risk factors such as lack of basic infrastructure, lack of governance structure, conflicts, cross-border impacts, impacts of macro-level (economic and trade) policies and impacts of climate change			
5. Effective drought mitigation and preparedness measures			
1) Mitigation and preparedness rather than relying solely on ad-hoc emergency response measures 2) Dialogue, exchange of information, and coordination between disaster reduction, development, and disaster response actors	(5-1) Importance of planning and structuring before the event, based on scenarios, contingency planning etc. (5-2) An integrat ed approach needs collaboration of partners. (4-7, 5-2. 5-3) Relevance of cross-border impacts.	(4-6, 5-1) Role of insurance schemes (e.g. Malawi: Index-based weather insurance by WB, Ethiopia:, Weather-indexed livelihood protection scheme by FAO and WFP). (5-3) Iraq Kurdistan Regional Government: Adjust water allocation according to prospects of drought informed by climate data/ products	(5-2) Need for more widely sharing existing info on “success stories” on combating aridification// degradation, (e.g., Kenya: Kitui sand dams / sub-surface dams to recharge aquifers on a landscape scale) (4-7, 5-2. 5-3) Need for cross-border, inter-national as well as national and intra-national approaches.

3) The selection of appropriate drought mitigation and preparedness measures with due considerations on such factors as environment, development, land use planning and climate change adaptation 4) A combination of top-down and bottom-up approaches for implementing effective mitigation and preparedness measures 5) Strengthened institutional capacity, coordinated mechanisms, identification of local needs and indigenous knowledge for effective mitigation and preparedness 6) Monitoring and early warning as key elements of disaster preparedness 7) Drought mitigation and preparedness with long-term commitment of resources	(5-5) Combination of policy and practices, which demands empowerment and capacities for institutions (defined in the broadest sense, including bodies that have the power to influence policy and implementation, communities etc.) (5-7) Policies should be reflected in resource allocation.	(5-3) Kenya: Sand dams in Kitui. Sub-surface dams to recharge aquifers on a landscape scale (5-5) Ethiopia: Workshop on Transboundary Rangeland Management for Livestock Feed Security, Addis Ababa, mid-November 2008, to better prepare for forage, feed and fodder needs in the event of drought. (5-5) Northern Kenya: Holistic Planned Grazing & Rangeland Management initiatives and capacity building around the Laikipia Wildlife Forum, Northern Rangelands Trust and Enhanced Livelihoods in the Mandera Triangle (ELMT) project – as learning and pilot sites, ready to spread to Ethiopia in the context of participatory community resource management	

Annex 5 Drought-related bibliographic references

(key references are highlighted in bold)

NOTE: The bibliographic references are organized by section in relation to the proposed elements of the Framework for Drought Risk Reduction to facilitate additional research.

Subsections:

Reference Section 1: Policies and Governance for Drought Risk Management
Reference Section 2: Drought Risk Assessment, Impact Assessment, and Early Warning
Reference Section 3: Drought Awareness and Knowledge Management
Reference Section 4: Reducing Underlying Factors of Drought Risk
Reference Section 5: Effective Drought Mitigation and Preparedness Measures
Reference Section 6: Drought Case Studies

REFERENCE SECTION 1: POLICIES AND GOVERNANCE FOR DROUGHT RISK MANAGEMENT

Anonymous 2003: U.S. Drought Response. *CQ Researcher,* **13**, 664-666.

Anonymous 1995: Drought management. *Presidents & Prime Ministers,* **4**, 41.

Anonymous 1993: Managing fragile ecosystems: combating desertification and drought: Agenda 21, Chapter 12. *Desertification Control Bulletin,* 9-18.

Botterill, L., 2005: Late Twentieth Century approaches to Living with Uncertainty: The National Drought Policy. *From Disaster Response to Risk Management: Australia's National Drought Policy,* L. C. Botterill and D. A. and Wilhite eds., Springer Publishers.

Botterill, L. C. and D. A. and Wilhite, 2005: From Disaster Response to Risk Management: Australia's National Drought Policy. Springer, Dordrecht, The Netherlands. 212 pp.

Bruins, H. J., 2000: Drought Hazards in Israel and Jordan: Policy Recommendations for Disaster Mitigation. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:178-2:193.

Bruins, H. J., 1999: Drought mitigation policies: waste water use, energy and food provision in urban and peri-urban Africa. *Urban and peri-urban agriculture in Africa: proceedings of a workshop, Netanya, Israel, 23-27 June 1996.* Netanya, Israel, Ashgate Publishing Ltd., 257-266.

CIHEAM, 2001: Mediterranean network on management strategies to mitigate drought.

Coughlan, M. J., C. E. Hounam and J. V. Maher, 1979: Drought hazard in Australia. Canberra, Australian Academy of Science, 51-60.

Durley, J. L., and R. C. d. Loë, 2005: Empowering communities to carry out drought contingency planning. *Water Policy,* **7**, 551-567.

Easterling, W. E., and D. A. and Wilhite, 1987: Improving drought policy: A plan of action (a report of the International Symposium and Workshop on Drought). *Land Use Policy,* **4**, 444-449.

Eriksen, S., and J. Lind, 2009. Adaptation as a Political Process: Adjusting to Drought and Conflict in Kenya's Drylands. *Environmental Management* 43(5):817-835.

FAO/NDMC, 2008. The Near East Drought Planning Manual: Guidelines for Drought Mitigation and Preparedness Planning. Food and Agriculture Organization of the United Nations Near East Regional Office (Cairo, Egypt) and the National Drought Mitigation Center (USA). FAO: Rome, Italy.

Garfin, G., 2007. Drought, climate variability, and implications for water supply and management. In Colby, B., and K.L. Jacobs (eds.) *Arizona Water Policy; Management Innovations in an Urbanizing, Arid Region*. Resources for the Future, Washington, D.C., pp. 61-78.

Garrido, A., A. Iglesias, L. Garrote, M. Moneo, A. Gómez, F. Flores, F. Cubillo, J.C. Ibáñez, M. Fernández, and A. Lapeña, 2005: Spain. Centre International de Hautes Etudes Agronomiques Méditerranéennes, Paris. *Options Méditerranéennes.Série B, Études et Recherches,* 131-154.

Garrote, L., F. Martin-Carrasco, F. Flores-Montoya, and A. Iglesias, 2007. Linking Drought Indicators to Policy Actions in the Tagus Basin Drought Management Plan. *Water Resources Management* 21(5):873-882.

Geringer, J., 2003: The Future of Drought Management in the States. *Spectrum: Journal of State Government,* **76**, 23.

Gupta, A. K., 1991: Drought, deprivation and sustainable development: why are the public policies so weak? Working Paper - Indian Institute of Management, Ahmedabad, India. No. 931, 37.

Hanuta, I., 2007. Developing a national drought strategy for agriculture in Canada. Abstracts with Programs - Geological Society of America 39(6): 60.

Hayes, M.J., O. Wilhelmi, and C.L. Knutson (2004) Reducing Drought Risk: Bridging Theory and Practice. *Journal of Natural Hazards Review*, 5(2):106-113

Haylock, H. J. K., and N. J. Ericksen, 2000: From State Dependency to Self-Reliance: Agricultural Drought Policies and Practices in New Zealand. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:105-2:114.

Horridge, M., J. Madden, and G. Wittwer, 2005: The Impacts of the 2002-2003 Drought on Australia. *Journal of Policy Modeling,* **27**, 285-308.

Hrezo, M. S., P. G. Bridgeman, and W. R. Walker, 1986: Integrating drought planning into water resources management. *Nat. Resour. J.,* **26**, 141-167.

Hundertmark, W., 2008. Building drought management capacity in the Mekong River basin. *Irrigation and Drainage* 57(3):279-287.

Hy, J. H. and W. L. Waugh, Jr., 1990: The Function of Emergency Management. *Handbook of Emergency Management: Programs and Policies Dealing with Major Hazards and Disasters,* W. L. Waugh, Jr. and R. J. Hy ed., Greenwood Press, 11-26.

Iglesias, A., and M. Moneo, 2005: Drought preparedness and mitigation in the Mediterranean: analysis of the organizations and institutions. *Options Méditerranéennes. Série B, Études et Recherches,* 1-199.

Iglesias, A. (ed.), 2009. *Coping with drought risk in agriculture and water supply systems: drought management and policy development in the Mediterranean*. Springer, Dordrecht.

Knutson, C.L., M.J. Hayes, and M.D. Svoboda (2007) Case Study of Tribal Drought Planning: The Hualapai Tribe. *Natural Hazards Review*, Vol. 8(4), pp. 125-131

Koshida, G., M. Alden, S. J. Cohen, R. A. Halliday, L. D. Mortsch, V. Wittrock, and A. R. and Maarouf, 2005: Drought Risk Management in Canada-US Transboundary Watersheds: Now and in the Future. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 287-317.

Louati, M. E., H. J. Mellouli, and M. L. El-Echi, 2005: Tunisia. *Options Méditerranéennes. Série B, Études et Recherches,* 155-188.

Medugu, I.N., M.R. Majid, and I.D. Choji, 2008. A comprehensive approach to drought and desertification in Nigeria: A brief evaluation of government policies. *Management of Environmental Quality* 19(6):690-704.

Monnik, K., 2000: Role of drought early warning systems in South Africa's evolving drought policy. *Early Warning Systems for Drought Preparedness and Drought Management. Proceedings of an Expert Group Meeting in Lisbon, Portugal, 5 - 7 September,* Lisbon, Portugal, World Meteorological Organization, 53-64.

Mukheibir, P., and G. Ziervogel, 2007. Developing a Municipal Adaptation Plan (MAP) for climate change: the city of Cape Town. Environment & Urbanization 19(1):143-158.

Mumme, S. P., 1999: Managing Acute Water Scarcity on the U.S.- Mexico Border. *Nat. Resour. J.,* **39**, 149.

National Drought Policy Commission, 2000: Preparing for drought in the 21st century. National Drought Policy Commission, http://govinfo.library.unt.edu/drought/finalreport/accesstoreports.html
Nelon, R., M. Howden, M.S. Smith, 2008. Using adaptive governance to rethink the way science supports Australian drought policy. *Environmental Science & Policy* 11(7):588-601.
O'Meagher, B., M. Stafford Smith, and D. H. White, 2000: Approaches to Integrated Drought Risk Management: Australia's National Drought Policy. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:115-2:128.
Ouassou, A., T. Ameziane, M. Belghiti, A. Ziyad, and A. Belhamd, 2005: Morocco. *Options Méditerranéennes. Série B, Études et Recherches,* 105-129.
Oyebande, L., 1990: Drought policy and drought planning in Africa. *Int. J. Water Resour. Dev.,* **6**, 260-269.
Quiggin, J., and R. G. and Chambers, 2004: Drought policy: a graphical analysis. *The Australia Journal of Agricultural and Resource Economics,* **48**, 225-251.
Quinn, M. L., 1982: Federal drought planning in the Great Plains: a first look USA. *Clim. Change,* **4**, 273-296.
Rossi, G., A. Cancelliere, G. Giuliano, S. Alecci, and I. Alba, 2005: Italy. *Options Méditerranéennes. Série B, Études et Recherches,* 65-104.
Shepherd, A., 1998: Drought contingency planning: evaluating the effectiveness of plans. *J. Water Resour. Plann. Manage.,* **124**, 246-251.
Thompson, P., and G. D. Lynne, 1994: Policy drought: the case of south Florida. *Water Resour Bull,* **30**, 19-26.
Tsakiris, G., G. Cavadias, D. Pangalou, and A. Nanou, 2005: Greece. *Options Méditerranéennes. Série B, Études et Recherches,* 49-63.
Tsiourtis, N. X., 2005: Cyprus. *Options Méditerranéennes.Série B, Études et Recherches,* , 25-47.
Vaughan Higgins, 2001: Calculating climate: 'advanced liberalism' and the governing of risk in Australian drought policy. *Journal of Sociology,* **37**, 299-316.
Vásquez-León, M., 2009. One Decade of Drought and Two of Neoliberal Reforms in the Sierra Sonorense: Responses by the Rural Poor. *Southern Rural Sociology* 24(1):44-66.
Way, N., 2004: Over-protected? *BRW,* **26**, 52-55.
Werrick, W. J., and and Whipple, W. Jr., 1994: National Study of Water Management During Drought: Managing Water for Drought.
Western Drought Coordination Council (U.S.), and United States. National Drought Policy Commission., 1999: The Western drought experience [computer file]: the Western Drought Coordination Council's report to the National Drought Policy Commission. Western Governors' Association, Denver.
WGA, 2006: Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System. Western Governors' Association, Denver, http://www.westgov.org/wga/publicat/nidis.pdf. 16 pp.
WGA, 1996: Drought Response Action Plan. Western Governors' Association, Denver.
Wilhite, D. A., 2001: Moving beyond crisis management. *Forum for Applied Research and Public Policy,* 16, 20-28.
Wilhite, D. A., 2000: Drought Preparedness in the U.S.: Recent Progress. *Status of Drought Management in Europe,* J. Vogt and F. Somma eds., Kluwer Academic Press.
Wilhite, D. A., 2000: Preparing for Drought: A Methodology *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:89-2:104.
Wilhite, D. A., 2000: Responding to Drought: Common Threads from the Past, Visions for the Future. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:158-2:167.
Wilhite, D. A., 2000: State Actions to Mitigate Drought: Lessons Learned *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:149-2:157.
Wilhite, D. A., 1996: A methodology for drought preparedness. *Natural Hazards,* **13**, 229-252.
Wilhite, D. A., 1993: Drought Assessment, Management, and Planning: Theory and Case Studies. Kluwer Academic Publishers. 293 pp.
Wilhite, D. A., 1993: Drought Mitigation Technologies in the United States: With Future Policy Recommendations. IDIC Technical Report Series 93-1. International Drought Information Center, University of Nebraska, Lincoln.
Wilhite, D. A., 1992: Preparing for Drought: A Guidebook for Developing Countries. Climate Unit, United Nations Environment Program, Nairobi, Kenya.
Wilhite, D. A., 1991: Drought Planning: A Process for State Government. *Water Resources Bulletin,* **27**, 29-38.
Wilhite, D. A., and M. J. and Hayes, 1998: Drought Planning in the United States: Status and Future Directions. *The Arid Frontier - Interactive Management of Environment and Development,* H. J. Bruins and H. and Lithwick eds., Kluwer Academic Publishers, 33-54.
Wilhite, D. A., L. Botterill, and K. and Monnik, 2005: National Drought Policy: Lessons Learned from Australia, South Africa, and the United States *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 137-172.
Wilhite, D. A., M. J. Hayes, and C. and Knutson, 2005: Drought preparedness planning: Building institutional capacity. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 93-135.
Wilhite, D. A., M. J. Hayes, C. Knutson, and K. H. and Smith, 2000: Planning for Drought: Moving from Crisis to Risk Management. *Journal of the American Water Resources Association,* 36, 697-710.
Wilhite, D. A., N. J. Rosenberg, and M. H. and Glantz, 1986: Improving federal response to drought. *Journal of Climate and Applied Meteorology,* **25**, 332-342.
Wilhite, D. A., and D. A. Wood, 2001: Revisiting Drought Relief and Management Efforts in the West: Have We Learned from the Past? *Journal of the West,* **40**, 18-25.
Wilhite, D.A., and D.A. Wood (eds), 1994: Drought Management in a Changing West: New Directions for Water Policy. IDIC Technical Report Series 94-1. International Drought Information Center, University of Nebraska-Lincoln.
Wilhite, D. A., and S. L. Rhodes, 1994: State-level drought planning in the United States: factors influencing plan development. *Water Int.,* **19**, 15-24.

REFERENCE SECTION 2: DROUGHT RISK ASSESSMENT, IMPACT ASSESSMENT AND EARLY WARNING

Alcamo, J., L. Acosta-Michlik, A. Carius, F.Eierdanz, R. Klein, D. Krömker, and D. Tänzler, 2008. A new approach to quantifying and comparing vulnerability to drought. *Regional Environmental Change* 8(4):137-149.
Anonymous 2000: Early Warning Systems for Drought Preparedness and Drought Management. Lisbon, Portugal, World Meteorological Organization.
Anonymous 1993: Managing fragile ecosystems: combating desertification and drought: Agenda 21, Chapter 12. *Desertification Control Bulletin,* 9-18.
Agnew, C., 2002: Drought, Desertification and Desiccation: The Need for Further Analysis. *Geography,* **87**, 256-267.
Agrawala, S., M. Barlow, H. Cullen, and B. Lyon, 2001: Drought and Humanitarian Crisis in Central and Southwest Asia: A Climate Perspective. IRI Special Report 01-11, New York.
Alcamo, J., M. B. Endejan, F. Kaspar, and T. Rösch, 2001: The GLASS model: a strategy for quantifying global environmental security. *Environmental Science & Policy,* **4**, 1-12.
Alley, W. M., 1984: The Palmer drought severity index: Limitations and assumptions. *Journal of Climate and Applied Meteorology,* 23, 1100-1109.
Arndt, T., and UNDP Office to Combat Desertification and Drought, 2000: (Report on the status of drought preparedness & mitigation in Sub-Saharan Africa) [computer file]. New York, NY: UNSO [Office to Combat Desertification and Drought], 2000.
Asokan, S.M., and D. Dutta, 2008. Analysis of water resources in the Mahanadi River basin, India under projected climate conditions. *Hydrological Processes* 22(18):3589-3603.

Bajgiran, P.R., M.F. Makhdoum, A. Khalili, and A.A. Darvishsefat, 2008. Using AVHRR-based vegetation indices for drought monitoring in the Northwest of Iran. *Journal of Arid Environments* 72(6):1086-1096.
Bak, B., and L. Labedzki, 2002: Assessing drought severity with the relative precipitation index (*RPI*) and the standardised precipitation index (*SPI*). *Journal of Water and Land Development,* 29-49.
Barnett, T.P., and D.W. Pierce, 2009. Sustainable water deliveries from the Colorado River in a changing climate. *Proceedings of the National Academy of Sciences of the United States of America* 106(18):7334-7338.
Barros, A.P., and G.J. Bowden, 2008. Toward long-lead operational forecasts of drought: An experimental study in the Murray-Darling River Basin. *Journal of Hydrology* 357(3-4):349-367.
Bayarjargal, Y., A. Karnieli, M. Bayasgalan, S. Khudulmur, C. Gandush, and C. J. Tucker, 2006: A comparative study of NOAA–AVHRR derived drought indices using change vector analysis. *Remote Sens. Environ.,* **105**, 9-22.
Below, R., E. Grover-Kopec, and M. Dilley, 2007. Documenting Drought-Related Disasters: A Global Reassessment. *Journal of Environment & Development* 16(3):328-344.
Benegas, L., J. Faustino, M. Campos, F. Jiminez, and B. Locatelli, 2009. A methodological proposal for the evaluation of farmer's adaptation to climate variability, mainly due to drought in watersheds in Central America. *Mitigation and Adaptation Strategies for Global Change* 14(2):169-183.
Benson, C., and E. and Clay, 2000: The Economic Dimensions of Drought in Sub-Saharan Africa. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:287-1:311.
Benson, C., and E. Clay, 1998: The Impact of Drought on Sub-Saharan African Economies. World Bank Technical Paper No. 401. The World Bank, Washington, D.C.
Blaikie, P., T. Cannon, I. Davis, and B. and Wisner, 1994: *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. Routledge Publishers.
Boken, V. K., 2005: Agricultural Drought and Its Monitoring and Prediction: Some Concepts. *Monitoring and Predicting Agricultural Drought: A Global Study* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 3-10.
Boken, V. K., A. P. Cracknell and R. L. Heathcote, 2005: *Monitoring and Predicting Agricultural Drought: A Global Study*. Oxford University Press.
Brewer, S., S. Alleaume, J. Guiot, and A. Nicault, 2007. Historical droughts in Mediterranean regions during the last 500 years; a data/model approach. *Climate of the Past* 3(2):355-366.
Brolley, J.M., J.J. O'Brien, J. Schoof, D. Zierden, 2007. Experimental drought threat forecast for Florida. *Agricultural and Forest Meteorology* 145(1-2):84-96.
Buckley, B.M., K. Palakit, K. Duangsathaporn, P. Sanguantham, and P. Prasomsin, 2007. *Climate Dynamics* 29(1):63-71.
Byun, H., and D. A. Wilhite, 1999: Objective Quantification of Drought Severity and Duration. *J. Clim.,* **12**, 1.
Calanca, P., 2007. Climate change and drought occurrence in the Alpine region: How severe are becoming the extremes? *Global & Planetary Change* 57(1/2):151-160.
Campbell, R., P. Crowley, and P. and Demura, 1983: Impact of Drought on National Income and Employment. *Quarterly Review of the Rural Economy,* **5**, 254-257.
Cancelliere, A., G. Di Mauro, B. Bonaccorso, and G. Rossi, 2007. Drought forecasting using the Standardized Precipitation Index. *Water Resources Management* 21(5):801-819.
Carolwicz, M., 1996: Natural Hazards Need Not Lead to Natural Disasters. *EOS,* **77**, 149-153.
Chamaillé-Jammes, S., H. Fritz, and F. Murindagomo, 2007. Detecting climate changes of concern in highly variable environments: Quantile regressions reveal that droughts worsen in Hwange National Park, Zimbabwe. *Journal of Arid Environments* 71(3):321-326.
Chang, T. J., H. Zheng, X. A. Kleopa, and C. B. Teoh, 1996: Development of an Expert System for Daily Drought Monitoring. *J. Comput. Civ. Eng.,* **10**, 20.
Changnon, S. D., 2003: Measures of Economic Impacts of Weather Extremes – Getting Better but Far from What Is Needed – A Call for Action. *Bulletin of the American Meteorological Society,* **84**, 1231-1235.
Changnon, S. A., R. A. Pielke, D. Changnon, R. T. Sylves, and R. Pulwarty, 2000: Human factors explain losses from weather and climate extremes. *Bulletin of the American Meteorological Society,* **18**, 437-442.
Clanet, V., 1981: Indices pluviometriques et sechage du fourrage au sol. *Levage bovin, ovin, caprin,* 27-30.
Cobon, D.H.., X. Zhang, J. Willcocks, G.M. McKeon, N.R. Toombs, G.S. Stone, J.O. Carter, and J.C. Scanlan, 2009. The climate change risk management matrix for the grazing industry of northern Australia. *Rangeland Journal* 31(1):31-49.
Collins, T.W., and B. Bolin, 2007. Characterizing vulnerability to water scarcity; the case of a groundwater-dependent, rapidly urbanizing region. *Environmental Hazards* 7(4):399-418.
Coughlan, M. J., 1987: Monitoring drought in Australia. *Planning for Drought: Toward a Reduction of Societal Vulnerability,* D. A. Wilhite and W. E. and Easterling eds., Westview Press, 131-144.
Coughlan, M. J., C. E. Hounam and J. V. Maher, 1979: Drought hazard in Australia, 51-60.
Cubillo, F., 2004: Droughts, risk management and reliability. *Water Science and Technology: Water Supply,* **4**, 1-11.
Cuddy, S., R. Letcher, F. H. S. Chiew, B. E. Nancarrow, and T. and Jakeman, 2005: A Role for Streamflow Forecasting in Managing Risk Associated with Drought and Other Water Crises. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 345-365.
Das, H. P., 2000: Monitoring the Incidence of Large-Scale Droughts in India. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:181-1:195.
Day, K. A., K. G. Rickert, and G. M. McKeon, 2005: Monitoring Agricultural Drought in Australia. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 369-385.
de Jager, J. M., M. D. Howard, and H. J. and Fouché, 2000: Computing Drought Severity and Forecasting its Future Impact on Grazing in a GIS. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:269-1:278.
Devereux, S.. 2007. The impact of droughts and floods on food security and policy options to alleviate negative effects. *Agricultural Economics* 37(s1):47-58.
Diaz, L. N., 2005: Monitoring Agricultural Drought Using El Niño and Southern Oscillation Data. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 28-39.
Dinar, A., and A. Keck, 2000: Water Supply Variability and Drought Impact and Mitigation in Sub-Saharan Africa *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:129-2:148.
Diodato, N., and G. Bellocchi, 2008. Drought stress patterns in Italy using agro-climatic indicators. *Climate Research* 36(1):53-63.

Dole, R. M., 2000: Prospects for Predicting Droughts in the United States *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:83-1:99.
Downing, T. and K. Bakker, 2000, Drought Discourse and Vulnerability, in D. A. Wilhite (ed.) Drought Hazards and Disasters: A Series of Definitive Major Works. London: Routledge, 213 – 230.
Dyer, J. A., 2000: Drought Monitoring for Famine Relief in Africa *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:223-1:233.
Easterling, W., and R. and Mendelsohn, 2000: Estimating the Economic Impacts of Drought on Agriculture. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:256-1:268.
Edwards, D. C., and T. B. and McKee, 1997: Characteristics of 20th century drought in the United States at multiple time scales. Climatology Rep. 97-2, Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado.
Eierdanz, F., J. Alcamo, L. Acosta-Michlik, D. Krömker, and D. Tänzler, 2008. Using fuzzy set theory to address the uncertainty of susceptibility to drought. *Regional Environmental Change* 8(4):197-205.

FAO/NDMC (2008) *A Review of Drought Occurrence, Monitoring, and Planning Activities in the Near East Region*, Food and Agriculture Organization of the United Nations Near East Regional Office and the National Drought Mitigation Center, USA. FAO: Rome, Italy, 44+ix pp.

Feng Qiang, Liu QinHuo, Tian GuoLiang, T. R. McVicar, Wang AngSheng, and D. L. B. Jupp, 2004: Experimental study on the RS-based drought monitoring in China by using the vegetation condition indexes (II) - models of RS-based drought monitoring and the analyzed results. *Arid Land Geography,* **27**, 477-484.

Field, J. O., 2000: Drought, the Famine Process, and the Phasing of Interventions. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:273-2:284.

Fiorentino, M., and V. Iacobellis, 2005: Towards reduction of uncertainty on MEDCLUB (MEDiterranean CLimate Ungauged Basins). *Predictions in ungauged basins: international perspectives on the state of the art and pathways forward,* S. W. Franks, M. Sivapalan, K. Takeuchi and Y. Tachikawa eds., Food and Agriculture Organization of the United Nations (FAO), 275-291.

Fisher, R.A., M. Williams, A.L. da Costa, Y. Malhi, R.F. da Cossta, S. Almeida, and P. Meir, 2007. The response of an Eastern Amazonian rain forest to drought stress: results and modelling analyses from a throughfall exclusion experiment. *Global Change Biology* 13(11):2361-2378.

Franks, S. W., 2005: Flood and drought risk in eastern Australia. *Predictions in ungauged basins: international perspectives on the state of the art and pathways forward,* S. W. Franks, M. Sivapalan, K. Takeuchi and Y. Tachikawa eds., Food and Agriculture Organization of the United Nations (FAO), 94-108.

Ghosh, S., and P.P. Mujumdar, 2007. Nonparametric methods for modeling GCM and scenario uncertainty in drought assessment. *Water Resources Research* 43(7): w07405.

Giannini, A., 2008. A climate model-based review of drought in the Sahel; desertification, the re-greening and climate change. Global and Planetary Change 64(3-4):119-128.

Gibbs, W. J., and and Maher, J. V., 1967: Rainfall deciles as drought indicators. *Bureau of Meteorology Bulletin,* 48.

Goddard, S., S. K. Harms, S. F. Reichenbach, T. Tadesse, and W. J. Waltman, 2003: Geospatial Decision Support for Drought Risk Management. *Commun ACM,* **46**, 35-37.

Grunewald, K., D. Brown, J. Monget, and J. Scheithauer, 2009. Characterisation of contemporary local climate change in the mountains of southwest Bulgaria. *Climatic Change* 95(3-4):535-549.

Guttman, N. B., 1998: Comparing the Palmer Drought Index and the Standardized Precipitation Index. *Journal of the American Water Resources Association,* 34, 113-121.

Guttman, N. B., J. R. Wallis, and J. R. M. and Hosking, 1992: Spatial comparability of the Palmer Drought Severity Index. *Water Resources Bulletin,* 28, 1111-1119.

Hayes, M., M. Svoboda, and D. A. and Wilhite, 2000: Monitoring Drought Using the Standard Precipitation Index. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:168-1:180.

Hayes, M. J., M. Svoboda, D. Le Comte, K. T. Redmond, and P. and Pasteris, 2005: Drought Monitoring: New Tools for the 21st Century. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 53-69.

Hayes, M. J., M. D. Svoboda, D. A. Wilhite, and O. V. and Vanyarkho, 1999: Monitoring the 1996 drought using the Standardized Precipitation Index. *Bulletin of the American Meteorological Society,* 80, 429-438.

Hayes, M. J., O. V. Wilhelmi, and C. and Knutson, 2004: Reducing Drought Risk: Bridging Theory and Practice. *Natural Hazards Review,* 5, 106-113.

Heddinghaus, T. R., and P. and Sabol, 1991: A review of the Palmer Drought Severity Index and where do we go from here? *Proceedings of the Seventh Conference on Applied Climatology,* American Meteorological Society, 242-246.

Heim, R. R. J., 2000: Drought Indices: A Review. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:159-1:167.

Heim, R. R., 2002: A Review of Twentieth-Century Drought Indices Used in the United States. *Bull. Am. Meteorol. Soc.,* 83, 1149.

Hertzler, G., R. Kingwell, J. Crean, and C. and Carter, 2006: Managing and Sharing the Risks of Drought in Australia. Invited paper presented to the 26th Conference of the International Association of Agricultural Economics, "Contributions of Agricultural Economics to Critical Policy Issues," Gold Coast, Queensland Australia, August 12-18, 2006.

Herweijer, C., 2007. North American droughts from Medieval times to the modern day; characterization, causes and global context. PhD thesis, Columbia University, New York.

Horridge, M., J. Madden, and G. and Wittwer, 2005: The Impacts of the 2002-2003 Drought on Australia. *Journal of Policy Modeling,* **27**, 285-308.

Hunt, B. G., 1991: The simulation and prediction of drought. Kluwer Academic Publishers, 89-103.

Hyman, G., M.C. de Vicente, J. Dixon, S. Wood, S. Fujisaka, and P. Jones, 2008. Strategic approaches to targeting technology generation: Assessing the coincidence of poverty and drought-prone crop production. *Agricultural systems* 98(1):50-61.

Ingram, K. T., 2005: Drought-Related Characteristics of Important Cereal Crops. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 11-27.

Jaishanker, R., V. K. Sehgal, T. Senthivel, and V. K. Dadhwal, 2006: Evaluation of SPOT-VEGETATION derived global vegetation assessment product for near-real time drought monitoring over India. *Proceedings of the National Academy of Sciences India. Section B, Biological Sciences,* **76**, 78-84.

Jensen, D. T., 2003: Monitoring Drought in the West. *Arid Land Research & Management,* **17**, 449.

Ji, L., and A. J. Peters, 2003: Assessing vegetation response to drought in the northern Great Plains using vegetation and drought indices. *Remote Sens. Environ.,* **87**, 85.

Kalis, M.A., M.D. Miller, and R.J. Wilson, 2009. Public Health and Drought. *Journal of Environmental Health* 72(1):10-11.

Karl, T. R., and R. W. and Knight, 1985: Atlas of monthly Palmer Hydrological Drought Indices (1931-1983) for the contiguous United States. National Climatic Data Center, Asheville, North Carolina.

Keenan, S. P., and R. S. and Krannich, 1997: The social context of perceived drought vulnerability. *Rural Sociology,* **62**, 69-88.

Keil, A., N. Teufel, D. Gunawan, and C. Leemhuis, 2009. Vulnerability of smallholder farmers to ENSO-related drought in Indonesia. *Climate Research* 38(2):155-169.

Keil, A., M. Zeller, A. Wida, B. Sanim, and R. Birner, 2008. What determines farmers' resilience towards ENSO-related drought? An empirical assessment in Central Sulawesi, Indonesia. Climatic change 86(3-4):291-307.

Keyantash, J., and J. A. Dracup, 2002: The Quantification of Drought: An Evaluation of Drought Indices. *Bull. Am. Meteorol. Soc.,* **83**, 1167.

Khan, S., T. Rana, and H.F. Gabriel, 2008. Standard precipitation index to track drought and assess impact of rainfall on watertables in irrigation areas. *Irrigation and Drainage Systems* 22(2):159-177.

Klemeš, V., 1987: Drought prediction: A hydrological perspective. *Planning for Drought: Toward a Reduction of Societal Vulnerability,* D. A. Wilhite and W. E. and Easterling eds., Westview Press, 81-94.

Kleschenko, A. D., E. K. Zoidze, and V. K. Boken, 2005: Monitoring Agricultural Drought in Russia. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 196-207.

Knutson, C., M. Hayes and T. Phillips, 1998: How to Reduce Drought Risk. A guide prepared by the Preparedness and Mitigation Working Group of the Western Drought Coordination Council. National Drought Mitigation Center, Lincoln, Nebraska, http://drought.unl.edu/plan/handbook/risk.pdf. 43 pp.

Knutson, C.L., S. Jones, M.E. Sittler, M. Higgins, M.D. Svoboda, D.R. Kluck, and D.A. Wilhite. 2008. *Development of a Low Flow Early Warning System for the NOAA National Weather Service, USA*, Stream Ecology and Low Flows, Special Issue of the International Journal of Ecological Economics and Statistics, 12(F08), 44-57.

Kogan, F., 2000: Global Drought Detection and Impact Assessment from Space. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:196-1:209.

Kogan, F. N., 1995: Droughts of the late 1980s in the United States as derived from NOAA polar-orbiting satellite data. *Bulletin of the American Meteorological Society,* **76**, 655-668.

Kogan, F. N., 1997: Global drought watch from space. *Bull. Am. Meteorol. Soc.,* **78**, 621-636.

Kokic, P., A. Potgieter, J. Carter, R. Nelson, and H. Meinke, 2007. From rainfall to farm incomes-transforming advice for Australian drought policy. I. Development and testing of a bioeconomic modelling system. *Australian Journal of Agricultural Research* 58(10):993-1003.
Koshida, G., M. Alden, S. J. Cohen, R. A. Halliday, L. D. Mortsch, V. Wittrock, and A. R. and Maarouf, 2005: Drought Risk Management in Canada-US Transboundary Watersheds: Now and in the Future. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 287-317.
Krol, M., and A. Bronstert, 2007. Regional integrated modelling of climate change impacts on natural resources and resource usage in semi-arid Northeast Brazil. *Environmental Modelling & Software* 22(2):259-268.
Krömker, D., F. Eierdanz, and A. Stolberg, 2008. Who is susceptible and why? An agent-based approach to assessing vulnerability to drought. *Regional Environmental Change* 8(4):173-185.
Lawrimore, J., R. R. Heim, M. Svoboda, V. Swail, and P. J. Englehart, 2002: Beginning a New Era of Drought Monitoring Across North America. *Bull. Am. Meteorol. Soc.,* **83**, 1191.
Lee, D. M., 1979: Australian drought watch system. *Botswana Drought Symposium,* Gaborone, Botswana, Botswana Society, 173-187.
Lehner, B., P. Döll, J. Alcamo, T. Henrichs, and F. Kaspar, 2006: Estimating the Impact of Global Change on Flood and Drought Risks in Europe: a Continental, Integrated Analysis. *Clim. Change,* **75**, 273-299.
Li Jinbao, Chen Fahu; E.R. Cook, Gou Xiaohua, and Zhang Yongxiang. 2007. Drought reconstruction for north central China from tree rings: the value of the Palmer drought severity index. *International Journal of Climatology* 7:903-909.
Lohani, V. K., and G. V. Loganathan, 1997: An early warning system for drought management using the Palmer drought index. *J. Am. Water Resour. Assoc.,* **33**, 1375-1386.
Lu, J., 2009. The dynamics of the Indian Ocean sea surface temperature forcing of Sahel drought. *Climate Dynamics*, 33(4):445-460.
Maher, J. V., 1973: Meteorological aspects of drought. Angus and Robertson, 41-54.
Mahowald, N.M., J.A. Ballantine, J.J. Feddema, and N. Ramankutty, 2007. Global trends in visibility; implications for dust sources. *Atmospheric Chemistry and Physics* 7(12):3309-3339.
Malley, Z.J.U., T. Matsumoto, and M. Taeb, 2009. Agricultural productivity and environmental insecurity in the Usangu plain, Tanzania: policy implications for sustainability of agriculture. *Environment, Development and Sustainability* 11(1):175-195.
Mason, S. J., and P. D. and Tyson, 2000: The Occurrence and Predictability of Droughts over Southern Africa *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:113-1:134.
McKee, T. B., N. J. Doesken, and J. and Kleist, 1995: Drought monitoring with multiple time scales. *Proceedings of the Ninth Conference on Applied Climatology,* American Meteorological Society, 233-236.
McKee, T. B., N. J. Doesken, and K. and Kleist, 1993: The relationship of drought frequency and duration to time scales. *Proceedings of the Eighth Conference on Applied Climatology,* American Meteorological Society, 179-184.
Meaker, G., and P. Johnson, 2005: StockPlan(R) - the impact of ImPack. *Moving from research to industry adoption. NSW Department of Primary Industries and CRC for Cattle and Beef Quality Conference, Quality Resort Nautilus, Coffs Harbour, New South Wales, 3-5 May 2005,* NSW Department of Primary Industries, 91-93.
Mendicino, G., and P. Versace, 2007. Integrated Drought Watch System: A Case Study in Southern Italy. *Water Resources Management* 21(8):1409-1428.
Mendicino, G., A. Senatore, and P. Versace, 2008. A groundwater resource index (GRI) for drought monitoring and forecasting in a Mediterranean climate. *Journal of Hydrology* 357(3-4):282-302.
Mengü, G., S. Anaç, and K. Topcuoglu, 2009. Analysis of drought in the Marmara region using the standardized precipitation index. *Fresenius Environmental Bulletin* 18(5):633-641.
Mishra, A. K., and V. R. Desai, 2005: Drought forecasting using stochastic models. *Stochastic Environmental Research & Risk Assessment,* **19**, 326-339.
Mohan, S., and P.K. Sahoo, 2008. Stochastic simulation of droughts. Part 2: regional droughts. *Hydrological Processes* 22(6):863-872.
Molle, F., A. Mamanpoush, J. Hoogesteger, 2008. Macro- and micro-level impacts of droughts: the case of the Zayandeh Rud river basin, Iran. *Irrigation and Drainage* 57(2):219-227.
Monnik, K., 2000: Role of drought early warning systems in South Africa's evolving drought policy. *Early Warning Systems for Drought Preparedness and Drought Management. Proceedings of an Expert Group Meeting in Lisbon, Portugal, 5 - 7 September,* Lisbon, Portugal, World Meteorological Organization, 53-64.
Morel-Seytoux, H. J., C. J. Daly, and T. Illangasekare, 1979: A river aquifer interactive model suited for evaluation of drought mitigation strategies. *Hydrological aspects of droughts: international symposium, 3-7 December 1979, New Delhi: proceedings,* New Delhi: Indian National Committee for IHP, CSIR: Indian Institute of Technology, 1979, 546-557.
Morid, S., V. Smakhtin, and M. Moghaddasi, 2006: Comparison of seven meteorological indices for drought monitoring in Iran. *Int. J. Climatol.,* **26**, 971-985.
Moye, L. A., 1988: The theory of runs with applications to drought prediction. *Journal of Hydrology,* **103**, 127.
Mustafa, G., D. J. Bosch, T. M. Younos, and B. B. Ross, 1987: A stochastic economic model for riparian irrigation expansion under drought risk. *American Society of Agricultural Engineers (Microfiche collection),* fiche no. 87-2039.
Narasimhan, B., and R. Srinivasan, 2005: Development and evaluation of Soil Moisture Deficit Index (SMDI) and Evapotranspiration Deficit Index (ETDI) for agricultural drought monitoring. *Agricultural & Forest Meteorology,* **133**, 69-88.
Narasimhan, B., R. Srinivasan, J. G. Arnold, and M. d. Luzio, 2005: Estimation of long-term soil moisture using a distributed parameter hydrologic model and verification using remotely sensed data. *Trans. ASAE,* **48**, 1101-1113.
Narasimhan, B., R. Srinivasan, and A. D. Whittaker, 2003: Estimation of potential evapotranspiration from NOAA-AVHRR satellite. *Appl. Eng. Agric.,* **19**, 309-318.
Nelson, R., H. Meinke, and P. Kokic, 2007. From rainfall to farm incomes-transforming advice for Australian drought policy. II. Forecasting farm incomes. *Australian Journal of Agricultural Research* 58(10):1004-1012.
Nicholls, N., and G. and Beard, 2000: The Application of El Niño-Southern Oscillation Information to Seasonal Forecasts in Australia. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:41-1:51.
Nicholls, N., M. J. Coughlan, and K. and Monnik, 2005: The Challenge of Climate Prediction in Mitigating Drought Impacts. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 33-51.
Niestle, A., 1990: An approach for drought risk assessment based on hydrologic records of the River Nile in connection with a groundwater flow model. *Berliner Geowissenschaftliche Abhandlungen, Reihe A: Geologie und Palaeontologie,* **120**, 1041.
Niestle, A., 1993: Hydrologic drought risk modelling for agricultural areas. A.A. Balkema, 699.
Nobre, P., and I. F. A. and Cavalcanti, 2000: The Prediction of Drought in the Brazilian Nordeste: Progress and Prospects for the Future. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:68-1:82.
Nyabeze, W. R., 2002: Determining parameter reliability levels in a digital information system for monitoring and managing hydrological droughts. *Physics & Chemistry of the Earth - Parts A/B/C,* **27**, 793.
O'Meagher, B., M. Stafford Smith, and D. H. White, 2000: Approaches to Integrated Drought Risk Management: Australia's National Drought Policy. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:115-2:128.
Olidapo, E. O., 1985: A comparative performance analysis of three meteorological drought indices. *Journal of Climatology,* **5**, 655-664.
Oyebande, L., 1990: Drought policy and drought planning in Africa. *Int. J. Water Resour. Dev.,* **6**, 260-269.
Palmer, W. C., 1968: Keeping track of crop moisture conditions, nationwide: The new crop moisture index. *Weatherwise,* 21, 156-161.
Palmer, W. C., 1965: Meteorological drought. U.S. Weather Bureau, Washington, DC.
Pandey, R. P., and K. S. Ramasastri, 2002: Incidence of droughts in different climatic regions. *Hydrological Sciences Journal,* **47**, S31-S40.
Pandey, S., H. Bhandari, S. Ding, P. Prapertchob, R. Sharan, D. Naik, S.K. Taunk, and A. Sastri, 2007. Coping with drought in rice farming in Asia: insights from a cross-country comparative study. *Agricultural Economics* 37(s1):213-224.
Panda, D.K., B.K. James, A. Kumar, A. Mishra, and S.K. Jena, 2007. The influence of drought and anthropogenic effects on groundwater levels in Orissa, India. *Journal of Hydrology* 343(3-4):140-153.

Paulo, A.A., and L.S. Pereira, 2008. Stochastic Prediction of Drought Class Transitions. *Water Resources Management* 22(9):1277-1296.
Phillips, O.L., 2009. Drought Sensitivity of the Amazon Rainforest. *Science* 323(5919):1244-1347.
Pinheiro, A. C., C. J. Tucker, D. Entekhabi, J. L. Privette, and J. A. Berry, 2001: Assessing the relationship between surface temperature and soil moisture in southern Africa. *Remote sensing and hydrology 2000. Selected papers from a conference held at Santa Fe, New Mexico, USA, 2-7 April 2000,* M. Owe, K. Brubaker, J. Ritchie and A. Rango eds., IAHS Press, 296-301.
Polemio, M., and D. Casarano, 2008. Climate change, drought and groundwater availability in southern Italy. *Geological Society Special Publications* 288:39-51.
Polsky, C., R. Neff, and B. Yarnal, 2007. Building comparable global change vulnerability assessments: The vulnerability scoping diagram. *Global Environmental Change Part A: Human & Policy Dimensions* 17(3/4):472-485.
Prairie, J., T. Fulp, U. Lall, and K. Nowak, 2008. A stochastic nonparametric approach for streamflow generation combining observational and paleoreconstructed data. *Water Resources Research* 44(6):w06423.
Pratt, M., M. S. Cerda, M. Boulahya, and K. Sponberg, 2005: Harnessing Radio and Internet Systems to Monitor and Mitigate Agricultural Droughts in Rural African Communities. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 276-282.
Qi ShuHua, Zhang YuanPei, Niu Zheng, Wang ChangYao, and Zheng Lin, 2005: Application of water deficit index in drought monitoring in China with remote sensing. *Acta Pedologica Sinica,* **42**, 367-372.
Quiring, S.M., and G.B. Goodrich, 2008. Nature and causes of the 2002 to 2004 drought in the southwestern United States compared with the historic 1953 to 1957 drought. *Climate Research* 36(1):41-52.
Quiring, S. M., and T. N. Papakryiakou, 2003: An evaluation of agricultural drought indices for the Canadian prairies. *Agricultural & Forest Meteorology,* **118**, 49.
Rao, A. S., and V. K. Boken, 2005: Monitoring and Managing Agricultural Drought in India. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 297-312.
Redmond, K. T., 2000: Integrated Climate Monitoring for Drought Detection *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:145-1:158.
Richter, G. M., and M. A. Semenov, 2005: Modelling impacts of climate change on wheat yields in England and Wales: assessing drought risks. *Agricultural Systems,* **84**, 77-97.
Risbey, J.S., K. Hamza, and J.S. Marsden, 2007. Use of climate scenarios to aid in decision analysis for interannual water supply planning. *Water Resources Management* 21(6):919-932.
Ropelewski, C. F., and C. K. and Folland, 2000: Prospects for the Prediction of Meteorological Drought. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:21-1:40.
Rose, A., 2004: Economic Principles, Issues, and Research Priorities in Hazard Loss Estimation *Modeling Spatial and Economic Impacts of Disasters,* Y. Okuyama and S. E. and Chang eds., Springer, 13-36.
Rossi, G., T. Vega, and B. Bonaccorso (eds.), 2007. Methods and tools for drought analysis and management. *Water Science and Technology Library*, Vol. 62.
Rouhani, S., 1989: A geostatistical tool for drought management. *Journal of Hydrology,* **108**, 257.
Rowland, J., J. Verdin, A. Adoum, and G. Senay, 2005: Drought Monitoring Techniques for Famine Early Warning Systems in Africa. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 252-265.
Schneckenburter, C. A., and R. and Aukerman, February 2003: Economic Effects of the Drought on Colorado's Recreation and Tourism. *Colorado Water (newsletter, Colorado State University), February*, 16-20.
Sear, C. B., 1999: Reducing the impact of drought in southern Africa - delivering and using better forecasts. *Decision tools for sustainable development.* I. F. Grant and C. Sear eds., Natural Resources Institute (NRI), 225-249.
Şen, Z., and V. K. Boken, 2005: Techniques to Predict Agricultural Droughts *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 40-54.
Shaban, A., 2008. Impact of climate change on water resources of Lebanon; indications of hydrological droughts. In Zereini, F., and H. Hoetzl (eds.) *Climatic changes and water resources in the Middle East and North Africa*. Springer-Verlag, Berlin, pp. 125-143.
Shafer, B. A., and L. E. and Dezman, 1982: Development of a Surface Water Supply Index (SWSI) to assess the severity of drought conditions in snowpack runoff areas. *Preprints, Western Snow Conference,* Colorado State University, 164-175.
Shaowu, W., Y. Jinlan, and Q. and Weihong, 2000: Predictability of Drought in China. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:100-1:112.
Sheffield, J., and E.F. Wood, 2008. Projected changes in drought occurrence under future global warming from multi-model, multi-scenario, IPCC AR4 simulations. *Climate Dynamics* 31(1):79-105.
Singels, A., and A. B. Potgieter, 1997: A technique to evaluate ENSO-based maize production strategies. *South African Journal of Plant and Soil,* **14**, 93-97.
Singh, A., 2005: International Activities Related to Dryland Degradation Assessment and Drought Early Warning *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 421-428.
Singh, R. P., Sudipa Roy, and F. Kogan, 2003: Vegetation and temperature condition indices from NOAA AVHRR data for drought monitoring over India. *Int. J. Remote Sens.,* **24**, 4393-4402.
Singh, R. P., S. Roy, and F. Kogan, 2005: Vegetation and temperature condition indices from NOAA AVHRR data for drought monitoring over India. *Int. J. Remote Sens.,* **24**, 4393-4402.
Sivakumar, M. V. K., 1992: Empirical analysis of dry spells for agricultural applications in West Africa. *J. Clim.,* **5**, 532-539.
Slegers, M.F.W., 2008. "If only it would rain": Farmers' perceptions of rainfall and drought in semi-arid central Tanzania. *Journal of Arid Environments* 72(11):2106-2123.
Sloto, R. A., 1991: Drought management based on water-level data, Chester County, Pennsylvania. *American Water Resources Association Technical Publication Series TPS*, **91-3**, 439.
Smakhtin, V. U., and D. A. Hughes, 2007: Automated estimation and analyses of meteorological drought characteristics from monthly rainfall data. *Environmental Modelling & Software,* **22**, 880-890.
Smart, A. J., B. Dunn, and R. Gates, 2005: Historical weather patterns: A guide for drought planning. *Rangelands,* **27,** 10-12.
Smith, M., 2000: The application of climatic data for planning and management of sustainable rainfed and irrigated crop production. *Agricultural and Forest Meteorology,* Accra, Ghana, 99-108.
Song, X., G. Saito, M. Kodama, and H. Sawada, 2004: Early detection system of drought in East Asia using NDVI from NOAA/AVHRR data. *Int. J. Remote Sens.,* **25**, 3105-3111.
Sonka, S., S. Changnon, S. Bard, and T. and Doehring, 2001: Midwestern Impacts of the 2000 Drought Forecasts. Ag Education & Consulting, LLC, Savoy, Illinois.
Soulé, P. T., 1992: Spatial patterns of drought frequency and duration in the contiguous USA based on multiple drought event definitions. *International Journal of Climatology,* **12**, 11-24.
Steinemann, A. C., M. J. Hayes, and L. F. N. and Cavalcanti, 2005: Drought Indicators and Triggers. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 71-92.
Steinemann, A. C., 2006: Using Climate Forecasts for Drought Management. *Journal of Applied Meteorology & Climatology,* **45**, 1353-1361.
Steinemann, A. C., and L. F. N. Cavalcanti, 2006: Developing Multiple Indicators and Triggers for Drought Plans. *Journal of Water Resources Planning & Management,* **132**, 164-174.
Stuth, J. W., J. Angerer, R. Kaitho, A. Jama, and R. Marambii, 2005: Livestock Early Warning System for Africa's Rangelands. *Monitoring and Predicting Agricultural Drought: A Global Study* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 283-294.
Su, Z., A. Yacob, J. Wen, G. Roerink, Y. He, B. Gao, H. Boogaard, and C. van Diepen, 2003: Assessing relative soil moisture with remote sensing data: theory, experimental validation, and application to drought monitoring over the North China Plain. *Physics & Chemistry of the Earth - Parts A/B/C,* **28**, 89.

Subbiah, A. R., 1993: Indian Drought Management: From Vulnerability to Resilience. *Drought Assessment, Management, and Planning: Theory and Case Studies,* D. A. Wilhite ed., Kluwer Academic Publishers.
Subrahmanyam, V. P., 1967: Incidence and Spread of Continental Drought. World Meteorological Organization, Geneva, Switzerland, WMO/IHD Report No. 2.
Sumathi, I., S. S. Bosu, and S. Senthilvel, 2000, publ. 2001: Assessment of periodicity of drought occurrence in Perambalur region. *Madras Agricultural Journal,* **87**, 724-727.
Sun Wei, Wang PengXin, Han LiJuan, Yan Kai, Zhang ShuYu, and Li XingMin, 2006: Further improvement of the approach to monitoring drought using vegetation and temperature condition indexes from multi-years' remotely sensed data. *Transactions of the Chinese Society of Agricultural Engineering,* **22**, 22-26.
Sun, R., X. Gao, C. M. Liu, and X. W. Li, 2004: Evapotranspiration estimation in the Yellow River Basin, China using integrated NDVI data. *Int. J. Remote Sens.,* **25**, 2523-2534.
Svoboda, M., D. LeComte, M. Hayes, R. Heim, K. Gleason, J. Angel, B. Rippey, R. Tinker, M. Palecki, D. Stooksbury, D. Miskus, and S. Stephens, 2002: The Drought Monitor. *Bulletin of the American Meteorological Society,* 83, 1181-1190.
Tadesse, T., 2000: Drought and its Predictability in Ethiopia. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:135-1:142.
Tadesse, T., J. F. Brown, and M. J. Hayes, 2005: A new approach for predicting drought-related vegetation stress: Integrating satellite, climate, and biophysical data over the U.S. central plains. *ISPRS J. Photogramm. Remote Sens.,* **59**, 244-253.
Tadesse, T., D. A. Wilhite, M. J. Hayes, S. K. Harms, and S. Goddard, 2005: Discovering Associations between Climatic and Oceanic Parameters to Monitor Drought in Nebraska Using Data-Mining Techniques. *J. Clim.,* **18**, 1541-1550.
Tadesse, T., M. Haile, G. Senay, B.D. Wardlow, and C.L. Knutson, 2008. The need for integration of drought monitoring tools for proactive food security management in sub-Saharan Africa. *Natural Resources Forum* 32(4):265-279.
Taenzler, D., A. Carius, and A. Maas, 2008. Assessing the susceptibility of societies to droughts: a political science perspective. *Regional Environmental Change* 8(4):161-172.
Tänzler, D., M. Feil, D. Krömker, and F. Eierdanz, 2008. The challenge of validating vulnerability estimates: the option of media content analysis for identifying drought-related crises. *Regional Environmental Change* 8(4):187-195.
Tapp, N., D. Thompson, N. Milham and D. Jackson, 1998: A stochastic analysis of drought management strategies for mixed farming in the central west of New South Wales. 23 pp.
Tesfaye, H., 1988: Causes and characteristics of drought in Ethiopia. *Ethiopian Journal of Agricultural Sciences,* **10**, 85-97.
Tian, G., and V. K. Boken, 2005: Monitoring Agricultural Drought in China. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 354-368.
Tsakiris, G., D. Pangalou, and H. Vangelis, 2007. Regional Drought Assessment Based on the Reconnaissance Drought Index (RDI). *Water Resources Management* 21(5):821-833.
Unganai, L. S., and T. Bandason, 2005: Monitoring Agricultural Drought in Southern Africa. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 266-275.
Veen, A. van der, 2004: Disasters and economic damage: macro, meso and micro approaches. *Disaster Prevention and Management: An International Journal,* **13**, 274-280.
Velasco, I., J. Aparicio, J. B. Valdés, J. Velázquez, and T. W. Kim, 2004: Drought index assessment in the watersheds of affluents from the Río Bravo/Río Grande River. *Ingeniería Hidráulica en México,* **19**, 37-53.
Vicente-Serrano, S. M., 2006: Differences in Spatial Patterns of Drought on Different Time Scales: An Analysis of the Iberian Peninsula. *Water Resour. Manage.,* **20,** 37-60.
Vicente-Serrano, S. M., 2005: El Niño and La Niña influence on droughts at different timescales in the Iberian Peninsula. *Water Resour. Res.,* **41**, W12415.
Vicente-Serrano, S. M., J. M. Cuadrat-Prats, and A. Romo, 2006: Early prediction of crop production using drought indices at different time-scales and remote sensing data: application in the Ebro Valley (north-east Spain). *Int. J. Remote Sens.,* **27**, 511-518.
Wan, Z., P. Wang, and X. Li, 2004: Using MODIS Land Surface Temperature and Normalized Difference Vegetation Index products for monitoring drought in the southern Great Plains, USA. *Int. J. Remote Sens.,* **25**, 61-72.
Webb, P., and T. Reardon, 1992: Drought impact and household response in East and West Africa. *Q. J. Int. Agric.,* **31**, 230-246.
Wells, N., S. Goddard, and M. J. Hayes, 2004: A Self-Calibrating Palmer Drought Severity Index. *J. Clim.,* **17**, 2335-2351.
Western Governors' Association, 2004: Creating a drought early warning system for the 21st century: The National Integrated Drought Information System. Western Governors' Association, http://www.westgov.org/wga/publicat/nidis.pdf.
WGA, 2006: Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System. Western Governors' Association, Denver, 16.
White, D.H., and J.J. Walcott, 2009. The role of seasonal indices in monitoring and assessing agricultural and other droughts: a review. *Crop & Pasture Science* 60(7):599-616.
Wilhelmi, O., K. Hubbard, and D. A. Wilhite, 2002: Spatial Representation of Agroclimatology in a Study of Agricultural Drought *International Journal of Climatology,* **22**, 1399-1414.
Wilhelmi, O., and D. A. Wilhite, 2002: Assessing Vulnerability to Agricultural Drought: A Nebraska Case Study. *Natural Hazards,* 25, 37-58.
Wilhite, D. A., 1993: Drought Assessment, Management, and Planning: Theory and Case Studies. Kluwer Academic Publishers. 293 pp.
Wilhite, D. A., and M. D. and Svoboda, 2000: Drought early warning systems in the context of drought preparedness and mitigation. *Early Warning Systems for Drought Preparedness and Management,* Lisbon, Portugal, World Meteorological Organization, 1-16.
Wilhite, D. A., M. D. Svoboda, and M. J. Hayes, 2005: Monitoring Drought in the United States: Status and Trends *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote, eds., Oxford University Press, 121-131.
Wilhite, D.A., M.D. Svoboda, and M.J. Hayes, 2007. Understanding the complex impacts of drought: A key to enhancing drought mitigation and preparedness. *Water Resources Management* 21(5):763-774.
Williams, J., 2000: Drought Risk Management in Southern Africa: Developing Institutions to Transform 'Belated Disaster Response' into 'Informed Preparedness.' *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:168-2:177.
Woodhouse, C., 2008. Evidence of climate variability and change from tree-ring records. Abstracts with Programs - Geological Society of America 40(6):19.
Wu, H., L. Soh, A. Samal, and X. Chen, 2008. Trend Analysis of Streamflow Drought Events in Nebraska. *Water Resources Management* 22(2):145-164.
Yang ShaoHui, and Wang YiMing, 2006: The research on the distribution of drought monitor sites. *Aktualni zadaci mehanizacije poljoprivrede. Zbornik radova, 34. medunarodnog simpozija iz područja mehanizacije poljoprivrede, Opatija, Croatia, 21-24 veljače 2006,* Zavod za Mehanizaciju Poljprivrede, Agronomski Fakultet Sveučilišta u Zagrebu, 267-274.
Yevjevich, V., 1967: An objective approach to definitions and investigations of continental hydrologic droughts. Colorado State University, Fort Collins, Colorado, Hydrology Papers No. 23.
Yinpeng Li, Wei Ye, Meng Wang, and Xiaodong Yan, 2009. Climate change and drought: a risk assessment of crop-yield impacts. *Climate Research* 39(1):31-46.
Zahner, R., and R. K. Myers, 1986: Assessing the impact of drought on forest health. *Proceedings of the Society of American Foresters National Convention,* 227-234.
Zereini, F., and H. Hoetzl (eds.), 2008. *Climatic changes and water resources in the Middle East and North Africa.* Springer-Verlag, Berlin.
Zhai, L., and Q. Feng, 2009. Spatial and temporal pattern of precipitation and drought in Gansu Province, Northwest China. *Natural Hazards* 49(1):1-24.
Zhang, Q., M. Gemmer, and J. Chen, 2008. Climate changes and flood/drought risk in the Yangtze Delta, China, during the past millennium. *Quaternary International* 176-177:62-69.

Zierl, B., 2001: A water balance model to simulate drought in forested ecosystems and its application to the entire forested area in Switzerland. *Journal of Hydrology,* **242**, 115.

REFERENCE SECTION 3: DROUGHT AWARENESS AND KNOWLEDGE MANAGEMENT

Anonymous 1993: Managing fragile ecosystems: combating desertification and drought: Agenda 21, Chapter 12. *Desertification Control Bulletin,* 9-18.

Bryant, E. A., 1991: *Natural Hazards.* Cambridge University Press.

Carolwicz, M., 1996: Natural Hazards Need Not Lead to Natural Disasters. *EOS,* **77**, 149-153.

Cubillo, F., 2004: Droughts, risk management and reliability. *Water Science and Technology: Water Supply,* **4**, 1-11.

Dracup, J. A., and D. R. Kendall, 1990: Floods and droughts. *Climate change and US water resources.* P. E. Waggoner ed., John Wiley and Sons Inc., 243-267.

Durley, J. L., and R. C. d. Loë, 2005: Empowering communities to carry out drought contingency planning. *Water Policy,* **7**, 551-567.

Field, J. O., 2000: Drought, the Famine Process, and the Phasing of Interventions. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:273-2:284.

Glantz, M. H., and and Katz, R. W., 1977: When is a drought a drought? *Nature,* 267, 192-193.

Glantz, M. H., 2000: Drought Follows the Plough: A Cautionary Note *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:285-2:291.

Glantz, M. H., 1994: Drought Follows the Plow: Cultivating Marginal Areas. Cambridge University Press.

Glantz, M. H., 1987: *Drought and Hunger in Africa: Denying Famine a Future.* Cambridge University Press.

Graumlich, L. J., and M. and Ingram, 2000: Drought in the Context of the Last 1,000+ Years: Some Surprising Implications. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:234-1:242.

Houérou, H. N. l., 1996: Climate change, drought and desertification. *J. Arid Environ.,* **34**, 133-185.

Jowitt, P. W., 1991: Development of a knowledge-based system for drought management. *Water Resour. Manage.,* **5**, 187.

Mukhala, E., 2005: Food and Agriculture Organization and Agricultural Droughts *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 411-420.

NAST (National Assessment Synthesis Team), 2001: Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. Report for the U.S. Global Change Research Program (GCRP). Cambridge University Press.

National Drought Policy Commission, 2000: Preparing for drought in the 21st century. National Drought Policy Commission, http://govinfo.library.unt.edu/drought/finalreport/accesstoreports.htm.

Nyong, A., F. Adesina, and B.O. Elasha, 2007. The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation & Adaptation Strategies for Global Change* 12(5):787-797.

Polsky, C., and D. W. and Cash, 2005: Drought, Climate Change, and Vulnerability: The Role of Science and Technology in a Multi-Scale, Multi-Stressor World. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 215-245.

Riebsame, W. E., S. A. J. Changnon, and T. R. and Karl, 1991: *Drought and Natural Resources Management in the United States: Impacts and Implications of the 1987-89 Drought.* Westview Press.

Rind, D., 2000: Drought, Variability, and Climate Change in the Twenty-First Century. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:264-2:272.

Rossi, G., A. Cancelliere, and G. Giuliano, 2005: Role of decision support system and multicriteria methods for the assessment of drought mitigation measures. *Drought management and planning for water resources,* J. Andreu, G. Rossi, F. Vagliasindi and A. Vela eds., CRC Press LLC, 203-240.

Russell, S., C. Lux, and G. Hampton, 2009. Beyond "Information": Integrating Consultation and Education for Water Recycling Initiatives. *Society & Natural Resources* 22(1):56-65.

Sandford, S., 1979: Towards a definition of drought. *Botswana Drought Symposium,* Gaborone, Botswana, Botswana Society.

Sivakumar, M. V. K., 2005: World Meteorological Organization and Agricultural Droughts. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 401-410.

Tannehill, I. R., 1947: *Drought: Its Causes and Effects.* Princeton University Press.

WGA, 2006: Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System. Western Governors' Association, Denver, http://www.westgov.org/wga/publicat/nidis.pdf. 16 pp.

Wilhite, D. A., 2004: Drought. *International Perspectives on Natural Disasters: Occurrence, Mitigation, and Consequences,* J. P. Stoltman, J. Lidstone and L. M. and Dechano eds., Kluwer Academic Publishers, 147-162.

Wilhite, D. A., 2000: Drought as a Natural Hazard: Concepts and Definitions *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:3-1:18.

Wilhite, D. A., 2000: Drought: A Global Assessment. Routledge, Taylor & Francis Group. 700 pp.

Wilhite, D. A., 1993: Drought Assessment, Management, and Planning: Theory and Case Studies. Kluwer Academic Publishers. 293 pp.

Wilhite, D. A., and M. and Buchanan-Smith, 2005: Drought as Hazard: Understanding the Natural and Social Context. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 3-29.

Wilhite, D. A., and M. H. and Glantz, 1985: Understanding the Drought Phenomenon: The Role of Definitions. *Water International,* 10, 111-120.

World Meteorological Organization, 1975: Drought and agriculture: Report of the CAgM Working Group on the Assessment of Drought. Geneva, Switzerland, WMO Technical Note No. 138.

REFERENCE SECTION 4: REDUCING UNDERLYING FACTORS OF DROUGHT RISK

Anonymous 1998: *The arid frontier: interactive management of environment and development.* Kluwer Academic Publishers. 381 pp.

Ayers, J., and S. Huq, 2009. The Value of Linking Mitigation and Adaptation: A Case Study of Bangladesh. *Environmental Management* 43(5):753-764.

Batima, P., B. Bold, T. Sainkhuu, and M. Bavuu, 2008. Adapting to Drought, Zud and Climate Change in Mongolia's Rangelands. In Leary, N. (ed.), *Climate Change and Adaptation*. Earthscan, London, Chapter 11, pp. 196-210.

Baas, S., and S. Ramasamy, 2008. Community based adaptation in action : a case study from Bangladesh : project summary report (phase 1), Improved adaptive capacity to climate change for sustainable livelihoods in the agriculture sector. Food and Agriculture Organization of the United Nations, Rome. http://0-www.fao.org.library.unl.edu/docrep/010/i0481e/i0481e00.htm

Benegas, L., J. Faustino, M. Campos, F. Jiminez, and B. Locatelli, 2009. A methodological proposal for the evaluation of farmer's adaptation to climate variability, mainly due to drought in watersheds in Central America. *Mitigation and Adaptation Strategies for Global Change* 14(2):169-183.

Boyd, R., and M.E. Ibarrarán, 2009. Extreme climate events and adaptation: an exploratory analysis of drought in Mexico. *Environment & Development Economics* 14(3):371-395.

Bruins, H.J. and Berliner, P.R., 1998: Bioclimatic Aridity, Climatic Variability, Drought and Desertification: Definitions and Management Options. *The Arid Frontier-Interactive Management of Environment and Development,* Bruins, H.J. and Lithwick, H. ed., Kluwer Academic Publishers, 97-116.

Cutter, S. L., 1996: Societal vulnerability to environmental hazards. *International Social Science Journal,* 47, 525-536.
Dabi, D.D., A.O. Nyong, A.A. Adepetu, V.I. Ihemegbulem, 2008. Past, Present and Future Adaptation by Rural Households of Northern Nigeria. In Leary, N. (ed.), *Climate Change and Adaptation*. Earthscan, London, Chapter 8, pp. 147-162.
Darnault, C.J.G., 2008. Sustainable development and integrated management of water resources. In Darnault, C.J.G. (ed.) *Overexploitation and Contamination of Shared Groundwater Resources; Management, (Bio)technological, and Political Approaches to Avoid Conflicts*. Springer, Dordrecht, Netherlands, pp. 309-324.
Devereux, S.. 2007. The impact of droughts and floods on food security and policy options to alleviate negative effects. *Agricultural Economics* 37(s1):47-58.
Dregne, H. E., 2000: Drought and Desertification: Exploring the Linkages *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:231-2:240.
Enfors, E., and L.J. Gordon, 2008. Dealing with drought: The challenge of using water system technologies to break dryland poverty traps. *Global Environmental Change Part A: Human & Policy Dimensions* 18(4):607-616.
Falkenmark, M.,and J. Rockström, 2008. Building resilience to drought in desertification-prone savannas in Sub-Saharan Africa: The water perspective. *Natural Resources Forum* 32(2):93-102.
Giannini, A., 2008. A climate model-based review of drought in the Sahel; desertification, the re-greening and climate change. Global and Planetary Change 64(3-4):119-128.
Gutiérrez-Castorena, E.V., C.A. Ortiz-Solorio, M.C. Gutiérrez-Castorena, L.Cajuste-Bontemps, and M. Rocha-Aguilar, 2008. Technical, economical and social actions of farmers to mitigate water deficit in Tamaulipas, Mexico. *Agriculture, Ecosystems & Environment* 128(1/2):77-85.
Homann, S., J. Steinbach, and B. Rischkowsky, 2008. The effect of development interventions on the use of indigenous range management strategies in the Borana Lowlands in Ethiopia. *Land Degradation & Development* 19(4):368-387.
Houérou, H. N. l., 1996: Climate change, drought and desertification. *J. Arid Environ.,* **34**, 133-185.
Hyman, G., M.C. de Vicente, J. Dixon, S. Wood, S. Fujisaka, and P. Jones, 2008. Strategic approaches to targeting technology generation: Assessing the coincidence of poverty and drought-prone crop production. *Agricultural Systems* 98(1):50-61.
Ifejika Speranza, C., B. Kiteme, and U. Wiesmann, 2008. Droughts and famines: The underlying factors and the causal links among agro-pastoral households in semi-arid Makueni district, Kenya. *Global Environmental Change Part A: Human & Policy Dimensions*18(1):220-233.
Kassahun, A., G.N. Smit, and H.A. Snyman, 2008. Impact of rangeland degradation on the pastoral production systems, livelihoods and perceptions of the Somali pastoralists in Eastern Ethiopia. *Journal of Arid Environments* 72(7):1265-1281.
Lehner, B., P. Döll, J. Alcamo, T. Henrichs, and F. Kaspar, 2006: Estimating the Impact of Global Change on Flood and Drought Risks in Europe: a Continental, Integrated Analysis. *Clim. Change,* **75**, 273-299.
Malley, Z.J.U., T. Matsumoto, and M. Taeb, 2009. Agricultural productivity and environmental insecurity in the Usangu plain, Tanzania: policy implications for sustainability of agriculture. *Environment, Development and Sustainability* 11(1):175-195.
Malley, Z.J.U., 2009. Linking environment and livelihood: process and impact of hydrological drought in the Usangu-Mtera ecosystem, Tanzania. *International Journal of Environment & Sustainable Development* 8(1):5-5.
Maukonen, T., 1995: Efforts to combat land degradation. *Environmental management: issues and solutions.* M. Atchia and S. Tropp eds., John Wiley & Sons, 60-64.
McAlpine, C.A., G.M. McKeon, H.A. McGowan, S.R. Phinn, J. Syktus, J.G. Ryan, and R.C. Deo, 2009. A continent under stress: interactions, feedbacks and risks associated with impact of modified land cover on Australia's climate. *Global Change Biology* 15(9):2206-2223.
MEA (Millennium Ecosystem Assessment), 2005: *Strengthening Capacity to Manage Ecosystems Sustainability for Human Well-Being.* Island Press.
Miller, E., and L. Buys, 2008. The impact of social capital on residential water-affecting behaviors in a drought-prone Australian community. *Society & Natural Resources* 21(3):244-257.
Nyong, A., F. Adesina, and B. Osman Elasha, 2007. The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change* 12(5):787-797.
O'Farrell, P.J., P.M.L. Anderson, S. J. Milton, and W.R.J. Dean, 2008. Human response and adaptation to drought in the arid zone: lessons from southern Africa. *South African Journal of Science* 104(11/12):34-39.
Osman-Elasha, B., N. Nagmeldin, E. Spanger-Siegfried, B. Dougherty, A. Hanafi, S. Zakieldeen, E. Sanjak, H.A. Atti, H.M. Elhassan, 2008. Community Development and Coping with Drought in Rural Sudan. In Leary, N. (ed.), *Climate Change and Adaptation*. Earthscan, London, Chapter 5, pp. 90-108.
Prabhakar, S.V.R.K., and R. Shaw. 2008. Climate change adaptation implications for drought risk mitigation: a perspective for India**.** *Climatic Change* 88(2):113-130.
Schwinning, S., J. Belnap, D.R. Bowling, and J.R. Ehleringer, 2008. Sensitivity of the Colorado Plateau to Change: Climate, Ecosystems, and Society. *Ecology & Society* 13(2):1-20.
Sen, Z., 2009. Global warming threat on water resources and environment; a review. *Environmental Geology* 57(2):321-329.
Sivakumar, M., and N. Ndiang'ui (eds.], 2007. *Climate and land degradation*. Springer, Berlin.
Stroosnijder, L. 2009. Modifying land management in order to improve efficiency of rainwater use in the African highlands. *Soil & Tillage Research* 103(2):247-256.
Thomas, R.J., 2008. Opportunities to reduce the vulnerability of dryland farmers in Central and West Asia and North Africa to climate change. *Agriculture, Ecosystems & Environment* 126(1/2):36-45.
Toni, F., and H. Evandro, 2008. The effects of land tenure on vulnerability to droughts in Northeastern Brazil. *Global Environmental Change Part A: Human & Policy Dimensions* 18(4):575-582.
UK, C. S., 1990: Report of a Workshop on Tackling Soil Erosion, Desertification and Drought-Related Problems, Jodhpur, India, 13 March-23 March 1989. *Report of a Workshop on Tackling Soil Erosion, Desertification and Drought-Related Problems, Jodhpur, India, 13 March-23 March 1989*. Desertification and Drought-Related Problems, Jodhpur, India, 27.
UNCCD, 1999: United Nations Convention to Combat Desertification (text with annexes). United Nations, Bonn, Germany.
Zawahri, N.A., 2008. International rivers and national security: The Euphrates, Ganges–Brahmaputra, Indus, Tigris, and Yarmouk rivers. *Natural Resources Forum* 32(4):280-289.

REFERENCE SECTION 5: EFFECTIVE DROUGHT MITIGATION AND PREPAREDNESS MEASURES

Abolpour, B., and M. Javan, 2007. Optimization model for allocating water in a river basin during a drought. *Journal of Irrigation and Drainage Engineering* 133(6):559-572.
Anonymous 2000: Early Warning Systems for Drought Preparedness and Drought Management. Lisbon, Portugal, World Meteorological Organization.
Anonymous 1995: Drought management. *Presidents & Prime Ministers,* **4**, 41.
Anonymous 1995: *Water resources management under drought or water shortage conditions. Proceedings of the EWRA 95 Symposium, Nicosia, Cyprus, 14-18 March, 1995.* A.A. Balkema.
Anonymous 1993: Managing fragile ecosystems: combating desertification and drought: Agenda 21, Chapter 12. *Desertification Control Bulletin,* 9-18.
Andreu, J., and A. Solera, 2005: Methodology for the analysis of drought mitigation measures in water resource systems. *Drought management and planning for water resources,* J. Andreu, G. Rossi, F. Vagliasindi and A. Vela eds., CRC Press LLC, 133-168.
Arndt, T., and UNDP Office to Combat Desertification and Drought, 2000: (Report on the status of drought preparedness & mitigation in Sub-Saharan Africa) [computer file]. New York, NY: UNSO, 2000.

Batchelor, C., C. Lovell, and I. Mharapara, 2000: Productive Water Points as a Means of Coping with Drought *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:17-2:28.

Benegas, L., J. Faustino, M. Campos, F. Jiminez, and B. Locatelli, 2009. A methodological proposal for the evaluation of farmer's adaptation to climate variability, mainly due to drought in watersheds in Central America. *Mitigation and Adaptation Strategies for Global Change* 14(2):169-183.

Bouwer, H., 1988: Water conservation for drought management. *American Water Resources Association Technical Publication Series TPS,* **88-2**, 499.

Boyd, R., and M.E. Ibarrarán, 2009. Extreme climate events and adaptation: an exploratory analysis of drought in Mexico. Environment & Development Economics 14(3):371-395.

Bruins, H. J., 1999: Drought mitigation policies: waste water use, energy and food provision in urban and peri-urban Africa. *Urban and peri-urban agriculture in Africa: proceedings of a workshop, Netanya, Israel, 23-27 June 1996.* Netanya, Israel, Ashgate Publishing Ltd., 257-266.

Bruins, H.J. and Berliner, P.R., 1998: Bioclimatic Aridity, Climatic Variability, Drought and Desertification: Definitions and Management Options. *The Arid Frontier-Interactive Management of Environment and Development,* Bruins, H.J. and Lithwick, H. ed., Kluwer Academic Publishers, 97-116.

Bucks, D. A., 1990: Water conservation for drought preparedness. *Proceedings 14th International Congress on Irrigation and Drainage, Rio de Janeiro, Brazil.* Rio de Janeiro, International Commission on Irrigation and Drainage, 83-98.

Cabrera, E., and J. García-Serra, 1999: Drought management planning in water supply systems : proceedings from the UIMP International Course held in Valencia, December 1997. *Water science and technology library v. 32,* Dordrecht and Boston: Kluwer Academic Publishers.

Chang, T. J., X. A. Kleopa, and C. B. Teoh, 1995: Use of Flood-Control Reservoirs for Drought Management. *Journal of Irrigation & Drainage Engineering,* **121**, 34.

Chantarat, S., C.B. Barrett, A. Mude, and C.G. Turvey, 2007. Using Weather Index Insurance to Improve Drought Response for Famine Prevention. *American Journal of Agricultural Economics* 89(5):1262-1268.

CIHEAM, 2001: Mediterranean network on management strategies to mitigate drought.

Colby, B.G., D.R. Smith, and K. Pittenger, 2007. Water transactions enhancing supply reliability during drought. In Colby, B.G., and K. Jacobs (eds.) *Arizona Water Policy: Management Innovations in an Urbanizing, Arid Region*. Resources for the Future, Washington, D.C., pp. 79-91.

Cubillo, F., 2004: Droughts, risk management and reliability. *Water Science and Technology: Water Supply,* **4**, 1-11.

Davies, S., 2000: Effective Drought Mitigation: Linking Micro and Macro Levels. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:3-2:16.

De Boodt, M., 1989: Desertification or desert reclamation? Change in climate or in human behaviour? *Greenhouse effect, sea level and drought: Proceedings of the NATO Advanced Research Workshop of Geohydrological Management of Sea Level and Mitigation of Drought.* Kluwer Academic Publishers, 225-240.

Dinar, A., and A. Keck, 2000: Water Supply Variability and Drought Impact and Mitigation in Sub-Saharan Africa. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:129-2:148.

Durley, J. L., and R. C. d. Loë, 2005: Empowering communities to carry out drought contingency planning. *Water Policy,* **7**, 551-567.

Dziegielewski, B., 2000: Drought Preparedness and Mitigation for Public Water Supplies *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:194-2:205.

Eriksen, S., and J. Silva, 2009. The vulnerability context of a savanna area in Mozambique: household drought coping strategies and responses to economic change. *Environmental Science & Policy* 12(1):33-52.

FAO/NDMC, 2008. The Near East Drought Planning Manual: Guidelines for Drought Mitigation and Preparedness Planning. Food and Agriculture Organization of the United Nations Near East Regional Office (Cairo, Egypt) and the National Drought Mitigation Center (USA). FAO: Rome, Italy.

Fisher, A., D. Fullerton, N. Hatch, and P. and Reinelt, 1995: Alternative for Managing Drought: A Comparative Cost Analysis. *Journal of Environmental Economics and Management,* **29**, 304-320.

Gaaloul, N., 2008. The role of groundwater during drought in Tunisia. In Zereini, F., and H. Hoetzl (eds.) *Climatic changes and water resources in the Middle East and North Africa*. Springer-Verlag, Berlin, pp. 239-266.

Garrick, D., G. Garfin, and K. Jacobs, 2008. Models, Assumptions, and Stakeholders: Planning for Water Supply Variability in the Colorado River Basin. *Journal of the American Water Resources Association* 44(2):381-398.

Garrote, L., F. Martin-Carrasco, F. Flores-Montoya, and A. Iglesias, 2007. Linking Drought Indicators to Policy Actions in the Tagus Basin Drought Management Plan. *Water Resources Management* 21(5):873-882.

Geerts, S., and D. Raes, 2009. Deficit irrigation as an on-farm strategy to maximize crop water productivity in dry areas. *Agricultural Water Management* 96(9):1275-1284.

Geringer, J., 2003: The Future of Drought Management in the States. *Spectrum: Journal of State Government,* **76**, 23.

Gupta, R. S., 1985: Ground-water reservoir operation for drought management. *J. Water Resour. Plann. Manage.,* **111**, 303.

Gupta, S. C., and V. K. Mehrotra, 1990: A multiset programming model for drought management. *Proceedings 14th International Congress on Irrigation and Drainage, Rio de Janeiro, Brazil.* Rio de Janeiro, International Commission on Irrigation and Drainage, 159-169.

Hadjigeorgalis, E., 2008. Managing Drought Through Water Markets: Farmer Preferences in the Rio Grande Basin. *Journal of the American Water Resources Association* 44(3):594-605.

Heathcote, R. L., 2000: 'She'll be Right, Mate.' Coping with Drought: Strategies Old and New in Australia. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:59-2:69.

Heathcote, R. L., and R. C. Stone, 2002: Braving the bull of heaven: drought management strategies, past present and future. *Geography monograph series; no. 7,* Milton, Qld.: Royal Geographical Society of Queensland.

Hertzler, G., R. Kingwell, J. Crean, and C. and Carter, 2006: Managing and Sharing the Risks of Drought in Australia. Invited paper presented to the 26th Conference of the International Association of Agricultural Economics, "Contributions of Agricultural Economics to Critical Policy Issues," Gold Coast, Queensland Australia, August 12-18, 2006

Hill, H. M., 1979: Drought mitigation in Canada's prairie provinces. *Hydrological aspects of droughts: international symposium, 3-7 December 1979, New Delhi: proceedings,* New Delhi: Indian National Committee for IHP, CSIR: Indian Institute of Technology, 1979, 570-576.

Hochrainer, S., G. Pflug, and R. Mechler, 2009. Climate change and financial adaptation in Africa. Investigating the impact of climate change on the robustness of index-based microinsurance in Malawi. *Mitigation and Adaptation Strategies for Global Change* 14(3):231-250.

Howard, K. W. F., 1990: Development and management of fossil groundwater resources for purposes of drought mitigation. *NATO ASI Series. Series C: Mathematical and Physical Sciences,* 495.

Hrezo, M. S., P. G. Bridgeman, and W. R. Walker, 1986: Integrating drought planning into water resources management. *Nat. Resour. J.,* 26, 141-167.

Iglesias, A. (ed.), 2009. *Coping with drought risk in agriculture and water supply systems: drought management and policy development in the Mediterranean*. Springer, Dordrecht.

Iglesias, A., A. Cancelliere, D. Gabina, A. Lopez-Francos, M. Moneo, G. Rossi (eds), 2007, Drought Management Guidelines, European Commission – EuropeAid Co-operation Office Euro-Mediterranean Regional Programme for Local Water Management (MEDA Water) Mediterranean Drought Preparedness and Mitigation Planning (MEDROPLAN), pp. 78.

Iglesias, E., A. Garrido, and A. Gomez-Ramos, 2003: Evaluation of drought management in irrigated areas. *Agricultural economics: the journal of the International Association of Agricultural Economists,* **29,** 211-229.

Iglesias, E., A. Gómez-Ramos, and A. Garrido, 2007: Economic drought management index to evaluate water institutions' performance under uncertainty. *Aust. J. Agric. Resour. Econ.,* **51,** 17-38.

Jallow, T., 2000: An Overview of the Activities of UNSO in Drought Preparedness and Mitigation. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:206-2:210.

James, G., and W. E. Smith, 1994: The drought survival guide. [Orange, NSW]: NSW Agriculture.

Jowitt, P. W., 1991: Development of a knowledge-based system for drought management. *Water Resour. Manage.,* **5**, 187.

Karamouz, M., and S. Araghinejad, 2008. Drought mitigation through long-term operation of reservoirs: case study. *Journal of Irrigation and Drainage Engineering* 134(4):471-478.
Kenney, D.S., J. Lowrey, K. Reidy, C. Goemans, and R. Klein, 2008. Residential water demand management: lessons from Aurora, Colorado. *Journal of the American Water Resources Association* 44(1):192-207.
Kenya, Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC), 2005: Mitigating drought-related disasters in the Greater Horn of Africa. *Bulletin - World Meteorological Organization,* **54**, 17-21.
Kininmonth, W. R., M. E. Voice, G. S. Beard, G. C. de Hoedt, and C. E. and Mullen, 2000: Australian Climate Services for Drought Management. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:210-1:222.
Knutson, C., M. Hayes and T. Phillips, 1998: How to Reduce Drought Risk. A guide prepared by the Preparedness and Mitigation Working Group of the Western Drought Coordination Council. National Drought Mitigation Center, Lincoln, Nebraska, http://drought.unl.edu/plan/handbook/risk.pdf. 43 pp.
Knutson, C.L., 2008. The role of water conservation in drought planning. *Journal of Soil and Water Conservation* 63(5):154a-160a.
Krysanova, V., H. Buiteveld, D. Haase, F.F. Hattermann, K. van Niekerk, K. Roest, P. Martínez-Santos, and M. Schlüter, 2008. Practices and Lessons Learned in Coping with Climatic Hazards at the River-Basin Scale: Floods and Droughts. *Ecology & Society* 13(2):1-27.
Liverman, D. M., 2000: Adaptation to Drought in Mexico *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:35-2:45.
Lund, J. R., and R. U. Reed, 1995: Drought Water Rationing and Transferable Rations. *Journal of Water Resources Planning & Management,* **121**, 429.
Margane, A., A. Borgstedt, and A. Subah, 2008. Water resources protection efforts in Jordan and their contribution to sustainable water resources management. In Zereini, F., and H. Hoetzl (eds.) *Climatic changes and water resources in the Middle East and North Africa*. Springer-Verlag, Berlin, pp. 325-345.
McCartney, D., 2000: Drought management the Australian way. *Rangelands,* **22**, 3-6.
Mengistie, A., 1997: Land surface water harvesting techniques and their application for drought mitigation measures. *Sustainability of water resources under increasing uncertainty. Proceedings of an international symposium of the Fifth Scientific Assembly of the International Association of Hydrological Sciences (IAHS), Rabat, Morocco, 23 April to 3 May 1997*. Rabat, Morocco, IAHS Press, 51-56.
Michelsen, A., and R. and Young, 1993: Optioning Agricultural Water Rights for Urban Water Supplies during Drought. *American Journal of Agricultural Economics,* **75**, 1010-1020.
Miller, K. A., 2000: Managing Supply Variability: The Use of Water Banks in the Western United States. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:70-2:86.
Morton, J., and D. Barton, 2002: Destocking as a Drought–mitigation Strategy: Clarifying Rationales and Answering Critiques. *Disasters,* **26**, 213-228.
O'Reagain, P., A. Reid, C. Holloway, and J. Bushell, 2009. Managing for rainfall variability: effect of grazing strategy on cattle production in a dry tropical savanna. *Animal Production Science* 49(2):85-99.
Ortega-Ochoa, C., M.C. Farmer, and C. Villalobos, 2007. A Pasture-Based Model for Extended Drought Management, Long-Term Sustainability, and Economic Viability in the Southern High Plains. *Forage and Grazinglands*, http://0-dx.doi.org.library.unl.edu/10.1094/FG-2007-1108-01-MG
Oweis, T. Y., 2005: The Role of Water Harvesting and Supplemental Irrigation in Coping with Water Scarcity and Drought in the Dry Areas. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 191-213.
Pandey, S., H. Bhandari, S. Ding, P. Prapertchob, R. Sharan, D. Naik, S.K. Taunk, and A. Sastri, 2007. Coping with drought in rice farming in Asia: insights from a cross-country comparative study. *Agricultural Economics* 37(s1):213-224.
Pattanayak, S. K., and R. A. Kramer, 2001: Pricing ecological services: willingness to pay for drought mitigation from watershed protection in eastern Indonesia. *Water Resour. Res.,* **37**, 771-778.
Payne, T.L., and J. Neuman, 2007. Remembering rain. *Environmental Law* 37(1):105-136.
Riebsame, W. R., 1991: Drought: opportunities for impact mitigation. *Episodes,* **14**, 62-65.
Rockström, J., 2003: Resilience building and water demand management for drought mitigation. *Physics & Chemistry of he Earth - Parts A/B/C,* **28**, 869.
Rossi, G., T. Vega, and B. Bonaccorso (eds.), 2007. Methods and tools for drought analysis and management. *Water Science and Technology Library*, Vol. 62.
Russell, C. S., 1988: Drought Management and Its Impact on Public Water Systems. *Am. Sci.,* **76**, 298-298.
Sinha, S. K., K. Kailasanathan, and and Vasistha, A. K., 1987: Drought management in India: Steps toward eliminating famines. *Planning for Drought: Toward a Reduction of Societal Vulnerability,* D. A. Wilhite and W. E. and Easterling eds., Westview Press, 453-470.
Smith, M., 2000: The application of climatic data for planning and management of sustainable rainfed and irrigated crop production. *Agricultural and Forest Meteorology,* Accra, Ghana, 99-108.
Smith, W.J., and Young-Doo Wang, 2008. Conservation rates: the best 'new' source of urban water during drought. *Water & Environment Journal* 22(2):100-116.
Stroosnijder, L. 2009. Modifying land management in order to improve efficiency of rainwater use in the African highlands. *Soil & Tillage Research* 103(2):247-256.
Subbiah, A. R., 2000: Response Strategies of Local Farmers in India *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group., 2:29-2:34.
Subbiah, A. R., 1993: Indian Drought Management: From Vulnerability to Resilience. *Drought Assessment, Management, and Planning: Theory and Case Studies,* D. A. Wilhite ed., Kluwer Academic Publishers.
Sukhija, B.S., 2008. Adaptation to climate change; strategies for sustaining groundwater resources during droughts. *Geological Society Special Publications* 288:169-181.
UNDP/UNSO, 2000: Drought Preparedness and Mitigation in Sub-Saharan Africa. United Nations Office to Combat Desertification and Drought, New York.
Unganai, L. S., 1994: Chronology of droughts in Southern Africa; the impacts and future management options. *SACCAR Newsletter,* 8-17.
Vermes, L., and A. Szemessy, 2000: Proceedings of the Central and Eastern European Workshop on Drought Mitigation, Budapest, Hungary. Budapest, Hungary, Ministry of Agriculture and Rural Development and Hungarian Meteorological Service.
Vickers, A., 2005: Managing Demand: Water Conservation as a Drought Mitigation Tool. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 173-190.
Vogt, J. V. [ed], 2000: Drought and drought mitigation in Europe. *Advances in Natural and Technological Hazards Research,* **14.**
von Kotze, A., and A. Holloway, 1999: Living with drought: drought mitigation for sustainable livelihoods. London : Intermediate Technology Publications.
Whitmore, J. S., 2000: Drought management on farmland. *Water science and technology library v. 35,* Dordrecht and Boston: Kluwer Academic Publishers.
Wilhite, D. A., 2002: Combating drought through preparedness. *Natural Resources Forum,* **26**, 275-285.
Wilhite, D. A., 2001: Moving beyond crisis management. *Forum for Applied Research and Public Policy,* 16, 20-28.
Wilhite, D. A., 2000: Drought Preparedness in the U.S.: Recent Progress. *Status of Drought Management in Europe,* J. Vogt and F. Somma eds., Kluwer Academic Press.
Wilhite, D. A., 2000: Responding to Drought: Common Threads from the Past, Visions for the Future. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:158-2:167.
Wilhite, D. A., 2000: State Actions to Mitigate Drought: Lessons Learned *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:149-2:157.
Wilhite, D. A., 1993: Drought Assessment, Management, and Planning: Theory and Case Studies. Kluwer Academic Publishers. 293 pp.
Wilhite, D. A., 1992: Preparing for Drought: A Guidebook for Developing Countries. Climate Unit, United Nations Environment Program, Nairobi, Kenya.

Wilhite, D. A., and M. D. and Svoboda, 2000: Drought early warning systems in the context of drought preparedness and mitigation. *Early Warning Systems for Drought Preparedness and Management,* Lisbon, Portugal, World Meteorological Organization, 1-16.

Wilhite, D. A., M. J. Hayes, and C. and Knutson, 2005: Drought preparedness planning: Building institutional capacity. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 93-135.

Wilhite, D. A., N. J. Rosenberg, and M. H. and Glantz, 1986: Improving federal response to drought. *Journal of Climate and Applied Meteorology,* 25, 332-342.

Wilhite, D. A., and D. A. Wood, 2001: Revisiting Drought Relief and Management Efforts in the West: Have We Learned from the Past? *Journal of the West,* **40**, 18-25.

Wilhite, D. A., and S. L. Rhodes, 1994: State-level drought planning in the United States: factors influencing plan development. *Water Int.,* **19**, 15-24.

Willett, G. S., 1988: Business management strategies for controlling drought risk. E.M.- Washington State University, Cooperative Extension Service, 48/8.

Williams, J., 2000: Drought Risk Management in Southern Africa: Developing Institutions to Transform 'Belated Disaster Response' into 'Informed Preparedness.' *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:168-2:177.

Zarafshani, K., M.J. Gorgievski, and G.H. Zamani, 2007. Dealing with drought: a comparison of perceptions and coping strategies of Iranian farmers from regions with different drought intensities. *Journal of Agricultural Education and Extension* 13(1):69-80.

Żarski, J., S. Dudek, R. Kuśmierek, and B. Grzelak, 2001: Role of sprinkler irrigation in atmospheric drought mitigation. *Inżynieria Rolnicza,* **5**, 541-547.

Zeuli, K. A., and J. R. Skees, 2005: Rainfall Insurance: A Promising Tool for Drought Management. *Int. J. Water Resour. Dev.,* **21**, 663-675.

Zilberman, D., D. Sunding, R. Howitt, A. Dinar, and N. and MacDougall, 1994: Water for California agriculture: lessons from the drought and new water market reform. *Choices,* **9**, 25-28.

REFERENCE SECTION 6: DROUGHT CASE STUDIES

Anonymous 1994: The Borana Plateau of Southern Ethiopia: synthesis of pastoral research, development and change, 1980-91. 393 pp.

Anonymous 1979: California water planning and policy. Selected issues. 251 pp.

Anonymous 1969: *An economic survey of drought affected pastoral properties-New South Wales and Queensland 1964-65 to 1965-66.* 51 pp.

Anonymous 1968: *Physical and financial effects of drought.* Sydney: Rur. Liaison Serv. Reserve Bank Aust., 49 pp.

Abtew, W., 2002: Droughts and water-shortages in the humid region of Central and South Florida. *Technical Publication - South Florida Water Management District, Environmental Monitoring and Assessment Department,* West Palm Beach, Florida.

Abtew, W., 2001: Droughts and water shortages in Central and South Florida. *Technical Publication - South Florida Water Management District, Environmental Monitoring and Assessment Department,* West Palm Beach, Florida.

Ahmad Gondal, M., 2001: Policy document on drought preparedness and crisis management in the province of Balochistan.

Ahmed, A. U., A. Iqbal, and A. M. Choudhury, 2005: Agricultural Drought in Bangladesh. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 313-322.

Ahn, H., 2000: Ground water drought management by a feedforward control method. *J. Am. Water Resour. Assoc.,* **36**, 501-510.

Akong'a, J., T. E. Downing, N. T. Konijn, D. N. Mungai, H. R. Muturi, and H. L. Potter, 1988: The effects of climatic variations on agriculture in central and eastern Kenya. *The impact of climatic variations on agriculture. Volume 2: Assesments in semi-arid regions.* M. L. Parry, T. R. Carter and N. T. Konijn eds., Kluwer Academic Publishers, 121-270.

Alcamo, J., M. B. Endejan, F. Kaspar, and T. Rösch, 2001: The GLASS model: a strategy for quantifying global environmental security. *Environmental Science & Policy,* **4**, 1-12.

Arndt, T., and UNDP Office to Combat Desertification and Drought., 2000: (Report on the status of drought preparedness & mitigation in Sub-Saharan Africa) [computer file]. New York, NY: UNSO [Office to Combat Desertification and Drought], 2000.

Asokan, S.M., and D. Dutta, 2008. Analysis of water resources in the Mahanadi River basin, India under projected climate conditions. *Hydrological Processes* 22(18):3589-3603.

Asrar-ul-Haq, 2002: Drought mitigation interventions by improved water management: a case study from Punjab - Pakistan. *Food production, poverty alleviation and environmental challenges as influenced by limited water resources and population growth. Volume 1A. 18th International Congress on Irrigation and Drainage, Montréal, Canada, 2002,* International Commission on Irrigation and Drainage (ICID), 1-12.

Australian Government, Department of Transport and Regional Services, 2004: Drought Impacts Beyond the Farm Gate: Two Regional Case Studies.

Ayers, J., and S. Huq, 2009. The Value of Linking Mitigation and Adaptation: A Case Study of Bangladesh. *Environmental Management* 43(5):753-764.

Baidal, M. K. and A. I. Neushkin, 1979: Macrocirculatory factors and drought prediction in the major agricultural regions of the USSR, 140.

Bajgiran, P.R., M.F. Makhdoum, A. Khalili, and A.A. Darvishsefat, 2008. Using AVHRR-based vegetation indices for drought monitoring in the Northwest of Iran. *Journal of Arid Environments* 72(6):1086-1096.

Barnett, T.P., and D.W. Pierce, 2009. Sustainable water deliveries from the Colorado River in a changing climate. *Proceedings of the National Academy of Sciences of the United States of America* 106(18):7334-7338.

Barros, A.P., and G.J. Bowden, 2008. Toward long-lead operational forecasts of drought: An experimental study in the Murray-Darling River Basin. *Journal of Hydrology* 357(3-4):349-367.

Batima, P., B. Bold, T. Sainkhuu, and M. Bavuu, 2008. Adapting to Drought, Zud and Climate Change in Mongolia's Rangelands. In Leary, N. (ed.), Climate Change and Adaptation. Earthscan, London, Chapter 11, pp. 196-210.

Baas, S., and S. Ramasamy, 2008. Community based adaptation in action : a case study from Bangladesh : project summary report (phase 1), Improved adaptive capacity to climate change for sustainable livelihoods in the agriculture sector. Food and Agriculture Organization of the United Nations, Rome. http://0-www.fao.org.library.unl.edu/docrep/010/i0481e/i0481e00.htm

Bazirake-Ntawera, C. G., 1977: Drought mitigation in Uganda. *Tea in East Africa,* **17**, 6-8.

Benegas, L., J. Faustino, M. Campos, F. Jiminez, and B. Locatelli, 2009. A methodological proposal for the evaluation of farmer's adaptation to climate variability, mainly due to drought in watersheds in Central America. *Mitigation and Adaptation Strategies for Global Change* 14(2):169-183.

Bharara, L. P., 1980: Social aspects of drought perception in arid zone of Rajasthan. *Annals of Arid Zone,* **19**, 154-167.

Bharara, L. P., and K. Seeland, 1994: Indigenous knowledge and drought in the arid zone of Rajasthan: weather prediction as a means to cope with a hazardous climate. *Internationales Asienforum,* **25**, 53-71.

Bhuiyan, C., R. P. Singh, and F. N. Kogan, 2006: Monitoring drought dynamics in the Aravalli region (India) using different indices based on ground and remote sensing data. *International Journal of Applied Earth Observation & Geoinformation,* **8**, 289-302.

Bochenek, Z., K. Dabrowska-Zielinska, A. Ciolkosz, S. Drupka, and V. K. Boken, 2005: Monitoring Agricultural Drought in Poland *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 171-180.

Boer, R., and A. R. Subbiah, 2005: Agricultural Drought in Indonesia *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 330-344.

Bogardi, I., I. Matyasovszky, A. Bardossy, and L. Duckstein, 1994: Estimation of local and areal drought reflecting climate change. *Trans. ASAE,* **37**, 1771-1781.

Bogardi, I., I. Matyasovszky, A. Bardossy, and L. Duckstein, 1994: A hydroclimatological model of areal drought. *Journal of hydrology,* **153**, 245-264.

Bokil, M., 2000: Drought in Rajasthan: in search of a perspective. *Economic and Political Weekly,* **35**, 4171-4175.
Bore, J. K. A., 1997: Composite tea plants: is there a future potential? *Tea,* Kericho, Kenya, 20-21 November, 116-122.
Boulal, H., and E. El-Mzouri, 2004: Impact of barley technologies on production improvement and the integration of crops in the semi-arid area of Morocco. *Options Méditerranéennes.Série A, Séminaires Méditerranéens,* 127-131.
Bowman, J. A., 1987: Aspects of irrigation in drought planning and ground-water management in Illinois. *Midwest Ground Water Conference,* **32.**
Boyd, D. S., G. M. Foody, and P. C. Phipps, 2006: Dynamics of ENSO drought events on Sabah rainforests observed by NOAA AVHRR. *Int. J. Remote Sens.,* **27**, 2197-2219.
Boyd, R., and M.E. Ibarrarán, 2009. Extreme climate events and adaptation: an exploratory analysis of drought in Mexico. Environment & Development Economics 14(3):371-395.
Brewer, S., S. Alleaume, J. Guiot, and A. Nicault, 2007. Historical droughts in Mediterranean regions during the last 500 years; a data/model approach. *Climate of the Past* 3(2):355-366.
Brolley, J.M., J.J. O'Brien, J. Schoof, D. Zierden, 2007. Experimental drought threat forecast for Florida. *Agricultural and Forest Meteorology* 145(1-2):84-96.
Bruins, H. J., 1999: Drought mitigation policies: waste water use, energy and food provision in urban and peri-urban Africa. *Urban and peri-urban agriculture in Africa: proceedings of a workshop, Netanya, Israel, 23-27 June 1996.* Netanya, Israel, Ashgate Publishing Ltd., 257-266.
Brunini, O., P. L. Da Silva Dias, P.L., A. M. Grimm, E. D. Assad, and V. K. Boken, 2005: Agricultural Drought Phenomenon in Latin America with focus on Brazil. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 156-168.
Burger, H., 1994: Nile groundwater interaction modeling in the northeastern Gezira and Dongola area (Sudan) for drought risk assessment, **39**, 56.
Byun, H., S. Hong, and V. K. Boken, 2005: Monitoring Agricultural Drought in South Korea. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 386-397.
Calanca, P., 2007. Climate change and drought occurrence in the Alpine region: How severe are becoming the extremes? *Global & Planetary Change* 57(1/2):151-160.
Calow, R. C. and Coauthors, 1997: Groundwater Management in Drought-prone Areas of Africa. *Int. J. Water Resour. Dev.,* **13**, 241-262.
Changnon, S. A., 2002: Impacts of the Midwestern Drought Forecasts of 2000. *J. Appl. Meteorol.,* 41, 1042.
Changnon, S. A., and D. R. Vonnahme, 2003: Impact of Spring 2000 Drought Forecasts on Midwestern Water Management. *Journal of Water Resources Planning & Management,* **129**, 18.
Chaudhury, S. H., 1984: Drought management for tea. *Circular no. 71,* Srimangal, Maulvibazar: Bangladesh Tea Research Institute.
Chen ChaurTzuhn, Yang ChiMing, and Chen JanChang, 2005: Satellite technology for vegetation drought monitoring in Taiwan. *Crop, Environment & Bioinformatics,* **2**, 50-60.
Chen YouQi, and He YingBin, 2006: An overview of research progress on drought in China. *JIRCAS Working Report,* , 31-37.
Chen, A. A., T. Falloon, and M. Taylor, 2005: Monitoring Agricultural Drought in the West Indies. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 144-155.
Cheng KeSheng, Yeh HuiChung, and Liou ChingYuan, 2000: Comparative study of drought prediction techniques for reservoir operation. *J. Am. Water Resour. Assoc.,* **36**, 511-521.
Chung YuhLurng, Chen ChaurTzuhn, Hsi ChenNi, and Liu ShihMing, 2005: Study of MODIS imagery band extraction applied to drought monitoring. *Taiwan J. For. Sci.,* **20**, 239-247.
Cobon, D.H.., X. Zhang, J. Willcocks, G.M. McKeon, N.R. Toombs, G.S. Stone, J.O. Carter, and J.C. Scanlan, 2009. The climate change risk management matrix for the grazing industry of northern Australia. *Rangeland Journal* 31(1):31-49.
Cochran, G., and T. Navoy, 1978: Management strategy for drought mitigation: a case study of the Walker River Irrigation District. *Desert Research Institute, President's Annual Report 1977-78*, p. 53.
Collins, T.W., and B. Bolin, 2007. Characterizing vulnerability to water scarcity; the case of a groundwater-dependent, rapidly urbanizing region. *Environmental Hazards* 7(4):399-418.
Cross, J. A., 1992: 1988 drought impacts among Wisconsin dairy farmers. *Trans. Wisc. Acad. Sci. Arts Lett.,* **80**, 21-34.
Cudgoe-Ofori, S., 1991: Drought mitigation and water resource schemes in pastoral northern Ghana: some aspects of international agency programmes. *Pastoral economies in Africa and long-term responses to drought. Proceedings of a Colloquium at the University of Aberdeen, April 1990.* African Studies Group, University of Aberdeen, 206-219.
Dabi, D.D., A.O. Nyong, A.A. Adepetu, V.I. Ihemegbulem, 2008. Past, Present and Future Adaptation by Rural Households of Northern Nigeria. In Leary, N. (ed.), *Climate Change and Adaptation*. Earthscan, London, Chapter 8, pp. 147-162.
Das, H. P., 2000: Monitoring the Incidence of Large-Scale Droughts in India. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:181-1:195.
Das, B. P., and C. D. Thatte, 2002: Innovative integration of streams and tanks for drought proofing a case study - Orissa, India. *Food production, poverty alleviation and environmental challenges as influenced by limited water resources and population growth. Volume 1A. 18th International Congress on Irrigation and Drainage, Montréal, Canada, 2002,* International Commission on Irrigation and Drainage (ICID), 1-16.
Davis, S. E., 1991: The role of groundwater in drought planning for the City of Phoenix. *American Water Resources Association Technical Publication Series TPS,* **91-2**, 49.
de Mello Lemos,Maria Carmen, 2003: A tale of two policies: The politics of climate forecasting and drought relief in Ceará, Brazil. *Policy Sci.,* **36**, 101.
De Pauw, E., 2005: Monitoring Agricultural Drought in the Near East *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 208-224.
Degaetano, A. T., 1999: A Temporal Comparison of Drought Impacts and Responses in the New York City Metropolitan Area. *Clim. Change,* **42**, 539.
del Moral Ituarte, L., and C. Giansante, 2000: Constraints to Drought Contingency Planning in Spain: The Hydraulic Paradigm and the Case of Seville. *Journal of Contingencies & Crisis Management,* **8**, 93.
Dieren, M. A., and G. Taylor, 2003: Examining Economic Impact and Recovery in South Dakota from the 2002 Drought.
Dieren, M. A., G. Taylor, and A. May, 2002: Direct and Indirect Effects of Drought on South Dakota's Economy. *South Dakota State University Economics Commentator (newsletter),* Aug. 26.
Diodato, N., and G. Bellocchi, 2008. Drought stress patterns in Italy using agro-climatic indicators. *Climate Research* 36(1):53-63.
Domenikiotis, C., M. Spiliotopoulos, E. Tsiros, and N. R. Dalezios, 2004: Early cotton production assessment in Greece based on a combination of the drought Vegetation Condition Index (VCI) and the Bhalme and Mooley Drought Index (BMDI). *Int. J. Remote Sens.,* **25**, 5373-5388.
Dracup, J. A. and P. A. Painter, 1979: Drought planning and management, 1-19.
Dupigny-Giroux, L. A., 2001: Towards characterization and planning for drought in Vermont. I. A climatological perspective. *J. Am. Water Resour. Assoc.,* **37**, 505-525.
Dupigny-Giroux, L. A., 2001: Towards characterizing and planning for drought in Vermont. II. Policy implications. *J. Am. Water Resour. Assoc.,* **37**, 527-531.
Durley, J. L., and R. C. d. Loë, 2005: Empowering communities to carry out drought contingency planning. *Water Policy,* **7**, 551-567.
Edmisten, K., J. Crawford, and M. Bader, 1994: Drought management for cotton production. *AG (North Carolina Agricultural Extension Service)*, http://www.ces.ncsu.edu/disaster/drought/dro-17.html.
Eiumnoh, A., R. P. Shrestha, and V. K. Boken, 2005: A Drought Warning System for Thailand *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 323-329.
Eriksen, S., and J. Lind, 2009. Adaptation as a Political Process: Adjusting to Drought and Conflict in Kenya's Drylands. *Environmental Management* 43(5):817-835.
Eriksen, S., and J. Silva, 2009. The vulnerability context of a savanna area in Mozambique: household drought coping strategies and responses to economic change. *Environmental Science & Policy* 12(1):33-52.

Estrela, T., A. Fidalgo, and M. Angel Pérez, 2005: Droughts and the European water framework directive: implications on Spanish river basin districts. *Drought management and planning for water resources,* J. Andreu, G. Rossi, F. Vagliasindi and A. Vela eds., CRC Press LLC, 169-191.

Falkenmark, M.,and J. Rockström, 2008. Building resilience to drought in desertification-prone savannas in Sub-Saharan Africa: The water perspective. *Natural Resources Forum* 32(2):93-102.

Fannberg, M. and M. Zetterberg, 1998: Development communication - a study on dissemination of information to smallholder farmers in Zimbabwe, 54.

FEMA, 1996: Drought of '96: Multi-State Drought Task Force finding. Federal Emergency Management Agency, Washington, D.C.

Fenemor, A., 1997: Floods and droughts: case studies. *Floods and droughts: the New Zealand experience,* M. P. Mosley and C. P. Pearson eds., New Zealand Hydrological Society, 187-201.

Feng Qiang, Liu QinHuo, Tian GuoLiang, T. R. McVicar, Wang AngSheng, and D. L. B. Jupp, 2004: Experimental study on the RS-based drought monitoring in China by using the vegetation condition indexes (II) - models of RS-based drought monitoring and the analyzed results. *Arid Land Geography,* **27**, 477-484.

Fisher, R.A., M. Williams, A.L. da Costa, Y. Malhi, R.F. da Cossta, S. Almeida, and P. Meir, 2007. The response of an Eastern Amazonian rain forest to drought stress: results and modelling analyses from a throughfall exclusion experiment. *Global Change Biology* 13(11):2361-2378.

Franks, S. W., 2005: Flood and drought risk in eastern Australia. *Predictions in ungauged basins: international perspectives on the state of the art and pathways forward,* S. W. Franks, M. Sivapalan, K. Takeuchi and Y. Tachikawa eds., Food and Agriculture Organization of the United Nations (FAO), 94-108.

Freitas, M. A. S., and M. H. A. Billib, 1997: Drought prediction and characteristic analysis in semiarid Ceará, northeast Brazil. *Sustainability of water resources under increasing uncertainty. Proceedings of an international symposium of the Fifth Scientific Assembly of the International Association of Hydrological Sciences (IAHS), Rabat, Morocco, 23 April to 3 May 1997*. Rabat, Morocco, IAHS Press, 105-112.

Fulazzaky, M. A., and H. Akil, 2004: Data management and warehousing for capacity building of the water resources sector in Indonesia. *55th Meeting of IEC International Commission on Irrigation and Drainage. International workshop on management of poor quality water for irrigation; institutional, health and environmental aspects, Moscow, Russia, 10 September 2004.* R. Ragab ed., International Commission on Irrigation and Drainage (ICID), 218-229.

Gaaloul, N., 2008. The role of groundwater during drought in Tunisia. In Zereini, F., and H. Hoetzl (eds.) *Climatic changes and water resources in the Middle East and North Africa*. Springer-Verlag, Berlin, pp. 239-266.

Garcia, C. P., A. Mestre Barceló, and J. L. Garcia Merayo, 2000: The Drought of 1991-5 in Southern Spain: Analysis, Economic Repercussions, and Response Measures. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:367-1:380.

Garrick, D., G. Garfin, and K. Jacobs, 2008. Models, Assumptions, and Stakeholders: Planning for Water Supply Variability in the Colorado River Basin. *Journal of the American Water Resources Association* 44(2):381-398.

Garrido, A., A. Iglesias, L. Garrote, M. Moneo, A. Gómez, F. Flores, F. Cubillo, J.C. Ibáñez, M. Fernández, and A. Lapeña, 2005: Spain. Centre International de Hautes Etudes Agronomiques Méditerranéennes, Paris. *Options Méditerranéennes.Série B, Études et Recherches,* 131-154.

Garrote, L., F. Martin-Carrasco, F. Flores-Montoya, and A. Iglesias, 2007. Linking Drought Indicators to Policy Actions in the Tagus Basin Drought Management Plan. *Water Resources Management* 21(5):873-882.

Giannini, A., 2008. A climate model-based review of drought in the Sahel; desertification, the re-greening and climate change. Global and Planetary Change 64(3-4):119-128.

Goodrich, G. B., and A. W. Ellis, 2006: Climatological Drought in Arizona: An Analysis of Indicators for Guiding the Governor's Drought Task Force. *Prof. Geogr.,* **58**, 460-469.

Gouranga Kar, Ravender Singh, and H. N. Verma, 2004: Alternative cropping strategies for assured and efficient crop production in upland rainfed rice areas of eastern India based on rainfall analysis. *Agric. Water Manage.,* **67**, 47-62.

Great Lakes Commission, 1990: A guidebook to drought planning, management and water level changes in the Great Lakes. Ann Arbor, Mich.: Great Lakes Commission.

Grunewald, K., D. Brown, J. Monget, and J. Scheithauer, 2009. Characterisation of contemporary local climate change in the mountains of southwest Bulgaria. *Climatic Change* 95(3-4):535-549.

Gupta, R. S., 1985: Ground-water reservoir operation for drought management. *J. Water Resour. Plann. Manage.,* **111**, 303.

Gutiérrez-Castorena, E.V., C.A. Ortiz-Solorio, M.C. Gutiérrez-Castorena, L.Cajuste-Bontemps, and M. Rocha-Aguilar, 2008. Technical, economical and social actions of farmers to mitigate water deficit in Tamaulipas, Mexico. *Agriculture, Ecosystems & Environment* 128(1/2):77-85.

Hadjigeorgalis, E., 2008. Managing Drought Through Water Markets: Farmer Preferences in the Rio Grande Basin. *Journal of the American Water Resources Association* 44(3):594-605.

Hanuta, I., 2007. Developing a national drought strategy for agriculture in Canada. Abstracts with Programs - Geological Society of America 39(6): 60.

Haylock, H. J. K., and N. J. Ericksen, 2000: From State Dependency to Self-Reliance: Agricultural Drought Policies and Practices in New Zealand *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:105-2:114.

Hill, H. M., 1979: Drought mitigation in Canada's prairie provinces. *Hydrological aspects of droughts: international symposium, 3-7 December 1979, New Delhi: proceedings,* New Delhi: Indian National Committee for IHP, CSIR : Indian Institute of Technology, 1979, 570-576.

Hochrainer, S., G. Pflug, and R. Mechler, 2009. Climate change and financial adaptation in Africa. Investigating the impact of climate change on the robustness of index-based microinsurance in Malawi. *Mitigation and Adaptation Strategies for Global Change* 14(3):231-250.

Hodges, A. W., and J. J. and Haydu, 2003: Economic Impacts of Drought on the Florida Environmental Horticulture Industry. University of Florida, Institute of Food & Agricultural Sciences, Food & Resource Economics Department, Gainesville, Florida.

Holechek, J. L., 1996: Drought in New Mexico: prospects and management. *Rangelands,* **18**, 225-227.

Holechek, J. L., and D. Galt, 2004: A new approach to grazing management: using multi-herd/variable stocking. *Rangelands,* **26**, 15-18.

Homann, S., J. Steinbach, and B. Rischkowsky, 2008. The effect of development interventions on the use of indigenous range management strategies in the Borana Lowlands in Ethiopia. *Land Degradation & Development* 19(4):368-387.

Homewood, K., and J. Lewis, 1987: Impact of Drought on Pastoral Livestock in Baringo, Kenya 1983-85. *J. Appl. Ecol.,* **24**, 615-631.

Horridge, M., J. Madden, and G. and Wittwer, 2005: The Impacts of the 2002-2003 Drought on Australia. *Journal of Policy Modeling,* **27**, 285-308.

Hundertmark, W., 2008. Building drought management capacity in the Mekong River basin. *Irrigation and Drainage* 57(3):279-287.

Ibrahim, A. M., 2001: Contract research project on application of agroecological zones database in drought management and water availability assessment / principal investigator, Abu Muhammod Ibrahim. Dhaka: Environment and GIS Support Project for Water Sector Planning, Ministry of Water Resources, Govt. of Bangladesh, 2001.

Ifejika Speranza, C., B. Kiteme, and U. Wiesmann, 2008. Droughts and famines: The underlying factors and the causal links among agro-pastoral households in semi-arid Makueni district, Kenya. *Global Environmental Change Part A: Human & Policy Dimensions*18(1):220-233.

Iglesias, A. (ed.), 2009. *Coping with drought risk in agriculture and water supply systems: drought management and policy development in the Mediterranean*. Springer, Dordrecht.

Iglesias, E., A. Garrido, and A. Gomez-Ramos, 2003: Evaluation of drought management in irrigated areas. *Agricultural economics: the journal of the International Association of Agricultural Economists,* **29,** 211-229.

Iglesias, E., A. Gómez-Ramos, and A. Garrido, 2007: Economic drought management index to evaluate water institutions' performance under uncertainty [electronic resource]. *Aust. J. Agric. Resour. Econ.,* **51,** 17-38.

Jackson, D., J. Hartley, M. Dignand, and D. Cordina, 1998: A stochastic analysis of drought management strategies for a sheep/beef enterprise in the Northern Tablelands of New South Wales / Deranie Jackson. [Orange, N.S.W.?] : NSW Agriculture, 1998.

Jacobs, K. L., G. M. Garfin, and B. J. Morehouse, 2005: Climate science and drought planning: the Arizona experience. *J. Am. Water Resour. Assoc.,* 41, 437-445.

Jaishanker, R., V. K. Sehgal, T. Senthivel, and V. K. Dadhwal, 2006: Evaluation of SPOT-VEGETATION derived global vegetation assessment product for near-real time drought monitoring over India. *Proceedings of the National Academy of Sciences India. Section B, Biological Sciences,* **76**, 78-84.

Ji, L., and A. J. Peters, 2003: Assessing vegetation response to drought in the northern Great Plains using vegetation and drought indices. *Remote Sens. Environ.,* **87**, 85.
Johnston, W. R., and R. E. Johnston, 1990: Preparing for agricultural water use in a drought. *Proceedings 14th International Congress on Irrigation and Drainage, Rio de Janeiro, Brazil.* Rio de Janeiro, International Commission on Irrigation and Drainage, 69-82.
Kar, G., R. Singh, and H. N. Verma, 2004: Alternative cropping strategies for assured and efficient crop production in upland rainfed rice areas of eastern India based on rainfall analysis. *Agric. Water Manage.,* **67**, 47-62.
Karamouz, M., and S. Araghinejad, 2008. Drought mitigation through long-term operation of reservoirs: case study. *Journal of Irrigation and Drainage Engineering* 134(4):471-478.
Kassahun, A., G.N. Smit, and H.A. Snyman, 2008. Impact of rangeland degradation on the pastoral production systems, livelihoods and perceptions of the Somali pastoralists in Eastern Ethiopia. *Journal of Arid Environments* 72(7):1265-1281.
Keil, A., N. Teufel, D. Gunawan, and C. Leemhuis, 2009. Vulnerability of smallholder farmers to ENSO-related drought in Indonesia. *Climate Research* 38(2):155-169.
Keil, A., M. Zeller, A. Wida, B. Sanim, and R. Birner, 2008. What determines farmers' resilience towards ENSO-related drought? An empirical assessment in Central Sulawesi, Indonesia. Climatic change 86(3-4):291-307.
Kenney, D.S., J. Lowrey, K. Reidy, C. Goemans, and R. Klein, 2008. Residential water demand management: lessons from Aurora, Colorado. *Journal of the American Water Resources Association* 44(1):192-207.
Kenny, M. L., 2002: Drought, Clientalism, Fatalism and Fear in Northeast Brazil. *Ethics, Place & Environment,* **5**, 123-134.
Kenya, Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC), 2005: Mitigating drought-related disasters in the Greater Horn of Africa. *Bulletin - World Meteorological Organization,* **54**, 17-21.
Kininmonth, W. R., M. E. Voice, G. S. Beard, G. C. de Hoedt, and C. E. and Mullen, 2000: Australian Climate Services for Drought Management. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:210-1:222.
Kjeldsen, T. R., A. Lundorf, and D. Rosbjerg, 1999: Barriers to sustainable water resources management - a Zimbabwean case study. *Hydrological Sciences Journal,* Wuhan, Hubei, China, 529-539.
Kleschenko, A. D., E. K. Zoidze, and V. K. Boken, 2005: Monitoring Agricultural Drought in Russia. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 196-207.
Knutson, C. L., M. J. Hayes, R. K. Hitchcock, J. Peake, and M. and Kleinschmit, 2006: Sustainable adaptations to drought and climate variability in agricultural production systems across Nebraska: Final Report to NOAA's Human Dimensions of Global Change Research (HDGCR) Program.
Koehnke, M., 1993: Nile groundwater interaction modeling in the northern Gezira Plain for drought risk assessment, 705.
Kokic, P., A. Potgieter, J. Carter, R. Nelson, and H. Meinke, 2007. From rainfall to farm incomes-transforming advice for Australian drought policy. I. Development and testing of a bioeconomic modelling system. *Australian Journal of Agricultural Research* 58(10):993-1003.
Krol, M., and A. Bronstert, 2007. Regional integrated modelling of climate change impacts on natural resources and resource usage in semi-arid Northeast Brazil. *Environmental Modelling & Software* 22(2):259-268.
Kulshreshtha, S. N., C. W. Grant, R. Marleau, and E. and Guenther, 2003: Technical Report: Canadian Droughts of 2001 and 2002.
Kulshreshtha, S. N., and K. K. Klein, 1990: Drought mitigation through large-scale intensive irrigation projects-a case study of the South Saskatchewan River Project. *Proceedings 14th International Congress on Irrigation and Drainage, Rio de Janeiro, Brazil.* Rio de Janeiro, International Commission on Irrigation and Drainage, 13-27.
Labedzki, L., 2004: Drought problems in Poland. *Woda Środowisko Obszary Wiejskie,* **4**, 47-66.
Lehner, B., P. Döll, J. Alcamo, T. Henrichs, and F. Kaspar, 2006: Estimating the Impact of Global Change on Flood and Drought Risks in Europe: a Continental, Integrated Analysis. *Clim. Change,* **75**, 273-299.
LEIGH, J. H., and A. D. WILSON, 1969: *The value and limitations of shrubs and trees for drought mitigation in the pastoral zone.* 9 pp.
Lemos, M. C., 2003: A tale of two policies: The politics of climate forecasting and drought relief in Ceará, Brazil. *Policy Sci.,* **36**, 101.
Lemos, M. C., T. J. Finan, R. W. Fox, D. R. Nelson, and J. Tucker, 2002: The use of seasonal climate forecasting in policymaking: lessons from Northeast Brazil. *Clim. Change,* **55**, 479-507.
Li Jinbao, Chen Fahu; E.R. Cook, Gou Xiaohua, and Zhang Yongxiang. 2007. Drought reconstruction for north central China from tree rings: the value of the Palmer drought severity index. *International Journal of Climatology* 7:903-909.
Li XingMin, Zheng YouFei, Liu AnLin, Zhang ShuYu, and Deng FengDong, 2004: A research on a remote sensing drought monitoring model in the east part of Weibei in Shaanxi Province. *Journal of Nanjing Institute of Meteorology,* **27**, 73-78.
Li, K., Y. Chen, and C. Huang, 2000: The Impacts of Drought in China: Recent Experiences. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:331-1:347.
Liebe, J., N. van de Giesen, and M. Andreini, 2005: Estimation of small reservoir storage capacities in a semi-arid environment: A case study in the Upper East Region of Ghana. *Physics & Chemistry of the Earth - Parts A/B/C,* **30**, 448-454.
Ligetvari, F., and S. Szalai, 2004: Monitoring of drought development: case study for the year 2003. *Proceedings of ICID Interregional Conference on food production and water: social and economic issues of irrigation and drainage, Moscow, Russia, 5-11 September 2004,* International Commission on Irrigation and Drainage (ICID), 2.4.6.
Liverman, D. M., 2000: Adaptation to Drought in Mexico *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:35-2:45.
Loeser, M.R.R., T.D. Sisk, and T.E. Crews, 2007. Impact of Grazing Intensity during Drought in an Arizona Grassland. *Conservation Biology the Journal of the Society for Conservation Biology* 21(1):87-97.
Louati, M. E., H. J. Mellouli, and M. L. El-Echi, 2005: Tunisia. *Options Méditerranéennes.Série B, Études et Recherches,* 155-188.
Lu, J., 2009. The dynamics of the Indian Ocean sea surface temperature forcing of Sahel drought. *Climate Dynamics*, 33(4):445-460.
Mahodaya, M. M., 1979: A critical study of the drought conditions in Dhar district, Madhya Pradesh and suggested measures for drought mitigation India. *Hydrological aspects of droughts: international symposium, 3-7 December 1979, New Delhi: proceedings,* New Delhi: Indian National Committee for IHP, CSIR: Indian Institute of Technology, 1979, 520-531.
Malley, Z.J.U., T. Matsumoto, and M. Taeb, 2009. Agricultural productivity and environmental insecurity in the Usangu plain, Tanzania: policy implications for sustainability of agriculture. *Environment, Development and Sustainability* 11(1):175-195.
Malley, Z.J.U., 2009. Linking environment and livelihood: process and impact of hydrological drought in the Usangu-Mtera ecosystem, Tanzania. *International Journal of Environment & Sustainable Development* 8(1):5-5.
Margane, A., A. Borgstedt, and A. Subah, 2008. Water resources protection efforts in Jordan and their contribution to sustainable water resources management. In Zereini, F., and H. Hoetzl (eds.) *Climatic changes and water resources in the Mid dle East and North Africa*. Springer-Verlag, Berlin, pp. 325-345.
Masaschi, B. S., 1978: Drought planning and relief in South Carolina; a review of the problems and present response capabilities.
Mason, S. J., and P. D. and Tyson, 2000: The Occurrence and Predictability of Droughts over Southern Africa. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:113-1:134.
Mathew, J., and S. Sankaran, 1993: Establishment and seedling vigour of dry-sown rice (*Oryza sativa*). *Indian Journal of Agronomy,* **38**, 293-295.
McAlpine, C.A., G.M. McKeon, H.A. McGowan, S.R. Phinn, J. Syktus, J.G. Ryan, and R.C. Deo, 2009. A continent under stress: interactions, feedbacks and risks associated with impact of modified land cover on Australia's climate. *Global Change Biology* 15(9):2206-2223.
Medugu, I.N., M.R. Majid, and I.D. Choji, 2008. A comprehensive approach to drought and desertification in Nigeria: A brief evaluation of government policies. *Management of Environmental Quality* 19(6):690-704.
Mekhora, T., 2003: Coping strategies against El Nino-induced climatic risk: case of Northeast Thailand. **20**, 1-2, 4-9.
Mendicino, G., and P. Versace, 2007. Integrated Drought Watch System: A Case Study in Southern Italy. *Water Resources Management* 21(8):1409-1428.
Mendicino, G., A. Senatore, and P. Versace, 2008. A groundwater resource index (GRI) for drought monitoring and forecasting in a Mediterranean climate. *Journal of Hydrology* 357(3-4):282-302.
Mengü, G., S. Anaç, and K. Topcuoglu, 2009. Analysis of drought in the Marmara region using the standardized precipitation index. *Fresenius Environmental Bulletin* 18(5):633-641.

Mersha, E., and V. K. Boken, 2005: Agricultural Drought in Ethiopia. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 227-237.
Meyer, S. J., K. G. Hubbard, and D. A. and Wilhite, 1993: A crop-specific drought index for corn. II. Application in drought monitoring and assessment. *Agron. J.,* **85**, 396-399.
Miller, E., and L. Buys, 2008. The impact of social capital on residential water-affecting behaviors in a drought-prone Australian community. *Society & Natural Resources* 21(3):244-257.
Miller, K. A., 2000: Managing Supply Variability: The Use of Water Banks in the Western United States. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:70-2:86.
Mogensen, V. O., and B. S. Hansen, 1979: Drought periods in Denmark 1956-1976. Calculations for field drainage. *Arsskrift, Kongelige Veterinaer- og Landbohoejskole,* 25-42.
Moghaddasi, M., S. Morid, H. Ghaemi, and J. M. V. Samani, 2005: Daily drought monitoring, Tehran Province. *Iranian J. Agric. Sci.,* **36**, 51-62.
Molle, F., A. Mamanpoush, J. Hoogesteger, 2008. Macro- and micro-level impacts of droughts: the case of the Zayandeh Rud river basin, Iran. *Irrigation and Drainage* 57(2):219-227.
Monnik, K., 2000: Role of drought early warning systems in South Africa's evolving drought policy. *Early Warning Systems for Drought Preparedness and Drought Management. Proceedings of an Expert Group Meeting in Lisbon, Portugal, 5 - 7 September,* Lisbon, Portugal, World Meteorological Organization, 53-64.
Morehart, M., N. Gollehon, R. Dismukes, V. Breneman, and R. Heimlich, 1999: An Economic Assessment of the 1999 Drought: Agricultural Impacts are Severe Locally, but Limited Nationally.
Morel-Seytoux, H. J., C. J. Daly, and T. Illangasekare, 1979: A river aquifer interactive model suited for evaluation of drought mitigation strategies Water allocation management. *Hydrological aspects of droughts: international symposium, 3-7 December 1979, New Delhi: proceedings,* New Delhi: Indian National Committee for IHP, CSIR: Indian Institute of Technology, 1979, 546-557.
Morid, S., V. Smakhtin, and M. Moghaddasi, 2006: Comparison of seven meteorological indices for drought monitoring in Iran. *Int. J. Climatol.,* **26**, 971-985.
Morton, J., and D. Barton, 2002: Destocking as a Drought–mitigation Strategy: Clarifying Rationales and Answering Critiques. *Disasters,* **26**, 213-228.
Mukheibir, P., and G. Ziervogel, 2007. Developing a Municipal Adaptation Plan (MAP) for climate change: the city of Cape Town. Environment & Urbanization 19(1):143-158.
Mustafa, G., D. J. Bosch, T. M. Younos, and B. B. Ross, 1987: A stochastic economic model for riparian irrigation expansion under drought risk. *American Society of Agricultural Engineers (Microfiche collection),*
Naganna, C., 1990: A strategy for drought mitigation using groundwater; a case study in Kolar District, Karnataka State, India. *IAHS-AISH Publication,* **173**, 31.
Naganna, C., and D. C. Barai, 1982: Drought mitigation strategy - a case study in the Kolar region, Karnataka. *Transactions, Institute of Indian Geographers,* **4**, 125-131.
Naidu, L. G. K., and S. Srinivas, 2005: Length of growing period as a criterion for identifying different drought types in Karnataka. *Indian J. Agric. Sci.,* **75**, 614-615.
Nefzaoui, A., and H. B. Salem, 2002: Cacti: efficient tool for rangeland rehabilitation, drought mitigation and to combat desertification. *Acta Horticulturae,* , 295-315.
Nelson, R., M. Howden, M.S. Smith, 2008. Using adaptive governance to rethink the way science supports Australian drought policy. *Environmental Science & Policy* 11(7):588-601.
Nelson, R., H. Meinke, and P. Kokic, 2007. From rainfall to farm incomes-transforming advice for Australian drought policy. II. Forecasting farm incomes. *Australian Journal of Agricultural Research* 58(10):1004-1012.
Niestle, A., 1990: An approach for drought risk assessment based on hydrologic records of the River Nile in connection with a groundwater flow model. *Berliner Geowissenschaftliche Abhandlungen, Reihe A: Geologie und Palaeontologie,* **120**, 1041.
Nobre, P., and I. F. A. and Cavalcanti, 2000: The Prediction of Drought in the Brazilian Nordeste: Progress and Prospects for the Future. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:68-1:82.
Nyabeze, W. R., 2004: Estimating and interpreting hydrological drought indices using a selected catchment in Zimbabwe. *Physics & Chemistry of the Earth - Parts A/B/C,* **29**, 1173-1180.
Nyong, A., F. Adesina, and B. Osman Elasha, 2007. The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change* 12(5):787-797.
Oba, G., 2001: The Importance of Pastoralists' Indigenous Coping Strategies for Planning Drought Management in the Arid Zone of Kenya. *Nomadic Peoples,* **5**, 89.
O'Farrell, P.J., P.M.L. Anderson, S. J. Milton, and W.R.J. Dean, 2008. Human response and adaptation to drought in the arid zone: lessons from southern Africa. *South African Journal of Science* 104(11/12):34-39.
Ogallo, L. A., 2000: Predicting Drought in Kenya: Prospects and Challenges. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:52-1:67.
Ogallo, L. A., S. B. Otengi, P. Ambenje, W. Nyakwada, and F. Githui, 2005: Monitoring Agricultural Drought: The Case of Kenya. *Monitoring and Predicting Agricultural Drought: A Global Study* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 238-251.
Onyango, J. W., 1992: A simple procedure for drought prediction over the "water year" for agricultural and hydrological schedules in West Kenya. *East African Agricultural and Forestry Journal,* **57**, 239-251.
Opper, R. H., 1994: Drought management in the Missouri River Basin. *Drought Management in a Changing West: New Directions for Water Policy,* Portland, Oregon, International Drought Information Center, University of Nebraska-Lincoln, 67.
Ortega-Ochoa, C., M.C. Farmer, and C. Villalobos, 2007. A Pasture-Based Model for Extended Drought Management, Long-Term Sustainability, and Economic Viability in the Southern High Plains. *Forage and Grazinglands*, http://0-dx.doi.org.library.unl.edu/10.1094/FG-2007-1108-01-MG
O'Shea, M. J., and R. Sage, 1999: Aquifer recharge: an operational drought-management strategy in North London. *Water and environmental management: journal of the Institution of Water and Environmental Management,* **13**, 400-405.
O'Shea, M., 1995: Borehole recharge; a drought management strategy in N. London, UK. *Proceedings of the International Symposium on Artifical Recharge of Ground Water,* **2**, 210.
Osman-Elasha, B., N. Nagmeldin, E. Spanger-Siegfried, B. Dougherty, A. Hanafi, S. Zakieldeen, E. Sanjak, H.A. Atti, H.M. Elhassan, 2008. Community Development and Coping with Drought in Rural Sudan. In Leary, N. (ed.), *Climate Change and Adaptation*. Earthscan, London, Chapter 5, pp. 90-108.
Ouassou, A., T. Ameziane, M. Belghiti, A. Ziyad, and A. Belhamd, 2005: Morocco. *Options Méditerranéennes.Série B, Études et Recherches,* 105-129.
Oyebande, L., 1990: Drought policy and drought planning in Africa. *Int. J. Water Resour. Dev.,* **6**, 260-269.
Pamuk, G., M. Özgürel, and K. Topcuoglu, 2004: Drought analysis of Aegean Region by Standardized Precipitation Index (SPI). *Ege Üniversitesi Ziraat Fakültesi Dergisi,* **41**, 99-106.
Panda, D.K., B.K. James, A. Kumar, A. Mishra, and S.K. Jena, 2007. The influence of drought and anthropogenic effects on groundwater levels in Orissa, India. *Journal of Hydrology* 343(3-4):140-153.
Pandey, R. P., 2004: Case study of Sonar and Bearma sub-basins of Ken Basin for drought proofing analysis. *Water and Energy International,* **61**, 14.
Pandey, S., H. Bhandari, S. Ding, P. Prapertchob, R. Sharan, D. Naik, S.K. Taunk, and A. Sastri, 2007. Coping with drought in rice farming in Asia: insights from a cross-country comparative study. *Agricultural Economics* 37(s1):213-224.
Pattanayak, S. K., and R. A. Kramer, 2001: Pricing ecological services: willingness to pay for drought mitigation from watershed protection in eastern Indonesia. *Water Resour. Res.,* **37**, 771-778.
Pattanayak, S. K., and R. A. Kramer, 2001: Worth of watersheds: a producer surplus approach for valuing drought mitigation in eastern Indonesia. *Environ. Dev. Econ.,* **6**, 123-146.

Phillips, O.L., 2009. Drought Sensitivity of the Amazon Rainforest. *Science* 323(5919):1244-1347.
Pielke Sr., R. A., N. Doesken, O. Bliss, T. Green, C. Chaffin, J.D. Salas, C.A. Woodhouse, J.J. Lukas, and K. Wolter, 2005: Drought 2002 in Colorado: An Unprecedented Drought or a Routine Drought? *Pure & Applied Geophysics,* **162**, 1455-1479.
Pirie, R. L., R. C. d. Loë, and R. Kreutzwiser, 2004: Drought planning and water allocation: an assessment of local capacity in Minnesota. *J. Environ. Manage.,* **73**, 25-38.
Polemio, M., and D. Casarano, 2008. Climate change, drought and groundwater availability in southern Italy. *Geological Society Special Publications* 288:39-51.
Ponce, V. M., 1995: Management of droughts and floods in the semiarid Brazilian Northeast--the case for conservation. *Journal of Soil and Water Conservation,* **55**, 422-431.
Poore, M. H., 1994: Drought management on North Carolina cow-calf farms. *AG (North Carolina Agricultural Extension Service),* http://www.ces.ncsu.edu/disaster/drought/dro-25.html.
Prabhakar, S.V.R.K., and R. Shaw. 2008. Climate change adaptation implications for drought risk mitigation: a perspective for India**.** *Climatic Change* 88(2):113-130.
Pratt, M., M. S. Cerda, M. Boulahya, and K. Sponberg, 2005: Harnessing Radio and Internet Systems to Monitor and Mitigate Agricultural Droughts in Rural African Communities. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 276-282.
Prieto, M. M., 2005: Droughts and Water Stress Situations in Spain. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 367-385.
Pulwarty, R. S., K. L. Jacobs, and R. M. and Dole, 2005: The Hardest Working River: Drought and Critical Water Problems in the Colorado River Basin. *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 249-285.
Qi ShuHua, Zhang YuanPei, Niu Zheng, Wang ChangYao, and Zheng Lin, 2005: Application of water deficit index in drought monitoring in China with remote sensing. *Acta Pedologica Sinica,* **42**, 367-372.
Queensland. Drought Mitigation Committee., Drought problems in Queensland Report of the Representative Committee on Drought Problems. Brisbane.
Querner, E. P., 2001: Impact assessment of drought mitigation measures in two adjacent Dutch basins using simulation modelling. *Journal of Hydrology,* **252**, 51.
Quiring, S. M., 2004: Developing a real-time agricultural drought monitoring system for Delaware. *Publications in climatology; v. 57, no. 1,* Middletown, Del.: Legates Consulting; Newark, Del.: University of Delaware, Center for Climatic Research.
Quiring, S.M., and G.B. Goodrich, 2008. Nature and causes of the 2002 to 2004 drought in the southwestern United States compared with the historic 1953 to 1957 drought. *Climate Research* 36(1):41-52.
Quiring, S. M., and T. N. Papakryiakou, 2003: An evaluation of agricultural drought indices for the Canadian prairies. *Agricultural & Forest Meteorology,* **118**, 49.
Rao, A. S., and V. K. Boken, 2005: Monitoring and Managing Agricultural Drought in India. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 297-312.
Rao, V. R., 1979: Drought mitigation measures for drought prone areas in Andhra Pradesh Irrigation, India. *Hydrological aspects of droughts: international symposium, 3-7 December 1979, New Delhi: proceedings,* New Delhi: Indian National Committee for IHP, CSIR: Indian Institute of Technology, 1979, 494-501.
Richter, G. M., and M. A. Semenov, 2005: Modelling impacts of climate change on wheat yields in England and Wales: assessing drought risks. *Agricultural Systems,* **84**, 77-97.
Riebsame, W. E., S. A. J. Changnon, and T. R. and Karl, 1991: *Drought and Natural Resources Management in the United States: Impacts and Implications of the 1987-89 Drought*. Westview Press, Boulder, Colorado.
Rodriguez-Pineda, J. A., L. Giddings, H. Gadsden, and V. K. Boken, 2005: Agricultural Drought in North-Central Mexico. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 132-143.
Rolbiecki, S., R. Rolbiecki, and C. Rzekanowski, 2005: Irrigation as a drought mitigation factor in raspberry cultivation on sandy soil. *Woda Środowisko Obszary Wiejskie,* **5**, 243-260.
Roncoli, C., K. Ingram, and P. Kirshen, 2001: The costs and risks of coping with drought: livelihood impacts and farmers' responses in Burkina Faso. *Climate Research,* **19**, 119-132.
Rossi, G., A. Cancelliere, and G. Giuliano, 2005: Multicriteria assessment of drought mitigation measures. *J. Water Resour. Plann. Manage.,* **131**, 449-457.
Rossi, G., A. Cancelliere, and G. Giuliano, 2005: Role of decision support system and multicriteria methods for the assessment of drought mitigation measures. *Drought management and planning for water resources,* J. Andreu, G. Rossi, F. Vagliasindi and A. Vela eds., CRC Press LLC, 203-240.
Rossi, G., A. Cancelliere, G. Giuliano, S. Alecci, and I. Alba, 2005: Italy. *Options Méditerranéennes.Série B, Études et Recherches,* 65-104.
Royal Society, 1978: Scientific aspects of the 1975-76 drought in England and Wales, 133.
Sakurai, T., 1997: Crop production under drought risk and estimation of demand for formal drought insurance in the Sahel. *Research paper no. 16,* Tokyo, Japan: National Research Institute of Agricultural Economics, Ministry of Agriculture, Forestry and Fisheries.
Salas, J. D., C. Fu, A. Cancelliere, D. Dustin, D. Bode, A. Pineda, and E. Vincent, 2005: Characterizing the Severity and Risk of Drought in the Poudre River, Colorado. *Journal of Water Resources Planning & Management,* **131**, 383-393.
Santo, F. E., R. Guerreiro, V. Cabrinha Pires, L. E. V. Pessanha, and I. M. and Gomes, 2005: Monitoring Agricultural Drought in Mainland Portugal. *Monitoring and Predicting Agricultural Drought: A Global Study* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 181-195.
Sastri, A. S. R. A. S., 2000: Agricultural Drought Management for Sustained Agricultural Development. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:46-2:58.
Schneckenburter, C. A., and R. and Aukerman, February 2003: Economic Effects of the Drought on Colorado's Recreation and Tourism. *Colorado Water (newsletter, Colorado State University),* 16-20.
Schwinning, S., J. Belnap, D.R. Bowling, and J.R. Ehleringer, 2008. Sensitivity of the Colorado Plateau to Change: Climate, Ecosystems, and Society. *Ecology & Society* 13(2):1-20.
Sear, C. B., 1999: Reducing the impact of drought in southern Africa - delivering and using better forecasts. *Decision tools for sustainable development.* I. F. Grant and C. Sear eds., Natural Resources Institute (NRI), 225-249.
Shaban, A., 2008. Impact of climate change on water resources of Lebanon; indications of hydrological droughts. In Zereini, F., and H. Hoetzl (eds.) *Climatic changes and water resources in the Middle East and North Africa*. Springer-Verlag, Berlin, pp. 125-143.
Shaowu, W., Y. Jinlan, and Q. and Weihong, 2000: Predictability of Drought in China. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:100-1:112.
Shepherd, A., 1998: Drought contingency planning: evaluating the effectiveness of plans. *J. Water Resour. Plann. Manage.,* **124**, 246-251.
Singels, A., and A. B. Potgieter, 1997: A technique to evaluate ENSO-based maize production strategies. *South African Journal of Plant and Soil,* **14**, 93-97.
Sinha, S. K., K. Kailasanathan, and and Vasistha, A. K., 1987: Drought management in India: Steps toward eliminating famines. *Planning for Drought: Toward a Reduction of Societal Vulnerability,* D. A. Wilhite and W. E. and Easterling eds., Westview Press, 453-470.
Sivakumar, M. V. K., 1992: Empirical analysis of dry spells for agricultural applications in West Africa. *J. Clim.,* **5**, 532-539.
Slegers, M.F.W., 2008. "If only it would rain": Farmers' perceptions of rainfall and drought in semi-arid central Tanzania. *Journal of Arid Environments* 72(11):2106-2123.
Sloto, R. A., 1991: Drought management based on water-level data, Chester County, Pennsylvania. *American Water Resources Association Technical Publication Series TPS,* **91-3**, 439.

Song, X., G. Saito, M. Kodama, and H. Sawada, 2004: Early detection system of drought in East Asia using NDVI from NOAA/AVHRR data. *Int. J. Remote Sens.,* **25**, 3105-3111.
Sonka, S., S. Changnon, S. Bard, and T. and Doehring, 2001: Midwestern Impacts of the 2000 Drought Forecasts.
Steinemann, A. C., and L. F. N. Cavalcanti, 2006: Developing Multiple Indicators and Triggers for Drought Plans. *Journal of Water Resources Planning & Management,* **132**, 164-174.
Stemp-Morlock, G., 2007. Australia's War on Drought. *Environmental Health Perspectives* 115(7):A348-A348.
Stroosnijder, L. 2009. Modifying land management in order to improve efficiency of rainwater use in the African highlands. *Soil & Tillage Research* 103(2):247-256.
Stuth, J. W., J. Angerer, R. Kaitho, A. Jama, and R. Marambii, 2005: Livestock Early Warning System for Africa's Rangelands. *Monitoring and Predicting Agricultural Drought: A Global Study* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 283-294.
Su, Z., A. Yacob, J. Wen, G. Roerink, Y. He, B. Gao, H. Boogaard, and C. van Diepen, 2003: Assessing relative soil moisture with remote sensing data: theory, experimental validation, and application to drought monitoring over the North China Plain. *Physics & Chemistry of the Earth - Parts A/B/C,* **28**, 89.
Subbiah, A. R., 2000: Response Strategies of Local Farmers in India. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group., 2:29-2:34.
Subbiah, A. R., 1993: Indian Drought Management: From Vulnerability to Resilience. *Drought Assessment, Management, and Planning: Theory and Case Studies,* D. A. Wilhite ed., Kluwer Academic Publishers.
Sumathi, I., S. S. Bosu, and S. Senthilvel, 2000: Assessment of periodicity of drought occurrence in Perambalur region. *Madras Agricultural Journal,* **87**, 724-727.
Sun Wei, Wang PengXin, Han LiJuan, Yan Kai, Zhang ShuYu, and Li XingMin, 2006: Further improvement of the approach to monitoring drought using vegetation and temperature condition indexes from multi-years' remotely sensed data. *Transactions of the Chinese Society of Agricultural Engineering,* **22**, 22-26.
Sun, R., X. Gao, C. M. Liu, and X. W. Li, 2004: Evapotranspiration estimation in the Yellow River Basin, China using integrated NDVI data. *Int. J. Remote Sens.,* **25**, 2523-2534.
Swaty, R. L., R. J. Deckert, T. G. Whitham, and C. A. Gehring, 2004: Ectomycorrhizal abundance and community composition shifts with drought: predictions from tree rings. *Ecology,* **85,** 1072-1084.
Swearingen, W. D., and A. and Bencherifa, 2000: An Assessment of the Drought Hazard in Morocco. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:279-1:286.
Tadesse, T., 2000: Drought and its Predictability in Ethiopia. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:135-1:142.
Tadesse, T., D. A. Wilhite, M. J. Hayes, S. K. Harms, and S. Goddard, 2005: Discovering Associations between Climatic and Oceanic Parameters to Monitor Drought in Nebraska Using Data-Mining Techniques. *J. Clim.,* **18**, 1541-1550.
Tapp, N., D. Thompson, N. Milham and D. Jackson, 1998: A stochastic analysis of drought management strategies for mixed farming in the central west of New South Wales. 23 pp.
Tesfaye, H., 1988: Causes and characteristics of drought in Ethiopia. *Ethiopian Journal of Agricultural Sciences,* **10**, 85-97.
Thomas, R.J., 2008. Opportunities to reduce the vulnerability of dryland farmers in Central and West Asia and North Africa to climate change. *Agriculture, Ecosystems & Environment* 126(1/2):36-45.
Thompson, P., and G. D. Lynne, 1994: Policy drought: the case of south Florida. *Water Resour. Bull.,* **30**, 19-26.
Tian, G., and V. K. Boken, 2005: Monitoring Agricultural Drought in China. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 354-368.
Toni, F., and H. Evandro, 2008. The effects of land tenure on vulnerability to droughts in Northeastern Brazil. *Global Environmental Change Part A: Human & Policy Dimensions* 18(4):575-582.
Tsakiris, G., G. Cavadias, D. Pangalou, and A. Nanou, 2005: Greece. *Options Méditerranéennes. Série B, Études et Recherches,* 49-63.
Tsiourtis, N. X., 2005: Cyprus. *Options Méditerranéennes. Série B, Études et Recherches,* 25-47.
UK, C. S., 1990: Report of a Workshop on Tackling Soil Erosion, Desertification and Drought-Related Problems, Jodhpur, India, 13 March-23 March 1989. *Report of a Workshop on Tackling Soil Erosion, Desertification and Drought-Related Problems, Jodhpur, India, 13 March-23 March 1989.* Desertification and Drought-Related Problems, Jodhpur, India, 27.
UNDP/UNSO, 2000: Drought Preparedness and Mitigation in Sub-Saharan Africa.
UNDP/UNSO, 2000: Report on the Status of Drought Preparedness and Mitigation in Sub-Saharan Africa, United Nations (Volume 1: Synthesis). UN Development Programme, Office to Combat Desertification and Drought, New York.
Unganai, L. S., and T. Bandason, 2005: Monitoring Agricultural Drought in Southern Africa. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 266-275.
Unganai, L. S., 1994: Chronology of droughts in Southern Africa; the impacts and future management options. *SACCAR Newsletter,* 8-17.
van Viet, N., and V. K. Boken, 2005: Agricultural Drought in Vietnam. *Monitoring and Predicting Agricultural Drought: A Global Study,* V. K. Boken, A. P. Cracknell and R. L. Heathcote eds., Oxford University Press, 345-353.
Vásquez-León, M., 2009. One Decade of Drought and Two of Neoliberal Reforms in the Sierra Sonorense: Responses by the Rural Poor. *Southern Rural Sociology* 24(1):44-66.
Vaughan Higgins, 2001: Calculating climate: 'advanced liberalism' and the governing of risk in Australian drought policy. *Journal of Sociology,* **37**, 299-316.
Velasco, I., J. Aparicio, J. B. Valdés, J. Velázquez, and T. W. Kim, 2004: Drought index assessment in the watersheds of affluents from the Río Bravo/Río Grande River. *Ingeniería Hidráulica en México,* **19**, 37-53.
Vermes, L., and A. Szemessy, 2000: Proceedings of the Central and Eastern European Workshop on Drought Mitigation, Budapest, Hungary. Budapest, Hungary, Ministry of Agriculture and Rural Development and Hungarian Meteorological Service.
Vicente-Serrano, S. M., 2006: Differences in Spatial Patterns of Drought on Different Time Scales: An Analysis of the Iberian Peninsula. *Water Resour. Manage.,* **20,** 37-60.
Vicente-Serrano, S. M., 2005: El Niño and La Niña influence on droughts at different timescales in the Iberian Peninsula. *Water Resour. Res.,* **41**, W12415.
Vicente-Serrano, S. M., J. M. Cuadrat-Prats, and A. Romo, 2006: Early prediction of crop production using drought indices at different time-scales and remote sensing data: application in the Ebro Valley (north-east Spain). *Int. J. Remote Sens.,* **27**, 511-518.
Vogel, C., M. Laing, and K. Monnik, 2000: Drought in South Africa, with Special Reference to the 1980-94 Period. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:348-1:366.
Vogel, C. H., and J. H. Drummond, 1993: Dimensions of drought: South African case studies. *GeoJournal,* **30**, 93-98.
Vogt, J. V. [ed], 2000: Drought and drought mitigation in Europe. *Advances in Natural and Technological Hazards Research,* **14**.
Wan, Z., P. Wang, and X. Li, 2004: Using MODIS Land Surface Temperature and Normalized Difference Vegetation Index products for monitoring drought in the southern Great Plains, USA. *Int. J. Remote Sens.,* **25**, 61-72.
Way, N., 2004: Over-protected? *BRW,* **26**, 52-55.
Webb, P., and T. Reardon, 1992: Drought impact and household response in East and West Africa. *Q. J. Int. Agric.,* **31**, 230-246.
Wheaton, E. E., 2000: Canadian Prairie Drought Impacts and Experiences. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:312-1:330.
Wilhelmi, O., K. Hubbard, and D. A. Wilhite, 2002: Spatial Representation of Agroclimatology in a Study of Agricultural Drought. *International Journal of Climatology,* **22**, 1399-1414.
Wilhelmi, O., and D. A. Wilhite, 2002: Assessing Vulnerability to Agricultural Drought: A Nebraska Case Study. *Natural Hazards,* **25**, 37-58.
Wilhite, D. A., 1993: Drought Assessment, Management, and Planning: Theory and Case Studies. Kluwer Academic Publishers. 293 pp.
Wilhite, D. A., L. Botterill, and K. and Monnik, 2005: National Drought Policy: Lessons Learned from Australia, South Africa, and the

United States *Drought and Water Crises: Science, Technology, and Management Issues,* D. A. Wilhite ed., CRC Press, Taylor & Francis Group, 137-172.

Williams, J., 2000: Drought Risk Management in Southern Africa: Developing Institutions to Transform 'Belated Disaster Response' into 'Informed Preparedness.' *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 2:168-2:177.

World Bank, 2006: Overcoming drought : adaptation strategies for Andhra Pradesh, India. *Directions in development,* Washington, DC : World Bank.

Wu, H., L. Soh, A. Samal, and X. Chen, 2008. Trend Analysis of Streamflow Drought Events in Nebraska. *Water Resources Management* 22(2):145-164.

Wubishet, A., W. C. Fairbank, and N. Peterson, 1992: Utilization of natural zeolites and a Bio-Reel for dairy washwater reclamation. *J. Dairy Sci.*, **75**, 160.

Yang ShaoHui, and Wang YiMing, 2006: The research on the distribution of drought monitor sites. *Aktualni zadaci mehanizacije poljoprivrede. Zbornik radova, 34. medunarodnog simpozija iz područja mehanizacije poljoprivrede, Opatija, Croatia, 21-24 veljače 2006,* Zavod za Mehanizaciju Poljprivrede, Agronomski Fakultet Sveučilišta u Zagrebu, 267-274.

Zarafshani, K., M.J. Gorgievski, and G.H. Zamani, 2007. Dealing with drought: a comparison of perceptions and coping strategies of Iranian farmers from regions with different drought intensities. *Journal of Agricultural Education and Extension* 13(1):69-80.

Żarski, J., S. Dudek, R. Kuśmierek, and B. Grzelak, 2001: Role of sprinkler irrigation in atmospheric drought mitigation. *Inżynieria Rolnicza,* **5**, 541-547.

Zereini, F., and H. Hoetzl (eds.), 2008. *Climatic changes and water resources in the Middle East and North Africa*. Springer-Verlag, Berlin.

Zhai, L., and Q. Feng, 2009. Spatial and temporal pattern of precipitation and drought in Gansu Province, Northwest China. *Natural Hazards* 49(1):1-24.

Zhang, Q., M. Gemmer, and J. Chen, 2008. Climate changes and flood/drought risk in the Yangtze Delta, China, during the past millennium. *Quaternary International* 176-177:62-69.

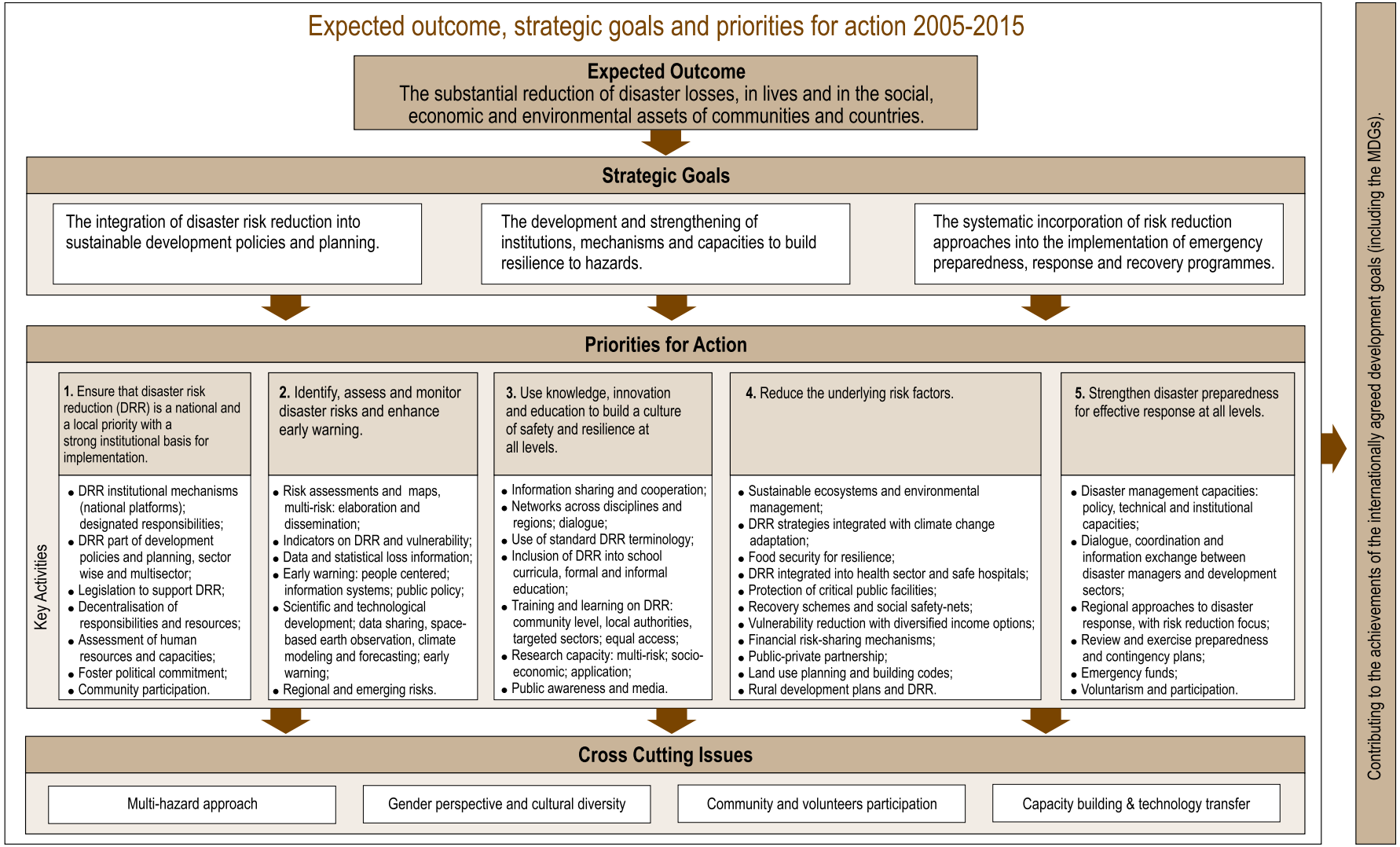
Zhang Zhigan, 1996: Karst water resources and drought management in Laibin County, Guangxi, China. *International Geological Congress, Abstracts = Congres Geologique International, Resumes,* **30, Vol. 3**, 322.

Zierl, B., 2001: A water balance model to simulate drought in forested ecosystems and its application to the entire forested area in Switzerland. *Journal of Hydrology,* **242**, 115.

Zilberman, D., D. Sunding, R. Howitt, A. Dinar, and N. and MacDougall, 1994: Water for California agriculture: lessons from the drought and new water market reform. *Choices,* **9**, 25-28.

Zonn, I., M. H. Glantz, and A. Rubinstein, 2000: The Virgin Lands Scheme in the Former Soviet Union. *Drought: A Global Assessment,* D. A. Wilhite ed., Routledge, Taylor & Francis Group, 1:381-1:388.

Annex 6: Summary Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters



DRR= disaster risk reduction

www.unisdr.org

Implementation and Follow-Up

In order to achieve the strategic goals and act upon the priorities for action, the Framework identifies the following tasks for implementation and follow-up by States, regional and international organizations in collaboration with civil society and other stakeholders. The ISDR partners, in particular the Inter-agency Task Force on Disaster Reduction (IATF/DR)* and secretariat, are requested to assist in implementing the Hyogo Framework for Action.

General Considerations

- Implementation by different stakeholders, multi-sectoral approach; participation of civil society (NGOs, CBOs, volunteers), scientific community & private sector is vital.
- States primarily responsible; an enabling international environment is vital, incl. strengthened regional capacities.
- Build multi-stakeholder partnerships.
- Particular attention to:
  - Small island developing States: Mauritius Strategy;
  - Least developed countries;
  - Africa.
- States, regional and international organizations to foster coordination among themselves and a strengthened International Strategy for Disaster Reduction (ISDR).
- Follow-up integrated with other major conferences in fields relevant to DRR; reviews as appropriate.

Actors

Critical tasks

States

- Designate national coordination mechanisms for the implementation and follow up, communicate to the ISDR secretariat;
- National baseline assessments of the status of DRR;
- Publish and update a summary of national programme for DRR including international cooperation;
- Develop procedure for reviewing national progress including systems for cost benefit analysis and ongoing monitoring on risk;
- Consider acceding to, approving or ratifying relevant international legal instruments and make sure they are implemented;
- Promote the integration of DRR with climate variability and climate change into DRR strategies and adaptation to climate change; ensure management of risks to geological hazards.

Regional Organizations and Institutions

- Promote regional programmes including for technical cooperation, capacity development, the development of methodologies and standards for hazard and vulnerability monitoring and assessment, the sharing of information and effective mobilization of resources;
- Undertake and publish regional and sub-regional baseline assessments;
- Coordinate and publish reviews on progress and support needs, and assists countries in preparation of national summaries;
- Establish specialized regional collaborative centers;
- Support the development of regional mechanisms and capacities for early warning, including for tsunami.

International Organizations (including UN System and IFIs)

- Encourage the integration of DRR into humanitarian and sustainable development fields;
- Strengthen the capacity of the UN system to assist disaster-prone developing countries in DRR and implement measures for assessment of progress;
- Identify actions to assist disaster-prone developing countries in the implementation of the Hyogo Framework, ensure integration and that adequate funding is allocated; assist in setting up national strategies and programmes for DRR;
- Integrate actions into relevant coordination mechanisms (UNDG, IASC, RCs and UN Country Teams);
- Integrate DRR into development assistance frameworks such as CCA/UNDAF, PRSP;
- In collaboration with networks and platform support: data collection and forecasting on natural hazards and risks; early warning systems; full and open exchange of data;
- Support States with coordinated international relief assistance, to reduce vulnerability and increase capacities;
- Strengthen international mechanisms to support disaster stricken States in post-disaster recovery with DRR approach
- Adapt & strengthen inter-agency disaster management training for DRR and capacity building.

ISDR (Inter-Agency Task Force on Disaster Reduction and secretariat)

- Develop a matrix of roles and initiatives in support of follow-up to the Hyogo Framework;
- Facilitate the coordination of effective actions within the UN system and other international and regional entities to support the implementation of the Hyogo Framework, identify gaps, facilitate processes to develop guidelines and policy tools for each priority area;
- In broad consultation, develop generic, realistic and measurable indicators. These indicators could assist States in measuring progress in the implementation of the Hyogo Framework;
- Support national platforms and regional coordination;
- Register relevant partnerships with Commission on Sustainable Development;
- Stimulate the exchange, compilation, analysis and dissemination of best practices, lessons learnt;
- Prepare periodic review on progress towards achieving the objectives of the Hyogo Framework and provide reports to the UNGA and other UN bodies.

Resource Mobilization: States, Regional and International Organizations

- Mobilize resources and capabilities of relevant national, regional and international bodies, including the UN system;
- Provide and support the implementation of the HFA in disaster prone developing countries, including through financial and technical assistance, addressing debt sustainability, technology transfer, public-private partnership and North-South and South-South cooperation;
- Mainstream DRR measures into multilateral and bilateral development assistance programmes;
- Provide adequate voluntary financial contribution to the UN Trust Fund for DR to support follow-up activities to Hyogo Framework; review usage and feasibility for the expansion of this fund;
- Develop partnership to implement schemes that spread risks, reduce insurance premiums, expand insurance coverage and increase financing for post-disaster reconstruction, including through public and private partnerships. Promote an environment that encourages a culture of insurance in developing countries.

Source: Outcome of the World Conference on Disaster Reduction, Kobe, Hyogo, Japan, 18-22 January 2005

* The IATF/DR was replaced in 2007 by the Global Platform for Disaster Risk Reduction

United Nations
International Strategy for Disaster Reduction

UNISDR, Geneva
Tel. :+41 22 917 8908/8907
Fax : +41 22 917 8964
isdr@un.org
www.unisdr.org

International Environment
House II
7-9 Chemin de Balexert
CH 1219 Châtelaine
Geneva, Switzerland

UNISDR Liaison Office, New York
palm@un.org

UNISDR Regional Office Africa
isdr-africa@unep.org
www.unisdr.org/africa

UNISDR Regional Office
The Americas
eird@eird.org
www.eird.org

UNISDR Regional Office Asia and the Pacific
isdr-bkk@un.org
www.unisdr.org/asiapacific

UNISDR Regional Office Arab States
info@unisdr-wana.org
www.unisdr.org/wana

UNISDR Regional Office Europe and Central Asia
isdr-europe@un.org
www.unisdr.org/europe

Invest Today for a Safer Tomorrow

UNISDR-23-2009-Geneva

This publication is printed on recycled paper using vegetable-based inks