A UN-Water Initiative

Proceedings of the Regional Workshop on

Capacity Development to Support National Drought Management Policies

for Latin America and the Caribbean Countries

WMO

UNCCD
United Nations Convention to Combat Desertification

FAO
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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

ANA (Brazil)	National Water Agency, Brazil
ANA (Nicaragua)	National Water Authority, Nicaragua
ANAM	National Environmental Authority, Panama
APF	Advocacy Policy Framework
ASIS	FAO Agriculture Stress Index System
AyA	Aqueduct and Sewer Authority, Costa Rica
CADENA	Natural Disaster Response Component, Mexico
CAZALAC	Centro del Agua para Zonas Áridas y Semiáridas de América Latina y el Caribe, Chile (UNESCO Category II Center)
CBD	Convention on Biological Diversity
CEMADEN	National Centre for Monitoring and Early Warning of Natural Disasters, Brazil
CENAD	National Centre for Managing Disaster Risk, Brazil
CGEE	Centro de Gestao e Estudos Estrategico, Brazil
CGRR	Centres for Risk Reduction Management, Cuba
CIESAS	Centro de Investigaciones y Estudios Superiores en Antropología Social, Mexico
CIMH	Caribbean Institute for Meteorology and Hydrology
CNE	National Commission for Risk Prevention and Emergency Response, Costa Rica
CNR	National Irrigation Commission, Chile
Conagua	National Water Commission, Mexico
CONALSED	National Committee for Drought and Desertification Control, Panama
COP	Conference of the Parties
COPECO	The Standing Contingency Committee of Honduras
CPTEC/INPE	Center for Weather Prediction and Climatic Studies at the National Institute of Space Research, Brazil
DNOCS	National Department Against Droughts, Brazil
DNPC	National Direction of Civil Protection
EMNDC	National Civil Defence, Cuba
ENSO	El Niño Southern Oscillation
ETP	Evapotranspiration
FAE	Agro-livestock Emergency Fund, Uruguay
FAO	Food and Agriculture Organization of the United Nations
FAP	Panama Savings Fund
FONDEN	National Natural Disaster Fund, Mexico
FOPREDEN	Natural Disaster Prevention Fund, Mexico
FUNCEME	Foundation Cearense for Meterology and Water Resources, Brazil
GFCS	Global Framework for Climate Services
GIS	Geographic Information System
GPCC	Global Precipitation Climatology Centre
GPVR	The Hazard, Vulnerability and Risk Group, Cuba
GRACC	Plan for Risk Management and Adaptation to Climate Change in the Agricultural Sector for 2012–202, PeruGTTGRD Technical Working Group for Disaster Risk Management, Peru

GWP	Global Water Partnership
HMNDP	High-level Meeting on National Drought Policy
IDB	Inter-American Development Bank
IDIAP	Institute for Agro-livestock Research, Panama
IDMP	Integrated Drought Management Programme
INDAP	Institute for Agro-livestock Development, Chile
INDECI	National Civil Defence Institute, Peru
INEI	National Institute for Statistics and Information, Peru
INETER	Department of Meteorology of the Nicaraguan Institute for Territorial Studies, Nicaragua
INMET	Institute of Meteorology, Brazil
INTA	National Institute of Agro-livestock Technology, Nicaragua
INUMET	Uruguayan Meteorological Institute
IPCC	Intergovernmental Panel on Climate Change
ISDR	United Nations International Strategy for Disaster Reduction
ITCZ	Inter-tropical Convergence Zone
LAC	Latin America and the Caribbean
MAG	Ministry of Agriculture and Livestock, Costa Rica
MAGFOR	Ministry of Agriculture, Nicaragua
MEF	Ministry of the Economy and Finance, Panama
MGAP	Ministry of Livestock, Agriculture and Fisheries, Uruguay
MIDA	Ministry for Agro-livestock Development, Panama
MINAGRI	Ministry of Agriculture and Irrigation, Peru
MINSA	Ministry of Health, Panama
NADM	North American Drought Monitor
NAP	National Action Plan
NDMC	National Drought Mitigation Center of the University of Lincoln, Nebraska
NDMP	UN-Water Initiative on Capacity Development to Support National Drought Management Policies
NIC	National Irrigation Commission, Jamaica
NMHS	National Meteorological and Hydrological Services
ODPEM	Office of Disaster Preparedness and Emergency Management, Jamaica
PAN	National Action Plan for Drought and Desertification Control, Panama
PAN-LCD	National Action Plan for Desertification and Drought Control, Honduras
PDI	Palmer Drought Index
PDSI	Palmer Drought Severity Index
PMPMS	Drought Prevention and Mitigation Programmes
PNDH	National Human Development Plan, Nicaragua
PRONACOSE	National Drought Control Programme, Mexico
RADA	The Rural Agricultural Development Authority, Jamaica
RENARE	Department for Renewable Resources, Uruguay
SAG	Agricultural and Livestock Service, Chile

SAGARPA	Secretariat for Agriculture, Livestock, Rural Development, Fisheries and Food, Mexico
SENACYT	National Secretariat for Science and Technology, Panama
SENAMHI	National Meteorological and Hydrological Service, Peru
SICA	Central American Integration System, Costa Rica
SINAGERD	The National System for Disaster Prevention, Mitigation and Relief, Nicaragua
SINAPRED	The National System for Disaster Prevention, Mitigation and Relief, Mexico
SPEI	Standardized Precipitation Evapotranspiration Index
SPI	Standardized Precipitation Index
SST	Sea Surface Temperatures
TSU	Technical Support Unit
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNW-DPC	UN-Water Decade Programme on Capacity Development
UP	University of Panama
USDM	United States Drought Monitor
WFP	World Food Programme
WMO	World Meteorological Organization

FOREWORD

Launched on 12 March 2013 on the margins of the High-level Meeting on National Drought Policy (HMNDP) in Geneva, Switzerland, the UN-Water initiative on Capacity Development to Support National Drought Management Policies (NDMP) is a collaborative effort of several Members, Partners and Programme of the UN-Water inter-agency mechanism: the World Meteorological Organization (WMO), the United Nations Convention to Combat Desertification (UNCCD), the Food and Agriculture Organization of the United Nations (FAO), the Convention on Biological Diversity (CBD) and the UN-Water Decade Programme on Capacity Development (UNW-DPC).

Together these partners aim to help drought-prone Member States formulate and adopt effective, risk-based national drought management policies through targeted development of capacities of the various stakeholders dealing with drought at all levels, including ministries, relevant institutions, practitioners and the society at large. It is clear that responding to drought proactively, before it happens, can reduce the often disastrous impacts on livelihoods and economies.

Regional workshops have been held for Eastern Europe, Latin America and the Caribbean (the topic of this proceedings), Asia and the Pacific regions, with further regional workshops planned for Africa and a wrap-up event in 2014 and 2015. The topic of the present proceedings covers the outcomes of the regional workshop for Latin American and the Caribbean Countries, which took place in Fortaleza, Brazil from 4 to 6 December 2013.

The level of cooperation required to execute an initiative like NDMP is considerable, not only among the partners involved at the UN level but also among partners at a national level. Therefore, the initiative's success is based in large part on the willingness of the collaborating organizations to contribute their competences and experiences in order to enter into an intense dialogue with countries from all over the world.

As coordinator of this UN-Water initiative, therefore, I would like to warmly thank our partner institutions, local hosts for regional workshops as well as, of course, all of the engaged participants who have made this initiative a success so far. We look forward to the future outcomes of this project and hope that by helping countries develop and implement national drought policies based on the philosophy of risk reduction, we can alter approaches to drought management at the country level and reduce the associated impacts.

Further information on the initiative is available from
www.ais.unwater.org/droughtmanagement

Reza Ardakanian
Founding Director/Officer-in-Charge

The UN-Water Decade Programme on Capacity Development (UNW-DPC)
on behalf of the partners in the UN-Water initiative on "Capacity Development to Support National Drought Management Policies"

SETTING THE SCENE

Donald Wilhite *University of Nebraska, USA*

The implementation of drought policy based on the philosophy of risk reduction can alter a nation's approach to drought management by reducing the associated impacts (risk). This was a motivating factor that led to the High-level Meeting on National Drought Policy (HMNDP), which took place in Geneva from 11 to 15 March 2013. Accordingly, the World Meteorological Organization (WMO) Secretariat, the Secretariat of the United Nations Convention to Combat Desertification (UNCCD) and the Food and Agriculture Organization of the United Nations (FAO), in collaboration with a number of UN agencies, including the UN-Water interagency mechanism, international and regional organizations and key national agencies, organized the HMNDP. The theme of HMNDP was "Reducing Societal Vulnerability – Helping Society (Communities and Sectors)."

Concerns about the spiralling impacts of drought on a growing number of sectors, the current and projected increase in the incidence of drought frequency and severity and the outcomes and recommendations emanating from the HMNDP, is drawing increased attention from governments, international and regional organizations, and non-governmental organizations on drought policy and preparedness planning. Simply stated, a national drought policy should establish a clear set of principles or operating guidelines to govern the management of drought and its impacts. The overriding principle of drought policy should be an emphasis on risk management through the application of preparedness and mitigation measures. This policy should be directed toward reducing risk by developing better awareness and understanding of the drought hazard and the underlying causes of societal vulnerability. The principles of risk management can be promoted by encouraging the improvement and application of seasonal and shorter-term forecasts, developing integrated monitoring and drought early warning systems and associated information delivery systems, developing preparedness plans at various levels of government, adopting mitigation actions and programmes, creating a safety net of emergency response programmes that ensure timely and targeted relief, and providing an organizational structure that enhances coordination within and between levels of government and with stakeholders. The policy should be consistent and equitable for all regions, population groups, and economic sectors and consistent with the goals of sustainable development.

As vulnerability to and the incidence of drought has increased globally, greater attention has been directed to reducing risks associated with its occurrence through the introduction of planning to improve operational capabilities (i.e., climate and water supply monitoring, building institutional capacity) and mitigation measures that are aimed at reducing drought impacts. This change in emphasis is long overdue. Mitigating the effects of drought requires the use of all components of the cycle of disaster management, rather than only the crisis management portion of this cycle. Typically, when drought occurs, governments and donors have followed with impact assessment, response, recovery and reconstruction activities to return the region or locality to a pre-disaster state. Historically, little attention has been given to preparedness, mitigation and prediction/early warning actions (i.e., risk management) and the development of risk-based national drought management policies that could reduce future impacts and lessen the need for government and donor interventions in the future. Crisis management only addresses the symptoms of drought, as they manifest themselves in the impacts that occur as a direct or indirect cause of drought. Risk-based management, on the other hand, is focused on identifying where vulnerabilities exist (particular sectors, regions, communities or population groups) and addresses these vulnerabilities through systematically implementing mitigation and adaptation measures that will lessen the risk to future drought events. Because societies have emphasized crisis management in past attempts at drought management, countries have generally moved from one drought event to another with little, if any, reduction in risk. In addition, in many drought-prone regions, another drought event is likely to occur before the region fully recovers from the last event.

Progress on drought preparedness and policy development has been slow for a number of reasons. It is certainly related to the slow-onset characteristics of drought and the lack of a universal definition. These characteristics make early warning, impact assessment and response difficult for scientists, natural resource managers and policymakers. The lack of a universal definition often leads to confusion and inaction on the part of decision makers since scientists may disagree on the existence of drought conditions and its severity. Severity is also difficult to characterize since it is best evaluated on the basis of multiple indicators and indices, rather than on the basis of a single variable. The impacts of drought are also largely non-structural and spatially pervasive. These features make it difficult to assess the effects of drought and to respond in a timely and effective manner. Drought impacts are not as visual as other natural hazards, making it difficult for the media to communicate the significance of the event and its impacts to the public. Public sentiment to respond is often lacking in comparison to other natural hazards that result in loss of life and property.

Associated with the crisis management approach is the lack of recognition that drought is a normal part of the climate. Climate change and associated projected changes in climate variability will likely increase the frequency and severity of drought and other extreme climatic events. In the case of drought, the duration of these events may also increase. Therefore, it is imperative for all drought-prone nations to adopt a more risk-based approach to drought management in order to increase resilience to future episodes of drought.

To provide guidance in the preparation of national drought policies and planning techniques, it is important to define the key components of drought policy, its objectives and steps in the implementation process. An important component of national drought policy is increased attention to drought preparedness in order to build institutional capacity to deal more effectively with this pervasive natural hazard. The lessons learned by a few countries that have been experimenting with this approach will be helpful in identifying pathways to achieve more drought resilient societies.

The challenge that nations face in the development of a risk-based, national drought management policy is complex and requires political will and a coordinated approach within and between levels of government and with the diversity of stakeholders that must be engaged in the policy development process. A national drought policy that is centred on the principles of risk-based management will provide a framework for shifting the paradigm from one traditionally focused on a reactive, crisis management approach to one that is focused on a proactive, risk-based approach that is intended to increase the coping capacity of the country and thus create greater resilience to future episodes of drought.

The formulation of a national drought policy, while providing the framework for a paradigm shift, is only the first step in vulnerability reduction. The development of a national drought policy must be intrinsically linked to the development and implementation of preparedness and mitigation plans at the provincial/state and local levels. These plans will be the instruments through which a national drought policy is executed. The guidelines for preparing a national drought policy and preparedness plans, which are the instruments for implementing a drought policy at the sub-national level, have been developed for publication through the Integrated Drought Management Programme (IDMP) of the Global Water Partnership (GWP) and the World Meteorological Organization (WMO). These guidelines are available from the IDMP website: **http://www.droughtmanagement.info/**.

Chapter 1

BACKGROUND AND RATIONALE

Drought, widely recognized as a creeping natural hazard, affects all climatic regions. As one of the most pervasive types of natural disasters, drought has huge impacts on food security, social stability, livelihoods, the environment and economies at large. While the impacts of drought can be significantly reduced through risk-based drought management policies and practices, to date most countries continue to pursue emergency and recovery strategies and respond only after droughts have taken their toll. Such reactive and 'piecemeal' approaches often prove to be ineffective. Proactive and risk-based national drought management policies and practices would greatly assist countries to build societal resilience to drought.

With the aim of supporting countries towards building their capacities for developing such proactive and risk-based drought management policies, several United Nations organizations approached the UN-Water Decade Programme on Capacity Development (UNW-DPC) to start a capacity development initiative on developing drought management policies. The UN organizations comprise: the Food and Agriculture Organization of the United Nations (FAO), the Secretariat of the United Nations Convention to Combat Desertification (UNCCD) and the World Meteorological Organization (WMO). In December 2013, the Secretariat of the Convention on Biological Diversity (CBD) formally joined the team of the UN-Water initiative and contributed to the second regional workshop in Brazil, as explained below. The initiative was launched at the occasion of the High-level Meeting on National Drought Policy (HMNDP) held in March 2013 in Geneva, Switzerland, which was followed by a series of regional workshops.

1.1 Objectives of the Initiative

There are three important concerns related to national drought management that need to be addressed in this process:

1. Raise awareness of the misperception between general development activities and drought preparedness. There is a need for identifying the problems related to specific drought issues in order to develop adequate plans and take appropriate and timely actions. This confusion is also perceived at the scientific and technical level;

2. Advance national drought management policies taking into account long-term issues to address drought and water scarcity problems. It is not a matter of short-term planning; and

3. Promote collaboration between sectors at country-level. In general, there is poor coordination between drought-relevant institutions. Sector coordination is very important if implementation on the ground is to succeed. Thus, preparing for drought and drought-related actions needs strong collaboration at different levels of planning, response, preparedness and capacity development.

The concerns described above are related with the mandate of various UN agencies. The objective of this joint initiative is to increase the capacities of developing countries and countries in transition in developing risk-based national drought management policies. This is based on the identification of the capacity needs from national to local levels to develop such policies and implement risk-based drought management strategies.

1.2 Regional Workshops on National Drought Management Policies

The UN-Water Initiative addresses capacity development to support the development of national drought management policies in the following sequence of workshops:

- International Kick-off Workshop at the High-level Meeting on National Drought Policy (HMNDP), which took place on 12 March 2013, in Geneva, Switzerland
- Regional Workshops for Eastern Europe (July 2013); Latin America and the Caribbean (December 2013); Asia-Pacific (May 2014) and various workshops in Africa, scheduled for August 2014 (Eastern and Southern Africa), November 2014 (West Africa) and the beginning of 2015 (for the MENA region)
- International Wrap-up Conference (2015)

Based on the proposed elements in the Compendium of National Drought Policy (Sivakumar et al., 2011), the regional workshops include different sessions, which were structured following a set of key elements of national drought policy, including the following areas:

- Drought Monitoring and Early Warning Systems
- Vulnerability and Risk Assessment
- Drought Preparedness, Mitigation and Responses

Each session includes a thematic presentation, which is followed by extended round-table discussions in breakout groups. As situations vary significantly from country to country, no prescriptive or stringent set of elements of a national drought policy is defined, but rather a set of elements guiding the policy development in each country's individual and specific situation. Most importantly, participants are introduced to a generic 10-step process for formulating drought policies, which is further elaborated in section three of this report.

The purpose of this workshop proceedings is to elaborate and document the workshop presentations, country reports and discussions in breakout groups for Latin America and the Caribbean (LAC) countries, which took place in Fortaleza, Brazil from 4-6 December 2013.

Chapter 2

THE WORKSHOP FOR LATIN AMERICA AND THE CARIBBEAN COUNTRIES

Brazil was selected as the location of the regional workshop for LAC countries. The workshop, held from 4-6 December 2013 in Fortaleza and hosted by the Brazilian Ministry of Integration, was attended by more than 30 participants from 12 countries in the LAC region: Argentina, Brazil, Chile, Costa Rica, Cuba, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru and Uruguay. The participants in the workshop were mainly experts who lead the development of drought management policies at the national level. Most countries were represented by two to three participants from diverse ministries (agriculture, environment, meteorology and the water sector) reflecting the interdisciplinary nature of drought. The ministries in these countries were asked to nominate participants based on the following criteria:

- Willingness and ability to produce, collectively with other country representatives, a preliminary synopsis on the status of drought and its management in their respective country, including existing capacities and perceived capacity needs (submitted before the workshop and reproduced as country reports in section 5 of this proceedings).
- Ability to work jointly in multisectoral teams for organizing and coordinating a network of stakeholders at country level.
- Ability to influence policy development and contribute to subsequent activities at country level.

2.1 Workshop Structure

The three-day workshop started with an opening session by Mr José Mauro Couto (Head of International Office at the Ministry of National Integration) and, on behalf of the organizers, Mr Robert Stefanski (Chief of Agricultural Meteorology Division, Climate and Water Department at WMO). In the opening session, the relevance of drought issues in a changing climate and increasing frequency of drought in the region were stressed and the need for timely and effective measures for improved preparedness and mitigation measures were highlighted.

In the second session, Donald Wilhite, a Professor at the University of Nebraska, United States, and book series editor for 'Drought and Water Crises', presented the key note on 'Managing drought risk in a changing climate: Breaking the hydro-illogical cycle'. A step-by-step process towards developing drought management policies was also presented, and participants were exposed to the biodiversity aspects of drought and drought management policies. The rest of the session was dedicated to presentations and discussions of country reports by the participants from the 12 countries. The country reports assessed the state of the national drought management practices of the respective countries. Preparing the country reports in advance provided participants from the same countries an opportunity to work together ahead of the workshop, creating a network among different ministries and disciplines.

The initiative is based on a set of key elements of national drought policy which fall under the following three areas: (i) Drought Monitoring and Early Warning Systems, (ii) Vulnerability Assessment and Impacts and (iii) Mitigation and Response. As situations vary significantly from country to country, no prescriptive or stringent set of elements of a national drought policy was defined, but rather a set of elements guiding the policy development in each country's individual and specific situation. The workshop's thematic presentations were streamlined to follow these three key areas. Each thematic presentation was followed by extended round table discussions in breakout groups.

The UN organizations (UN-Water Members) engaged in this initiative were represented by Mohamed Bazza (Senior Officer at FAO), Robert Stefanski (Chief of Agricultural Meteorology Division in the Climate and Water Department at WMO), Simone Schiele (Junior Professional Officer at CBD), Heitor Matallo (Programme Officer, UNCCD) and Daniel Tsegai (Programme Officer, UNW-DPC).

2.2 Major Workshop Outcomes

The thematic presentations and the breakout group discussions covered several key areas and exposed the participants to a wide spectrum of drought management policies and their context-specific relevance. Issues discussed at length varied from drought monitoring and early warning systems to various drought indices and data issues in drought monitoring systems in the LAC region. The major components of drought monitoring systems were emphasized: timely data and acquisition, synthesis (analysis) of data used to 'trigger' set actions within a plan, and efficient dissemination networks (web, media, extension, etc.). Approaches of drought monitoring ranging from single index (parameter) to multiple indices (parameters) and composite index were also clarified. The steps on drought vulnerability and risk assessment and the typologies of different drought risk management measures were discussed, including drought preparedness, mitigation, response and recovery. A range of short and long-term risk management options were underlined which build societal resilience through national drought policies and preparedness plans. Most notably, the following steps towards drought planning were discussed: (i) drought characterization, (ii) monitoring and early warning, (iii) vulnerability and impact assessment and (iv) mitigation and response options. A generic 10-step process of formulating drought policies was the core of the discussion during the three-day workshop. Finally, the cost-benefit of 'inaction on drought' and the cost effectiveness of risk-based, as opposed to disaster response, drought management strategies were underlined. The major achievements of the workshop can be summarized as follows:

- It improved the awareness of participants in terms of drought and drought management issues and the needs and strategies for national drought policies based on the principles of risk reduction.
- It equipped participants with tools and strategies for improved decision support, risk assessments of vulnerable sectors, population groups, regions and more importantly mitigating drought effects.
- It exposed participants to up-to-date methodologies to develop (improve) monitoring, seasonal forecasts, early warning and information delivery systems.
- It improved workshop participants' understanding and quantification of drought impacts versus mitigation costs.
- Finally, the workshop promoted national and regional networks of stakeholders working on drought and drought-related issues, which will in a way ensure efficiency and effectiveness of measures to address drought.

For more information on the initiative, please visit the initiative's online platform: **www.ais.unwater.org/droughtmanagement**.

Photos from the regional workshop

Opening by Robert Stefanski (WMO) and José Mauro Couto (Brazilian Ministry of National Integration)

Workshop in progress

Workshop participants

Chapter 3

THEMATIC SESSIONS

3.1 Towards Developing Drought Management Policy: The 10-Step Process

Daniel Tsegai, UN-Water Decade Programme on Capacity Development (UNW-DPC)

With a more sweeping impact than any other natural hazard, drought ranks first in terms of its complex and multidimensional nature and with significant secondary and tertiary impacts. However, the risks of drought can be mitigated by proactive and risk-based drought management policies and practices instead of the more common practice of emergency and recovery strategies that regulate crisis which is most often ineffective and too late.

The session introduced the processes in the development of national drought policies to mitigate the risks of drought and enhance effective response to drought and the objectives and challenges of such policies. The objectives of national drought policy are, among others: supporting vulnerable economic sectors and population groups to adopt 'self-reliant' measures which promote effective risk management strategies; promoting sustainable use of the agricultural and other natural resource base; and to facilitate early recovery from drought through actions consistent with national drought policy objectives.

The generic 10-step planning process to formulate national drought policies, developed by Wilhite et al. (2011) were elaborated focusing on the most relevant elements of each of the steps, which are as follows:

1. Appoint a national drought management policy commission;
2. Define the goals of a risk-based national drought management policy;
3. Seek stakeholder participation;
4. Collect inventory data and financial resources, and identify groups at risk;
5. Prepare/write the key tenets of a national drought management policy;
6. Identify research needs and fill institutional gaps;
7. Integrate science and policy aspects of drought management;
8. Publicize the drought management policy and build public awareness;
9. Develop educational programmes for all age groups and stakeholders;
10. Evaluate and revise national drought management policy.

The above 10-step process is one of the many approaches and not the only approach to assist nations to develop national drought policies. Its implementation requires political will and coordinated approach among diverse stakeholders engaged in the process. The 10-step process can and should be modified according to the national context.

The importance of relevant institutional arrangements for a drought policy was also elaborated during the session. Political commitment, building strong institutions and appropriate governance, and cultivating stakeholder participation with special emphasis on a "bottom-up" approach including the communities (both in decision-making and implementation) are some of the institutional arrangements that could strengthen the process of developing a national drought policy. Furthermore, preparedness at all levels of government (individuals, community and decision makers, local and regional authorities) and having a legal or institutional framework with defined responsibilities and cross-sectoral collaboration are preconditions for a successful national drought policy process. The session also highlighted some of the current challenges to develop national drought policies including: (i) fragmented responsibilities for drought risk management, (ii) low priority given to drought by governments, (iii) weak drought risk governance capacities, and (iv) conflict on water use and excess water use.

The last part of the presentation introduced successful case studies of national drought policies. The first case presented the efforts of the Australian government, which has successfully moved away from a crisis management approach towards an increased empha-

sis on climate risk management. The Australian national drought policy aimed at primary producers and other sections of rural Australia to adopt "self-reliant" measures to managing climatic variability and ensure early recovery of agricultural and rural industries consistent with long-term sustainable levels. Brazil is another country, which through its drought policies has reduced the economic and social vulnerability in the Northeast of the country. Environmental vulnerability has, however, increased due to its increased human pressure on the natural resource of the semi-arid Northeast of Brazil. With its clear planning framework for drought risk management which goes from 'preparedness, 'pre-alert', 'alert' and 'emergency', Spain is another good example for the successful implementation of different management actions for drought policy. Lastly, a process that China pursues in addressing its drought related activities, including monitoring, early warning, impact assessment, emergency response, hazard relief and recovery was presented.

3.2 Biodiversity and Drought

Simone Schiele, Convention on Biological Diversity (CBD)

Drought and biodiversity are linked in a number of ways. Droughts can have severe negative impacts on biodiversity and ecosystem services, while biodiversity and ecosystems can also play a crucial role in reducing risks associated with drought.

3.2.1 Impacts of drought on biodiversity

Droughts have negative impacts on biodiversity. For example, droughts and sustained high temperatures can cause habitat and species degradation and loss, leading to a decrease in biological productivity (see for example Anderegg et al., 2013). The reduction in biological productivity caused by droughts can lead to a lower vegetation cover that increases albedo, and to reduced water recycling, thus decreasing precipitation. Reduced vegetation cover also leads to soil erosion and further reduction of productivity.

Ecosystem degradation, caused by droughts and other factors, can aggravate the impacts of droughts, as the degradation process reduces the capacity of ecosystems to buffer its impacts. When an ecosystem collapses, its buffering ability and other vital ecosystem services are lost (Munang et al., 2013). Hence, environmental degradation can also impact livelihoods of people and reduce their resilience to droughts. Reduced vegetation increases soil erosion and the siltation of water bodies both within and beyond drought affected areas, which leads to a reduced availability of water (Tabacchi et al., 2000). Degradation of soil, including loss of soil structure, loss of soil carbon, soil biodiversity and the ability to retain moisture leads to a reduction in yields (FAO, 2005). Droughts also lead to a reduced availability of non-timber forest and range products such as wild fruit and vegetables.

3.2.2 Role of biodiversity and ecosystems in reducing risks associated with drought

Ecosystems contribute to reducing risks associated with disasters, including droughts, in two important ways: First, ecosystems can reduce physical exposure to drought and mitigate its impacts. For example, vegetation cover in dry land areas increases resilience to drought, and shelterbelts, greenbelts and other types of living fences act as barriers against wind erosion and sand storms (PEDDR, 2011). Second, healthy ecosystems provide various ecosystem services important to human well-being, which enable communities to cope with and recover from disasters (Munang et al., 2013). For example, marshes, lakes and floodplains release wet season flows slowly during drought periods. Forests on watersheds are important for water recharge and purification, drought mitigation and

safeguarding drinking water supply. Ecosystems also play a particularly important role as affected communities, especially in poor, rural areas often turn to their surrounding environment to meet their immediate needs for food, water and shelter (PEDDR, 2011).

It is important to recognize the multiple functions and services provided by ecosystems, and to understand the ecological and technical requirements for their conservation and restoration, in order to harness the potential of ecosystems for drought management. Ecosystem functions should be considered in long-term planning, but demonstrating short-term benefits, especially to local communities, can support the engagement of key stakeholders. Local stakeholders can play an important role in promoting the sustainable management of ecosystems for drought management (Munang et al., 2013).

3.2.3 Drought management options based on the conservation and sustainable use of biodiversity

A number of management options based on the conservation and sustainable use of biodiversity can reduce drought risks and therefore should be considered in drought management planning and implementation (CBD, 2009). These include integrated land and water management (the application of the ecosystem approach), conservation and management of key natural resources, traditional knowledge, innovations and practices, and the use of agricultural biodiversity.

Measures that protect soils from erosion, salinization, and other forms of soil degradation effectively prevent desertification and reduce the vulnerability of ecosystems to droughts. Practices such as overgrazing, overexploitation and unsustainable irrigation exacerbate dry land vulnerability. Land management strategies to reduce vulnerability include rotational use of rangelands, matching stocking rates to the carrying capacity of ecosystems, developing management plans for wetlands in dry lands and favouring diverse species composition.

It is important to mainstream integrated land and water management for food security and poverty reduction. Improved water management practices to reduce vulnerability include the use of traditional water-harvesting techniques, water storage, and diverse soil and water conservation measures. Improving groundwater recharge through soil-water conservation, upstream revegetation and floodwater spreading can provide reserves of water for use during drought periods (MEA, 2005).

Furthermore, the conservation of locally adapted species of plants and animals can increase the resilience of the ecosystem in the face of drought. For example, droughts have been demonstrated to have a more significant impact on imported livestock species when compared to local varieties or wild relatives (CBD, 2009).

Maintaining the vegetative cover to protect soils from wind and water erosion is a key preventive measure against desertification, while also preventing the loss of ecosystem services during drought episodes (MEA, 2005). Where restoration is required, it is important to protect the site from further disturbance; collect seed stocks and encourage natural regeneration where it is occurring; control weed species; and develop a full restoration plan defining restoration objectives within the framework of the intended outcome, the budget available and views of relevant stakeholders. As with the above, conservation and restoration efforts which use local species can yield more positive results in terms of drought management (Bainbridge, 2007).

Inland wetlands are an important land and water interface and can therefore mitigate the effects of the hydro-climatic variations associated with droughts. Inland water bodies, such as lakes, surface water reserves and groundwater reserves, are a strategic source of water and their conservation can help increase resilience of semi-arid countries and water stressed communities (ECOSOC, 2009).

An essential element of drought management plans is building the resilience of farming and pastoral communities and the resilience of landscapes. Indigenous and local communities have an important role to play in preventing desertification through effective dry land resource management and in particular water management, which is often based on local decision-making structures and conflict resolution mechanisms. Indigenous and local communities also use seed, crop and animal diversity as a portfolio against weather extremes including drought and climate change. As such, many local communities have a well-developed knowledge of plant and animal biodiversity that can support conservation and sustainable use efforts (CBD, 2009).

Indeed, drawing on local and traditional knowledge, innovations and practices, and in partnership with science, it is the local communities that are in the best position to implement practices to prevent desertification and to manage drought (MEA, 2005).

Another element of drought management is addressing food security. Therefore, some countries look to increase access to drought-tolerant crop varieties in drought-affected

regions. The idea behind the development of drought-tolerant crop varieties is to exploit the drought tolerance genes of the staples which have withstood harsh climatic condition for thousands of years (CGIAR, 2014). This includes both identifying varieties with lower water requirements and varieties with higher salt tolerance (in response to increased salinization associated with irrigation and drought).

In order to take advantage of such genetic resources, however, it is important to conserve wild races of common crops. Such conservation can take place either in situ through the protection of areas where such wild races can be found, or ex situ through mechanisms such as seed banks. In addition, regional efforts to improve the drought tolerance of crops can be effective when considering the scope and scale of most droughts that cross national borders (CBD, 2009).

The conservation and sustainable use of agricultural biodiversity through methods such as agroforestry, conservation tillage, intercropping, etc., can also reduce vulnerability from drought. In particular, such practices in managed ecosystems can help maintain vegetative cover, conserve soil biodiversity and provide alternative sources of food and fodder during times of drought, thereby reducing off-farm pressures on biodiversity and associated ecosystem services (CBD, 2009).

3.2.4 The Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is one of the three Rio Conventions emerging from the UN Conference on Environment and Development in 1992. Its objectives are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The CBD has 193 Parties. The governing body of the CBD, the Conference of the Parties (COP), adopted a number of decisions that are relevant to the development of national drought management plans.

In decision X/35, the COP urged Parties to develop, revise and implement drought management plans taking into account the impact of drought and desertification on biodiversity, including through risk management and management of biodiversity for the prevention of drought and desertification.

The COP, in decision X/28, also noted the role of biodiversity and ecosystems in providing services that reduce vulnerability to the impact of some natural disasters, in particu-

lar water-related impacts such as flooding and drought. The COP encouraged Parties to recognize the role of healthy ecosystems, and in particular wetlands, in protecting human communities from some natural disasters and to integrate these considerations into relevant policies. In addition, the COP encouraged Parties to conserve, sustainably use and, where necessary, restore ecosystems so that freshwater flows and water resources sustain biodiversity and thus contribute to human well-being.

Furthermore, the COP, in decision X/2, adopted the Strategic Plan for Biodiversity 2011-2020 and its twenty Aichi Targets, representing a universally agreed framework for action on biodiversity and a foundation for sustainable development for all stakeholders, including agencies across the UN system:

- Aichi Biodiversity Target 14: "By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable."
- Aichi Biodiversity Target 15: "By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks have been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification."

In the context of the Strategic Plan for Biodiversity, the COP also requested the Parties to develop national and regional targets, using the Strategic Plan for Biodiversity and its Aichi Targets as a flexible framework and to review, update and revise their national biodiversity strategies and action plans in line with the Strategic Plan for Biodiversity. National biodiversity targets and elements of national biodiversity strategies and action plans provide readily available elements for national drought management plans.

Relevant national goals and targets from the Latin American region include, for example, a goal by Guatemala that by 2022, 15 per cent of biodiversity and ecosystem services have been restored, improving their capacity to adapt to climate change and contributing to the decline in social and environmental vulnerability. Guatemala intends that by 2018 coping mechanisms have been developed and that there is decreased social and environmental vulnerability caused by the effects of climate change in order to maintain

the integrity of biodiversity and the functioning of ecosystem services and livelihoods of population.

The Dominican Republic adopted a national target that by 2016, ecosystems resilience and biodiversity contribution to carbon sequestration will be improved, through conservation and restoration, including restoration of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and the fight against desertification.
Venezuela committed to develop and strengthen environmental contingencies programmes and to define areas at high risk for environmental contingencies (forest fires, disasters, etc.) that threaten biodiversity conservation.

Conclusion

Considering the role of biodiversity and ecosystems in all stages of developing drought management plans can lead to benefits for both, the conservation and sustainable use of biodiversity, and efficient disaster risk reduction. Existing tools, guidance and plans under the Convention on Biological Diversity can be used to develop or further enhance drought monitoring and early warning systems, vulnerability and risk assessments, and drought preparedness, mitigation and response measures.

3.3 Drought Monitoring and Early Warning Systems

Robert Stefanski, World Meteorological Organization (WMO)

This thematic session proposed by WMO focused on the topic of drought monitoring and early warning systems, including background information on the regional workshops and the outcomes of the High-level Meeting on National Drought Policies (HMNDP). It also discussed the different drought indices and their data issues and provided a number of successful examples of drought monitoring and early warning systems as well as a summary of ongoing WMO drought initiatives. The basis for this initiative was formed by the outcomes of the HMNDP, which produced science and policy documents.

The science document noted that a National Drought Management Policy (NDMP) has several key elements:

- Promoting standard approaches to vulnerability and impact assessment,
- Implementing effective drought monitoring and early warning systems,
- Enhancing preparedness and mitigation actions,
- Implementing emergency response and recovery measures that reinforce national drought management policy goals, and
- Understanding the cost of inaction.

The sessions of the regional workshops are organized along the five elements above. The documents and other materials from the HMNDP can be found at **www.hmndp.org**.

With regard to drought monitoring and early warning systems, it was stated that scientists monitor drought for many of the following reasons: it is a normal part of the climatic cycle, drought impacts are significant and widespread, many socio-economic sectors are affected, and drought is expensive. One important point is that droughts cause more deaths and displace more people than any other kind of natural disaster. A drought-monitoring system is important since it allows for early drought detection, improves response (by being proactive), 'triggers' actions within a drought plan, is a critical mitigation action and forms a foundation of a drought plan. The components of a drought-monitoring system include timely data and information acquisition, synthesis/analysis of data used to 'trigger' set actions within a plan and an efficient dissemination network (web, media, extension, etc.).

It was noted during the session that potential drought monitoring system products and reports can include historical analysis (climatology, impacts, magnitude, frequency), op-

erational assessments (cooperative data, SPI and other indices, automated networks, satellite and soil moisture data, media and official requests) and also predictions/projections (SPI and other indices, soil moisture, stream flow, seasonal forecasts, SST's). Components of a drought early warning and information system involve monitoring and forecasting, tools for decision makers, drought risk assessment and planning, and education and awareness.

Next, the presentation focused on drought indices used for drought monitoring, which could involve a single index or parameter, multiple indices or parameters, or a composite index. Many examples of drought indices were shown, including mean rainfall compared with a 30-year period of record, number of days since a significant rain, snow water content, the Standardized Precipitation Index (SPI), the Palmer Drought Index (PDI), stream flow indices, composite indices and indices based on remotely-sensed data.

The presentation also elaborated on the concept of indicators and triggers of drought. An indicator is a variable or variables used to describe drought conditions with examples such as precipitation, stream flow, groundwater, reservoir levels, soil moisture, snow pack, vegetation health/stress, fire danger ratings and PDI. A trigger is defined as a specific value of the indicator that initiates and terminates a certain level of a drought plan and associated management responses. An example of a trigger would be precipitation below the 5th percentile for two consecutive months. There are several considerations in choosing indicators and triggers which include the following: proper and timely detection of drought, spatial and temporal sensitivity, supplies and demands, start of drought/end of drought, composite and multiple indicators, data availability, validity and clarity, and ease of implementation. In addition to these indicators, other information such as short, medium and long-range weather and climate forecasts and drought impacts are useful for drought monitoring. Drought indices are important since they simplify complex relationships and provide a good communication tool for diverse audiences. They are a quantitative assessment of anomalous climatic conditions such as intensity, duration and spatial extent. They also provide a historical reference (probability of recurrence) that can be used for planning and design applications.

The session also touched on the efforts of WMO and other partners in trying to determine if consensus might be reached on a drought index for the three types of drought: meteorological, agricultural and hydrological. This involved reviewing the background and outcomes of the "Inter-Regional Workshop on Indices and Early Warning Systems for Drought" that was held in December 2009 in Lincoln, Nebraska, United States.

The major outcome of the Lincoln workshop was that drought indices should be used which are based on a sound statistical and historical perspective: SPI and percentiles. The group recommended that the SPI be used as a meteorological drought index. The breakout groups on agricultural and hydrological drought could not reach a consensus. The workshop adopted the "Lincoln Declaration" which stated that the National Meteorological and Hydrological Services (NMHS) are encouraged to use SPI to characterize meteorological droughts and provide this information in addition to indices currently in use. Besides, a comprehensive user manual for the SPI should be developed that describes the index, computation methods, specific examples of current use, strengths and limitations, mapping capabilities and areas of application. The "Manual on the Standardized Precipitation Index" is now available at: **http://www.wmo.int/pages/prog/wcp/agm/publications/agm_proceedings.php**. A recent variation of the SPI index was mentioned, called the Standardized Precipitation Evapotranspiration Index (SPEI) by Vicente-Serrano et al. (2010), which includes a temperature component. The required inputs to run the programme are precipitation, mean temperature and latitude of the site(s). (For more information please visit: **http://sac.csic.es/spei/index.html**).

Important data issues with drought indices and monitoring were also highlighted. It was stressed that accurate and long-term weather data is needed. For the SPI, at least 30 years of rainfall data are required. With data from fewer years, the SPI might become unreliable. For agricultural and hydrological drought indices, other data is needed such as potential evapotranspiration (ETP), departure of ETP from normal, affected crops (conditions, growth stages) and soil moisture (measurement/simulation/departure from normal). Also, gridded datasets can be used (i.e., GPCC - Global Precipitation Climatology Centre: **http://gpcc.dwd.de**) along with remotely sensed data and reanalysis of weather model data. It was noted that vulnerability and impact data are limited with regard to area and length of record, and that this needs to be improved. The example of the US Drought Monitor (USDM) was used to show how an indicator and a trigger can be applied. The USDM has different levels that can be used as trigger and is applied by several US states.

Finally, two WMO initiatives which involve many other partners were briefly summarized. The first one was the Global Framework for Climate Services (GFCS), a UN-led initiative spearheaded by WMO to guide the development and application of science-based climate information and services in support of decision-making. This concept was first developed during the World Climate Conference-3 (Geneva, 2009) and was unanimously approved by an Extraordinary WMO Congress in 2012. The vision of the GFCS is to en-

able society to better manage the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to such risks. This will be done through the development and incorporation of science-based climate information and prediction into planning, policy and practice.

The other drought initiative is the Integrated Drought Management Programme (IDMP), which was also established at the HMNDP. The expected IDMP services to be provided are the following: regional coordination of drought monitoring, prediction and early warning activities; inception of pilot projects and coordination of regional projects to showcase best practices; collection and dissemination of information and knowledge on good practices; guidelines, methodologies, tools and supporting documentation on policy development and management practices and procedures; and capacity building and advice on Integrated Drought Management. The work of IDMP started in August 2013 when the Technical Support Unit (TSU) was staffed. It was stressed that the IDMP will work in conjunction with all partners involved in these regional workshops to ensure that there is a coordinated and cohesive effort with regards to drought management issues. For more information on IDMP, see **www.droughtmanagement.info**.

The presentation also summarized the outcomes of a regional workshop on Drought and its Impacts on Mexico, Central America and the Caribbean held in Antique, Guatemala from 4 to 8 November 2013. Some of the major conclusions of the workshop included: exploring the possibilities of regional integration in pilot projects, strengthening the linkages between the UNCCD and National Meteorological and Hydrological Services (NMHSs), establish a protocol for communication between NMHSs authorities and decision-makers in order to be able to efficiently implement the mitigation measures in the presence of a forecast of drought, develop capacity in the implementation and interpretation of various drought indices in the region, and strengthen interdisciplinary work between climatologists and meteorologists, hydrologists, and agricultural specialists.

3.3.1 Procedures and challenges in early warning systems

The first breakout group tackled the question: "What are the current procedures and challenges on early warning systems?" The participants emphasized the importance of understanding and analysing the current status of water resources as well as the historical trends. They highlighted the role of data on snow packs and precipitation amounts, given the presence of a melting process during summer in certain regions. As the countries differ in topography, climate and resources, some parameters are more important

for certain regions than for others. However, the relevance of meteorological and hydrological data was stressed. Participants also shared their concerns regarding the quality of seasonal and long-term forecasts, since it is often the case that they are not completely reliable. It was also noted that the number of monitoring stations and their density – which are identified as extremely important for supporting early warning systems – is declining in the LAC region.

3.3.2 Meteorological and hydrological networks, data quality and sustainability needs

The second breakout group dealt with the question: "What are the meteorological and hydrological networks, data quality and sustainability needs?" The participants noted that meteorological, hydrometeorological and hydrological data are fairly well handled by the organized services and that at present there are databases made up of existing networks from different sources. They also noted that communication systems are generally fairly good. The meteorological services provide three-month climate forecasts. However, they also highlighted some of the problem areas, such as missing and poor distribution of stations, deficiency in the quality and standardization of data, poor integration of institutions for training on databases, poor monitoring of agrometeorological and hydrological drought, lack of the ability to interpret the data and information, and the unreliability of the data, which does not allow the continuity of the data to make a complete dataset. The participants then listed the following challenges: implementation and management of databases, decentralization of information, sustainability of stations, compatibility and diversification of technology, and methods to systematize and to apply the information in an operational manner.

3.3.3 Communicating and liaising on drought monitoring and early warning between national institutions

The third group discussed the question "What mechanisms are in place for communicating and liaising drought monitoring and early warning information between national institutions?" The discussion focused on creating the legal framework to define hierarchical leadership roles and protocols to manage drought and to have effective data exchange and transmission of information for communication. The regulatory framework requires defining the coordination and leadership and seeking the participation of others. The group noted that whatever the institution or committee is leading the process it should be empowered by the legal framework. The participants stressed that there needs to be economic capacity and political support for the activities and that quantified impacts must be disseminated. In addition, there must be a formal process to make agreements and that roles of the actors involved in the process must be defined. It was suggested to

start with publicly backed simple indicators and then gradually adopt a more complex process of indicators. The governance structures should communicate to regional, local, state, municipal, and governments. There should be increased visibility for the institutional committee or leading institution. Lastly, the group noted that when communicating to users the impact of drought, there should be a feedback mechanism so that the early warning can be improved.

3.4 Vulnerability and Risk Assessment

Heitor Matallo,United Nations Convention to Combat Desertification (UNCCD)

This thematic session addressed the topic of vulnerability and risk assessment and covered the main concepts and the methodological aspects related to the topic. The discussions were focused on the direct and indirect impacts of drought in dry land ecosystems.

The basic concepts used in the presentation come from the United Nations International Strategy for Disaster Reduction (ISDR) and UNCCD which have established a comprehensive set of definitions such as "vulnerability", "hazard", "drought", "disaster" and "risk". The combination of these basic definitions leads us to the following:

- Vulnerability is expressed by the conditions determined through physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards, including land degradation and desertification.
- Hazard is a potential damaging 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 and environmental degradation.
- Drought means 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.
- Disaster is defined as a serious disruption of the functioning of a community or a society that involves 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.
- Risk entails the combination of the probability of an event and its negative consequences. Drought (Disaster) Risk refers to the potential loss of lives, re-

duced health status, livelihoods, assets and ecosystem services in connection with drought, which could occur to a particular community or a society over a specified time period in the future.

Therefore, risk assessment is the process of identifying, quantifying, and ranking the vulnerabilities in a drought scenario, which means the assessment of threats from potential droughts to the population, infrastructure and environment. Other aspects are also involved in the assessment, namely the socio-economic and institutional analysis, the estimation of the duration of the exposure to droughts through weather forecast and the definitions of minimum capacities and measures to be taken.

Drought produces a large number of impacts that affect the social, environmental and economic standards of living. The lack of expected rainwater in a non-prepared rural economy strongly affects rangeland and forest productivity, reduces crop production, and increases livestock and wildlife death rates and damage to wildlife and fish habitats. A reduction in crop productivity usually results in less income for farmers, increases food prices and causes unemployment and migration.

Dry lands are of great concern when it comes to drought and natural disasters, since the conditions for sustainability in these regions are not the same when compared to other ecosystems, particularly those without water limitations. The figure below shows the conditions for sustainability vis-à-vis the temperature and water availability. According to the model developed by Stewart, et al. (FAO, 2008), sustainability is a great challenge in dry lands and droughts are the main concern in those areas.

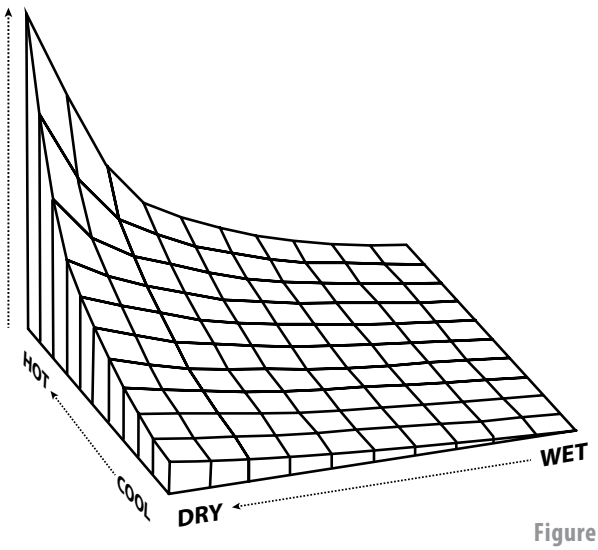

Figure 1: Difficulty of achieving sustainability

The presentation mentioned that drought in Latin America is mainly due to the El Niño/ La Niña occurrence and should not be seen as uncommon by national governments and land users. El Niño/La Niña can be forecast by the weather forecast services in the region and preparedness should be a permanent activity. However, the lack of appropriate institutions and the involvement and training of land users in preparedness still make droughts one of the main damaging phenomena in dry lands of the region.

In more general terms, it was mentioned that the management capacity to tackle risk disasters in Latin America and the Caribbean is quite low and should be improved. The Inter-American Development Bank (IDB) developed an index to measure the management capacity to cope with disasters (which can be seen as a proxy for the vulnerability index) and the result, as illustrated in the figure below. In analysing the disaster management capacity in the LAC countries it can be concluded that policy formulation and implementation is still the main challenge in the region.

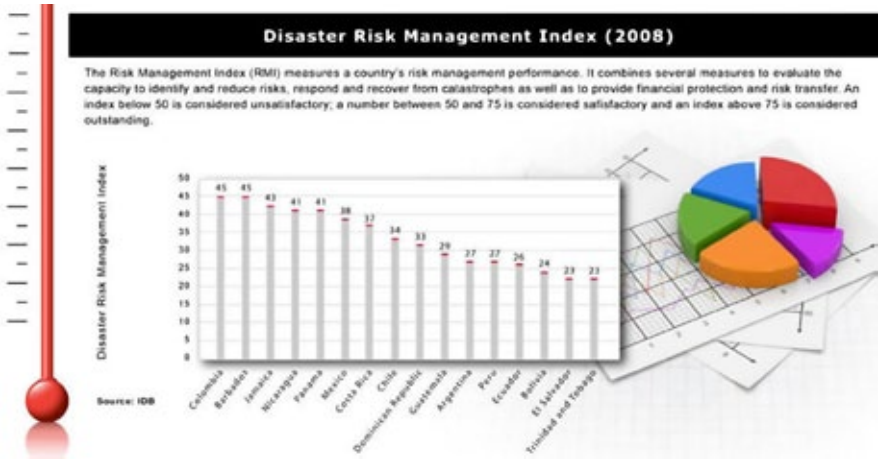

Figure 2: The Disaster Risk Management Index

3.4.1 UNCCD's role in drought management

Parties to the UNCCD COP 10 requested the Secretariat to develop an Advocacy Policy Framework (APF) on Drought:

- The APF on Drought provides the UNCCD secretariat with tools and approaches for assisting country parties in addressing key drought issues and concerns.
- The overarching goal of this APF is to promote the development and adoption of policies that reduce societal vulnerability to drought.
- The Advocacy Policy Framework on Drought has been adopted at COP 11 held September 2013 in Windhoek, Namibia.

Other measures that could improve preparedness against drought can be mentioned:

- National Action Plans (NAP) as a tool to contribute to national policies on combating desertification and mitigate the effects of draught.
- UN Agencies (WMO, FAO, UNCCD and others) cooperating to support countries to improve decision-making processes and National Policies on Drought Management (decision 9/COP 11).
- UN and International Agencies to promote the establishment of an Investment Framework to cope with drought and desertification at country level.

After the presentation and general discussions, breakout groups started working on three main themes described below.

3.4.2 Who is the most vulnerable to drought?

The group discussed this issue and the general consensus was that people living in rural areas should be the focus of policies to cope with drought, with a particular focus on small-scale farmers who live in isolated areas and face seasonal food shortages, chronic malnutrition and poor access to basic services. Other groups are also vulnerable to droughts at different levels, such as medium-scale farmers and livestock producers. It was also mentioned that some sectors are largely affected by drought and should be covered by the policies. These sectors, especially in areas with low supply and distribution infrastructure, include public and private companies which are dedicated to supplying drinking water to the population as well as hydropower generation companies.

3.4.3 What are the causes of/reasons for vulnerability to drought?

The group mentioned the well-known causes of vulnerability such as the shortage of rainfall, land degradation and poverty. Emphasis was made on the lack of proper infrastructure and policies. In fact, a set of suggestions (which were discussed during the presentation) were accepted as the main challenges to reduce vulnerability and to promote development in dry lands:

- Strengthening the infrastructure at farm level (communication, hydrological infrastructure, access to local markets).
- Diversifying and improving productive activities to reduce the risk of drought.
- Promoting the traditional and new technologies to improve standards of living (irrigation, rainwater harvesting).
- Promoting innovation for dry lands development.

3.4.4 Who plays which role in developing the mitigation policies and plans that reduce drought impacts and vulnerability at all levels?

The group recognized the public sector as the main responsible in promoting the policies to reduce vulnerability, to improve living conditions and to combat poverty in dry lands. The public sector is generally organized in different sub-sectors or ministries that play a crucial role in the implementation of development policies. For example, education, science and technology were mentioned. Some of the actions to be taken include encouraging information sharing systems to be extensively and efficiently used in the countries. These systems should be based on basic principles, such as:

- Implementation and management of databases,
- Decentralization of information,
- Compatibility of technology and sustainability in the functioning of data stations,
- Systematization and application of information for operational work, and
- Diversification of technology.

Even though the above-mentioned issues are technical, they are basic in terms of ensuring the production of reliable and updated information needed for an efficient involvement of the local population in land management and preparedness.

3.5 Drought Preparedness, Mitigation and Response

Mohamed Bazza, Food and Agricultural Organization of the United Nations (FAO)

Research by R. B. Gill (2008) concluded that the Mayans who lived in Mesoamerica – a region that includes Southern Mexico and territories of Guatemala, El Salvador and Belize and also contains the western portions of Nicaragua, Honduras and Costa Rica – died of hunger and thirst. This was because of a series of devastating droughts that occurred between 800-1000 A. C. Similar accounts of drought and their impacts are recorded throughout the history of Latin America and the Caribbean, demonstrating that drought is a normal phenomenon of the region's climate. Gill explains that the Mayan populations "were largely destroyed by brutal forces of nature against which there was no defense …". While it is still true that humans can do nothing to stop drought, today it is possible to mitigate its impacts, thanks to new advances in science, technology and knowledge.

Alongside, "Monitoring and Early Warning" and "Vulnerability and Risk Assessment" as discussed previously, "Drought Preparedness, Mitigation and Response" constitutes the third pillar of drought risk management. The three pillars are also closely linked as explained during the session presentation. The session recalled the following definitions, along the lines of the HMNDP Compendium on National Drought Policy and the National Drought Mitigation Center (NDMC) of the University of Lincoln-Nebraska:

Drought Preparedness: Established policies and specified plans and activities taken before drought to prepare people and enhance institutional and coping capacities, to forecast or warn of approaching dangers, and to ensure coordinated and effective response in a drought situation (contingency planning).

Drought Planning: Actions taken by individual citizens, industry, government and others before drought occurs to mitigate impacts and conflicts arising from drought.

Response to Drought: Efforts such as the provision of assistance or intervention during or immediately after a drought disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term or protracted duration.

Recovery from Drought: Decisions and actions taken after a drought with a view to restoring or improving the pre-drought living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce drought risk.

Drought Mitigation: Any structural/physical measures (e.g. appropriate crops, dams, engineering projects) or non-structural measures (e.g. policies, awareness, knowledge development, public commitment and operating practices) undertaken to limit the adverse impacts of drought.

Traditionally, response to drought – and at times recovery from it – constitutes the main action that countries take, as an emergency measure after drought has been declared. Such response is unplanned and hastily applied after drought has taken its toll of damages and scourges.

Response to drought, including recovery, remains an important component of pro-active drought risk management. This kind of drought response is planned before drought occurs and constitutes an integral part of a drought plan. As such, response measures contribute to building long-term resilience to drought. Numerous advantages and synergies result from the integration of response and recovery measures into a drought plan as explained during the session.

The output of "Vulnerability and Risk Assessment" is a list of who (e.g., groups of practitioners or layers of the society) or what (e.g., economic sectors) is vulnerable to drought, arranged in the order of priority from highest to lowest. The ordering is done on the basis of agreed criteria, such as economic loss stemming from drought impacts. For each element of this list, starting from highest priority, the measures and actions that are needed in view of eliminating and reducing those impacts, and thus increasing the coping capacity of who/what is vulnerable to them, is established. These measures and actions are called "Risk Management Options".

Drought risk management options included in a drought plan should address the root causes of vulnerability, so that their implementation results in increasing capacities to cope with drought and reducing impacts. The set of risk management options that can potentially be included in a drought plan can be split into three categories, based on the time of their action: long, medium, and short term, as indicated in Table 1 below.

The short-term measures are implemented before, during and after drought in a timely manner, based on indices or triggers linked to drought indicators determined by "Monitoring and Early Warning". The three categories complement each other and constitute an integral drought risk management plan.

Table 1: Set of risk management options

CATEGORY	LONG-TERM	SHORT-TERM	RESPONSE AND RECOVERY
OBJECTIVE	Resilience Building	Drought Mitigation	Impact Reduction
IMPLEMENTATION FRAMEWORK	Regular Development Programs	Drought Plan	Response within Drought Plan
IMPLEMENTATION TIME	Continuous	Before, During and After Drought	During and After Drought

A long but non-exhaustive list of typical measures for all three categories is given in the presentation. The latter also explains the procedure for linking actions to indices and drought indicators and provides examples for doing so. Long-term measures and actions are fundamental for building resilience to drought. They are normally included in the strategies and action plans of the main sectors affected by drought, such as water, agriculture and environment, etc. These measures constitute an integral part of national drought risk management, and for this reason, revisiting the strategies of these sectors to ensure their inclusion is an important step of developing national drought management policies. It should be noted however, that despite their utmost importance in building resilience to drought, long-term measures do not shield completely against drought impacts. They need to be supplemented by well-planned medium-term or mitigation measures as well as by response and recovery measures.

After the thematic presentation, the participants were split into two groups to practice applying the methodologies introduced by the session. The two groups focused on water and agriculture, respectively, and proposed drought risk management measures of medium- and long-term dimensions, relevant for their countries.

The group discussions revealed that most participating countries have some experience in proactive risk management but drought is only rarely part of the framework and even when it does it is still managed reactively on an emergency basis. Mexico is the only country that embarked on a process of establishing a full-fledged proactive drought management plan, thanks to political will from leading policymakers. Jamaica is among the countries with relatively good experience in agricultural drought management within the framework of collaboration with FAO. Brazil is also launching preparation of drought policy focused only on dry regions of the country.

The identified main priority measures related to water are summarized below:

- Storage increase

- Monitoring of supply and demand

- Quality protection through the establishment of norms, laws, policies, monitoring and certification

- Awareness and education on status and occurrence of drought

- Drinking water supply:
  - Rehabilitation and maintenance
  - Purification
  - Desalination
  - Regulation of consumption
  - Water saving awareness
  - Infrastructure differentiation
  - Dams and diversions
  - Consumption reduction
  - Rainwater harvesting

- Agriculture and Animal Husbandry
  - Irrigation technology (efficiency increase)
  - Exploration / introduction of less water demanding crops
  - Water harvesting, reservoirs and wells
  - Changes in water use regulation to encourage water saving

- Hydropower generation
  - Energy consumption control
  - Incentive to improve efficiency
  - Improve efficiency in energy generation and distribution
  - Network interconnection systems
  - Adoption of integrated river basin management

- Other
  - Fire control
  - Erosion and degradation control (Sustainable Land Management)
  - Incentives for energy and water efficiency
  - Prioritize water delivery for sensitive industries in respect of food security and energy generation
  - Market based strategies/insurance
  - Accommodation of industrial complexes in water-rich areas
  - Incentives for dry or low energy industries
  - Adoption of water footprint indicator as industry value
  - Temporary employment on resilience building actions.

Unfortunately, the report prepared by the group that worked on agriculture is no longer available. Based on the reporter's notes, the group confirmed the high vulnerability of agriculture in all countries, placing it as the most affected. Small-holder farmers, the landless, agriculture labourers and, in some cases, other groups such as the elderly and women farmers were identified as the most vulnerable groups within agriculture. The measures and actions recommended for mitigating drought impacts on the sector were numerous, including: expansion of the area under irrigation and irrigation efficiency improvement; adoption of crop insurance; provision of timely information to farmers, herders, fishermen, foresters, etc.; water harvesting and soil and water conservation practices; and research on drought tolerant crop species and genotypes, etc.

3.6 Summary

The thematic presentations and the breakout group discussions covered several key areas and exposed the participants to a wide spectrum of drought management policies and their context-specific relevance. Issues discussed in depth ranged from drought monitoring and early warning systems to various drought indices and data issues in drought monitoring systems. The major components of drought monitoring systems were emphasized, namely timely data and acquisition, impact data and synthesis/analysis of data used to 'trigger' actions and the need for efficient dissemination networks (web, media, extension, etc.). Approaches of drought monitoring were clarified, ranging from single index/parameter, to multiple indices/parameters and composite index.

The steps on drought vulnerability and risk assessment and the typologies of different drought risk management measures were also discussed, including drought prepared-

ness, mitigation, response and recovery. A range of risk management options were underlined in order to build societal resilience through national drought policies and preparedness plans, which comprise short and long-term measures. Most notably, the steps towards drought plans were discussed: (i) drought characterization, (ii) monitoring and early warning, (iii) vulnerability and impact assessment, and (iv) mitigation and response options. The generic 10-step process of formulating drought policies formed the backbone of the entire discussion during the three-day workshop. The cost of inaction on drought and the long-term cost effectiveness of risk-based drought management strategies when compared with the cost of disaster response and crisis management were highlighted.

In general, the achievements of the workshop can be summarized as follows:

- The workshop improved the awareness of participants in drought management issues and the needs and strategies for national drought policies based on the principles of 'risk reduction'.
- The workshop equipped participants with tools and strategies for improved decision support, risk assessments of vulnerable sectors, population groups, regions and, most importantly, mitigating drought effects.
- The workshop furnished participants with up-to-date methodologies to develop/improve drought monitoring, seasonal forecasts, and early warning and information delivery systems.
- The workshop also improved participants' understanding and the long-term benefits of risk-based drought management policies versus crisis-based policies.

The workshop was able to promote national and regional networks of stakeholders working in various ministries including agriculture, environment and meteorology and encouraged mutual learning, which can help ensure the effectiveness of measures to address drought impacts and pave the way for formulating comprehensive national drought policies for their countries.

References:

Anderegg, W. R. L., J. M. Kane and L. D. L. Anderegg (2013). *Consequences of widespread tree mortality triggered by drought and temperature stress*. Nature Climate Change 3 (2013), 30–36.

Bainbridge, B. A (2007). *Guide for Desert and Drylands Restoration: New Hope for Arid Lands.* Society for Ecological Restoration International.

Consultative Group on International Agricultural Research (CGIAR), *Drought-Tolerant Crops for Dry lands*. Accessed at: http://www.cgiar.org/impact/global/des_fact2.html

Convention on Biological Diversity (2009). *Biodiversity of Dry and Sub-humid Lands: Follow-Up to Requests of the Conference of the Parties in Decision IX/17.* Note by the Executive Secretary, UN Doc. UNEP/CBD/SBSTTA/14/13.

Economic and Social Council, Commission on Sustainable Development (2009). Seventeenth session, 4-15 May 2009. *Policy options and actions for expediting progress in implementation: Drought Report of the Secretary-General*. UN Doc. E/CN.17/2009/6.

European Parliament and the Council (2007). Communication from the Commission to the European Parliament and the Council: *Addressing the challenge of water scarcity and droughts in the European Union*. COM/2007/0414 final.

Food and Agriculture Organization of the United Nations (2005). *The importance of soil organic matter. Key to drought-resistant soil and sustained food and production*. FAO Soils Bulletin 80, 2005.

Gill, R.B. (2008). *The Great Maya Droughts: Water, Life, and Death*. University of New Mexico Press.

ISDR (2009), International Strategy for Disaster Risk Reduction Terminology on Disaster Risk Reduction. Available from: http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

Keyantash, John, and John. A. Dracup (2002). T*he Quantification of Drought: An Evaluation of Drought Indices.* Bull. Amer. Meteor. Soc, Vol. 83, pp. 1167–1180.

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Desertification Synthesis.*. World Resources Institute, Washington, DC.

Munang, R., I. Thiaw, K. Alverson, J. Liu and Z. Han (2013). T*he role of ecosystem services in climate change adaptation and disaster risk reduction*. Current Opinion in Environmental Sustainability 5 (2013), 1-6.

Sivakumar, M VK, Raymond P. Motha, Donald A Wilhite, John J Qu (2011). *Towards a compendium on National Drought Policies. Proceedings of an Expert Meeting*. World Meteorological Organization. Geneva.

Tabacchi, E., L. Lambs, H. Guilloy, A.-M. Planty-Tabacchi, E. Muller and H. Decamps (2000). *Impacts of riparian vegetation on hydrological processes*. Hydrological Processes, Vol. 14, No.16-17, pp. 2959-2976.

Turner, B I, Roger E. Kasperson, Pamela A. Matson, James J. McCarthy, Robert W. Corell, Lindsey Christensen, Noelle Eckley, Jeanne X. Kasperson, Amy Luers, Marybeth L. Martello, Collin Polsky, Alexander Pulsipher, and Andrew Schiller (2003). *A Framework for Vulnerability Analysis in Sustainability Sciences*. Proceedings of the National Academy of Sciences, Vol. 100, No.14, pp. 8074-8079.

Vicente-Serrano, Sergio. M. Begueria and Juan I. López-Moreno (2010). *A multi-scalar drought index sensitive to global warming: the standardized precipitation evapotranspiration index*. Journal of Climate, Vol. 23, pp. 1696-1718.

Vörösmarty, Charles J., Pamela Green, Joseph Salisbury, and Richard B. Lammers (2000). *Global Water Resources: Vulnerability from Climate Change and Population Growth*. Science, Vol. 289, pp. 284-88.

Wilhite, Donald A., Michael J. Hayes and Cody L. Knutson (2005). *Drought Preparedness Planning: Building Institutional Capacity*. In Wilhite (ed) (2005) Drought and Water Crises: Science, Technology, and Management Issues. Boca Raton: CRC Press.

NATIONAL REPORTS

Map of Participant Countries:

Argentina

Vanina Pietragalla[1] and María Laura Corso[2]

Background

A great deal of work has gone into identifying droughts and assessing their intensity, using precipitation data from surface weather stations. For example, Ravelo and Rotondo (1987a) and Scian and Donnari (1997) studied droughts in the pampas and their impact on wheat crop yields. Ravelo and Pascale (1999) identified and evaluated droughts in various localities of Córdoba and Buenos Aires, using information from weather stations and satellite images. Ravelo (1999) characterized drought in the pampas prairies using drought indices and satellite information. Whereas an analysis of precipitation in the pampas appears to indicate a steady increase in precipitation, as reflected by an isohyets shift to the west (Sierra et al., 1993:194; Sierra et al., 1995) and a corresponding increase in areas and yields for some crops (Pascale and Damario, 1996), it has been found that drought intensity has not decreased in the west (Ravelo et al., 1999).

Given that droughts are closely linked to the variability and amount of precipitation, it would be useful to have an analysis making it possible to identify the existence of temporal and spatial drought patterns, especially in areas which have been recently converted to agriculture or where new, more water-intensive crops have been introduced. As can be seen from Figures 1 and 2, which analyse the Palmer Drought Severity Index (PDSI) over time, this phenomenon varies throughout the country, generating different impacts depending on the specific characteristics of the individual ecosystems.

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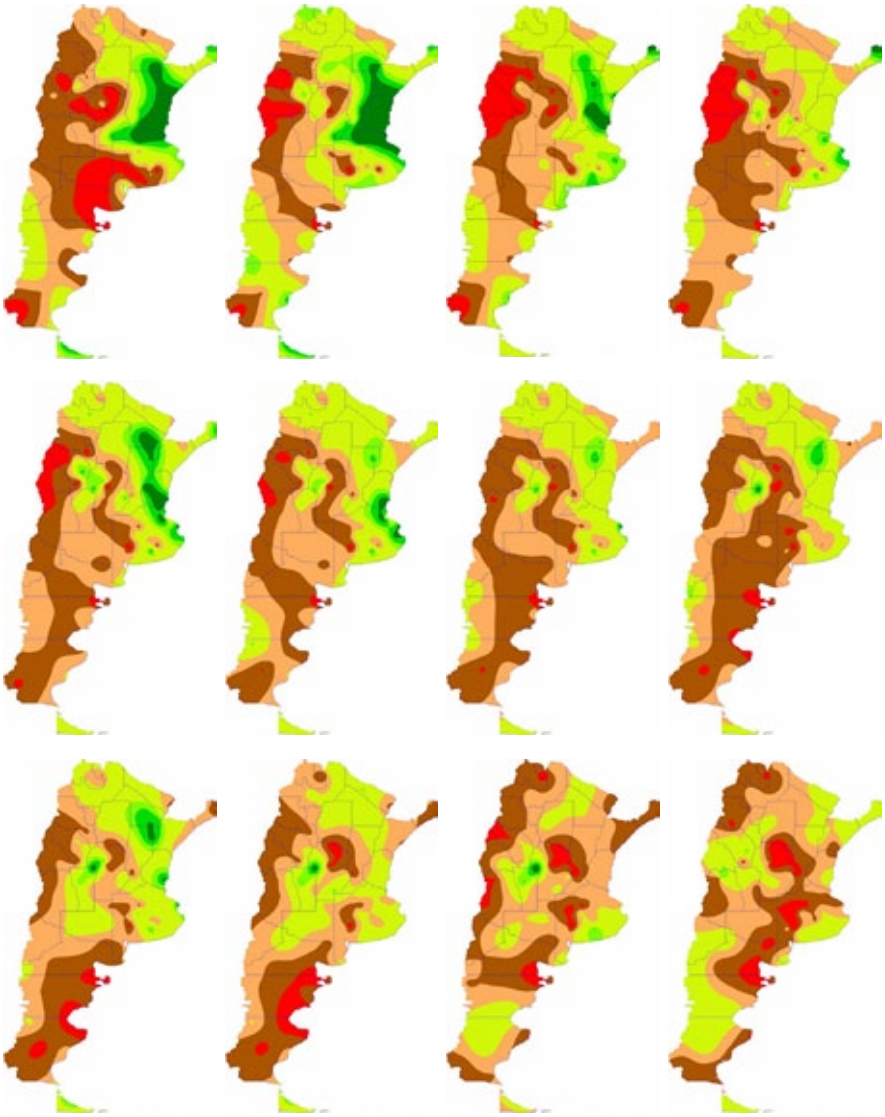

Figure 1: Nationwide changes in the Palmer Index for 2010

Source: Centre for Surveying and Evaluating Agricultural and Natural Resources (CREAN), CONICET-University of Córdoba

Extreme humidity	*3.00 or more*
Excess humidity	*2.00 to 3.00*
Incipient/moderate humidity	*1.00 to 2.00*
Normal	*1.00 to -1.00*
Incipient/moderate drought	*-1.00 to -2.00*
Severe drought	*-2.00 to -3.00*
Extreme drought	*-3.00 or less*

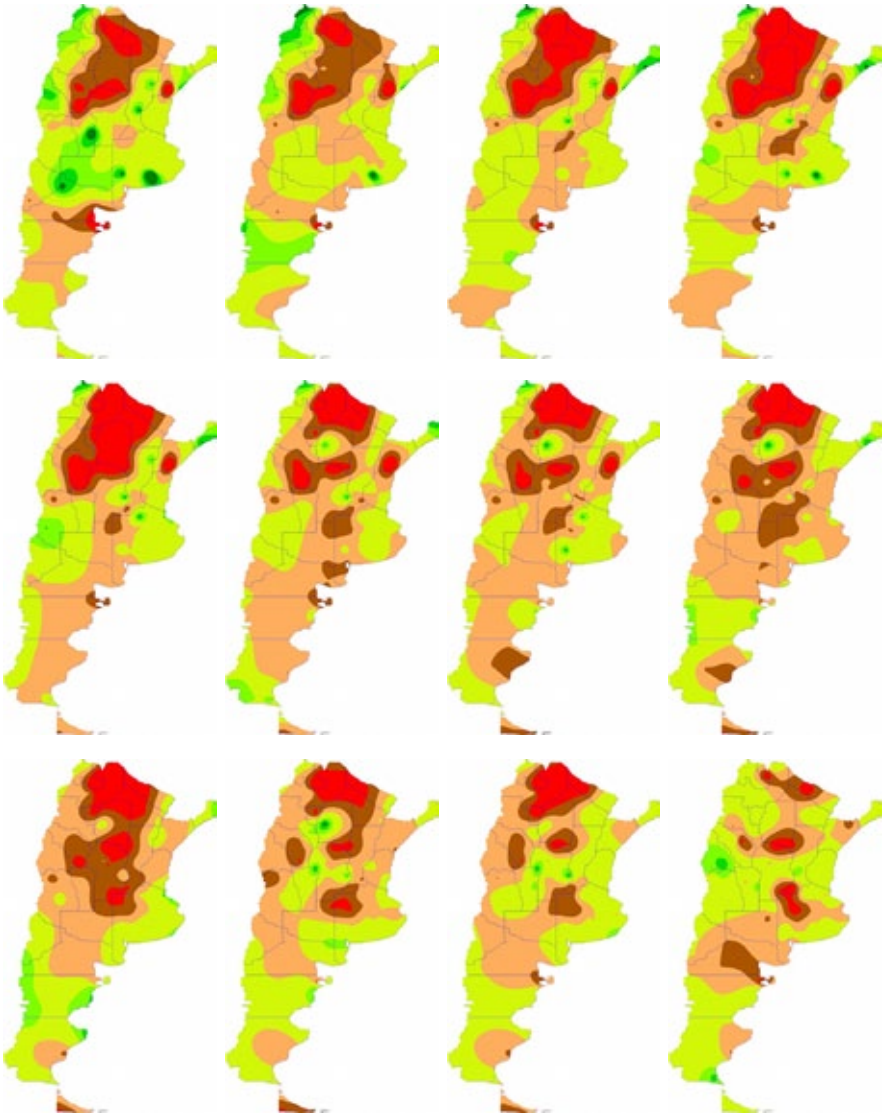

Figure 2: Nationwide changes in the Palmer Index for 2013

Source: Centre for Surveying and Evaluating Agricultural and Natural Resources (CREAN), CONICET-University of Córdoba

Extreme humidity	*3.00 or more*
Excess humidity	*2.00 to 3.00*
Incipient/moderate humidity	*1.00 to 2.00*
Normal	*1.00 to -1.00*
Incipient/moderate drought	*-1.00 to -2.00*
Severe drought	*-2.00 to -3.00*
Extreme drought	*-3.00 or less*

According to a report by the Centre for Social and Environmental Studies (2004), floods and droughts were the natural disasters which caused the most damage in Argentina or were the most intense during the period 1970–2001.

Vulnerability assessment

The damages and losses associated with this type of disaster are considerable and are estimated at an equivalent loss of 1.1 per cent of Gross Geographic Product (Ministry of Territorial Planning, Public Investment and Services, 2008). They impact human life and living conditions (hydro meteorological disasters accounted for 27 per cent of deaths and 89 per cent of evacuations affecting 1.8 million people over the past 40 years) and were responsible for losses amounting to millions in various sectors, especially with regard to not only the housing, road network and agro-livestock sectors, but also to energy, drinking water supply, communications and industry, given that this type of disaster hits the educational sector hardest (due to both infrastructural damage and to the suspension of classes and the use of schools as centres for evacuees).

Droughts affect 100 per cent of the country's provinces, especially in the centre and the north. Inter alia, they usually generate heavy losses in agro-livestock production, even though there is insufficient data on their impact. They have been identified as one of the main threats (along with floods) by technical teams in the north-east provinces working on the National Programme for Disaster Risk Prevention and Reduction and Territorial Development (UNDP, 2010), which reported considerable drought-related income loss. Seasonal drought frequency varies from one region to another.

A study conducted in the semi-arid pampas, in the provinces of La Pampa (Santa Rosa) and San Luis (Villa Reynolds), where the probability of drought occurrence for this zone is once every three years, showed an annual economic loss for La Pampa estimated at $931,556. By way of comparison, for the province of San Luis, where the probability of drought occurrence is once every four years, the annual economic loss is estimated at $673,891 (Ravelo et al., 1999).

Another more recent case was the extreme drought in the south-east of the province of Buenos Aires (2008–2009), where drought losses for livestock were reflected by lower rates for weaning, pastoral fattening and animal mortality. In agriculture, the main impact was felt in wheat production, where drought generated a 50 per cent reduction in areas sown and harvested before the end of the crop-growing cycle, leading to sharp losses for those living in the south-eastern part of the province.

Relief fund for emergencies and drought response

Most emergency relief in Argentina is provided through the Law on Agro-livestock Emergencies (Article 10.390/86), which foresees subsidies for farmers who have been impacted by various climate events. The Law classifies beneficiaries into two categories: (a) emergencies, and (b) disasters. The former category is made up of producers whose productive capacity has been reduced by at least 50 per cent, whereas the latter category consists of growers who have suffered a production drop of 80 per cent or more (Art. 8).

The Law makes provision for compensation in the form of preferential loans, tax breaks, public works and social assistance where an emergency or a natural disaster has been declared (Art. 10). This presupposes that the Law puts remedial action before prevention, that is, the Law is applied once the event has occurred. In the event of a prolonged drought, producers accumulate tax obligations and loans, thereby aggravating their situation.

Likewise, the solutions proposed by the Law are of an economic nature (Art. 4 inc. c) and do not mention any type of training for growers affected by the event. Article 10 proposes measures of a social nature to "help agro-livestock workers and their families who have been affected by an emergency or a natural disaster", but these measures are neither listed nor spelled out. These are points that require further work in relation to the development of a comprehensive drought management policy.

Drought mitigation practices

As mentioned above, the Law on Agro-Livestock Emergencies is the instrument used to deal with emergencies and natural disasters. It states that in every province and municipality, there is a body responsible for dealing with emergencies and natural disasters. In practice, however, this does not really reflect the situation, given that, on the local level, not all of the authorities have the capacities and resources to respond. An initial estimate based on the experience of the National Direction of Civil Protection (DNPC) is that, out of the country's 2198 municipalities, between 30 per cent and 40 per cent have an organized civil defence system (Argentine Red Cross, 2009).

Accordingly, priority should be given to drought management, which must be implemented comprehensively in order to make up for the socio-productive shortfalls suffered by the actors affected, taking measures to ensure that droughts do not become irreversible.

Need for drought management knowledge and skills

Even though Argentina has excellent technical capacity for analysing drought-related impacts from a social, economic and environmental perspective, it still lacks a multidisciplinary, inter-agency plan allowing a comprehensive, nationwide approach, given that the main studies conducted were limited to the pampas, where the impact on the regional economy may be severe. However, the social impacts of drought are greater in other regions.

This being so, there is an urgent need to develop an early warning information system for drought and to monitor and evaluate the impacts of droughts. The information produced (by various users) would then be disseminated in order to improve the decision-making process concerning drought-related issues.

With a view to reducing or preventing the economic losses or negative social impacts generated by the occurrence of droughts, it is proposed to develop a system which, once operational, should make it possible to identify and assess droughts on a countrywide basis. Such an early warning system would facilitate the preparation of contingency plans and action to be taken in the event of a drought, with regard to crop-planting or the choice of a productive activity.

References

Andrade, M.I., P. Laporta and.L. Lezzi (2009). *Sequías en el Sudoeste bonaerense: Vulnerabilidad e incertidumbre*. Geograficando, vol. 5, No. 5, pp. 213-231.

Argentine Red Cross. https://www.ifrc.org/en/what-we-do/where-we-work/americas/argentine-red-cross/.

Bartolomé, M., M. G Caputo, A. Celis, H. Herzer and C. Rodríguez (2004). *El clima y otros factores de riesgo productivo en la pampa húmeda argentina*. Realidad Económica, vol. 202, pp. 88-107.

Centro de Estudios Sociales y Ambientales (2004). *Informe Final IAI. ENSO Argentina*. Chap. II National Analysis.

Cruz Roja Argentina (2009). *Documento País: Riesgos de Desastres en Argentina. Resumen Ejecutivo*. Buenos Aires, Argentina.

Dirección de Conservación del Suelo y Lucha contra la Desertificación de la Secretaría de Ambiente y Desarrollo Sustentable de Argentina (1999). *Proyecto de Alerta Temprana para la Sequía y Mitigación de sus Efectos*. Working document.

Ministry of Territorial Planning, Public Investment and Services of Argentina. http://www.minplan.gob.ar/.

Pascale, A.J., and E. A. Damario, (1996). *Modificación de las condiciones agroclimáticas para el cultivo del girasol en la Argentina durante el período 1961-90*. Rev. Facultad de Agronomía, vol, 16, Nos. 1-2, pp.119-125.

Penman, H.L.,(1948). *Natural evaporation from open water, bare soil and grass*. Royal Soc. London Proc. Ser. , vol, 193, pp. 120-146.

Ravelo, A. C., C. Rebella, C. Villanueva, R. Zanvettor, R. Rodriguez, W. Da Porta, and M.M Skansi (1999). *Plan Piloto: Desarrollo de un sistema para la detección, seguimiento y evaluación de las sequías agrícolas en Argentina*.

Ravelo, A. C. and V.H. Rotondo (1987a). *Caracterización climática de las sequías en Río Cuarto, Córdoba*. Minutes of the IIIrd National Meeting of Agrometeor, Vaquerías, Córdoba, (Argentina). pp. 165-169.

Ravelo, A. C. and V.H. Rotondo, (1987b). *Variabilidad de las sequías en regiones semiáridas y húmedas*. Minutes of the 1st National Days for Arid and Semi-arid Zones. National University of Santiago del Estero.

Ravelo, A. C. and A.J. Pascale, (1997). *Identificación de la ocurrencia de sequías mediante imágenes del satelite NOAA e información terrestre*. Rev. Fac. de Agronomía. 7th Argentine Meeting and 1st Latin American Meeting of Agrometeorology, vol. 17, No.1, pp. 101-105.

Scian, B. and M, Donnari, (1997). R*etrospective analysis of the Palmer drought severity index in the semi-arid Pampas region*, Argentina. Inter. J. Climatology, vol pp. 17:313-322.

Sierra, E.M., R. Hurtado and L. Spescha, (1993). *Corrimiento de las isoyetas anuales medias decenales (1941-1990) en la región pampeana*. Rev. Facultad de Agronomía, vol. 14, No. 2, pp. 139-144.

Sierra, E.M., R. Hurtado, L. Spescha, I. Barnatan, and C. Messina, (1995). *Corrimiento de las isoyetas semestrales medias decenales (1941-1990) en la región pampeana*. Rev. Facultad de Agronomía, vol. 15, Nos. 2-3, pp.137-143.

United Nations Development Programme (UNDP) (2010). *Strengthening National Capacities for Disaster Risk Reduction and Livelihoods Recovery*. Available from http://www.et.undp.org/content/ethiopia/en/home/operations/projects/environment_and_energy/project_DRRandLivelihood.html.

Brazil

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Background

Drought in Brazil affects in particular, but not exclusively, the semi-arid Northeast, a large area of about 800,000 km^2 covering eight of the nine states, in addition to the north of Minas Gerais. Low Precipitation is not the problem, it is between 400 and 800 mm on average, but evapotranspiration is very high, between 2,000 and 3,000 mm per year. In addition, rainfall is concentrated to four months of the year only, usually January to April in the northern part of the Northeast. Intra-annual and inter-annual variability is high. Being a climatic marginal region, any small variation in quantity or distribution of rainfall causes large impacts.

Drought has always been a problem in the Northeast of Brazil, in particular after the increase in population density. For three hundred years, the Northeast was the main economic region in Brazil, based on sugarcane production in the coastal forest zone and the cattle civilization in the backlands or "sertão", the Brazilian name for the semi-arid region. The most famous drought, when viewed in terms of its devastating impacts, was a three-year drought from 1877 to 1879. This drought triggered the beginning of organized policy responses in order to reduce impacts and to provide relief for the population. In 1877, it is said that 500,000 people died of hunger and thirst, and the cattle activity was practically decimated. Recently, there were droughts in 2002, 2003, 2010, 2012 and 2013. The impacts of drought continue to be high. In 2012 and 2013, practically all rain-fed agriculture was destroyed, and a large part of the cattle stock died, transferred to other places or sold for a lower price. Water resources are mainly impacted as many rural communities and even cities lose their water sources.

Brazil has a long history of drought policies traditionally aimed at providing emergency relief, but also the so-called permanent policies that have contributed to reduce, but not eliminate, social and economic vulnerability. In particular, a large water infrastructure was created through the construction of thousands of big, medium and small dams, together with transport and urban infrastructure. More recently, social protection policies have been effective in providing income for the poor population.

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Drought monitoring and early warning systems

There is a long tradition with regard to the production and collection of data on rainfall in Brazil. There is a network of meteorological stations, which provide reliable information on precipitation. More recently, institutions like the Brazilian Institute of Meteorology (INMET), the Brazilian National Water Agency (ANA), the Centre for Weather Prediction and Climatic Studies at the National Institute of Space Research (CPTEC/INPE), the National Center for Managing Disaster Risk (CENAD), the National Centre for Monitoring and Early Warning of Natural Disasters (CEMADEN) and the Foundation of Meteorology of the State of Ceará (FUNCEME) have been involved in drought impact mitigation initiatives to enhance and improve drought monitoring and early warning systems.

For the last 20 years, there has been progress with regard to understanding the regional climate and to applying the new knowledge to predict climate and probability of a drought in the next season, with an anticipation of three months. In fact, for the last 15 years, FUNCEME, INMET and INPE/CPTEC have been organizing an annual forum for climate prediction in the Northeast. This is one region with good conditions for climate prediction, in seasonal terms, for the rainy season between January and May, in view of the Inter-tropical Convergence Zone (ITCZ), and its relationship with the Sea Surface Temperatures (SST) of the tropical Atlantic and the action of the El Niño Southern Oscillation (ENSO).

States like Ceará have pioneered in using climate information to enlighten agricultural and water policies. There is a need to strengthen coordination among the various institutions involved, at federal and state levels, and also to strengthen the network of data collection on climate and weather variables, vegetation index and water resources.

Vulnerability assessment

The Northeast of Brazil is a region that is highly vulnerable to drought. Being a climatic marginal region, it is highly impacted by any reduction in rainfall. Reductions in rainfall are frequent, with an estimated five years of precipitation below normal every 10 years. Agricultural activities developed by small family farmers in the semi-arid area are the most vulnerable. In droughts like the recent ones, in 2012 and 2013, most small farmers lost between 90 and 95 per cent of their production of beans, maize and manioc, which are the main subsistence staples. As a consequence, there is a fall in agricultural output from subsistence farmers. Social vulnerability is also high, as these farmers and rural workers who depend on their agricultural activities lose their source of income during severe drought periods. These are also the poorest, and hence the most vulnerable to

drought crises. Besides economic and social vulnerability, there is also high environmental vulnerability. Drought, together with unsustainable land use, affects land, water and biodiversity resources and leads to land degradation and desertification in several subareas in the semi-arid Northeast.

Emergency relief and drought response

There is a long tradition in Brazil with regard to emergency relief and drought response. There is a system of National Defence under the Ministry of Integration and in coordination with the states. This system is prepared to coordinate response in case of drought. The initiative to declare an emergency situation starts at the local level – the municipality, followed by the state, and is finally at the national level. This allows for emergency action to be taken. Throughout the last one hundred years and before, emergency actions have been linked to (1) provide water supply to affected populations, (2) create ways to provide and income for the rural poor, and (3) create alternatives for animal feeding. In the recent 2012-2013 drought, the federal and state governments have distributed water to rural dispersed populations, using more than 8,000 water trucks. In the year 2013, some cities have depended on emergency solutions due to the lack of water caused by the drought. With regard to income creation, the traditional way was to create jobs, including the construction and cleaning of roads and communal infrastructure, and employ the affected population in such jobs. Since 2010, however, these jobs have been substituted by social protection programmes that provide a cash transfer to each poor family, the so called "bolsa família" programme. Together with the system of rural retirement, which benefits rural workers and small farmers, these have eliminated the need for the beneficiaries to work before they get the emergency assistance packages. With regard to animal feeding, the government has also organized a system to transport maize from the large producing region of Brazil, the centre west, to the north-east, and sell it at subsidized prices to the farmers. This has reduced livestock mortality in the north-east.

Practices to alleviate drought impacts

After the drought of 1877, it became clear that it was necessary to start accumulating water in reservoirs in the semi-arid regions. The first dam, or açude, which is the name in Portuguese, was built in Ceará, the Cedro dam. In 1909, the government created an institution devoted to reducing drought impacts, the 'National Department Against Droughts' (DNOCS). The DNOCS built a large number of dams in all the states. This, together with transport infrastructure and improvement in accessibility, has reduced vulnerability with regard to water supply and has allowed the increase in population densities in semi-arid regions. After 1960, other institutions like SUDENE and BNB and the increasing partici-

pation of the state governments have contributed to reduce vulnerability through (a) reducing dependency on rain-fed agriculture, (b) enhancing infrastructure and accessibility, (c) increasing employment opportunities, (d) exploring new agricultural developments such as promoting irrigation and agro industries, and (e) promoting regional development which increases opportunities.

The need for drought management knowledge and skills

On one hand, Brazil has made much progress with regard to emergency and long-term responses to drought, while on the other hand, there is still need for much action with regard to strengthening the institutional framework, improvement of coordination among the federal institutions and between federal and state institutions, involvement of the local municipal governments and community organizations. Brazil does not have a consolidated drought policy, though there are many components of such policy that are in place that need improvement. There is a crucial need to improve and consolidate a system of monitoring and early warning. Though there are researchers involved in vulnerability and impact studies, this is an area where there is a need for better coordination and strengthening. Based on existing experience and on exchange of knowledge and information with national and international institutions and experts, there is presently an opportunity for Brazil to consolidate its drought policy and to improve drought management.

References

Magalhães, Antonio R. (1988). T*he Effects of Climatic Variations on Agriculture in Northeast Brazil. In The Impact of Climatic Variations on Agriculture*. Vol 2: Assessment in Semi-arid Regions, M. L. Parry, T.R.Carter and N.T.Konijn, eds. UNEP/IAASA, Kluwer Academic Publishers, London.

Magalhães, Antonio R and Michael H. Glantz (eds) (1992). *Socioeconomic Impacts of Climate Variations and Policy Responses in Brazi*l. UNEP/GOV. CEARÁ/ESQUEL FOUNDATION.

Magalhães, Antonio Rocha and Eduardo Savio Martins (2011). *Drought and Drought Policy in Brazil*. In Towards a Compedium on National Drought Policy: Proceedings of an Expert Meeting. Sivakumar, Mannava V.K., Raymend P. Motha, Donald A. Wilhite, and John J. Qu (eds).Washington, DC, Geneva, Switzerland.

Chile

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Background

In Chile, due to the persistence of the "La Niña" phenomenon and the blocking of frontal systems in autumn/winter, over the past 10 years water tables have tended to remain lower than normal, reflecting two periods of drought, namely 2007–2008 and 2010 to date. The 2007–2008 events affected a large share of the country, from the Atacama region to the Lakes District (Figure 1). In 2007, the average rainfall shortage nationwide was 48.6 per cent and the hardest-hit region was Atacama (90 per cent), followed by O'Higgins (40-50 per cent shortage), and lastly, Maule and Biobío (30-50 per cent shortage) (Velasco, 2008).

Figure 1:
Map of regions in Chile

The main effects have been seen in agriculture, the leading economic activity for the area, with an estimated 80,000 farmers affected (Valencia, 2011). In March 2008, a presidential decree was issued reducing voltage as a preventive measure up until October of the year 2012 (NWRS, 2012). The severe socioeconomic impact of this phenomenon has led to conflicts among water users (mines, farmers, agro industry, drinking water, energy, etc.), virtually throughout the country. The current drought began in 2010 between the regions of Atacama and Biobío and its effects can still be seen, primarily in the regions of Coquimbo and Valparaíso. Agriculture has been the hardest hit, and the drop in dam water levels led to the introduction of energy-saving measures in 2010. In February 2013, dam water levels declined by 10%, corresponding to a volume of 30.1% of total storage capacity. The current level (as of December 2013) is 16.7% below the level in December 2012 and 56.3% below the historic average.

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Vulnerability assessment

The vulnerability of economic sectors depends not only on the environmental conditions determined by the supply of resources but also on water users' ability to cope with shortages. Chile has abundant water resources compared to other countries, but this abundance is unevenly distributed throughout the country. From Santiago to the north, freshwater supply is limited (around 639 m^3/inhabitant/year), pointing to clear water stress. Notwithstanding, water demand continues to increase as a result of the national development goals set. To the south, water supply is abundant (in excess of 9,000 m^3/inhabitant/year). In connection with the above, it is precisely in the north and centre of the country that water consumption is most intense (primarily due to mining and agriculture). By way of contrast, in the south, the main concern is water contamination and the impact of large hydroelectric power stations (non-consumptive use).

Moreover, in the central northern and northern zone, water stress and watershed destruction are on the rise due to excessive demand for water, leading in many cases to watershed exhaustion and ecosystem destruction. Hydroelectric companies amass water, impacting water users downstream, whereas mining companies use large amounts of water for their activities. A lack of water in the rural agricultural sector leads to reduced yields, food shortages and desertification. In some cases, populations that traditionally had abundant water must now be supplied by means of water tank trucks, which affects their quality of life and increases health risks. This is primarily a problem in semi-concentrated rural communities where the percentage of coverage rises to 2 per cent, affecting 540 communities (195,000 inhabitants) (CONICYT, 2013).

On the basis of water use typology and in light of vulnerability to water stress, the worst-affected sectors of the economy in terms of consumptive use are, by decreasing order of importance, water companies, the agroforestry sector, industry and mining. As far as consumption is concerned, the agro forestry sector is the heaviest water user, around 70 per cent (ibid, 2013). As for non-consumptive use, the generation of hydroelectric power, environmental use (flora and wildlife conservation, natural parks) and recreation occupy the top three slots.

Relief fund for emergencies and drought response

Relief funding for drought events in Chile primarily takes the form of human drinking water supply and food aid for the hardest-hit sectors. Activities are implemented by civil defence bodies and local authorities on the basis of social vulnerability criteria. With regard to agro-livestock production, assistance provided can be broken down into two catego-

ries. The first consists of direct payments, while the second involves targeted incentives. The first category may be further subdivided into un-earmarked cash grants, vouchers for buying fodder and, to some extent, direct deliveries of feed. Targeted incentives primarily consist of loan promotion programmes geared to the improvement of property infrastructure in order to ensure better preparedness for future water shortages, for example through improvements to irrigation systems, availability of better productive inputs, soil carbon sequestration and moisture retention systems, etc.

The criteria for determining the type of aid applicable in a given case are directly related to the event's impact on production, farmers' degree of dependence on their crops (focus on subsistence agriculture and family agriculture) and the specific characteristics of the affected zone (generally rain-fed sectors devoted to livestock production). In the most critical years (2008 and 2012), some $35 million worth of aid was disbursed plus support for medium-sized and large-scale irrigation works. Resources for farmers are provided by the three main institutions connected to the Ministry of Agriculture: the Institute for Agro-livestock Development (INDAP), the Agricultural and Livestock Service (SAG) and the National Irrigation Commission (CNR). The National System for Agricultural Emergencies and Agro climatic Risk Management, which forms part of the Ministry of Agriculture, is responsible for declaring agricultural emergencies.

Drought mitigation practices

The Ministry of Agriculture introduced a National System for Agricultural Emergencies and Agro climatic Risk Management, which is designed to ensure better management of agricultural emergencies and agro climatic risks at the ministerial and property level, based on a shift from the management of emergencies to the management of agro climatic risk. This system is composed of a National Commission, 15 regional commissions and an executive body.

As far as drought is concerned, this system has led to drought management protocols, regional diagnoses of the main drought-prone zones and items, in addition to an information system which disseminates current and past conditions and the main climate forecasts and warnings as well as their possible impacts on agriculture, along with technical production-related recommendations for these climate conditions, thereby improving producers' capacities. Another key practice promoted is the use of agricultural insurance, which is available to cover certain crop failures due to lack of water in some seasons. With regard to energy, the Government of Chile has taken various steps aimed at encouraging energy efficiency and the use of alternative energies.

Need for drought management knowledge and skills

Given the complex, cross-cutting nature of drought management issues and the vast areas concerned, the rapid growth of productive activities, the need to optimize drought risk policies and management as well as the climate change scenario, it would be useful for Chile to develop capacities involving the following:

- Development and implementation of integrated water resource management, with a view to maximizing economic results and well-being evenly without jeopardizing the sustainability of vital ecosystems;
- Techniques for providing information on the magnitude, consequences and impact of water shortages, with a view to building awareness among the actors concerned;
- Monitoring and exploitation of satellite data for the generation of maps and indices on current water status and preparation of future scenarios, as tools for supporting water-dependent productive sectors;
- Local capacity-building in the field of climate change adaptation and drought risk management;
- Training in adaptive water resource management by means of the incorporation of hydrological, climatic, social and economic development analyses with a view to generating and/or promoting the coordination needed to develop projects involving multidisciplinary proposals.

References

CONICYT (2013). *Data on water consumption in Chile*. Explora Conicyt Programme, Available from: http://graficas.explora.cl/otros/agua/consumo2.html.

Chilean National Water Resource Strategy 2012 – 2025.

Meza L, S. Corso and S. Soza (2010). *Gestión del riesgo de sequía y otros eventos climáticos extremos en Chile*. FAO. ISBN 978-92-5-306491-5, Available from: www.fao.cl/pubs/pdf/climachl.pdf

Valencia R. (2011). *El racionamiento eléctrico como generador de costos políticos*. La Nación, 10 February 2011.

Velasco J. (2008). *Sequía en Chile: Cómo usar mejor el agua*. Available from: www.redagricola.com

Costa Rica

Bernal Soto[1]

Background

Drought affects almost all climatic regions. It is generally associated with the world's dry lands, however drought occurs in all climates. Drought is considered a natural disaster, which is due to a deficiency of precipitation over an extended period. Drought results in a shortage of water for the development of such economic activities as agriculture, cattle breeding, industry, recreation and tourism. Various definitions have been established depending on different viewpoints. Meteorological drought occurs during a period of time when the rainfall recorded is less than the average. Hydrological drought occurs over a period of time when both surface runoff and subsurface groundwater flow are below average. Agricultural drought occurs over a period of time when there is insufficient moisture in the soil for crop growing.

In Costa Rica, the highest risk zones for extremely dry events run from the northern Pacific and the northern zone to Lake Nicaragua. They range through the Pacific coastal region down to the south and in the central region. These areas feature some high vulnerability patterns. In particular, the dry conditions in the Pacific coastal region in Costa Rica are associated with El Niño. On average, 90 per cent of all cases of meteorological drought can be explained by the presence of the El Niño phenomenon, especially in Guanacaste, the region hardest hit by El Niño-related drought.

Vulnerability assessment

For the Intergovernmental Panel on Climate Change (IPCC 2007), vulnerability is defined as, " the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes." As far as Costa Rica is concerned, in terms of extremely dry scenarios (IMN, 2011), Guanacaste and Puntarenas provinces are the most drought risk areas, while Heredia features the lowest risk due to its low vulnerability. At the level of the cantons and in accordance with vulnerability patterns, it is possible to distinguish three major zones at high or medium risk of extremely dry events.

High-risk Zone 1 takes in the cantons of La Cruz of the northern Pacific region, Upala, Los Chiles and Guatuso of the northern region, Parrita and Turrubares up to the central Pacific

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region and Buenos Aires and Pérez Zeledón in the southern region. It is characterized by low levels of human development, widespread poverty and a lack of decent housing with access to electricity and piped drinking water. Its cantons show a lower index of gender equality, linked to its conditions of vulnerability. Droughts have been the most frequent in the northern region over the past decade. High-risk Zone 2 covers the cantons of the country's central region: Mora, San José, Desamparados, Alajuelita, Cartago and the central canton of Puntarenas. It is characterized by low levels of primary health care in relation to population density and low water availability per person. Clearly, these problems are related to the concentration of the population in these cantons. Droughts which occur in this zone are intense, widespread and frequent. High-risk Zone 3 is located, geographically speaking, in the northern Pacific region of Costa Rica. It encompasses all the cantons of Guanacaste province apart from La Cruz. The major vulnerability problems vary, with no pattern set, even though the majority can be traced to infrastructural shortcomings and poor living conditions. Droughts which occur in this zone are the most intense and the most frequent.

Table 1 shows the characteristics of extremely dry events in the climate regions of Costa Rica, for the period of 1960 – 2009. As can be seen, the northern Pacific is the region where extremely dry events are the most frequent, the most widespread and the most intense.

Table 1: Characteristics of extremely dry events in the climate regions of Costa Rica

REGION	INTENSITY CRITERION (%)*	RELATIVE COVERAGE CRITERION (%)**	FREQUENCY OF EVENT (YEARS)
PACIFICO NORTE	20	83	7.3
PACIFICO CENTRAL	18	91	8.6
PACIFICO SUR	18	86	8.8
REGIÓN CENTRAL	15	95	7.5
ZONA NORTE	17	66	7.8
CARIBE NORTE	17	83	8.2
CARIBE SUR	17	83	8.4

*The limit below which the observer deficit is considered to be an extreme dry event.

**The percentage of relative coverage for which the extreme event is significantly prevalent in the region. The coverage is determined by the number of weather stations used. For example, if 10 stations were used to study the North Pacific in a dry year, and the 10 stations showed a deficit above the criterion value (20%), this would mean that the relative coverage of the drought in that particular year was 100%.

Source: National Meteorological Institute. Costa Rica, 2013

Recent publications back the positions taken by the National Meteorological Institute: In the region of Chorotega (Central America Data, 2012), around 1,200 hectares of rice have been lost and some 5,000 hectares of sugar cane have been affected along with large areas of grazing land. In the same region, drought also affected some 2,000 hectares of corn, 122 hectares of watermelon and smaller areas of sweet peppers, tomatoes, beans and papaya. Losses amount to USD 6 million for this Pacific region alone.

Other sources note that various communities of the canton of "Nicoya" and "Guanacaste" will have to depend on water rationing, as winter 2013 left a 25 per cent water gap, according to data provided by the Aqueduct and Sewer Authority (AyA), with farmers and cattle breeders being the hardest hit. Farmers such as Ángel Mena, from Nicoya, have noted that rice and bean crops were affected, with crops being lost due to a lack of rain, exacerbated by further problems such as a shortage of drinking water due to low water levels in the wells.

The Ministry of Agriculture and Livestock (MAG) has already issued a warning for Guanacaste due to the foreseeable impact of El Niño over 2014 and 2015: that is, a sharp contraction in the agro-livestock sector. El Niño was responsible for a drop in rainfall of up to 60 per cent in 2013. In 2013 (Espejo, 2013) Tania López Lee, Deputy Minister of MAG, explained that "ever since we first started to become worried because of the 'heat waves' in June 2012, we started monitoring the situation, and then declared an "El Niño" year. As a result, we have been providing assistance and briefing producers so that they can prepare, for example, by means of hay bales, silage and water-saving measures". A third publication (IMN, 2013) notes that accumulated losses in Costa Rica for 2005-2011 caused by adverse climatic events totalled $ 710 million, according to Roberto Flores, the coordinator of the economic impact study of hydro meteorological phenomena in Costa Rica." Accumulated infrastructural losses were close to USD 367 million for the period studied. The bulk occurred in Puntarenas, Guanacaste, Limón and San José", he added. As for the agro-livestock sector, he noted that drought had been responsible for losses of $168 million over the past 20 years.

But the impact of climate change does not stop there. According to Alvaro Umaña, consultant and former Minister of the Environment and Energy (Espejo, 2013), the climate variable impacts construction costs and the operation of hydroelectric plants. "In particular, a scarcity of rainfall has led to a need for more thermal power generation, which is more costly", he explained. Precisely, the water and energy sectors are two of the priorities of the national climate change plan. The other three priorities are the transport, housing and agricultural sectors, stated William Alpízar, MINAE Director for Climate Change.

Relief fund for emergencies and drought response

The FAO (2014) has noted that emergency response may be described as a sequence of events, sometimes called a disaster cycle, which may be broken down into eight different phases, each of which requires different measures. The phases are as follows:

- Prevention;
- Preparedness;
- Warning;
- Assessment of impact and immediate post-disaster needs;
- Relief, when immediate humanitarian assistance is required;
- Rehabilitation, when the first attempts are made to restore the rural population's subsistence system;
- Reconstruction, when destroyed infrastructure is replaced; and
- Sustainable recovery, when conditions return to normal.

FAO participates in all of these phases, together with its internal and external partners and national authorities. Mindful of the high cost of emergency operations, FAO constantly strives to prevent disaster-related emergencies. However, when they do occur, it attempts to mitigate their impact and accelerate the recovery process, which culminates in sustainable agricultural development. One of the conclusions of the recent Workshop on drought in Mexico, Central America and the Caribbean (Espejo, 2013) was that, "on other occasions, drought aid provided by such multilateral bodies as FAO or IMF acts as a disincentive for governments to adopt a structural approach to the drought issue". As far as Costa Rica is concerned, the usual practice is to issue an emergency decree (2008), as was the case with the DATE drought in northern Costa Rica, in an area bordering on Nicaragua, which led to crop and livestock loss as well as drinking water problems. In this case, the decree in 2008 was signed by the Minister of the Presidency, Rodrigo Arias, and by the Minister of Agriculture and Livestock, Javier Flores, during a visit to the zone, which, since last December (DATE) has been hit by a shortage of rainfall; the impact of which has not been officially quantified. The publication explains that the decree will allow the immediate disbursement of 150 million colons to help the worst affected agricultural and livestock communities and areas. In addition, the government is hoping that with the decree, there will be an additional 550 million colons in the immediate future to complete the recovery process in agricultural areas, protect livestock and meet drinking water needs.

To sum up, in Costa Rica, drought response and emergency relief funds are activated and channelled through the National Commission for Risk Prevention and Emergency Response (CNE), once an emergency decree has been issued.

Drought mitigation practices

In the case of Costa Rica, the key to drought mitigation practices is understanding the patterns of how El Niño impacts countries (IMN, 2011). These include:

- Drop in the amount of rainfall;
- Uneven distribution throughout the year;
- Increase in the number of dry days;
- Longer dry spells;
- Longer dry season;
- Shorter rainy season; and
- Temperature rise

Likewise, it is essential to view drought as a risk:

- It is a normal climate characteristic;
- It occurs in all types of climates;
- Its characteristics vary from one region to another; and;
- Definitions must be region- and sector-specific

Drought impacts provide a good yardstick for measuring its severity and reflect a society's vulnerability or resilience.

In this respect, some of the conclusions of the recent Workshop on drought in Mexico, Central America and the Caribbean (2013) were as follows:

- The drought assessment index which is the most widely used by all the hydro meteorological services in the area is the Standardized Precipitation Index (SPI). This yardstick is generally used in conjunction with other aspects, such as drought extent or magnitude.
- Irrigation or drainage systems offer a very effective means of mitigating the effects of drought and climate variability but tend to be in the hands of large-scale commercial farmers, which exclude small-scale growers. Irrigation systems enhance water security and facilitate adaptation to drought and the effects of climate change.
- Good examples of the linkage between drought monitoring and political decision-making exist in the region:
    - The North American Drought Monitor (NADM), which is operated jointly by Canada, the United States and Mexico, and all of the related policy measures to ensure that this monitoring leads to adaptation action;
    - The regional strategy for reducing food and nutritional insecurity, taken

on board by the Central American Integration System (SICA). The Regional Water Resources Committee (CRRH) provides decision-making information through such initiatives as the Climate Forum (seasonal forecasts), operated by the seven meteorological services of the countries forming the Central American peninsula;

- During drought episodes, disaster mitigation institutions host frequent meetings in all of the countries in the area between the technical and scientific bodies which issue warnings and decision makers.

Need for drought management knowledge and skills

Dr. Donald A. Wilhite from the School of Natural Resources, University of Nebraska-Lincoln has noted that "there is a need to break the hydro-illogical cycle – the main challenge in terms of drought management" (www.ais.unwater.org/droughtmanagement). He has further noted the following points related to crisis management:

- If we keep on doing what we have always done, we will get the same results we have always got.
- We need to adopt a new drought management paradigm.

In this respect, some of the general conclusions from the recent workshop on drought in Mexico, Central America and the Caribbean are timely:

Activity 1: Visibility and regional integration of activities related to drought monitoring, follow-up and prediction.

- Increase the visibility of regional activities relating to drought monitoring, follow up and prediction.
- Explore possibilities for regional integration in pilot projects of the Global Framework for Climate Services and/or as an IDMP regional project in Mexico, Central America and the Caribbean.
- Strengthen existing ties between the Convention on desertification and drought mitigation and the NMHSs.

Activity 2: Drought identification and characterization in Mexico, Central America and the Caribbean. The aim of this activity is to generate a criterion and a methodology to define drought in this region insofar as it features heterogeneous characteristics, within a training framework. The idea is to establish methodologies and protocols developed for and suited to the region in terms of water risk and drought management.

- Review systems for assessing drought indices (SPI) together with the Caribbean Institute for Meteorology and Hydrology (CIMH).
- Build capacity for applying and interpreting different drought indices in the area.
- Develop pilot activities with users (sectoral meetings) to identify critical values for drought indices in the different sectors (define thresholds). Better drought characterization would make it possible to improve early warning systems.
- Strengthen, between services, interdisciplinary work between meteorologists and hydrologists, agricultural experts, etc.
- Set up and run a discussion forum on drought issues and the implementation status of actions and measures.

References

Central America Data (2012). C*osta Rica: Pérdidas en el agro por $6,25 millones*. Nacion.com, 12 abril 2010. Available from: http://www.centralamericadata.com/es/article/home/Costa_Rica_Perdidas_en_el_agro_por_625_millones

Food and Agriculture Organization (FAO) (n.d.) *FAO brief for emergencies*. Available from: http://www.fao.org/docrep/w6020s/w6021s04.htm

Gil, Francisco Espejo (2013). *Drought risk management in a changing climate*. Workshop on drought in Mexico, Central America and the Caribbean, Antigua (Guatemala), November,.State Meteorological Agency.

Instituto Meteorologico Naiconal (IMN) (2011). *Analysis of current water-related risk in Costa Rica due to climate change, with a view to promoting human development*. Department of Climatology and Applied Research / National Meteorological Institute.

Instituto Meteorologico Nacional (IMN) (2013). *A possible future climate risk scenario based on the current climate during the extreme phases of the ENOS phenomenon.* Workshop on drought in Mexico, Central America and the Caribbean, held in Antigua (Guatemala) in November.

Cuba

Cecilia M. Fonseca Rivera[1]

Background

In recent years, the number of drought episodes in Cuba has increased, impacting agro-livestock production and soil conservation efforts, as reflected by clear signs of salinization and desertification in coastal and semi-arid areas. Intense droughts occurred during the summers of 1993, 1994, 1998 and 2000, with a series of droughts from April to July 1998 viewed as the most severe since 1941 (Lapinel et al., 2003). More recently, in the first decade of this century, Cuba was hit by intense, widespread droughts in 2004 and 2005 (Lapinel et al., 2006). These are considered to be the most critical drought events over the past century of documented history in Cuba and caused damage resulting in losses of more than a billion pesos ($USD 37 million). Likewise, the severe series of droughts during 2009-2010 in the western half of the country were considered as the most severe ever recorded in this region (Lapinel et al., 2013). Both events hit the population hard, causing considerable economic loss and environmental damage.

It is a well-known fact that drought occurrences alternate with other extreme events such as tropical cyclones. For example, in 2006, 2007 and 2008, there was considerable cyclonic activity in the region, boosted directly or indirectly by the increases in total annual rainfall in Cuba (Lapinel et al., 2007 a, b). For example, the effects of Hurricane Gustav reduced the impact of the drought which occurred in 2008. Subsequently, however, a new drought event occurred in 2009-2010 which affected the entire Caribbean region and hit Cuba hard, where water shortages were characterized as severe. All of these elements underscore the need to pay close attention to repeated harmful drought occurrences which, combined with high rates of evaporation, lead to soil exhaustion and a drop in underground water reserves.

Vulnerability assessment

Like other countries in the region, Cuba is vulnerable to extreme climatic abnormalities, depending on the exposed elements and the magnitude of the impacts involved. In this regard, efforts have been made to build capacity and develop the necessary resources to mitigate adverse climate effects, engage in social and economic restructuring, learn from experience and adapt – in short, to develop resilience to climate variability and change.

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Notwithstanding, when such harmful events as droughts occur, the population in general and the agro-livestock sector in particular are the most vulnerable sectors. Due to the water shortages caused by the exhaustion of water points and wells, people are obliged to secure water by different means, which creates enormous problems and unforeseen expenditure. When inevitable crop loss threatens the agricultural sector; it is not possible for famers to plant as planned, creating major operational problems which persist even after drought ends.

The impacts on agriculture and water resources also have negative consequences for society as a whole, particularly with regard to human health, which is severely affected by a lack of water and by the alternation of periods of heavy rainfall, generally linked to the appearance of epidemic diseases. Fighting such epidemics entails considerable costs as regards the maintenance of adequate health standards. Another sector often affected by drought is the environment. As Cuba is an island, the coastal zone is a key part of the system as a whole. By reducing the flow of fresh water to the coast, droughts affect land and marine biodiversity in zones bordering on the coast, generating negative impacts, which extend from the environmental sphere to the economic and social dimensions.

Relief fund for emergencies and drought response

Since the beginning of its revolution, Cuba has had to cope with the effects of such undesirable events as droughts. As part of a painstaking, complex nationwide effort, it has implemented major, systematic steps to ensure sound drought management, which have helped to gradually reduce drought risks. In the early 1960s, a major effort was made with the Voluntad Hidráulica (Hydraulic Will) Policy. Later, in the 1990s, the UNCCD Action Programme was implemented systematically on the basis of networking.

The point should be made that the management of disaster risk reduction is a state obligation for state organs and bodies, economic entities and social institutions, with input from officials in the provincial and municipal departments and delegations, among others. In the event of an emergency caused by the effects of intense droughts, like the ones which have occurred in recent years, the National Defence Council is responsible for developing comprehensive strategies for drought response and national recovery at the headquarters of the National Defence Council, which is hosted by the National Civil Defence (EMNDC). In agreement with the Centre, EMNDC, together with the territorial civil defence bodies, is responsible, once damages and losses have been evaluated, for overseeing the use and allocation of the resources earmarked for disaster reduction,

including the sums budgeted annually for vulnerability reduction as part of the Socio-economic Plan and the State Budget. These amounts are calculated via the process of harmonization and the inclusion of international development aid projects (Directive 1, 2010 EMNDC).

The material and financial resources required for disaster reduction are determined in accordance with the procedures laid down by the Ministry of the Economy and Planning and by the Ministry of Finance and Prices (Directive 1, 2010 EMNDC). Resource allocation depends on the magnitude of the event and the population affected, as a crucial component of the civil defence system.

Drought mitigation practices

The severe, widespread droughts which have hit Cuba in recent decades have affected all spheres of social and economic life as well as the environment. This is why, in accordance with the means recommended by WMO to deal with drought events in the country, Cuba has first of all developed an Integrated Drought Monitoring and Early Warning System. This mechanism, which features meticulous monitoring of drought events, their characteristics and possible development, makes it possible to prepare and improve long-term strategies for facilitating drought monitoring and achieving sustainable management of natural resources, via the inclusion of plans for the adoption of emergency measures at the local, national, sub-regional and regional levels.

The establishment of the Hazard, Vulnerability and Risk Group (GPVR) and the creation of the Centres for Risk Reduction Management (CGRR), with the help of national experts and scientific institutions, together with the National Chiefs of Staff of Civil Defence, provide examples of steps taken to facilitate risk reduction management in Cuba. After developing the appropriate methodologies, the GPVR implements the determination of drought risk reduction as one of the pillars of disaster reduction efforts at all levels. Efforts are currently underway to conduct hazards studies for all of the country's municipalities and to identify vulnerabilities in order to evaluate risks. The National Chiefs of Staff of Civil Defence oversee the reduction of vulnerabilities via the systematic compilation of the findings of hazard, vulnerability and risk reduction studies; facilitate the organization and execution of disaster management measures; and increase public awareness of risks and document risks nationwide. Their organizational structure, functioning and equipment are decided in accordance with the methodology prepared by EMNDC.

Need for drought management knowledge and skills

Cuba has human resources trained in drought management practices. Specialists from the various institutions responsible for water, the Ministry of Science, Technology and the Environment, and the Ministry of Agriculture, among many others, pay close attention to drought-related issues. However, the main gap is a lack of financial resources to meet all of the technological, scientific and operational requirements of an undertaking of this nature and scope. The second shortcoming, which is just as critical, is the need for better, more effective integration of all sectors and stakeholders concerned by drought-related issues, by means of rapid, widespread display of early warnings for drought hazards, as well as the correct evaluation of potential risks and timely response backed by studies conducted by specialized groups on the different types of drought throughout the country. All of these activities, which are to be implemented on the basis of a comprehensive vision combined with greater availability of financial resources, would no doubt be strengthened by the adoption of national guidelines based on international experience gleaned from the conclusions of the High Level Meeting on National Drought Policy (HMNDP).

References

Centella, A., C. Fonseca, V. Cutié and R. Báez (2006). *Predicción a largo plazo de la sequía agrícola y evaluación científica de los riesgos asociados a la ocurrencia de la sequía meteorológica y agrícola en Cuba*. PRCT 4072: Análisis y Pronostico del tiempo y el clima y sus implicaciones socio económicas (Analysis and forecasting of the weather and climate and their socioeconomic ramifications). Parte I: Sequía Meteorológica (Part I: Meteorological drought). 100 pp

Centella A., C. Fonseca, V. Cutié, and I. González (2006). *Causas de la reciente sequía acaecida en la Región Oriental de Cuba*. Climate Variability and Change- Hydrological Impacts (proceedings of the Fifth FRIEND World Conference held at Havana, Cuba, November,. IAHS Publication 308 ISSN 0144-7815.

Centella, A., C. Fonseca, V. Cutié and R. Báez (2007). *Monografía de la Sequía en Cuba*. Componente Meteorológico. Project No. 4072 Programa Ramal de Ciencia y Técnica (Programme science and technology branch): Análisis y pronóstico del tiempo y el clima terrestre y espacial (Analysis and forecasting of the weather and land and space climate), Meteorological Institute, Havana, Cuba.

Fonseca, C., V. Cutié, D. Pérez, R. Aroche, R. Báez, R. Rivero, I. Rivero and R. Pérez (2003). *La sequía en Cuba. Monografía*. Climate Center, Meteorological Institute, Havana, Cuba, pp. 243

Fonseca, C., V. Cutié and Dagne Boudet (2007). *Movimientos troposféricos verticales sobre Cuba y sus características en condiciones de lluvias medias y extremas durante el período estacional lluvioso*. Climate Center, Meteorological Institute, Ministry of Science, Technology and the Environment, Havana, Cuba. CP: 11 700

Lapinel B., R. Rivero, V. Cutié, R. Rivero, N. Varela and M. Sardiñas (1993-2013). *Sistema para la vigilancia de la sequía. Análisis para el período 1931-1990*. Report of the Camagüey Scientific and Technical Territorial Office.

Honduras

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Background

In Honduras, 137 of the country's 298 municipalities have been classified as drought-prone under the National Action Plan for Desertification and Drought Control (PAN-LCD), the relevant technical and strategic instrument developed in 2005. Nationwide consultations point to increasingly rapid land degradation, which in turn accelerates desertification. This is due to the impact of natural resource extraction in addition to the forestry, agricultural and livestock industry, where unsustainable practices have contributed to land degradation. Nationwide surveys have revealed that, for years where the ENSO phenomenon is present, as evaluated through the Drought Severity Index (ISS), the country has a high average number of intense droughts (see Figure 1) and very severe maximum dry events in certain regions.

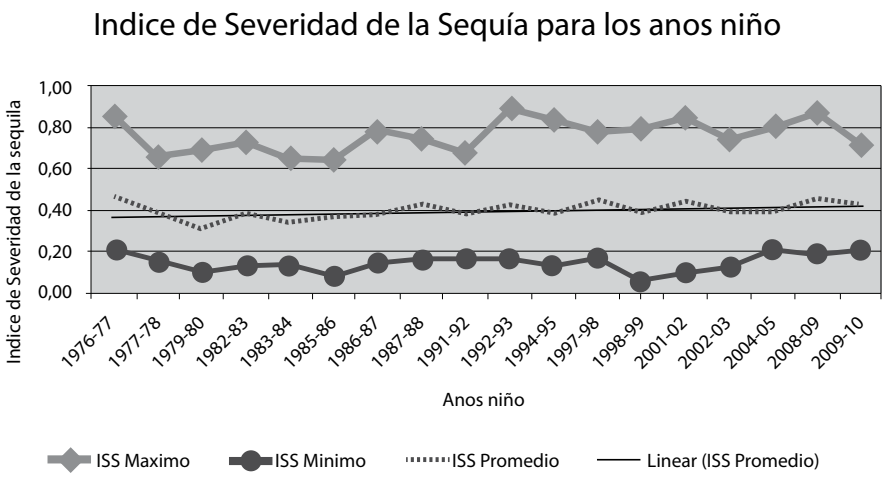

Figure 1: Drought severity index in Honduras

Source: Drought severity study, Peña (2012)

Desertification poses a very real threat to people who live on land that was originally dry forest (for example, Choluteca, Valle, southern el Paraíso, etc.) and who soon notice that meteorological conditions aggravate desertification, drought and food in-

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[3]National Weather Service
[4]Ministry of Environment, Water Direction

security. Honduras is affected by this environmental problem in an area vulnerable to prolonged heat waves located in the departments of Choluteca, Valle, La Paz, El Paraíso, Francisco Morazán, Intibucá, Lempira, Comayagua, Santa Bárbara, Yoro and Olancho. This area coincides with the sites where agricultural drought emergencies have been declared. However, there is little real awareness of the problem's impact, and the limited data on overall drought losses in ENSO years indicate an amount in the neighbourhood of about $25.9 million for fisheries and agriculture (IHCIT, 2010).

Table 1: Estimate of drought losses for 1997 - 2009

SECTOR	TIPO DE PERDIDA	AÑO NINO					TOTALES
		97-98	2002-2003	2004-2005	2006-2007	2008-2009	
PERCUARIO	Lempiras	-214,718,257.74	-763,238,866.95	-19,655,492.00	-413,112,278.02	***	-1,410,724,895.10
	Dólares	-11,348,745.12	-40,340,320.66	-1,038,873.78	-21,834,687.00	***	-74,562,626.59
AGRICULTURA	Quintales	-1,392,245.15	72,403,772.635	-2,780,034.68	-40,770,017.89	-34,826.22	
	Lempiras	-24,630,773.32	7,708,306,803.89	-2,317,116,422.41	-198,886,684.53	-16,134,595.40	-3,486,675,279.56
	Dólares	-1,301,837.91	-37,436,934.67	-122,469,155.52	-10,511,981.21	-852,779.88	-184,285,162.77
NO. DE ATENCIONES MEDICAS		*	37,781.40	14,186.40	**	**	51,967.80
PÉRDIDAS TOTALES EN LEMPIRAS							-4,897,400,174.66
PÉRDIDAS TOTALES EN DÓLARES							-258,847,789.36

Source: prepared using data from the national disaster and loss inventory database – UNAH

Vulnerability assessment

Table 2 shows the impact of droughts for the period 1970-2010 for the different sectors according to the "Desinventar" database, as follows:

Table 2: Impact of droughts for the period 1970-2010

SECTOR	IMPACTO
Social (Damnificados)	503,801 damnificados
Transporte (vias afectadas)	300 metros de vias afectadas
Cultivos y bosques (hectáres afectadas)	402,916.7 hectáreas afectadas
Salud	6 epidemias y plagas

Source: prepared using data from the national disaster and loss inventory database – UNAH "DesInventar" disaster inventory system. http://www.desinventar.org/es/

Although databases show many more epidemics generated by other causes, the data for Table 2 seem a bit insufficient, despite the difficulty of compiling and systematically recording information on the impact of droughts. It should be noted that the vast majority of those affected suffered damage to their health, indicating that agriculture and health have been the hardest-hit sectors nationwide.

- The inventory shows 532 drought events which caused natural disasters in different parts of the country, and reveals that droughts were generated by various causes.
- The area with the greatest drought losses over time is the so-called "dry corridor" in the south of the country and part of the west, for which data are available from 1915 to 2011
- The impact of droughts has increased in recent years, above all in terms of loss of crop and livestock loss (IHCIT, 2013).

As can be seen from Figure 2, 19 per cent of the territory is affected by water shortage, 5 per cent has an overabundance of water, and 76 per cent of the territory features an average.

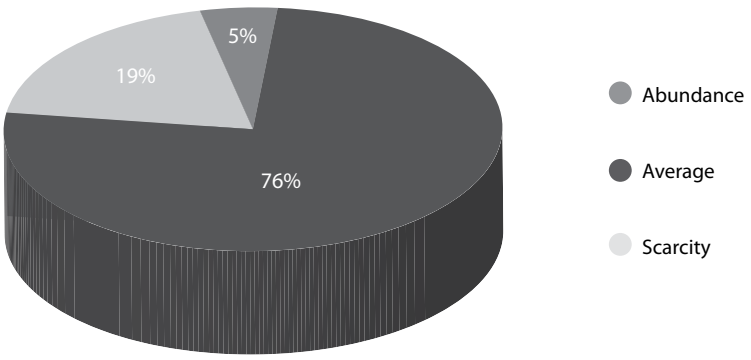

Figure 2: Water availability in Honduras (in percentage of territory)

Source: UNAH-IHCIT (2012)

The areas suffering from water shortages are in the centre, south and north-west. The areas with abundant water are in the north centre, north-east and part of the centre/north-west.

Various studies underscore the country's vulnerability:

1. The National Action Plan for Desertification and Drought Control (PAN-LCD)

As per the PAN-LCD, in Honduras 137 high-priority municipalities located in the departments of Choluteca, El Paraíso, Valle, La Paz and the south of Francisco Morazán have been officially classified as part of the "dry corridor".

2. Atlas of Arid Zones in Latin America and the Caribbean

The Atlas of Arid Zones in Latin America and the Caribbean (ALC) presents the findings of this regional initiative, whereby some 26 countries in the area worked together to map arid, semi-arid and humid zones in Latin America and the Caribbean.

Figure 4 shows the preliminary analysis for Honduras for the year 2006, with input from SERNA and international experts.

3. Profile of the Central American "Dry Corridor"

The Food and Agriculture Organization of the United Nations (FAO), with the financial support of the European Commission's Office for Humanitarian Aid and Civil Protection (ECHO), has established that drought has a potentially severe impact on 33 municipalities in 3.9% of the national territory. In 54.3% of the country, drought is severe, affecting 103 municipalities. In the other 76 municipalities accounting for 41.7% of the territory, the impact of drought is low.

4. IHCIT-UNAH 2012 drought survey

This survey shows that economic development is primarily regional in nature and that per capita economic growth and technological change are fragmented and slower than in other fields. As can be seen from the map, the areas affected by water shortages are growing.

Relief fund for emergencies and drought response

Honduras has no consolidated relief fund for emergency drought events, which makes it difficult to report on costs incurred and drought response. However, there are institutions like COPECO (the Standing Contingency Committee), which responds to emergencies. Moreover, in severe cases a presidential decree may be issued, and other bodies such as FAO work to support all institutions which join forces in specific circumstances to cope with situations declared as drought emergencies which are generally characterized by widespread crop and livestock loss. In addition, initiatives such as the World Food Programme (WFP) support vulnerable groups through food-for-work programmes and take emergency response measures, which are implemented through various cooperation

projects and programmes hosted by various national institutions. In conclusion, there are isolated emergency response measures in this field that must be consolidated through an emergency relief fund featuring a compensation system as well as strategic guidelines and actions that not only focus on contingency schemes but also offer prevention plans.

Drought mitigation practices

Various steps have been taken nationwide by national institutions, external development cooperation bodies and NGOs, which are directly or indirectly related to drought mitigation: Irrigation supply for Microsystems covering an area of 400-800 m^2, to benefit vulnerable groups in drought-stricken areas. These include:

- Construction and operation of micro-irrigation systems (400-800 square meters) via the harvesting of rainwater and runoff. Strategic partnerships have been established with NGOs operating in the affected areas.
- Partnerships with the World Food Programme to mitigate crop loss.
- Re-introduction of native seeds, which adapt better to drought events because they are from the same ecosystem.
- Existence of seed distribution programmes.
- Mulching management practices.

Furthermore, in its fifth country report to UNCCD, the country reported on various good practices: 1) the decision not to burn mulching material; 2) the building of dead barriers made of stone; 3) rainwater harvesting; 4) worm-breeding; 5) creating dead barriers made of mulch; 6) ensuring zero tillage; 7) creating wooden stake dams; 8) implementing the Quesungual agro forestry system; 9) ensuring the use of green manures for crop rotation; and 10) utilizing model processes for implementing WatSan projects, payments for environmental services and cisterns for rainwater collection (for more information please see http://www.unccd-prais.com/).The Secretariat for Agriculture and Livestock publishes a quarterly newsletter which contains forecasts and tips to help growers decide which crops to plant and which steps to take. It is also working to produce nationwide surveys for the identification of the most drought-prone areas.

In general, the topic of good practices is covered by various institutions and projects, such as the Climate Change Adaptation Fund and local initiatives in the individual municipalities implemented by NGO and governmental institutions which are present in some of the municipalities.

Need for drought management knowledge and skills

Some of the capacity gaps are as follows:

- Lack of institutional coordination between expert bodies and related institutions;
- Inefficient information flow: no efforts are made to predict the magnitude and relevant of particulars of events, thereby aggravating drought-related problems;
- Insufficient funding, especially for drought prevention efforts;
- Lack of a system for compiling the information generated countrywide;
- Limited implementation of "learning farms";
- Lack of a programme for the exchange of experience making it possible to disseminate good practices and thereby help with decision-making.

As for the level of knowledge and skills, there is an urgent need for the following:

- Training in water resource optimization and soil moisture retention in conditions of limited rainwater;
- Effective operation of a national training centre for agricultural development. The centre could be geared more to informal producers and training, given that the academy is already doing a good job on a more formal level;
- The re-introduction of agricultural extension workers, making it possible to advise growers and assist them with their productive activities. No one is performing such activities at present, although the public would no doubt welcome them;
- Community-level mobilization, consolidation, training and awareness-building;
- Specialized drought-related study programmes for technical and scientific experts (there are no specialists in the country).

References

FAO (2011). *Estudio de Caracterización del "Corredor Seco" Centroamericano*. FAO, Rome

Secretaría de Recursos Naturales y Ambiente (SERNA) (Secretariat for Natural Resources and the Environment). 2005. *National Action Plan for Desertification and Drought Control.* 71pp.

Secretaría de Recursos Naturales y Ambiente (SERNA) (2013). *Reporte de Buenas prácticas en Manejo Sostenible de Tierras* Available from: http://www.unccd- prais.com/.

Sistema de Inventario de Desastres (DesInventar) (2010). *Inventory of disasters and losses in Honduras*. Available from: http://online.desinventar.org/. Accessed on date

UNESCO (2010). Atlas de Zonas Áridas de América Latina y el Caribe (ALC). *Programa Hidrológico Internacional de la UNESCO para América Latina y el Caribe*. Documento Técnico 25. Montevideo.

Universidad Autónoma de Honduras. Instituto Hondureño de Ciencias de la Tierra (UNAH-IHCIT) (2010). *Perdidas por sequía en Honduras durante el periodo de 1997 al 2010*. UNAH-IHCIT, p. 24.

Universidad Autónoma de Honduras. I*nstituto Hondureño de Ciencias de la Tierra* (UNAH-IHCIT) (2012). Atlas Climático de Honduras UNAH-IHCIT.

Jamaica

Lenworth Fulton[1]

Background

Jamaica lies within the Atlantic hurricane belt (and straddles a geological fault line in the Greater Antilles. The island experiences a bimodal rainfall pattern with distinct dry and rainy periods; with the southern coast experiencing much less annual rainfall levels than the rain shadowed north. This factor heavily influences the risk of the listed hydro-meteorological and associated disasters for the island. Over the past two decades, the frequency and intensity of natural disasters including drought directly affecting Jamaica have risen significantly. While drought affects wide section of population resulting in frequent restrictions in water supply of for domestic and agricultural uses, agriculture is universally accepted as the most affected of economic endeavours. Jamaica's agricultural systems are largely rain-fed, resulting in susceptibility to variations in rainfall patterns. Vulnerability of the agriculture sector to drought coincides with periods of low rainfall, which occur between the bimodal peaks of the rainfall (Figure 1).

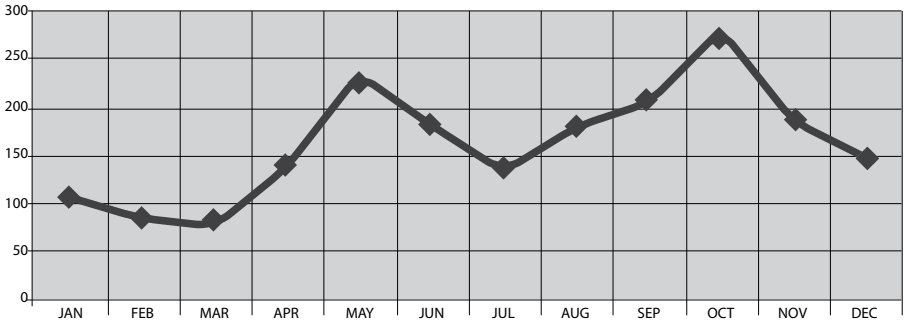

Figure 1: Jamaica: 30-year mean rainfall 1951-1980 (mm)

Source: Meteorological Services of Jamaica, 2009 (250 Stations)

Jamaica's bimodal rainfall pattern consists of two peak periods with higher values of rainfall and corresponding periods of lower rainfall amounts. The primary peak occurs in October and the secondary in May. The lowest amounts are at a minimum during the period February to March and the month of July. A comparison of the 30-year mean from 1951 to 1980 with the 1971 to 2000 mean by the Meteorological Service has shown that the island's rainfall patterns and values have not changed. However, the main changes

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noted are that of wetter dry periods and drier wet periods. The drought conditions affecting several of the productive agricultural zones has severely restricted domestic crop establishment, as well as yields in some areas.

At present, the most severely impacted by drought parishes are: St. Thomas, St. Andrew, St. Catherine, Clarendon, Manchester, St. Elizabeth, Westmoreland and sections of St Ann. From its data-gathering in the field, the Rural Agricultural Development Authority (RADA) reports that there are approximately 4.6 thousand hectares currently under production in these parishes. Of this amount, 1.6 thousand hectares are being adversely affected by the prevailing drought. However, with the sparse levels of rainfall, the percentage reduction in crop yields currently ranges from as low as two per cent to as high as 70 per cent (Table 1). This stark variation in yields is to be attributed to the varying types of crops grown in the different parishes and their respective responses to the sustained lack of adequate water.

Table 1: Effect of drought conditions on agricultural production in Jamaica (2013)

PARISH	ESTIMATED HA. UNDER PRODUCTION	ESTIMATED HA. AFFECTED BY DROUGHT	EXPECTED YIELD (t)	RANGE REDUCTION IN CROP YIELD
St. Thomas	271.2	37.0	652.8	11-28%
St. Andrew	246.6	30.1	379.18	2-51%
St. Ann	370.4	130.3	1,452.0	25-50%
St. Catherine	301.3	159.4	1,709.0	18-50%
Clarendon	607.7	160.4	2,656.74	10-30%
Manchester	1,126.3	282.2	4,080.4	25-70%
St. Elizabeth	1,328.3	789.3	9,644.1	29-40%
Westmoreland	312.4	17.5	189.2	10-30%

The Ministry of Agriculture and Fisheries had put in place several programmes and initiatives to increase growth of the sector through attracting new investments and instituted an import substitution strategy for agricultural crops such as onion, Irish potato, carrot, sweet pepper and tomato, that can be competitively produced locally. Such initiatives can be seriously jeopardized by the impacts of natural disasters, including drought resulting in failure to meet economic targets and negatively impact on the people's livelihood.

Jamaica places a great effort in developing capacities of all vulnerable sectors in dealing with the impacts of climate change and natural disasters in a sustainable manner. The

country will soon have a comprehensive disaster-management policy which, among others things, will set out a medium to long-term strategy to minimize the perennial effects of drought on the island.

Drought monitoring and early warning system

A drought monitoring network was set through close collaborations of the Office of Disaster Preparedness and Emergency Management (ODPEM), the National Irrigation Commission (NIC) and the Water Resources Authority.

The Meteorological Service is responsible for monitoring, analysing and archiving the rainfall records of Jamaica. Its Climate Branch maintains a rainfall network of nearly four hundred rain gauges and rainfall recorders located strategically across the island. From the information collected the values for the island's drought Index are computed. This index is used to determine the onset, intensity and end of a drought in Jamaica. Monthly electronic Agromet Bulletins are issued to assist stakeholders with information on rainfall and drought conditions. In April 2007, the Ministry initiated a Disaster Risk Management mechanism specifically for the agricultural sector.

Vulnerability assessments

Jamaica is particularly vulnerable to the drought hazard because of the following reasons:

- As a developing country, Jamaica is particularly vulnerable to drought as it relies heavily on agriculture.
- Jamaica lies within the tropics and so it is dependent on more than one rainy season. A deficiency in any one season can produce a damaging drought.
- Predominant number of approximately 260, 000 farmers in Jamaica fall in the category of small, rain-dependent farms, with less than two hectares in size per household.
- The increase in Jamaica's population due to urbanization, has led to a great increased demand for an already limited supply of water.
- Limited/poor national water storage systems.

Strategies Being Implemented by the Ministry of Agriculture & Fisheries to Address the Impact of the Drought

Owing to the localized nature of drought in Jamaica and the largely agricultural specificity of its impact, this hazard tends not to have the prominence of large-scale phenomena such as hurricanes and floods. However, recent drought events and associated wildfires especially in the agricultural breadbasket areas of southern Jamaica have focused attention on the need for a long-term strategy for drought-risk reduction. The Ministry of Agriculture and Fisheries is pursuing the following short to medium-term interventions:

Short-term interventions include the following:

- Training farmers and other stakeholders in efficient water management and land husbandry practices including mulching with the aid of plastic or grass liners to retain soil moisture, adding organic matter to soil to increase its water holding-capacity and establishing wind-breaks around fields;
- RADA will continue to truck water to production areas where possible;
- Encouraging farmers to use efficient and economical irrigation systems where practical and as resources permit e.g., gravity drip systems, small portable pumps, tanks for water storage (black tanks);
- Encouraging farmers to plant seeds in trays instead of direct seeding in order to use available water more efficiently;
- Assisting farmers to improve their crop portfolio mix by planting drought-tolerant crops e.g., cassava, pineapple, sweet potato, gungo peas, gingers;
- Encouraging farmers to install temporary guttering systems to catch water from sporadic rainfall;
- Exploring the rehabilitation of existing permanent water tanks in communities across the island;
- Sourcing funds to develop proposed irrigation schemes as outlined in the National Irrigation Development Plan prepared by the NIC; and
- Increases in the level of production and the range of crops produced under protective cultivation.

Medium-Term Interventions include:

- Utilizing Geographic Information System (GIS) technology to cross-match key production areas with rainfall data for the last two years in specific areas, in order to better inform water management strategies for those locations;
- Determining the water availability in key production areas - the Ministry has asked the Water Resources Authority to identify available water resources and determine the capacity that can be used in key agricultural areas;
- Implementing Rain Water Harvesting and Small-Scale Irrigation Projects in Southern St Elizabeth - The Ministry is awaiting approval from the FAO for this project which will serve approximately 500 farmers and establish at least 20 demonstration rainwater harvesting systems (such as guttering and micro dams) and other appropriate technologies on small farms in that region;
- Ensuring that the Ministry's Research and Development Division and the Centre of Excellence for Advanced Technology work to develop drought-resistant varieties of crops that are suitable for Jamaica;
- Conducting research on alternative crops that can be grown in greenhouses;
- Examining alternative storage mechanisms; and
- Strengthening of multi-sectoral approach to disaster risk management.

Reference

Meteorological Services of Jamaica (2006). *Environmental management scoping of the Portland Bright Area, inclusive of the Goat Islands, final report*. Meteorological Services of Jamaica

Mexico

Felipe Ignacio Arreguín Cortés[1] and Mario López Pérez[2]

Background

Mexico has suffered the effects of drought throughout its history. Even though we do not know the exact dates, there were periods of drought in ancient Mexico. There is information on a severe drought which occurred in 1540 in the Valley of Mexico, during which chroniclers observed that it "rained fire", the crops failed and the lagoon's water level fell.

Table 1: Regional breakdown of historical droughts

LOCATION	PERIODS		
	PRE-HISPANIC	1521-1821	1821-1900
CENTER	93%	48%	27%
CENTRAL-NORTH	7%	6%	29%
NORTH	-	12%	23%
TOTAL C IN N	100%	86%	79%
CENTER	-	48%	27%
CENTRAL-SOUTH	-	5%	14%
SOUTH		7%	5%
TOTAL C IN S	-	60%	46%

Source: CIESAS. Regional breakdown of historical droughts

It is officially recognized that in 2009, Mexico experienced its second worst drought in 60 years, that 2010 was the rainiest year on record, and that in 2011, the worst drought of the past six decades affected 52 per cent of the country. The Secretariat for Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) reports that for the 2011 crop year, 2.7 million hectares were affected, involving seven of the main crops, above all in Sinaloa, Zacatecas and Guanajuato. Over the past three years, drought has been responsible for the loss of over a million cattle. Based on information published in the digital version of the Mexican daily Reforma, from 2010 to date, northern Mexico has experienced an intense drought culminating in the death of 1.3 million cattle, while another million head of livestock have had to be put down, according to the National

[1,2] Comisión Nacional del Agua - Secretaría de Medio Ambiente y Recursos Naturales

Confederation of Livestock Organizations. SAGARPA declared a natural disaster in the agro-livestock, aquaculture and fisheries sectors in 37 municipalities of Coahuila and 51 municipalities of Nuevo León in early May 2013.

Moreover, stockbreeders, growers and officials from Tamaulipas asked for an emergency to be declared in 41 of the 43 municipalities due to prolonged drought. Starting from 2009 to the present (except 2011) the Mexico City Metropolitan area has been subject to cuts in the annual water quota of up to 30 per cent as a result of a drought-related shortage of water from surface water sources. The Monterrey Metropolitan area implements water-rationing measures when its water sources are low, and recent years have not proved an exception.

Vulnerability assessment

As it is located, geographically speaking, in the Tropics, Mexico is highly vulnerable to droughts and floods. Research shows that climate change has increased the frequency and severity of droughts, especially in arid areas. This is reflected by Mexico's First Communication to the United Nations Framework Convention on Climate Change, with a map showing drought severity. It is difficult to determine when this phenomenon will recur, and its occurrence has turned Mexico from a corn exporter into a corn importer. It has affected the entire economy: first of all, via higher prices for agricultural produce; second, through higher prices for any industries dependent on agricultural inputs as well as the meat, textiles, wool and cotton sectors; and finally, consumers. Farming provides a livelihood for a third of Mexico's population, and the social sector ("ejidos", or common lands) is primarily devoted to rain-fed agriculture, which is vulnerable to extremes.

The effects in terms of livestock loss and an increase in forest fires have been very severe over the last four years. Damage has also been extensive in the aquaculture production sector. Mexican towns with more than 2500 inhabitants generally rely on underground water, and there are water supply problems of various natures that mask the effects of the drought. However, there are relevant cases such as Guadalajara, Monterrey, León, Morelia, Tijuana, Mexicali, Reynosa, Villahermosa and Mexico City (accounting for more than 40 per cent of the population) that have additional surface water sources which have been affected by the drought, leading to shortages. Out of all these cities, only Monterrey has applied a water saving and conservation strategy in response to the drought. Drought hits towns of less than 2500 inhabitants the hardest, which is why the Secretariat for Social Development and the National Water Commission operate annual water supply programmes for their benefit, using various instruments and mechanisms.

Relief fund for emergencies and drought response

Since 2012, Mexico has alleviated the occurrence of droughts by means of the National Natural Disaster Fund (FONDEN) and the Natural Disaster Response Component (CADENA), which allocate resources to municipalities based on criteria for non-recurrent droughts. Although there is a Natural Disaster Prevention Fund (FOPREDEN), it has minimal resources for drought prevention studies and projects. Also as a result of droughts since 2009, the Mexican Government issued a decree in 2012 to improve coordination among federal bodies in coping with the effects of drought, seeking to guarantee the supply of water for human consumption.

Drought mitigation practices

In view of the major economic losses and material damage affecting farmers, livestock breeders and water systems, Mexico decided to change its drought management policy, moving from a reactive vision to a proactive, preventive, risk-based approach. The recurrent droughts in most of the country throughout its history, with extreme events during 2010 – 2013, as well as the "Guidelines establishing criteria and mechanisms for issuing general agreements in emergency situations caused by the occurrence of drought, along with preventive and mitigation measures by national water users to ensure efficient water use in times of drought", served as a basis for the President of Mexico to announce the National Drought Control Programme (PRONACOSE) on 10 January 2013, designating the National Water Commission (Conagua) as the body responsible for coordination.

The set of principles according to which the programme is planned and executed, not necessarily by order of importance, include the following: (a) build local capacities inside and outside Conagua to ensure that PRONACOSE keeps operating after the initial six-year time frame; (b) launch an aggressive training programme on basic concepts of drought and success stories, seeking to enlist the greatest possible number of national and international experts on both this topic and on monitoring and evaluation; (c) increase awareness among local water actors, initially through information on drought occurrence and vulnerability in relation to watersheds (and subsequently by targeting water users in terms of water use). This would pave the way for an initial programme of ad hoc preventive and mitigation measures and opportunities for implementation, which would subsequently be adjusted and fine-tuned by consensus on the basis of implementation, evaluation and experience; (d) coordinate and guide the programmes operated by federal institutions, backed by an inter-agency commission and working groups established by law, whose mission would be to advise and evaluate PRONACOSE and fund watershed projects proposed by local actors; (e) encourage efforts by experts and researchers

to help find solutions to needs identified during the programme development stage and for PRONACOSE in general; (f) run an ongoing communication and outreach programme focusing on the concepts of occurrence, vulnerability, participation and prevention, as well as an understanding of how droughts evolve; and (g) evaluate PRONACOSE indicators based on the implementation and impact of preventive measures to reduce drought vulnerability.

The first PRONACOSE line of action has five components: (1) preparation, implementation and evaluation of drought prevention and mitigation programmes; (2) drought warning and monitoring; (3) development and strengthening of the institutional drought response framework – the establishment of the Intersectoral Drought and Flood Response Commission and working groups to inform, support, advise and evaluate the programme; (4) research; and (5) training, communication and outreach.

The second line of action has two components: (1) establishment of a legal and administrative protocol; and (2) publication and implementation of general agreements to guarantee the supply of water for human consumption during severe or extremely severe droughts.

The third line of action has two components: (1) coordination of the application of the programme resources of the National Natural Disaster Fund and related federal government bodies; and (2) ongoing review of said programmes and their operating rules to ensure effective and efficient application for drought mitigation purposes.

In 2013, Conagua started to issue timely warnings and monitor droughts, publishing monthly figures for watersheds, states and municipalities, according to the degree of intensity as assessed using the North American Drought Monitor. It also determines SPIs and SDIs on a weekly basis for the main weather points and stations. These results are then published on its Internet portal.

Conagua is also developing 26 Drought Prevention and Mitigation Programmes (PMPMSs) for each individual Watershed Board, relying on the experience developed in the USA (the National Drought Mitigation Center) and in other countries. These bodies deal with the specific characteristics of drought and vulnerability of each watershed. A handbook has been developed and staff from Conagua and 12 institutions have been trained in awareness-building and research, to ensure standardized activities and minimum content for the PMPMSs. These programmes are to be implemented during the sec-

ond and third year then evaluated during the fourth year, fine-tuned in the fifth year and implemented once again in the sixth year. The aim is to ensure ownership of these joint groups and their steady, ongoing implementation after the initial six-year time frame.

The fifth of April marked the creation of the Intersectoral Commission for Drought and Flood Response, which is composed of 13 bodies and meets on a quarterly basis. Working groups have been set up within the Commission to evaluate the PMPMSs and to coordinate and guide federal programmes for financing watershed-related activities. In addition, a Committee of Experts was established to promote and propose strategies and lines of research and to evaluate, advise, inform and support PRONACOSE.

A few lines of basic research have been defined and initiated, which are designed to complement those identified in the PMPMSs and proposals by experts and researchers.

Along similar lines, there is a need for a broad, ongoing outreach and communication campaign based on awareness-building regarding drought and its present and future impacts. Even though drought is a recurrent topic in Mexico, its economic and social impacts are insufficiently documented. Such historical information must be properly collated and disseminated, as part of the awareness-building strategy targeting users in particular and society in general. This phase is scheduled to begin in the second year of the programme. Knowing how to correctly interpret information of the evolution, occurrence, vulnerability and implementation of the PMPMSs is crucial to the outreach and communication campaign.

From the first year onwards, there will be continuous training efforts targeting all users and officials of the Watershed Board on drought awareness and drought mitigation practices. The participation of national and international experts in local capacity-building, from programme drafting to programme evaluation and implementation, is a basic premise of PRONACOSE.

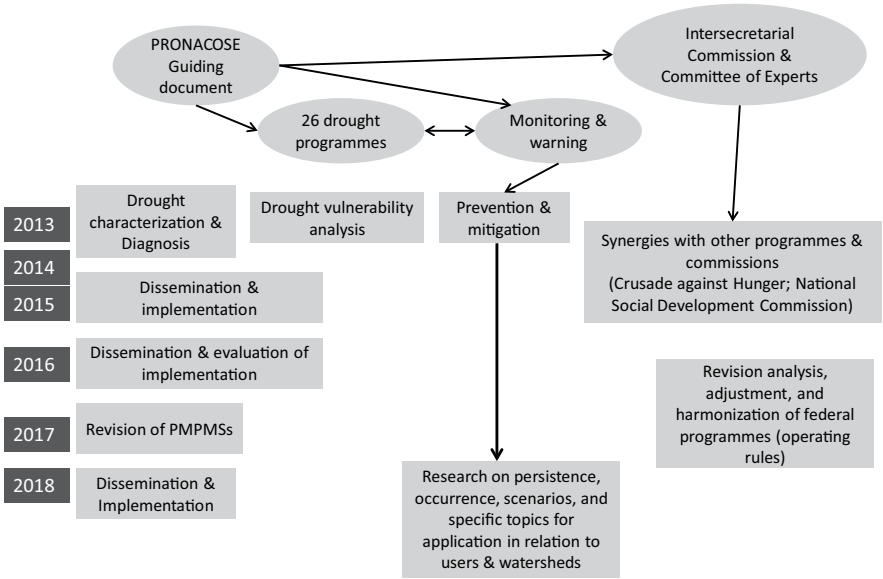

Figure 1: Programme for follow-up, evaluation and improvement, 2013-2018

Need for drought management knowledge and skills

- Provide feedback and fine-tune the PMPMSs with regard to watersheds and major users.
- Improve and expand measurement; increase the amount of reliable climatological and hydrological data for drought-related decision-making and management.
- Document historical droughts which have caused disasters throughout history as well as current droughts.
- Improve the early warning system:
  - Improve the current drought monitor
  - Develop more specific indices for prevention purposes
  - Monitor/publish run-off and 'piezometer' data
  - Obtain drought monitoring products based on mapping and remote sensing
  - Publish at varying intervals a drought monitoring newsletter for State bodies
  - Peruse daily drought monitoring maps, available at Conagua's main web page, together with soil moisture evaluation and products based on remotely sensed data.
- Reconstruct time series for rainfall, temperature and evaporation; develop complete databases and series for design and prognosis.
- Generate (non-prognostic) drought scenarios (of the type USA-Wilhite and SPI at 3, 6 and 12 months) (SDI).

- Study the drivers which explain climate variability (El Niño, La Niña, PNO, NAO, Pacific and Atlantic Decadal Oscillations, sea surface temperatures (SSTs), sun storms, etc.)
- Study drought history by means of dendrochronology, polar ice caps, sediments, etc.
- Determine vulnerability and impact with regard to national and regional droughts:
  - Study the meaning and usefulness of climate information;
  - Gather meteorological and climate information to evaluate the hazard;
  - Diagnose the water sector's vulnerability in terms of watersheds and cities;
  - Diagnose the water sector's vulnerability in terms of watersheds and cities;
- Develop methodologies to evaluate social and sectoral vulnerability to drought; develop strategies to overcome drought damage as quickly and cost-effectively as possible.
- Generate and implement models for water use optimization, from water supply sources to the various users, including service costs, opportunity costs, rates geared to self-financing, and differential rates by sector and by volume.
- Evaluate cost-benefits (of opportunities) or multiple criteria for defining adaptation measures.
- Promote water awareness and a water culture to encourage a change in attitude and views among common users with regard to the vulnerability and limits of available water, its conservation, proper use and cost.
- Strengthen training programmes for Conagua staff, users and researchers in various topics such as drought guidelines and drought management procedures, as well as drought prevention and mitigation.

References

Centro de Investigaciones y Estudios Superiores en Antropología Social (CIESAS). http://www.ciesas.edu.mx/
Coordinación del Servicio Meteorológico Nacional (CSMN). http://smn.cna.gob.mx/

Componente de Atención a Desastres Naturales (CADENA). http://www.sagarpa.gob.mx/Delegaciones/zacatecas/Lists/Padrn%20de%20Beneficiarios/AllItems.aspx?RootFolder=%2FDelegaciones%2Fzacatecas%2FLists%2FPadrn%20de%20Beneficiarios%2FComponente%20Atenci%C3%B3n%20a%20Desastres%20Naturales%20en%20el%20Sector%20Agropecuario%20y%20Pesquero%20(CADENA)

El Economista. 23 de enero de 2012. http://eleconomista.com.mx/sociedad/2012/01/22/mexico-umbral-sequia-historica

Fondo de Desastres Naturales (FONDEN). http://www.proteccioncivil.gob.mx/es/ProteccionCivil/Normatividad1

Fondo para la prevención de Desastres Naturales (FOPREDEN). http://www.proteccioncivil.gob.mx/es/ProteccionCivil/FOPREDEN

Instituto Nacional de Ecología y Cambio Climático (INECC). *Severidad de la sequía*. http://www2.inecc.gob.mx/publicaciones/libros/32/cap6.html

Primera Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. http://www.inecc.gob.mx/cpcc-lineas/634-cpcc-comnal-1

Programa Nacional contra Sequías (PRONACOSE). Programas de Medidas Preventivas y de Mitigación de las Sequías (PMPMS). Comisión Nacional del Agua. Subdirección General Técnica. Gerencia de Ingeniería y Asuntos Binacionales del Agua. http://www.pronacose.gob.mx/

Quinta Comunicación Nacional Ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. http://www2.inecc.gob.mx/publicaciones/download/

Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA). http://www.sagarpa.gob.mx/Paginas/default.aspx.

Nicaragua

Jamil Robleto Molina[1]

Background

In Nicaragua, drought periods are closely related to the appearance of the El Niño phenomenon; however, some drought periods are due to changes in atmospheric circulation rather than El Niño. Whereas in Nicaragua accumulated annual precipitation ranges between 750 mm in the driest part to 4500 mm in the zones with the greatest accumulated precipitation, drought varies in severity, severely impacting the Pacific coastal regions, where accumulated annual rainfall is between 1100 mm and 1900 mm, the northern region, with accumulated annual rainfall of 750 mm to 1800 mm, and the central region, with accumulated annual rainfall between 800 mm and 2000 mm, although these figures are only averages.

Over the past decade, the greatest drought damage was recorded in 2001 and 2011, directly affecting the country's agricultural production cycle and occurring in the months of May, July, August and September, leading to losses of over 103,700 manzanas (Mz) (MAGFOR) of basic grains (maize, beans, rice, sorghum and others), especially in July-August 2001. There are no final figures for 2010, but institutional reports indicate losses similar to those of 2001. From 1997 to 2010, drought impacted a total of 37 municipalities in an area called the "dry corridor", indirectly affecting over 2 million inhabitants and directly affecting over 100,000 people.

Vulnerability assessment

As can be seen from the above pictures, vulnerable areas increased over the past decade, coming to be known as the country's "dry corridor" and affecting 37 municipalities located in the centre/north and part of the Pacific coastal region. The agricultural sector is the most vulnerable, given the predominance of agro-livestock production. However, within this same sector, the worst affected are small-scale producers with limited resources growing subsistence crops. Droughts cause drinking water shortages and malnutrition, which have a direct effect on children, leading to a high degree of vulnerability.

On the basis of climate trends over the past decade and their consequences, owing to the shortage of water required for subsistence, it has been possible to characterize drought-stricken areas. Although this information has not been published to date, there is a close correlation with the areas affected in recent years.

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[1]Hydrologist / National Water Authority (ANA), Nicaragua

Relief fund for emergencies and drought response

The Government's new strategy has included the development of a Drought Plan aimed at the following: providing food aid to the poorest, hardest-hit families in the dry zone; facilitating access to drought-tolerant seed varieties for growing basic grains; capitalizing poor farming families via the transfer of food production vouchers; facilitating the transfer of skills and techniques for feeding cattle in summer, funding small-scale projects for water harvesting and monitoring agricultural production as an early warning tool.

Emergency relief funding is provided via the national budget and disbursed under the responsibility of the relevant governmental bodies, such as the National System for Disaster Prevention, Mitigation and Relief (SINAPRED), the Ministry of Agriculture (MAGFOR), the National Institute of Agro-livestock Technology (INTA) and the Ministry of Health (MINSA), together with the municipalities and local organizing structures (Family, Community and Life Cabinets). All of these bodies work together to implement the various aid and technical support programmes designed to reintegrate those affected in better conditions after the impact of the drought. The criteria for selecting beneficiaries are primarily based on the severity of impact linked to the prevalent poverty index. However, considerable support is provided by such bodies as FAO, UNDP, WFP, and local actors (NGOs), for the various drought mitigation and emergency programmes, such as the creation of community seed banks for the production of drought-tolerant certified seeds, which have yielded satisfactory results. All of these activities are directly linked to the goals of the National Human Development Plan (PNDH) of the Government of the Republic.

Drought mitigation practices

One of the key measures concerns direct efforts in areas characterized by a high degree of land degradation (80 per cent), which influences the development of sustainable land management plans. UNDP has provided support, together with the Ministry of the Environment, with a view to promoting long-term environmental services and helping to reduce poverty in these areas.

A drought monitoring system has been introduced which relies on the weather monitoring network, consisting of a network of telemetric stations for real-time transmission, operated by the Department of Meteorology of the Nicaraguan Institute for Territorial Studies (INETER). Efforts are underway to update nationwide drought surveys with data using 2010 as a baseline.

Need for drought management knowledge and skills

- There is insufficient technical capacity for drought research.
- To date, the topic of drought management is not really taken up in depth; rather, it is treated in a sector fashion, depending on the objective to be evaluated.
- From a technical standpoint, there is a need for capacity-building to enable application of the various practical drought management tools suited to the conditions of the country or region.
- Strengthening of monitoring networks in order to ensure a sufficient supply of high-quality data suitable for use in various analyses and applied scenarios, with a view to deepening knowledge of droughts.

Conclusion

The issue of drought in Nicaragua is clearly a salient phenomenon with varying degrees of severity every year. Up until now, the public is only aware of droughts when they result in significant consequences or damage, in terms of agricultural production or food shortages for the affected population. However, major efforts are being made to pinpoint the effects of droughts, despite financial constraints that limit the effectiveness of drought research by the relevant bodies.

Notwithstanding, the Government's willingness to intervene via poverty reduction or drought mitigation measures is no doubt one of the main tools helping to alleviate the impact of drought on drought-stricken zones.

Reference

National Water Authority (ANA) of Nicaragua, http://www.ana.gob.ni/. Accessed November 2014.

Panama

Casimiro Véliz[1], Aris Escobar[2] and Karina Rivera Gómez[3]

Background

Panamanian watersheds have also been hit by processes of degradation, a by-product of interactions between human populations and nature. In recent years, soil erosion and degradation problems have been identified. This primarily occurs in the eastern part of the country, where groups of peasant and indigenous families living in critical conditions. Their livelihood depends on the production of subsistence crops on lands characterized by severe constraints and no conservation systems as a result of environmentally unsustainable practices.

Land considered as dry and degraded accounts for 27 per cent (20,788 square kilometres) of the country and is occupied by approximately a half a million people (516,464 persons). Indigenous populations account for the bulk of these individuals. The fact that they belong to indigenous population represents greater pressure on the environment, which is the main source of livelihood for these communities.

The National Action Plan for Drought and Desertification Control (PAN) recognizes that in the country, there are areas affected by drought and soil degradation, which consist of 36 districts, 227 "corregimientos" (the smallest administrative unit) and 20 watersheds. The areas hardest hit by land degradation are Arco Seco, Sabana Veragüense, the corregimiento of Cerro Punta and Comarca Ngöbe-Buglë. These are defined on the basis of the drought and soil degradation processes observed, as a result of the stringent productivity requirements to which they are subjected. In all, crop and livestock farms account for 35 per cent (7,275.65 square kilometres) of the total.

By means of resolution AG-0098 of 26 March 2004, the National Environmental Authority established the National Committee for Drought and Desertification Control (CONALSED), composed of the National Environmental Authority (ANAM) and other State bodies, as well as academies and NGO, with a view to implementing and following up the PAN.

[1]Ministerio del desarrollo agropecuario
[2,3]National Environmental Authority of Panama (ANAM)

Vulnerability assessment

In recent years, the Government has taken preventive action as the dry season has grown longer. Droughts have clearly impacted the agro-livestock sector, and a state of emergency was declared in 2013 with a view to allocating $3 million for the Arco Seco region to cope with the extended drought. The funds were used as support for producers in the form of animal fodder, medicine and water supply for productive activities, given that reports from the Ministry for Agro-livestock Development place livestock losses at $186,000.

In the energy sector, 60 per cent of the energy used nationwide is generated by hydroelectric plants, which means that rain is vital for the development of the country's economy. Over the past two years, the Government has introduced energy-saving measures aimed at avoiding electricity power cuts and rationing, both of which curtail economic growth. The energy-saving measures adopted in 2013 included the closure of public and private educational centres and working time reduction in public entities, primarily with a view to avoiding the use of air conditioning, which accounts for 60 per cent of national energy consumption.

What is more, the National Council of Private Enterprise and the Chamber of Commerce of Panama adopted the Government's recommendations in addition to supplying their own energy via electrical power plants, a potential energy saving of 200 to 300 megawatts. The most severe impact in terms of drinking water was felt in certain rural areas, where the drop in precipitation aggravated existing conditions of inadequate or insufficient water resources. In Panama, these rural areas coincide with the critical areas described above.

Likewise, owing to the late rainy season, the Panama Canal Authority has introduced water-saving measures for the passage of ships through the locks. One such measure was the suspension of hydraulic assistance to ships leaving the locks, which consists of injecting water into the rear of the lock to raise the ship's prow with a view to speeding up the process. In addition, more ships were scheduled to pass the locks in pairs (depending on ship size).

Relief fund for emergencies and drought response

The Panama Savings Fund (FAP) was established to deal with emergencies. Accordingly, when the circumstances warrant, a request is submitted for the declaration of a state of emergency, which must then be approved by the Council of Ministers. In this respect, in

2013 the allocation of $3 million was approved, an amount which was earmarked for the region of Arco Seco to offset the effects of drought on agro-livestock production.

The Ministry for Agro-livestock Development has developed a National Emergency Plan to support producers. In 2011, 2012 and 2013, this entity disbursed approximately $6 million to cover losses suffered by the agriculture and livestock sector. The same fund was used in response to flooding.

Drought mitigation practices

Table 1: Drought mitigation practices in Panama

INSTITUTION	DROUGHT CONTROL MEASURES AND PROCEDURES
MINISTRY FOR AGRO-LIVESTOCK DEVELOPMENT (MIDA)	MIDA promotes the efficient use of water for irrigation, agroforestry practices, implementation of organic farming and the adoption of silvopastoral systems, among other techniques.
MINISTRY OF HEALTH (MINSA)	MINSA promotes the preservation of a healthy environment, which includes the quality of water for human consumption.
NATIONAL SECRETARIAT FOR SCIENCE AND TECHNOLOGY (SENACYT)	SENACYT promotes research and human capacity-building via models and simulations to predict future climate scenarios.
MINISTRY OF THE ECONOMY AND FINANCE (MEF)	Administers the national drought support funds.
UNIVERSITY OF PANAMÁ (UP)	Trains professionals in drought control techniques and conducts research in this field.
ELECTRICITY TRANSMISSION COMPANY (ETESA)	Operates the network of weather stations in Panama.
INSTITUTE FOR AGRO-LIVESTOCK RESEARCH (IDIAP)	Conducts research into species adaptation to drought and ways of mitigating its impact
NATIONAL ENVIRONMENTAL AUTHORITY (ANAM)	Develops standards for the promotion of drought and desertification control efforts. Operates a National Action Plan for Drought and Desertification Control. Engages in reforestation and runs projects aimed at preserving watersheds.

Need for drought management knowledge and skills

Training is needed for aquifer recharge and efficient water resource management, as well as rainwater collection and utilization. More training is also required in the field of sustainable land management. Likewise, we must emphasize the need to fine-tune models for estimating drought cycles in Panama.

Given the emergency situations created by recurrent drought in Panama, it is problematic to introduce changes in the field of livestock management, agriculture and other rainfall-dependent sectors on a solely empirical basis. What is needed is better knowledge in order to cope with this environmental challenge and reduce its impact on the living standards of Panamanian citizens.

References

Ministerio del desarrollo agropecuario, http://panamatramita.gob.pa. Accessed November 2014.

National Environmental Authority of Panama. http://www.anam.gob.pa/. Accessed November 2014.

Peru

Dora Soto Pardo[1]

Background

In Peru, the majority of events recur over time, given the cyclical nature of climatic and hydrological factors. During a given time frame, droughts and other events may occur, the magnitude of which is intensified by the presence of El Niño and La Niña phenomena and climate change. A large share of the national territory is prone to periodic droughts, including large parts of the coast and mountains, the intensity of which depends on the occurrence of specific climatic conditions, which are the opposite of the El Niño phenomenon.

Between 2000 and 2010, 163 drought events were reported nationwide, broken down as follows: Pacific coastal region (127 events), followed by the Lake Titicaca region (25 events) and the Atlantic coastal region (11 events). The droughts varied in terms of frequency, with the highest frequency between three and nine years, with 85 events and 70 events, respectively. The largest number of events was reported between 2000 and 2008 and in the year 2010, with 73 and 62 events, respectively, as can be seen from the Table 1.

Table 1. Occurrence of drought events in Peru (2000-2010)

FREQUENCY	YEARS OF OCCURRENCE			TOTAL
BEFORE 2000	Between 2000 and 2008	2009	2010	
ANNUAL		23	62	85
BIENNIAL				
BETWEEN 3-9 YEARS	70		70	
MORE THAN 10 YEARS	3			5
ONLY ONCE				1
TOTAL	73	25	62	163

Source: Prevention plan to deal with the presence of natural phenomena such as floods, landslides and droughts, Lima, National Water Board, Ministry of Agriculture, October 2010

[1]Autoridad Nacional del Agua, Peru

In the coastal regions, 126 drought events were reported, with 11 in the Atlantic coastal region. The 2010 drought hit eastern Peru particularly hard. The droughts in the Altiplano were severe, as this region is more vulnerable owing to the sharp fluctuations in precipitation; 25 events were reported. In all, 66,724 families and 332,087 hectares were affected throughout the country. In 2011, droughts affected the departments of Arequipa, Cajamarca, Lambayeque, Piura, La Libertad, Lima, Moquegua, Tacna, Amazonas, Huánuco, San Martín, Junín and Puno. The consequences of droughts are crop and livestock loss, the proliferation of pests and disease. Droughts primarily hurt small-scale farmers, as well as urban populations and electricity production.

Vulnerability assessment

Droughts mainly impact agriculture, leading to major economic losses in rainfall-dependent areas (rain-fed agriculture). In the mountains, which are primarily located in the Atlantic coastal region, approximately 95 per cent of all farmland is cultivated by means of rain-fed agriculture (1.2 million hectares). Critical periods affect agricultural production immediately, severely impacting the local economy – crop yields fall, and in the case of long periods with 20 per cent less rainfall or short periods with 30 per cent less rainfall, crops can fail, due to the fact that the majority of crops are food crops with short roots.

Droughts severely affect southern Peru in the form of a shortage of rainfall, which directly impacts crops from rain-fed agriculture, leading to crop and livestock losses. The Puno Altiplano is the most vulnerable to droughts. On the coast (Pacific coastal region), the impact of droughts is reflected by a reduction in the area sown as a percentage of total available agricultural acreage. The majority of farmers in the country own less than five hectares (81.8 per cent of agro-livestock farms), the bulk of which (67.9 per cent) are located in the mountains. According to the National Institute for Statistics and Information (INEI), in 2012, poverty in rural areas affected 53.0 per cent of the population, with 19.7 per cent classified as extremely poor.

Among the populations located in the Atlantic coastal region, particularly in the jungle and high jungle, reduced river flow affects fisheries, the main source of animal protein. It also impacts navigation, as rivers are the main means of transportation in these regions. The effects of drought on the lower part of a watershed located in the Pacific coastal region (where approximately 70 per cent of the country's inhabitants live) may be mitigated via underground water pumped from wells. However, if a drought lasts more than two years, the water table falls, thereby reducing water supply, a problem that primarily affects the poorest population group.

Relief fund for emergencies and drought response

Types of emergencies:

The Handbook for evaluating risks arising from natural phenomena breaks down risks as follows:

- Risks due to the Earth's internal geodynamics (earthquake, tsunami, volcanoes);
- Risks due to the Earth's external geodynamics (mass movement);
- Risks due to phenomena of a hydrometeorological or oceanographic nature (flooding, drought, land erosion and temperature drops).

Beneficiary sectors and population

In accordance with the Plan for Risk Management and Adaptation to Climate Change in the Agricultural Sector for 2012–2021 (GRACC Plan), which is supported by FAO, the following drought risk classification has been made: five regions have been classified as low risk – Amazonas, Cuzco, Huánuco, Lima and Pasco; 12 regions have been classified as medium risk – Ancash, Apurímac, Arequipa, Ayacucho, Cajamarca, Huancavelica, Junín, La Libertad, Moquegua, Piura, Puno and Tumbes; and three regions have been classified as high risk – Ica, Lambayeque and Tacna.

Risk calculation relies on information at the administrative district level on agricultural and livestock vulnerability, which is calculated beforehand. Another tool is thematic information on the most recurrent hazards that directly affect the agricultural sector, which is provided by the National Meteorological and Hydrological Service (SENAMHI). Information corresponding to administrative districts is subsequently extracted for risk analysis purposes.

The results obtained for agricultural and livestock risk are only approximate, given that they are based on very different sources of information from different institutions and vary widely over time, especially information from the agro-livestock survey of 1994, which constitutes the only official information published which provides interrelated variables of interest that are needed to calculate agro-livestock vulnerability.

Some details concerning the National Forum and other institutions responsible for managing disaster response are mentioned below:

The National Disaster Risk Management System is composed of the following: the Presidency of the Council of Ministers, the National Centre for Risk Estimation, the National Council for Disaster Risk Management, the National Civil Defence Institute, regional and local authorities, the National Centre for Strategic Planning, the armed forces, the national police, private entities and civil societies. Its action plans are broken down into management components, such as risk assessment, risk prevention and reduction, preparedness, response and recovery, as well as reconstruction.

The National Disaster Risk Management System – Law No. 29664, Article 1. (SINAGERD) was established as an inter-agency, synergistic, decentralized, cross-cutting participatory body with a view to identifying and reducing risks associated with hazards or minimizing their effects, as well as preventing the generation of new risks, together with preparedness and response in disaster situations based on the establishment of disaster risk management principles, policy guidelines, components, processes and instruments.

National Civil Defence Institute (INDECI) Regulations, Articles 8 and 9

8.1 It is a public implementing body composed of SINAGERD, the technical entity responsible for coordinating, facilitating and overseeing the formulation and implementation of national policy, and the National Plan for Disaster Risk Management, as regards the processes of preparedness, response and recovery.

8.2 It develops, proposes and advises the governing body, as well as the other public and private entities which make up SINAGERD, with regard to policy, guidelines and mechanisms in relation to disaster preparedness, response and recovery.

8.3 It assists in the processes of response and recovery, especially where the imminent danger or disaster exceeds the response capacity, providing the necessary support through the competent authorities.

9 Role of INDECI; inter alia, to oversee, follow up and evaluate countrywide the implementation of the processes of preparedness, response and recovery, proposing the corresponding improvements and measures; and to issue technical opinions in advance to the Presidency of the Council of Ministry on the need to declare a state of emergency when a hazard or disaster is imminent.

Article 18. Functioning of the working groups for SINAGERD organization and coordination.

18.5 Organize proactive management through

a. The regional civil defence system

b. The Regional Emergency Operations Centres (COERs) and the Local Emergency Operations Centres (COELs), and

c. The regional and local civil defence platforms.

18.6 Coordinate SINAGERD's preparedness, response and recovery processes with the Security and National Defence System.

Article 31.-Response

Response, which is an integral part of disaster risk management, is composed of the body of actions and activities implemented in conjunction with an emergency or disaster, either when it occurs or immediately before.

Article 32.- Response sub-processes

Response sub-processes are as follows:

32.1 Implementation and coordination of emergency or disaster relief (self-help campaigns, first response and humanitarian aid)

32.2 Operational analysis (identification of damage, needs analysis, timely intervention)

32.3 Search and rescue (protection of property and maintenance of public order)

32.4 Health (meet public health needs)

32.5 Comunications (activities to ensure communication between the actors)

32.6 Response logistics (provide adequate supplies as well as teams and staff for emergency assistance)

32.7 Humanitarian aid (provide shelter, food, goods and tools, and protect vulnerable groups.

32.8 Mobilization (allocate and use resources and goods from the nation's potential in accordance with Law No. 20101, the Law on National Mobilization.

Drought mitigation practices

Below are some actions that have been developed in conjunction with preventing, mitigating and reducing the effects of droughts:

National drought observatory

Plans are underway to develop a monitoring and early warning tool that would provide decision makers, farmers and end users with reliable, timely information on meteorological, hydrological and agricultural conditions, by incorporating and generating drought indices capable of explaining in temporal and spatial terms the magnitude of a drought for the country. Such information is in great demand by users, for whom it must be accessible and easily understandable. This proposal was made by the National Water Board (ANA), with the support of the Universidad Nacional Mayor de San Marco, to public and private bodies as well as such international bodies as FAO, GIZ and UNESCO (cooperation). The relevant profile is being prepared.

National drought frequency map,via LMOMENTS: work is continuing on the analysis of drought frequency (SENAMHI, ANA and the Universidad Nacional Mayor de San Marcos), based on the capacity-building efforts made by the Water Centre for Arid and Semi-arid Zones for Latin America and the Caribbean (CAZALAC), yielding the first preliminary nationwide drought frequency map (July 2013), which will be incorporated as an Observatory input. SENAMHI applied this methodology for the first time in 2008, to the regions of La Libertad and Lambayeque, within the framework of a pilot project sponsored by CAZALAC. The area studied included 11 watersheds located in northern Peru.

ANA is planning to set up a Technical Working Group for Disaster Risk Management (GTT-GRD) through the National Information System for Water Resources. In addition, an Early Warning System is being introduced to monitor disasters in the form of extreme hydrological events.

Drought monitoring: At present, SENAMHI conducts drought monitoring in the form of rainfall characterization with a view to detecting water shortages. The methodology used is the Standardized Precipitation Index (SPI). What is more, FAO-Peru has worked together to conduct a drought diagnosis in Peru and identify the most vulnerable regions, as detailed in the GRACC Plan for 2012-2021. The drought management activities conducted by the Geophysics Institute of Peru focus on generating new knowledge via the conduct of various studies and projects in the field of climate variability and change, applicable to various parts of the country.

A number of publications on the topic of droughts and dry spells in Peru, showing the respective authors, are available at the following institutional webpage: http://www.met.igp.gob.pe/publicaciones/

Espinoza et al. (2011) noted that the recurrent presence of severe drought events the Amazon in recent years (1995, 1998, 2005 and 2010), of which the drought in 2010 was one of the most severe for eastern Peru. In general, droughts in the western Amazon (Peruvian side) are associated with positive anomalies of the North Tropical Atlantic Ocean and to a weakening of the trade winds. These factors, combined with an increase in subsidence in the central and southern Amazon, explain the drop in the amount of rainfall and discharges. In 1998, however, following the intense El Niño of 1997-98, a drought was most likely due to a divergent anomaly in water vapour in the western Amazon, which is characteristic of warm events in the Pacific Ocean. Likewise, during the intense drought of 2010, its greater intensity and longer duration, compared with the 2005 drought, can also be explained by the presence of El Niño in the austral summer and intense warming in the Atlantic (Espinoza et al., 2011).

Research in the mountains focused on the Mantaro River basin and valley, pertaining *inter alia* to the identification, classification and analysis of short dry periods (dry spells), which are directly related on a synoptic and seasonal scale to moisture ingress into the Andes from eastern South America, and to the indirect relationship between rainfall in the Mantaro River basin with thermal conditions in the Pacific Ocean (decrease in precipitation in the case of El Niño events, and the opposite during La Niña events) and a pronounced trend towards a drop in precipitation in the Mantaro River basin and valley since the mid-1970s and a rise in annual rainfall from 2010 onwards, a drop associated with global thermal warming.

In accordance with the Organizational Regulations and Role of the National Water Board, Article 34(b), the Department for Multisectoral Water Studies and Projects plays the role of participating in the drafting and conduction of preinvestment studies for multisectoral projects in the field of water management, flow control and flood protection, in support of regional and local authorities and other entities.

The Ministry of Agriculture and Irrigation (MINAGRI) is working to improve native seeds (potatoes) to make them more resistant to water stress. In addition, some regional authorities and NGOs engage in **water harvesting**; **storage sheds** for storing fodder have been introduced through MINAGRI programmes (Agrorural); and steps have been taken to **enhance efficiency** in terms of distribution and use, by means of projects developed by the Subsectoral Irrigation Programme (MINAGRI).

Need for drought management knowledge and skills

Recent years have been marked by an increase in drought prevention efforts in Peru. There is the "Climate Change Adaptation Plan for the Agricultural Sector 2005–2015" (GRACC Plan), which includes countrywide drought vulnerability, hazard and risk maps and the "Prevention Plan for Natural Phenomena such as Floods, Landslides and Droughts".

In the past, the National Civil Defence Institute intervened in various types of emergencies. However, there is a need to gather more hydrometeorological information; establish mechanisms to ensure that outgoing information is not released before an exploratory data analysis has been conducted; systematize information available in hard copy form; increase the density of the network of weather stations on the high Andean plateau (elevations in excess of 2500m) and the Amazon region; and monitor plans for the maintenance of existing weather stations. To do this, SENAMHI will need not only more financial resources but also better logistics.

There is also a need to integrate risk management information with the various sectors of government and its different bodies as well as with local and regional authorities who, owing to their proximity and by means of the principle of subsidiarity, directly assist the population when events such as droughts occur. Here, it is necessary to introduce drought research classes at university; promote research into drought-related topics; establish drought thresholds by region; encourage the cultivation of xerophilous alternative crops; develop models for optimizing the operation of high-priority reservoirs; develop mechanisms for drinking water supply during water shortages; and identify successful drought management experiences.

References

Congress of the Republic (2010). *Law on Water Resources, No. 29338 of 30 March 2009 and its Regulations* (adopted via Supreme Decree No. 001-2010-AG,July 2010.

Congress of the Republic. (2011). Law No. 29664, *Law Establishing the National Disaster Risk Management System* (SINAGERD), enacted on 8 February 2011

Ministry of Agriculture, MINAGI-FAO (2010). *Management Plan for Climate Change Risk and Adaptation in the Agricultural Sector for 2012–2021 - GRACC Plan, 2010-2011*.

Ministry of the Environment, MINAM. (n.d.). *National Climate Change Strategy*, Supreme Decree No. 086-2003-PCM.

National Centre for the Estimation, Prevention and Reduction of Disaster Risk (CENEPRED) (2013). *Handbook for evaluating risks arising from natural phenomena*. Adopted via Prefectural Resolution No. 058-2013- CENEPRED, 29 October.

National Centre for the Estimation, Prevention and Reduction of Disaster Risk (CENEPRED) (2013). A*dministrative procedural guideline for evaluating risks arising from natural phenomena*. Adopted via Prefectural Resolution No. 058-2013-CENEPRED, 29 October.

National Centre for the Estimation, Prevention and Reduction of Disaster Risks (CENEPRED) (2013). *Handbook for evaluating risks arising from natural phenomena*. Adopted via Prefectural Resolution No. 058-2013-CENPRED of 29 October.

National Centre for the Estimation, Prevention and Reduction of Disaster Risks (CENEPRED) (2013). *Administrative procedural guideline for evaluating risks arising from natural phenomena*. Adopted via Prefectural Resolution No. 058-2013-CENPRED, 29 October.

National Forum (2012). *Normative framework for corrective and future disaster risk management, Law No. 29664, establishing the National Disaster Risk Management System – SINAGRED*, 30 November, Raúl Porras Barrenechea hemicycle, Congress of the Republic.

Presidency of the Council of Ministers. (2011). *Supreme Decree No. 048-2011-PCM adopting the Regulations of Law No. 29664*

References to legal texts

National Water Use Policy and Strategy of Peru, 24 April 2009.

Prepared by the Multisectoral Technical Commission in accordance with Ministerial Resolution No. 051-2007-PCM. Its purpose is to define the frame of reference within which the public and private sectors must interact when managing water resources in Peru, with a focus on integrated management. Chapter VII.12, which deals with prevention of risks, mitigation of impacts and adaptation to climate change, states that the goal is to continue efforts to prevent risks and mitigate the impacts of floods and droughts on human lives and the economy. Some of the proposed strategies are: establishing criteria and parameters for evaluating hydrological conditions with a view to issuing declarations of states of emergency and implementing systems for predicting and providing early warning of extreme events.

Law on Water Resources, No. 293338

Title I National Water Use Management System

CHAPTER II, National Water Board, Article 15: Role of the National Water Board:

1. To prepare the national water use policy and strategy and the national water use plan and to implement, oversee and evaluate its execution.
2. To establish guidelines for preparing and updating plans for the management of water resources in watersheds; to adopt them and to oversee their execution.
3. On the basis of previous technical studies, to declare the exhaustion of natural water sources, closed or protection areas, and states of emergency due to a water deficit or surplus, the contamination of natural water sources or any conflict related to the sustainable management of water resources, enabling the appropriate measures.
4. Operate, organize and administer the National Water Resource Information System

Title V, Protection of Water; Article 89 Prevention of the effects of climate change. The National Water Board, in coordination with the Environmental Board, must develop strategies and plans for preventing and adapting to the effects of climate change, in relation to volumes of water and local, regional and national climate variations. Likewise, it analyses the vulnerability of water resources, glaciers, lakes and water flows in conjunction with climate change.

Uruguay

María Methol[1] and Daniel Silveira[2]

Background

Uruguay is located between 30 and 35 degrees latitude south and the climate is subtropical with well-defined seasons. The mean annual average is 18°C.; the maximum mean is 30°C and the minimum is 7°C, even though the extremes may range from -6°C (winter) and 40°C (summer). Average annual rainfall varies between 1,200 mm and 1,500 mm. There is a high degree of year-on-year variability, as well as considerable variability between seasons (Figure 1).

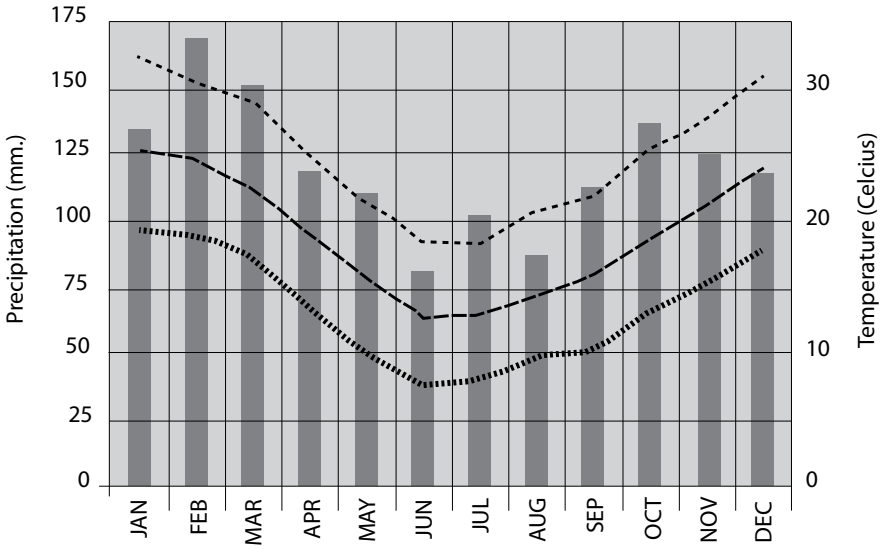

Figure 1. Mean monthly precipitation and mean, maximum and minimum temperatures. Artigas Weather Station

[1]Ing. Agr. Montevideo, Uruguay
[2]Ing. Agr. Salto, Uruguay

Table 1. Interannual variability of precipitation for 1971-2009 for Artigas Weather Station (No. 86330)

MONTH	MEAN RAINFALL (mm) [1]	DESVEST (mm) [1]	% [2/1]	MAX (mm)	MIN (mm)
JAN	139.34	108.12	77.59%	449.70	14.40
FEB	161.17	108.94	67.59%	427.60	9.20
MAR	136.63	93.47	68.41%	363.70	29.10
APR	162.98	123.51	73.96%	520.60	15.00
MAY	124.59	92.15	73.96%	367.40	1.10
JUN	94.10	52.34	55.62%	247.90	14.10
JUL	91.03	66.28	72.81%	307.90	20.00
AUG	72.49	48.64	67.10%	187.90	3.00
SEP	108.23	65.38	60.41%	283.40	15.90
OCT	137.58	69.43	50.47%	336.00	30.00
NOV	143.75	115.16	80.11%	562.80	3.50
DEC	125.40	91.14	72.68%	436.90	11.00

The majority of the severe drought events in Uruguay have been linked to the El Niño Southern Oscillation (ENSO) phenomenon, when negative variations occur in the equatorial Pacific Ocean and positive deviations occur in the Southern Oscillation Index (SOI) (Figure 1 and Table 1). Another factor is the (colder) water temperature of the Atlantic Ocean in the Gulf of Santa Catarina. As these events do not feature the same duration, severity or geographical distribution, they generate a high degree of uncertainty.

Over the past two decades, droughts occurred in 1988/89, 1998/99, 2005 (partial, in the Northeast), 2008/9 and 2010/11 (in the North). Over the last ten years, the most severe and most widespread drought was recorded in 2008/09. The sectors most affected by drought are agro-industry and energy, given the crucial role of agro-livestock production in the economy and the country's reliance on hydroelectric power.

Monitoring and early warning systems

The Agro-climate and Information Systems Unit of the National Institute for Agro-livestock Research (INIA-GRAS, available from: http://www.inia.org.uy/online/site/148070I1.php) publishes such agro-climatic variables as deviations in rainfall, soil water percentage and vegetation index on a monthly basis (NDVI) but no thresholds have been defined for each variable or set of variables.

The Uruguayan Meteorological Institute (INUMET) http://www.meteorologia.gub.uy) generates two monthly rainfall indicators: precipitation quintiles (Table 2) and the Standardized Precipitation Index at 1, 3, 6 and 12 months. Quintiles for periods of three months or more with a precipitation quintile of 2 or less in a given locality are defined as meteorological drought. The Department for Renewable Resources (RENARE) of the Ministry of Livestock, Agriculture and Fisheries (MGAP) (http://www.renare.gub.uy/) develops soil-related information like the Uruguayan Soil Recognition Charter on a scale of 1:1,000,000 and a soil group charter CONEAT (1:20.000). This consists of a zoning system for homogeneous areas defined by their productive capacity as compared with the country's mean production capacity (index of 100). A new soil charter featuring greater resolution (1:40,000) is in the works.

Table 2. Precipitation quintiles by weather station

STATION	MAY 2013	JUN 2013	JUL 2013	AUG 2013	SEP 2013	OCT 2013
BELLO UNIÓN	4	1	3	1	3	1
ARTIGAS	4	1	3	1	1	2
RIVERA	5	1	2	2	2	3
SALTO	5	0	2	1	3	5
TUCUAREMBÓ	5	1	1	2	4	5
PAYSANDÚ	5	0	2	1	3	2
MÉLO	3	2	2	3	6	4
YOUNG	4	1	3	1	4	3
PASO DE LOS TOROS	5	1	3	2	5	3
MERCEDES	4	1	2	2	2	3
TREINTA Y TRES	4	1	2	3	6	1
FLORIDA	4	1	4	3	5	1
COLONIA	3	1	1	2	5	1
ROCHA	4	2	2	3	5	0
SAN JOSÉ	3	1	2	1	6	2
CARRASCO	3	1	2	1	5	0

Much more than normal: quintile 5
More than normal: quintile 4
Normal: quintile 3
Less than normal: quintile 2
Much less than normal: quintile 1

In addition, the INIA-GRAS website publishes soil moisture balance figures on a monthly basis. This makes it possible to estimate the water content available in a given region, in the light of soil storage capacity, effective precipitation, potential atmospheric demand for water and transpiration of vegetation (Penman-Monteith method).
All of this information will be included in a new information system that is being developed by the MGAP, called the National Agro-livestock Information System. The main aim is to help prevent and control risks in the field of agro-livestock production. Emphasis will be placed on evaluating agro-climatic risks for different crops and types of livestock production through the analysis of time series (production, meteorological and social statistics) and simulation models. In addition, agro-climatic variables will be monitored and early warning systems further improved via the introduction of predefined thresholds.

The meteorological and hydrological institutions and networks operating in the drought management field are MGAP, given the high impact of drought on the agricultural and livestock sector, and the National Emergency System. MGAP operates the Emergency Agro-livestock Fund and declares emergencies on the basis of assessments provided by INUMET and INIA-GRAS organizations. The National Water Department (Ministry of Housing, Land Use and the Environment) was established recently with a view to managing the administration, use and control of water resources, in accordance with the provisions of the Water Code (Decree-Law No. 14,859) and Law No. 16,858 on Agricultural Water, in close coordination with MGAP.

There is a need to inject additional human and material resources into INUMET, given that for decades, the previous Directorate of Meteorology did not have the necessary budgetary resources to function properly and update equipment. The weather station network operated by INUMET is inadequate in terms of geographical distribution. The point should also be made that the weather stations are not automated.

Vulnerability assessment

The agribusiness sector is the leading economic and social activity in view of its contribution to job creation, GDP (9 per cent of the primary sector and 25 per cent when agribusiness is included) and exports (70 per cent of the total).

Here, the main risk is drought. Even though all agro-livestock activities are impacted by a drought event, livestock farming is the hardest hit, owing to its key socioeconomic role and the extent of its territorial coverage. Production is dependent on natural grasslands, and when droughts start in spring, this leads to heavy losses which primarily affect live-

stock producers, who are obliged to sell part of their herd at a loss and reduce pregnancy rates, resulting in fewer calves the following year. In many cases, drought leads to the death of livestock (drought-related livestock mortality has been estimated at 1 per cent). These losses in turn impact the meatpacking industry and related services (transport, agricultural machinery, etc.) for the next two or three years to come because of the drop in the amount of livestock for slaughter. For the drought of 2008/09, direct losses were estimated at $400 million; when the indirect losses in the meatpacking industry and related services as well as the drop in employment are factored in, losses amounted to $1 billion (3 per cent of GDP) (Paolino et al., 2010).

The most vulnerable actors are small family producers, who account for 57 per cent of all livestock farms. They raise cattle using natural grasslands located on soil that is not suitable for farming owing to its low capacity for water storage and is therefore very vulnerable to water stress. In addition, they have limited financial capacity and resources to purchase feed additives to mitigate livestock loss. Another major problem is the lack of drinking water for people and livestock, as a result of which the local authorities and MGAP are obliged to move animals and allocate drinking water.

According to a study by Paolino et al (2010), droughts affect all economic sectors and production factors, and the impact of these effects is compounded by the effects generated within the cattle breeding sector. Consequently, this is a problem that involves an impact on society as a whole, not just on livestock producers who bear the brunt of the drought-related drop in production. As can be expected, the overall impact is much broader.

Relief fund for emergencies and drought response

When an agricultural and livestock emergency is declared, usually due to drought, the Agro-livestock Emergency Fund (FAE) is used to support those producers who have been hardest hit by the drought.

MGAP procures livestock feed additives, usually via imports, and divides them up among the most vulnerable family producers with the help of Rural Development Committees which operate in every department and on which local authorities and local producers' associations are represented. These additives are provided via loans at very low rates, which producers must pay back to MGAP. During the 2008/09 drought, more than 30,000 tonnes of additives and grains were distributed, representing a total value of some $6 million.

The National Emergency System also facilitates the implementation of such measures, es-

pecially as far as water distribution is concerned. Other forms of support include subsidized electricity rates for dairy establishments. The MGAP Agro-livestock Programming and Policy Office is currently analysing the implementation of parametric insurance based on the NDVI of pastures for acquisition by MGAP in order to ensure the availability of funds for purchasing feed additives in time of drought (Methol, 2012).

Drought mitigation practices

- Promote the development of "Multipredial" irrigation by means of shared dams;
- Help develop solutions for ensuring the supply of water to establishments run by small and medium-sized livestock and dairy producers throughout the country (water well, mills, storage dams and distribution infrastructure in the establishment);
- Promote good range management practices in order to boost production system output and increase resilience to drought events (management based on fodder height, reduction of animal density, division of pastures, shade, drinking troughs, etc.).

By means of various projects implemented by the MGAP's General Directorate for Rural Development, which enjoy the support of international development cooperation bodies such as the World Bank and the Inter-American Development Bank, family and small producers are briefed on projects in their establishments with a view to the application of the various means for preventing and mitigating the impact of drought (Table 3).

Table 3. Number of projects implemented and amounts disbursed via the MGAP* General Directorate for Rural Developmen

	NUMBER OF PROJECTS	AMOUNTS (USD)
WATER FOR ANIMAL PRODUCTION	1,894	12,087,314
DROUGHT PREVENTION	682	3,164,970
RRNN (WATER)	1,667	10,018,679
LIVESTOCK PROJECT	292	360,783
CATTLE BREEDING SUPPORT PLANS	1,138	1,278,744
TOTAL	5,673	26,910,490

Source: General Directorate for Rural Development – MGAP

* For an explanation of the MGAP project, see page 118

Need for drought prevention knowledge and skills

Various steps have been taken to promote adaptation to drought and greater climate variability, which increases after a drought occurs. What is lacking is a comprehensive climate risk management policy in the agricultural and livestock sector, which promotes drought prevention and relief, including financial management of support via financial instrument for the transfer of risk (parametric insurance, disaster relief funds, etc.). A comprehensive climate risk management policy would include:

- Developing an adequate drought management framework;
- Improving and developing drought risk estimation methodologies for different regions and production types; and
- Improving and extending early warning systems, by defining thresholds and establishing protocols for action.

References

Bidegain M.(2009). Variabilidad climática y sequías en Uruguay Departamento de Ciencias de la Atmósfera. Facultad de Ciencias, Universidad de la República de Uruguay (Department of Atmospheric Sciences. Faculty of Sciences, University of the Republic of Uruguay).

Dirección General de Recursos Naturales Renovables del MGAP http://www.renare.gub.uy/

Instituto Uruguayo de Meteorología (INUMET) (Uruguayan Institute of Methodology). http://www.meteorologia.gub.uy.

Methol M. (2012). *Estudio de factibilidad: seguro de índices para cubrir sequías extremas en pasturas de áreas ganaderas*. In: OPYPA Yearbook 2012. 311-331 http://www.mgap.gub.uy/opypa/ANUARIOS/Anuario2012/material/pdf/27.pdf

Paolino C., M. Methol M. and D. Quitans. (2010). *Estimación del impacto de una eventual sequía en la ganadería nacional y bases para el diseño de políticas de seguros*. In: OPYPA Yearbook 2010. 277-287 http://www.mgap.gub.uy/opypa/ANUARIOS/Anuario2010/material/pdf/23.pdf

Proyecto Manejo Integrado de Recursos Naturales y la Biodiversidad (Producción Responsable). Dirección General de Desarrollo Rural del MGAP (General Directorate for Rural Development, MGAP). http://www.cebra.com.uy/presponsable/

Unidad Agro-clima y Sistemas de Información del Instituto Nacional de Investigación Agropecuaria (INIA-GRAS). http://www.inia.org.uy/online/site/148070I1.php

Valdivia P., Stutley C., Baccini D. Vila F., (2013). (forthcoming). *NDVI Pasture index-based insurance for Livestock Producers in Uruguay*. Feasibility Study: Final Report. The World Bank

ANNEX 1: WORKSHOP PARTICIPANTS AND ORGANIZERS

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ANNEX 2: WORKSHOP AGENDA (4-6 DECEMBER 2013)

Workshop Agenda: Day 1

08:30-09:00 Registration

09:00-13:00 Session 1: Opening and Country reports

09:00-10:00 Session 1a: Opening Statements

- Opening statement(s) by High-level authorities from the Gov't of Brazil (15 Minutes)
- Welcoming statement (Robert Stefanski, on behalf of Organizing partners) (10 minutes)
- A roundtable introduction of participants and expectations (35 minutes)

10:00-10:30 Session1b: Overview

Overview of the initiative, objectives and scope of the Workshop (UNW-DPC)

11:00–10:00 Session 2: Setting the Scene (+1 day)

11:00-12:00 Session 2a: Keynote (Donald A. Wilhite, University of Nebraska)

12:00-13:00 Session 2b: Drought management policy: The 10-step process (Daniel Tsegai, UNW-DPC)

14:00–14:30 Session 2c: Biodiversity and Drought (Simone Schiele, CBD)

14:30- 16:30 Session 2d: Country Reports

Country reports on drought status/management strategies

17:00-18:30 Session 2e: Breakout Groups (3 groups)

- Group A: What are the challenges for developing national drought policies?
- Group B: What are the institutional arrangements necessary for developing national drought policies?
- Group C: What are the steps being undertaken for developing national drought policies (country specific discussion)?

Workshop Agenda: Day 2

09:00 – 10:00 **Session 2f: Presentations of Working Group Results and Discussion**
(10 minutes per group and 30 minutes for discussion)

10:00-12:45 **Session 3: Drought Monitoring and Early Warning Systems**
(Robert Stefanski, WMO)

10:00-10:45 **Session 3a: Thematic Presentation**

- Introduction to drought monitoring and early warning systems
- Data requirements (meteorological, hydrological, etc.) for drought monitoring Identifying occurrence of/exposure to droughts (types, onset, intensity)
- Different drought indices and measurement methods
- Successful examples/Ongoing initiatives

11:15-12:45 **Session 3b: Breakout Groups**

- Group A: What are the current procedures/ challenges on Early warning systems?
- Group B: What are the meteorological and hydrological networks, data quality, sustainability needed?
- Group C: What mechanisms are in place for communicating and liaising drought monitoring and early warning information between national institutions?

13:45- 14:45 **Session 3c: Presentations of Working Group Results and Discussion**
(10 minutes per group and 30 minutes for discussion)

14:45-18:30 **Session 4: Vulnerability and Risk Assessment**
(Heitor Matallo, UNCCD)

14:45-15:30 **Session 4a: Thematic Presentation:**

- Impacts of drought: Environmental, economic, societal considerations/ implications
- Significant secondary and tertiary impacts
- Successful examples/ongoing initiatives targeting vulnerability and risk assessment

Day 2 cont'd

15:30–17:00 **Session 4b: Breakout Groups:**

- Group A: Who/What is most vulnerable to drought in your country
- Group B: Provide the causes/reasons of vulnerability to drought in your country
- Group C: What are the criteria you used for prioritizing vulnerability?

17:30-18:30 **Session 4c: Presentations of Working Group Results and Discussion**
(10 minutes per group and 30 minutes for discussion)

Workshop Agenda: Day 3

09:00 -14:30 **Session 5: Drought Preparedness, Mitigation and Response**
(Mohamed Bazza, FAO)

09:00–10:00 **Session 5a: Thematic Presentation**

- Drought preparedness
- Drought mitigation measures
- Integration of drought response and recovery in drought plan

10:30-12:00 **Session 5b: Breakout Groups**
Using the result of the impact and vulnerability assessment (Session 4),
i. Develop risk managements measures
ii. Include both medium- and long-term measures
iii. Specify the responsible agency(ies) for each measure

13:30- 14:30 **Session 5c: Presentation of Working Group Results and Discussion**
(10 minutes per group and 30 minutes for discussion)

14:30 – 17:00 **Session 6: Wrap-up and Concluding Session**
(Robert Stefanski, WMO)

14:30 – 16:00 **Country Representative Feedback**
A selection of countries present the take-home message from the workshop and their action plans and specific foreseen implementation challenges followed by discussion

16:30 – 17:00 **Synthesis and Concluding Remarks:**
(WMO, on behalf of all partners and hosting organization)

- Briefing on follow-up and expectations and closing speech (WMO)
- Q & A