TOWARDS A COMPENDIUM ON NATIONAL DROUGHT POLICY

PROCEEDINGS OF AN EXPERT MEETING

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Towards a Compendium on National Drought Policy

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Editors

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Proceedings of a WMO Expert Meeting held in Washington, DC, USA

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Proposed Elements in the Compendium on National Drought Policy

Preface

Given the current concerns with climate change, projected increases in the frequency, intensity, and duration of droughts and resulting impacts on many sectors, in particular food, wáter, and energy, there is cause for concern regarding the lack of drought preparedness and appropriate drought management policies for virtually all nations. Despite the repeated occurrences of droughts tlhroughout human history and the large impacts on different socio-economic sectors and the environment, no concerted efforts have ever been made to initiate a dialogue on the formulation and adoption of national drought policies. Amongst all the countries in the world, only Australia has developed a national drought policy based on the principles of risk management. However, the elements of this policy have deteriorated in recent years resulting in a re-examination of this policy today.

In order to address the issue of national drought policy, the World Meteorological Organization (WMO) Congress at its Sixteenth Session held in Geneva from 16 May to 3 June 2011 recommended the organization of a “High Level Meeting on National Drought Policy (HMNDP). Accordingly, WMO and the Secretariat of the United Nations Convention to Combat Desertification (UNCCD), in collaboration with a number of UN agencies, International and Regional Organizations, and key national agencies, plan to organize the HMNDP in Geneva in March 2013.

Since the National Drought Policy for any given country will depend very much on the local circumstances, institutional capacity, and priorities, it is important that the guidance on national drought policy to any government should not be prescriptive. Instead, a Compendium of Desirable Elements in a National Drought Policy will be compiled and countries around the world will be encouraged to adopt the elements that will be appropriate to their local circumstances and national priorities and design their national drought policies.

Hence, WMO, together with the George Mason University, the United States Department of Agriculture (USDA), and the U.S. National Drought Mitigation Center (NDMC) of the University of Nebraska-Lincoln organized an Expert Meeting on the Preparation of a Compendium on National Drought Policy from July 14-15, 2011, at George Mason University in Fairfax, Virginia, USA.

Fourteen papers presented at the Expert Group Meeting are brought together in this volume. These papers present an overview of national drought policies; the elements of national drought policies; drought plans in selected countries; the integrated drought information systems, and the proposed elements in the Compendium on National Drought Policy.

We wish to convey our sincere thanks to Mr. Michel Jarraud, the Secretary-General of WMO, and Dr. Roger Stough, Vice President for Research and Economic Development of George Mason University for their encouragement and support in the organization of the Expert Meeting at George Mason University.

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National Drought Policy - Overview

Current Droughts: Context and Need for National Drought Policies

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Abstract

Droughts produce a large number of socio-economic impacts which may arise from the interaction between natural conditions and human factors. There is growing evidence that the frequency and extent of drought has increased as a result of global warming. Some information on the current droughts in 2011 around the world in the Horn of Africa, China, Texas in the US, and England and Wales is presented. The context of current droughts calls for pro-active future actions to cope with droughts. National governments must adopt policies that engender cooperation and coordination at all levels of governments in order to increase their capacity to cope with extended periods of water shortages due to drought. Despite the repeated occurrences of droughts throughout human history and the large impacts on different socio-economic sectors, no concerted efforts have ever been made to initiate a dialogue on the formulation and adoption of national drought policies. The time is ripe for nations to move forward with the development of a pro-active, risk-based national drought policy. Without a coordinated, national drought policy that includes effective monitoring and early warning systems to deliver timely information to decision makers, effective impact assessment procedures, pro-active risk management measures, preparedness plans aimed at increasing the coping capacity, and effective emergency response programs directed at reducing the impacts of drought, nations will continue to respond to drought in a reactive, crisis management mode. In order to address the issue of national drought policy, the World Meteorological Organization (WMO) Congress at its Sixteenth Session held in Geneva from 16 May to 3 June 2011 recommended the organization of a "High Level Meeting on National Drought Policy (HMNDP). "Accordingly, WMO and the Secretariat of the United Nations Convention to Combat Desertification (UNCCD), in collaboration with a number of UN Agencies, International and Regional Organizations and key national agencies, plan to organize the HMNDP in Geneva in March 2013. Plans for the development of Compendium of Desirable Elements in a National Drought Policy are described.

Introduction

Drought ranks first among all natural hazards according to Bryant (1991) who ranked natural hazard events based on various characteristics, such as severity, duration, spatial extent, loss of life, economic loss, social effect, and long-term impact. Drought produces a large number of socio-economic impacts as water is integral to produce goods and provide certain services. The socio-economic impacts of droughts may arise from the interaction between natural conditions and human factors, such as changes in land use and land cover, water demand and use. Excessive water withdrawals can exacerbate the impact of drought.

Some direct impacts of drought are reduced crop, rangeland, and forest productivity; reduced water levels; increased fire hazard; increased livestock and wildlife death rates; and damage to wildlife and fish habitat. A reduction in crop productivity usually results in less income for farmers, increased prices for food, unemployment, and migration.

There is growing evidence that the frequency and extent of drought has increased as a result of global warming. The fraction of land surface area experiencing drought conditions has risen from 10-15 percent in the early 1970s to more than 30 percent by early 2000 (Dai et al. 2004). There has been a general tendency towards decreased precipitation in the semi-arid regions. For example, Henry et al. (2007) showed that during the period 1993-2006, there has been a strong and persistent rainfall deficit in eastern Australia and similarly reduced rainfall conditions in the south-west corner of Australia have continued. Reductions of unto 20 percent in annually

averaged totals are common across large regions of Australia. A global analysis has shown that abrupt changes in rainfall are more likely to occur in the arid and semi-arid regions, and that this susceptibility is possibly linked to strong positive feedbacks between vegetation and climate interactions (Narisma et al. 2007).

This paper presents some information on the current droughts in the first half of 2011 and the need for national drought policies to deal with the growing impacts of droughts around the world.

Current Droughts

Horn of Africa Drought Crisis Situation

As of early August 2011, drought in Somalia, Kenya, Ethiopia, and Djibouti pushed tens of thousands of people from their homes as millions face food insecurity. According to the press release of 17 August 2011 from the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), about 12 million people were desperately in need of food assistance across the Horn of Africa, as the worst drought in 60 years continued to ravage eastern Africa. Somalia was by far the worst hit of the three countries. An estimated 3 million of its 10million people were described as being “displaced” meaning that they have abandoned their homes and villages and fled to either Kenya or Ethiopia or into the scores of makeshift tented shanty-towns which have sprung up around Somalia's war torn capital city Mogadishu. According to OCHA, an additional 800,000 people in Kenya were in need of food aid from August 2011, and the numbers of Somali refugees continued to rise. About 1.25 million children across Southern Somalia were in urgent need of life saving interventions and 640,000 were acutely malnourished.

Evidence of severely reduced food access, acute malnutrition, and crude mortality indicates that a famine was ongoing during August 2011 in two areas of southern Somalia: the Bakool agropastoral livelihood zones and all areas of Lower Shabelle (FEWSNET 2011). A humanitarian emergency existed across all other regions of the south, and the humanitarian response was inadequate to meet emergency needs. This crisis in southern Somalia was driven by a combination of factors. The total failure of the October-December *Deyr*rains (secondary season) and the poor performance of the April-June *Gu*rains (primary season) have resulted in crop failure, reduced labor demand, poor livestock body conditions, and excess animal mortality.

Most of the Greater Horn of Africa (GHA) may be classified to have arid and semi-arid climate that is characterized by high variability in rainfall, and recurrences of extreme climate events such as drought and floods. According to CRED (2006), drought disasters account for less than 20 percent of the proportion of disasters occurrence in Africa, they represent more than 95 percent of the death toll caused by disasters and more than 80 percent of the number of people affected by disasters in Africa.

The drought crisis in GHA is due to repeated failures of rains over the past two years. According to ICPAC (2009), March – April – May rainy season in the central part of the GHA region in 2009 was very dry and most of this sector received between 25 to 75 percent of normal rains for the period, while Northern and Eastern Ethiopia, Eritrea and most of Somalia received less than 25 percent of normal rain for the period. The drought has been prolonged during the period June to September 2009 as most of Kenya received less than 25 percent of normal rains for this period. This deficit in rainfall comes after several consecutive rainy season failures witnessed in Somalia (four consecutive failures), in Ethiopia (four consecutive failures) in Kenya (three consecutive failures), and in Eritrea (three consecutive failures).

Severe droughts then persisted over most parts of the eastern sector of equatorial GHA since the last quarter of 2010 with far reaching socio-economic implications that included lack of water, pasture, energy and food; famine; loss of livestock, life and property; mass migration and environmental refugees, among others. The persistence of drought over some of these areas has been associated with La Niña conditions.

A typical December in much of East Africa is rainy; a 3-month rainy period ends before a dry stretch that usually lasts from January to March. In 2010, however, the rains were erratic and ended in early November. December was hot and dry. Two thirds of Somalia received less than 75 percent of normal rainfall (Somalia Water and Land Information Management 2011).Without rain, the pastureland and cropland in the region produced poor crops and little grass for livestock, leading to food shortages and livestock deaths. Poor or failed rainfall during the short rain growing season (October to December) is a classic La Niña signal. In late 2010, a strong La Niña cooled surface waters in the central and eastern Pacific Ocean, while allowing warmer water to build in the eastern Pacific. The pool of warm water in the east intensifies rains in Australia, the Philippines, and Indonesia. This pattern also increases the intensity of westerly winds over the Indian Ocean, pulling moisture away from East Africa toward Indonesia and Australia. This results in drought over most of East Africa.

The observed March-April 2011 rainfall in GHA (ICPAC, 2011) is shown in Fig. 1. The northern, eastern, and western parts of the northern sector of the GHA have received less than 25 percent of the MAM long-term mean rainfall by the end of April 2011. The central and southern parts of the northern sector received between 25 and 75 percent of the MAM long-term mean. This extended into the much of the western and central parts of the equatorial sector of the GHA and northern coast of Tanzania. The eastern parts of the equatorial sector recorded less than 25 percent of the MAM long-term mean during the March-April 2011 period. The southwestern parts of equatorial sector extending to most parts of the southern sector received between 75 and 125 percent of the MAM long-term mean.

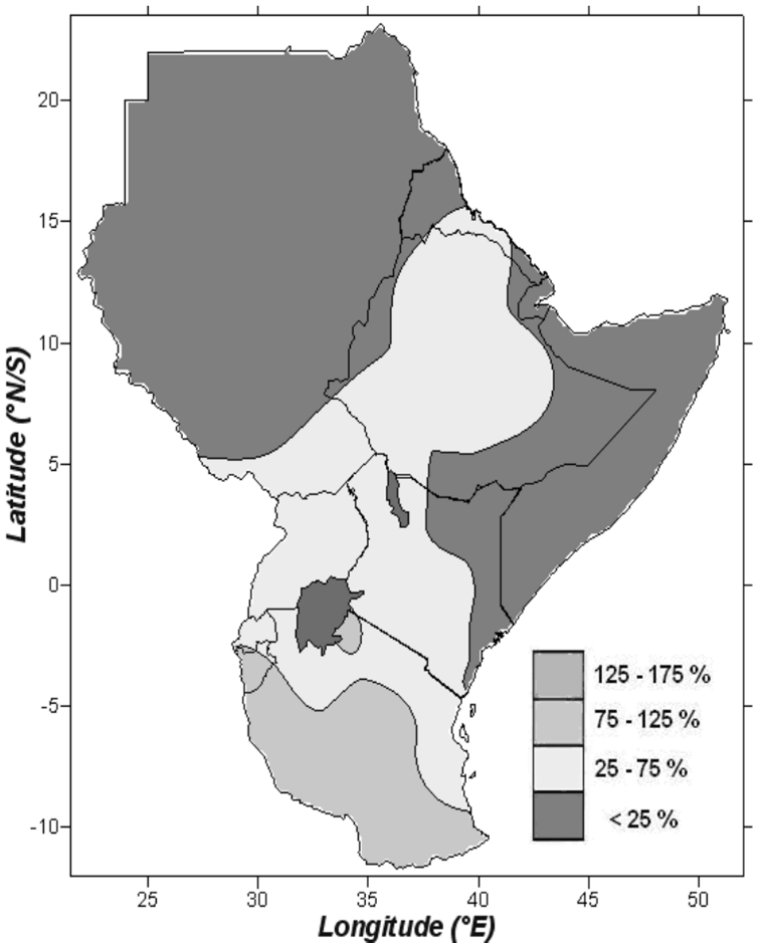

Figure 1. Observed March-April 2011 Rainfall in Greater Horn of Africa (Source: ICPAC 2011)

Detailed information for the March-April-May seasonal rainfall over the northern sector of the GHA in comparison to the long-term mean is shown in Figure 2. At most of the locations, rainfall during the three month period was less than 100 mm.

In Kenya, the Arid and Semi-Arid Lands (ASALs) are located in the Northeastern and Northern parts of the country, including many areas of the Southeast Lowlands and the Coast and they cover over 80 percent of the country's total area. According to the Kenya Meteorological Department, the country was under severe drought conditions in the ASALs. Rainfall during the March-April-May season ("Long Rains") in many of the ASALs was amongst the lowest. For instance, at Moyale, rainfall during this period was the lowest ever on record during the season during the last 50 years.

According to FEWSNET, during June and July, coastal Hagaa rain showers along the southern Somalia coast in the Shabelle and Juba regions have been below-average and erratic. The lack of coastal rains has negatively affected crops and cropping conditions in agro-pastoral areas leading to the drying out of some crops.

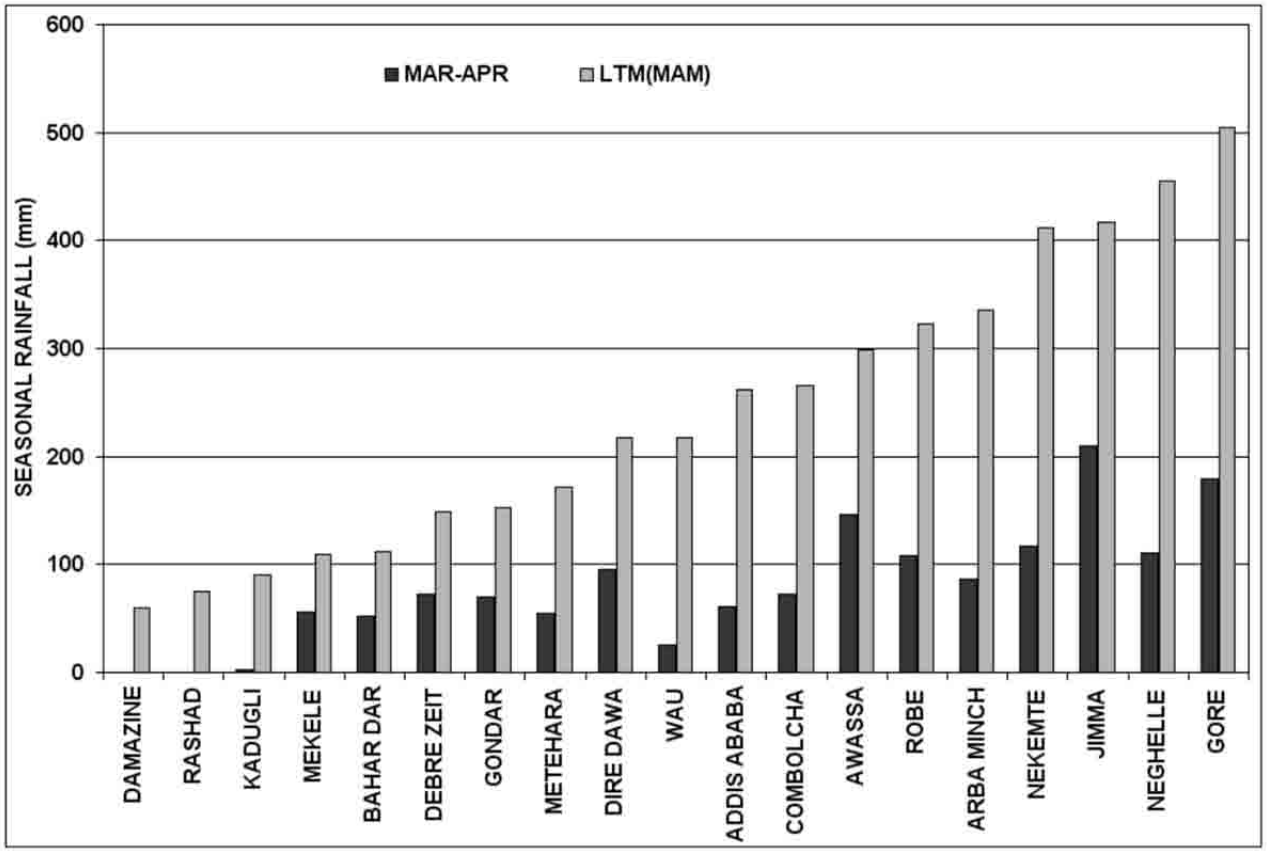

Figure 2. Comparison of Rainfall Received During March and April 2011 and the Long-term Mean for the March-April-May Seasonal Rainfall over Northern Sector of the GHA

According to FEWSNET (2011), as of 2 September 2011, about 18.91 million people in East Africa are declared food insecure, with the largest numbers in Somalia, Ethiopia, Kenya, and Sudan (Table 1).

Table 1. Food Insecure Population in Different Countries of East Africa(as on 2 September 2011)

Country	Food Insecure Population
Somalia	4 million
Ethiopia	4.95 million (including 450,000 refugees)
Kenya	4.15 million (including 402,000 refugees)
Sudan	4 million
South Sudan	1.5 million
Uganda	169,000
Djibouti	140,000 (including 20,000 refugees)
Total	18.91 million

Droughts in China

The monsoon rains that usually flood southern China's middle Yangtze River in spring did not come in 2011, and according to the China Meteorological Administration (CMA), rainfall in Hubei, Jiangxi, Anhui, Jiangsu and Zhejiang was at its lowest level in more than 50 years. Official figures from Hubei province showed that 1,392 reservoirs in the region were too depleted to generate any electricity at all.

High temperatures and record low rainfall in 2011 have caused water levels on the middle and lower reaches of the Yangtze River to dwindle, cutting support to thousands of hydropower plants as well as millions of hectares of farmland. Water levels on the Yangtze midstream in 2011 were 6 meters lower than they were the same time in the previous year, with rainfall only a fifth of the levels seen in 2010, according to the China Daily newspaper. According to the China Meteorological Administration (CMA), on July 25, southern China recorded the maximum range of high temperature. South of the Yangtze River, South China, the Yangtze-Hanshui Valley and the Yangtze-Huaihe Valley were all hit by heat wave.

Almost 35 million people across five provinces on the middle and lower reaches of the Yangtze have been affected to different degrees by the drought, according to the Chinese Ministry of Civil Affairs. That number included 4.2 million who have difficulty getting drinkable water. In Hubei and Hunan provinces, the drought has threatened drinking supplies for more than one-million people. In neighboring Jiangxi province, Poyang Lake, China's largest freshwater lake, has hit a 59-year low and rice transplants around it have stopped. Direct economic losses were estimated at 15 billion yuan ($2.3 billion).

The affected provinces of Hubei, Hunan, Jiangxi, Anhui, and Jiangsu together accounted for 47 percent of China's total rice output in 2010, according to China's Agricultural Yearbook. The drought has hit 7 million hectares of farmland, mainly in the five provinces of Hunan, Hubei, Jiangxi, Anhui and Jiangsu, the country's "home of rice and fish" along the middle and low-reaches of the Yangtze River. Rice acreage in these five provinces accounts for nearly half the total rice area. But early season rice accounted for only 16 percent of China's total rice output of 196 million tons in 2010.

Lake Honghu lies next to the Yangtze, separated from the river by a strip of land with dykes and sluice gates. The lake's waters are usually up to 1.5 meters deep across much of its 348 sq km (134 sq mile) area, but in 2011 the lake was about 40 cm deep at most.

Lake systems around the central Yangtze River have also dried up. In Hubei province, 1,400 small lakes have become so shriveled that authorities have declared them "dead" and banned any water pumping, state media reported. Known as the "land of a thousand lakes" and a major producer of China's grain and cotton, Hubei has been in the grip of a drought for over5 months during 2011, according to China's state-run news agency Xinhua. According to a survey conducted by the Hubei provincial agricultural department The drought has left about 315,000 people and 97,300 livestock in the province short of drinking water and affected about 2 million acres of farmland.

The drought, which has lasted for 5 months, has brought water levels in the middle part of the Yangtze to a near-record low. For the second time since the Three Gorges Dam, the world's largest hydroelectric project, began operating, officials have had to make emergency water discharges from it to help ease the drought.

Drought in Texas

After abundant rainfall during September 2009 to July 2010 in Texas, rains stopped in August 2010 (except for some isolated rain showers in September 2010) and it has remained almost completely dry in the South-Central U.S. region since October 2010 (Peña 2011). The El Niño pattern (which favors rain in the southern U.S. tier) was active in Texas during the first half of 2010, but in 2011 most of the South-Central U.S. region, including Texas, was experiencing the effects of the La Niña. La Niña favors a dry southern U.S. tier. While parts of central Texas received some rain on May 2, 2011, most of Texas was facing the 4th driest period on record. March and April were the driest March-April on record, by a large margin. The state averaged only 1.03 inches; the previous record was 1.76 inches and the long-term average is 4.18 inches.

As measured in Uvalde, Texas, which probably represents the relative drought situation in a large portion of the state, most of Texas entered into drought conditions (75% of average rainfall) around August 2010 and has remained in a dry spell since then (Fig. 3). April 2011 ended without any measurable rainfall, making the period from October 1, 2010, through the end of April 2011, in Uvalde, Texas, as the driest period on record. Only 1.13 inches of moisture fell, compared to a long term cumulative average of close to 11.3 inches during the same period.

In addition, unseasonably hot temperatures, dry forage and high, dry winds have increased the risk of road-side and field fires. Since the beginning of the official weather keeping in 1895 in Texas, 2011 marked the hottest June ever in Texas with an average of 85.2 degrees, breaking the previous mark of 84.9 set in 1953. Estimates indicate that wildfires have burned about 1.5 million acres in Texas, including about 6,400 in Kimble County.

According to the U.S. Drought Monitor, by August 2011, all of Texas was in a drought stage, and about one-fourth of the state was in "exceptional drought," the highest drought level that occurs every 50 to 100 years. The period from February through June was by far the driest on record with a statewide average of 4.26 inches of rain. The next driest on record occurred in 1917 with 6.45 inches.

The lack of rain has caught up to central Texas' soil, which is simply too dry to grow crops or grass. Grass for grazing has become scarce, and hay, a common supplement or replacement for grass, has skyrocketed in price because of its short supply. Corn and grain feed, a more water-intensive way of feeding cattle, was also scarce during drought (Mashhood, 2011). This has forced ranchers to start selling off cattle, whether slaughter-ready or not. High supply at auctions has driven down the price of cattle and other livestock, giving ranchers less money to buy seed cattle. To build herds back up, ranchers will have to buy much more expensive 3- to 4-year-old cattle. Ninety percent of Texas' beef cows are located in counties with severe to exceptional drought contributing the majority of the losses already suffered by Texas.

According to the Texas A&M University's Agrilife Extension Service, .the current drought is likely to be the costliest in a 12-month span. In May, Agrilife reported losses statewide at $1.2 billion. The cost of the current drought may be even twice that of the previous most-costly drought, which cost $4.1 billion in 2006.

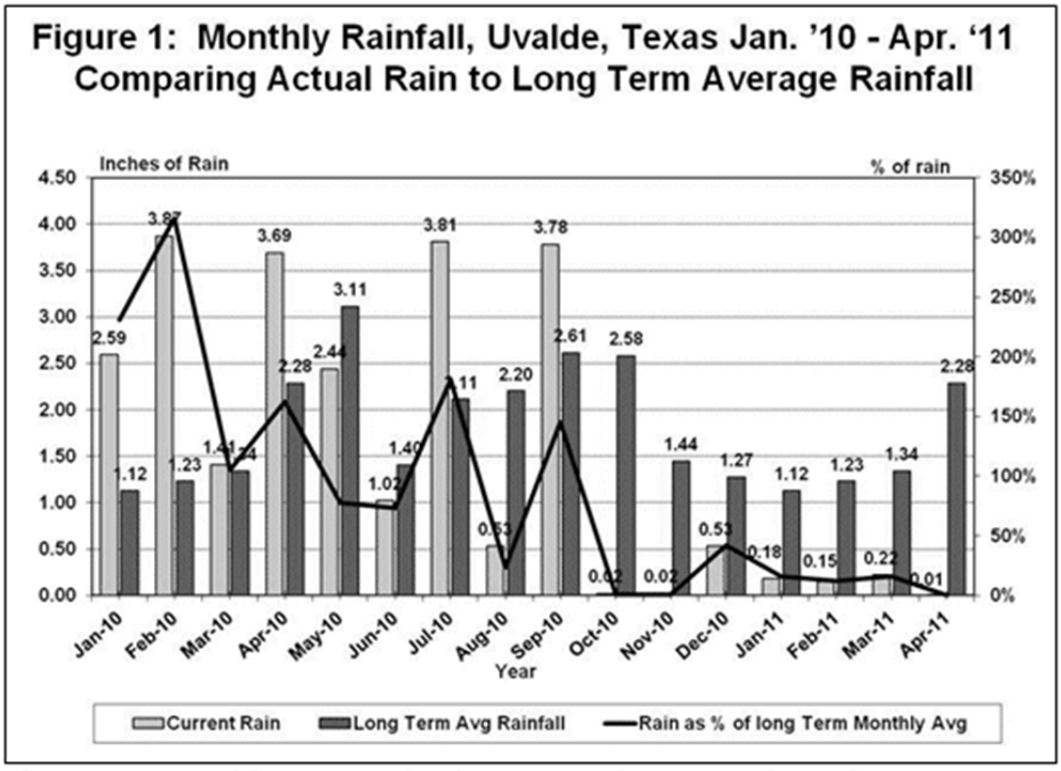

Figure 3. Monthly Rainfall in Uvalde, Texas, During January 2010 to April 2011 in Comparison to the Long-term Average Rainfall

Drought in England and Wales

The Environment Agency of United Kingdom announced on June 10, 2011, a move to drought status for Lincolnshire, Cambridgeshire, parts of Bedfordshire and Northamptonshire, and western Norfolk. This was triggered by river and groundwater levels and risk to the environment and farmers. Most of the South East (except an area covering central and northern London) was at risk of drought. Drought was declared in the Anglian region.

This has been the driest spring on record in the south east and central southern England and the driest across England and Wales since 1990. Some reservoir levels were below normal for the time of year and groundwater levels were in decline (as expected at this time of year).

The majority of rivers across south west, central, and eastern England had below average river flows, with some being notably low. Although some areas across the country have benefited from recent rainfall, this has done little to improve the situation in the driest areas.

Low river flows were impacting on farmers that rely on spray irrigation during dry spells in the growing season to water their crops. Water for spraying is abstracted from rivers under license and conditions attached to those licenses mean that some farmers have had to stop taking water for irrigation. Dry conditions also affected the livestock industry in certain parts of the country where grass growth has been held back.

Another important socio-economic impact of current droughts is that the average cost of cereals was going up. The average global price of cereals jumped by 71 percent to a new record in the year to April, more than three times higher than a decade ago, prompting FAO to warn that Europe faced a pivotal few weeks.

Context of Current Droughts for Pro-active Future Actions

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)**,** a warmer climate, with its increased climate variability, will increase the risk of droughts (Table SPM2 in IPCC 2007). An increase of droughts over low latitudes and mid-latitude continental interiors in summer is likely (Table SPM2 in IPCC 2007)), but sensitive to model land-surface formulation. The proportion of the land surface in extreme drought, globally, is predicted to increase by a factor of 10 to 30; from 1-3 percent for the present day to 30 percent by the 2090s. The number of extreme drought events per 100 years and mean drought duration are likely to increase by factors of two and six, respectively, by the 2090s (Burke et al. 2006).

Most semi-arid river basins in developing countries are more vulnerable to climate change than basins in developed countries, as population, and thus water demand, is expected to grow rapidly in the future and the coping capacity is low (Millennium Ecosystem Assessment, 2005). A number of global-scale (Alcamo and Henrichs 2002; Arnell, 2004), national-scale (Thomson et al. 2005), and basin-scale assessments (Barnett et al. 2004) show that semi-arid and arid basins are the most vulnerable basins on the globe with respect to water stress. According to an FAO study in which the climate change impact was not considered (Bruinsma 2003), an increase in irrigation water withdrawals of 14 percent is foreseen by 2030 for developing countries. If precipitation decreases, irrigation water demands, which dominate water use in most semi-arid river basins, would increase, and it may become impossible to satisfy all demands.

National governments must adopt policies that engender cooperation and coordination at all levels of governments in order to increase their capacity to cope with extended periods of water shortages due to drought. The ultimate goal is to ensure effective and inclusive coordination mechanisms to create more drought resilient societies and ensure food security at the domestic level.

Need for a National Drought Policy

With the world population projected to reach 7.5 billion, the world's farmers will have to produce40 percent more grain in 2020, and the challenge is to revive agricultural growth at the global level. Given the current concerns with climate change, projected increases in the frequency, intensity, and duration of droughts and resulting impacts on many sectors, in particular food, water, and energy, there is cause for concern regarding the lack of drought preparedness and appropriate drought management policies for virtually all nations. Despite the repeated occurrences of droughts throughout human history and the large impacts on different socio-economic sectors, no concerted efforts have ever been made to initiate a dialogue on the formulation and adoption of national drought policies. Amongst all the countries in the world, only Australia has developed a national drought policy based on the principles of risk management. However, the elements of this policy have deteriorated in recent years resulting in a re-examination of this policy today.

The time is ripe for nations to move forward with the development of a pro-active, risk-based national drought policy. Without a coordinated, national drought policy that includes effective monitoring and early warning systems to deliver timely information to decision makers, effective impact assessment procedures, pro-active risk management measures, preparedness plans aimed at increasing the coping capacity, and effective emergency response programs directed at reducing the impacts of drought, nations will continue to respond to drought in a reactive, crisis management mode. Lack of a clear national drought policy implies that governments at the national, state, and community levels will continue with the status quo, i.e., reacting to the impacts of drought with little coordination between national, state, and local agencies. National governments must adopt policies that engender cooperation and coordination at all levels of governments in order to increase their capacity to cope with extended periods of water shortages due to drought. The ultimate goal is to create more drought resilient societies.

The implementation of a drought policy can alter a nation's approach to drought management. In the past decade, drought policy and preparedness has received increasing attention from governments, international and regional organizations, and nongovernmental organizations. 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 policy should be consistent and equitable for all regions, population groups, and economic sectors and consistent with the goals of sustainable development. 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 programs, creating a safety net of emergency response programs that ensure timely and targeted relief, and providing an organizational structure that enhances coordination within and between levels of government and with stakeholders.

The goals of a national drought policy described above could contribute immensely to poverty alleviation, economic development, and societal and environmental wellbeing as a whole, especially in the developing countries. Consequently, it would be most useful if a high level dialogue on the national drought policies could be initiated to ensure that government actions transcend far beyond the conventional reactive approaches. In fact, it has been demonstrated that traditional drought assistance or relief programs actually result in less self-reliance and more dependence on governments, increasing the vulnerability of sectors to future drought events. If more acceptable results are to be achieved in dealing with droughts, a new approach should be taken and a new attitude adopted. A high level meeting could help develop such a new approach through development of a common understanding of the issues involved, discussing the different approaches that could be incorporated into a national drought policy and finally, establishing a framework of a national drought policy that could help all the nations around the world.

WMO Plans for the Development of National Drought Policies

In order to address the issue of national drought policy, the World Meteorological Organization (WMO) Congress at its Sixteenth Session held in Geneva from 16 May to 3 June 2011 recommended the organization of a "High Level Meeting on National Drought Policy (HMNDP)."Accordingly, WMO and the Secretariat of the United Nations Convention to Combat Desertification (UNCCD), in collaboration with a number of UN Agencies, International and Regional Organizations and key national agencies, plan to organize the HMNDP in Geneva in March 2013.

HMNDP will provide practical insight into useful, science-based actions to address the key drought issues being considered by governments and the private sector under the UNCCD and the various strategies to cope with drought. The event will include a high-level or policy segment for Heads of State or Governments and Ministers.

Need to Develop a Compendium on National Drought Policy

Since the National Drought Policy for any given country will depend very much on the local circumstances and priorities, it is important that the guidance on national drought policy to any government should not be prescriptive. Instead, a Compendium of Desirable Elements in a National Drought Policy (*hereinafter referred to as Compendium*) will be compiled and countries around the world could be encouraged to adopt the elements that will be appropriate to their local circumstances and national priorities and design their national drought policies.

Hence WMO, in collaboration with the George Mason University's College of Science (COS), the US National Drought Mitigation Center (NDMC) and the U.S. Department of Agriculture (USDA) organized the Expert Meeting on the Preparation of a Compendium on National Drought Policy at the George Mason University in Fairfax, Virginia (USA), from 14 to 15 July 2011. Outcomes of the meeting are described by Sivakumar et al. (2011).

Conclusions

Given the current concerns with the increasing frequency and magnitude of droughts, the time is now ripe for the formulation of effective national drought policies. A compendium on national drought policies and consultations with governments ahead of the HMNDP could help initiate a global debate for quick formulation and adoption of national drought policies. Organization of the HMNDP could provide an opportunity for common dialogue and a consensus inter-governmental declaration endorsing the adoption of national drought policies.

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National Drought Policies: Addressing Impacts and Societal Vulnerability

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Abstract

Drought is a naturally occurring event that is associated with virtually all climatic regions. Given its slow onset and other characteristics, including its spatial dimensions and duration, impacts are difficult to assess and have been, historically, poorly documented. These impacts are strongly influenced by a society's exposure to the hazard and the vulnerability of that society to the hazard. This vulnerability is continually changing in response to increasing population, land use changes, technology, government policies, and many other factors. Therefore, each drought event is superimposed on a society with differing vulnerabilities than existed when the previous drought event occurred. Drought impacts are increasing worldwide, both as a result of these changing vulnerabilities and, perhaps, because of an increase in the frequency, severity, and duration of drought events. To lessen societal vulnerability, it is imperative for nations to move away from the crisis management approach to drought management and toward a more proactive, risk-based approach, including the adoption of national drought policies that reflect this new paradigm. Emphasis must be given to the development of improved drought monitoring and early warning systems and the delivery of this information to decision makers at all levels. It is also essential that vulnerability assessments be conducted in order to determine who and what is at risk and why. A final step is the identification and implementation of appropriate mitigation measures or actions that will reduce future impacts on economic sectors and population groups.

Introduction

Drought is a complex, pervasive natural hazard, often referred to as a 'creeping phenomena' (Tannehill, 1947). As a result of its complexity, literally hundreds of definitions of drought exist, reflecting different climatic characteristics from region to region and sector-specific impacts. Conceptually speaking, drought results from a deficiency of precipitation from expected or normal that, when this deficiency is extended over a season or longer period of time, is insufficient to meet the demands of human activities. Droughts are typically classified as meteorological, agricultural, hydrological, or socioeconomic (Wilhite and Glantz 1985; Dracup et al. 1980). However, all types of drought originate from a deficiency of precipitation resulting in water shortage for some activity or some group. Of course, the severity of drought in both a temporal and spatial sense can be exacerbated by other factors such as high temperatures, low relative humidity, and high winds. Drought must be considered a relative, rather than absolute, condition. The ultimate results of these precipitation deficiencies are, at times, enormous economic and environmental impacts as well as personal hardship. These impacts ripple through the economy and produce significant secondary and tertiary impacts as well.

Impacts of drought appear to be increasing in both developing and developed countries, a clear indication of nonsustainable development in many cases and, perhaps, providing an indication of changes in climate and its variability resulting from an enhanced greenhouse effect or global warming. Lessening the impacts of future drought events will require nations to pursue development of drought policies that emphasize a wide range of risk management techniques, including improved monitoring and early warning systems, preparedness plans, and appropriate mitigation actions and programs.

Drought Management: The Crisis Management Approach

The approach taken by essentially all governments at both the national and local level is to react to drought through what is commonly referred to as the hydro-illogical cycle (Figure 1). This approach is characterized by a growing level of concern as the severity of the drought increases over a period of several months or more. However, no drought management plan is in place that oversees government agency responses or the coordination of those responses. It is widely known that responding to crisis is largely ineffective, and the actions of the multiple government agencies with responsibilities for responding to the drought conditions are usually poorly coordinated. This type of response is largely directed at addressing the impacts that are occurring. These impacts are a reflection of societal vulnerability. This largely reactive approach actually leads to an increase in societal vulnerability since the recipients of drought relief or assistance programs become dependent on government programs to rescue them by providing resources to survive the crisis. This approach discourages the development of self-reliance and implementation of improved resource management practices.

All drought-prone regions have a 'reference' drought that has helped to focus attention on the devastating impacts that can be associated with a severe drought episode. For the United States, the reference drought for most parts of the country is the severe drought that began in 1931 and extended through 1939 for many parts of the country and is associated with the famous 'Dust Bowl' period in American history. This series of drought years was noteworthy for several reasons. First, the severity, duration, and spatial extent of the drought during a critical settlement period in the nation's history and the economic depression of the period resulted in substantial economic, environmental, and social impacts across the country, including the exodus of many people from the Great Plains to the far western states, especially California and Oregon. The peak drought year, in terms of areal coverage, was 1934, when 65% of the country experienced severe to extreme drought. Second, it was the first time the federal government had become actively engaged in drought relief programs. The federal government had largely relied on the efforts of private organizations, such as the Red Cross, and churches to provide relief to the victims of drought (Wilhite 1983; Wilhite et al. 1986). The government's engagement in drought relief included a combination of reactive programs and several more noteworthy mitigation-type measures directed at reducing the vulnerability of the Great Plains and other regions. Most noteworthy was the formation of the Soil Conservation Service within the U.S. Department of Agriculture. This agency's mission was to improve soil and water management and conservation practices throughout the country. Of course, during this period there was no drought early warning system in place, as government entities relied largely on precipitation departures from normal to make assessments of drought severity in the region.

The impacts of drought are much more complex today, a trend that will continue. Once largely characterized as a problem for the agricultural sector, the impacts of drought have now escalated and cascaded into many other sectors such as energy, transportation, recreation and tourism, urban water supply, and water quality. The environmental and social impacts are also more dramatic, resulting in significant conflicts between water users. These impacts cascade as drought conditions evolve from a short-term precipitation deficiency, commonly referred to as meteorological drought, to a longer-term period of precipitation deficiency leading to agricultural and hydrological drought, as illustrated in Figure 2. Agricultural drought is associated with deficiencies in soil moisture, which, in turn, affects agricultural production. As precipitation deficiencies continue, shortages in hydrological systems (i.e., reservoirs and lakes, streamflow, ground water levels) begin to emerge, resulting in significant impacts in the other sectors mentioned above.

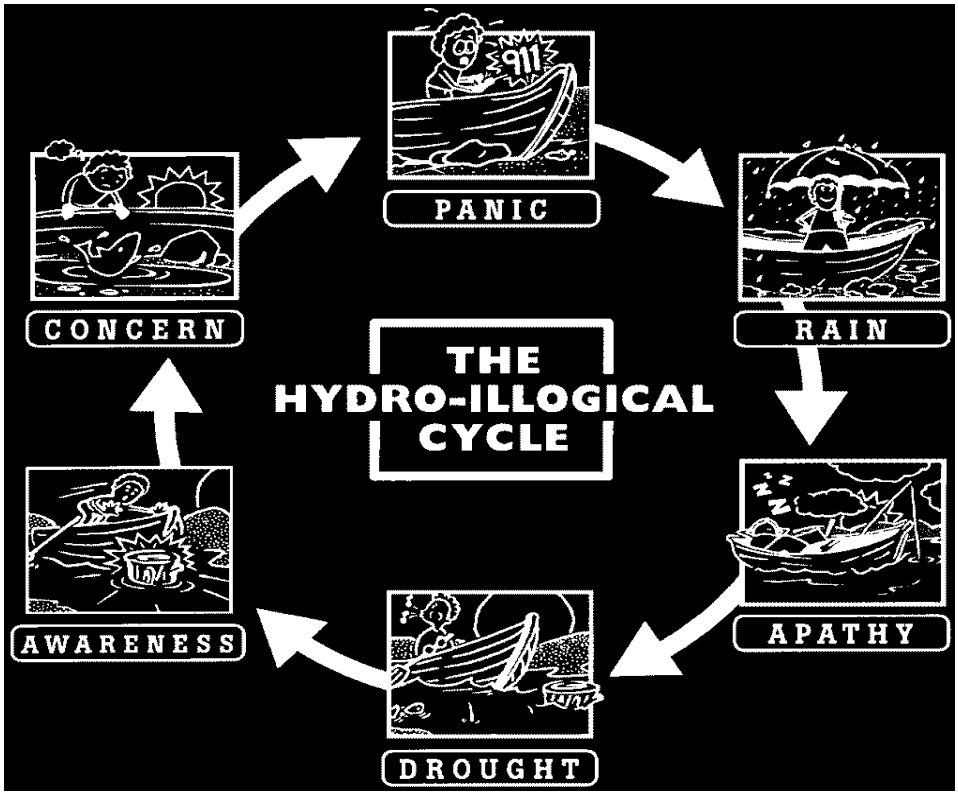

Figure 1.The hydro-illogical cycle (Source: NDMC website, http://drought.unl.edu/Planning/HydroillogicalCycle.aspx).

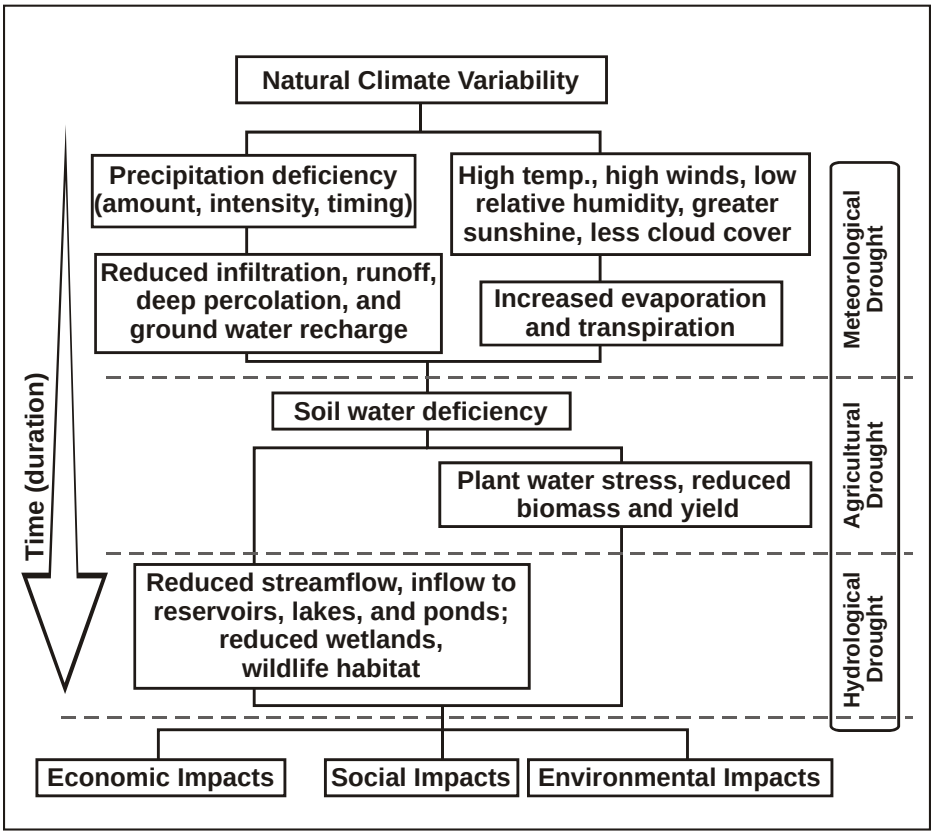

Figure 2. The evolution of drought types and impacts (Source: National Drought Mitigation Center, University of Nebraska–Lincoln).

Figure 3 represents the historical occurrence of drought in the United States for the period of 1895 to 2011, expressed as the percent area of the country experiencing severe to extreme drought. Several important features of drought are illustrated in this figure during the period of record. First, drought affects a portion of the country each year, ranging from less than 10% in some years and reaching levels of more than 40% in several major drought episodes. Second, the percent area affected is highly variable during this period of record, but drought events tend to cluster, such as during the 1930s, 1950s, 1960s, and so forth. The recent series of drought years have been rather dramatic in terms of duration, intensity, and spatial extent, beginning in the late 1990s and continuing to present. The major drought events illustrated in this figure are also important for another reason—each one represents a 'window of opportunity' for improved drought management and planning. Referring once again to Figure 1, each major drought episode captures the attention of the public, natural resource managers, and policy makers by highlighting the complex series of impacts associated with these events and the need for a more proactive, risk-based management approach.

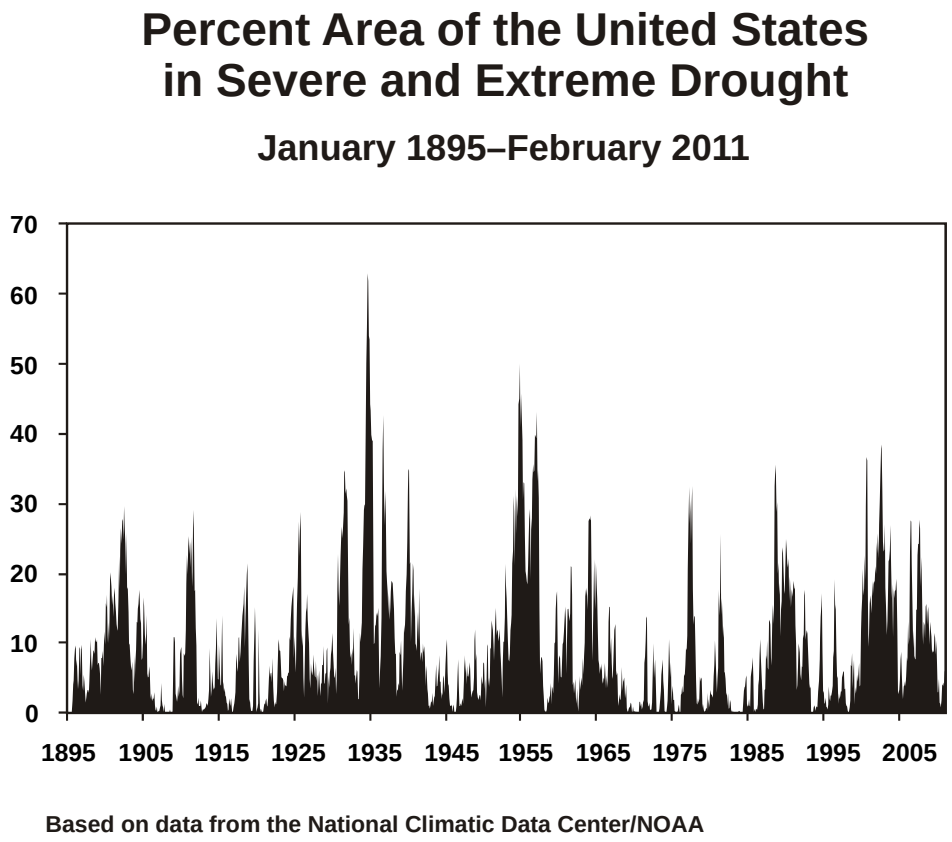

Figure 3. Percent area of the United States in severe and extreme drought, 1895–2011 (Source: Compiled from data from NOAA's National Climatic Data Center).

Current and Future Droughts: Key Observations

It is clear from the recent occurrences of drought in the United States that there is a growing need to enhance planning and policy efforts to deal with the expanding drought impacts and their complexities. Several key points are to be noted. First, the impacts from recent droughts have led to greater sectoral impacts and reflect the increasing vulnerability of much of the country to periods of severe and extended water shortages. Second, there is a significant migration of population in the United States to more water-short areas in the southwest, south-central, and far western states, as well as a

significant shift in population to the southeastern states, particularly Georgia and Florida. This shift in population was noteworthy between 1990 and 2000, and the latest census information through 2010 indicates that it is continuing. Percentage increases during the 1990s ranged from 30% to more than 60% in the states of Arizona, Colorado, Utah, and Nevada. These already water-short states in the western United States are now being further water-stressed as population increases dramatically and water seems to be more limited as a result of warmer winters, declining snowpack and runoff, and higher rates of evapotranspiration. Third, water demand is increasing rapidly in many parts of the country in association with expanding populations. Thus, conflicts between water use sectors are increasingly leading to greater transboundary issues between states and with Mexico and Canada. Fourth, many river basins in the country are currently fully or over-appropriated. The ability of states to manage water supplies with an expanding population under various climate change scenarios is an important area of concern for many decision makers. Finally, many feel that current water laws and institutions are outmoded and unable to deal with these expanding pressures of a growing population and changing vulnerabilities to increased climate variability and changes in climate state.

Projections of an increased frequency and severity of drought conditions from the most recent IPCC report (2007) provide further cause for concern (Figure 4). Using the output from the A1B scenario, a significant increase in drought is expected for Central America, the southwestern United States, the Amazon Basin, southern Africa, the Mediterranean Basin, Australia, and Indonesia. Some of these regions are currently significantly water-stressed, so a trend toward increased drought is cause for significant concern.

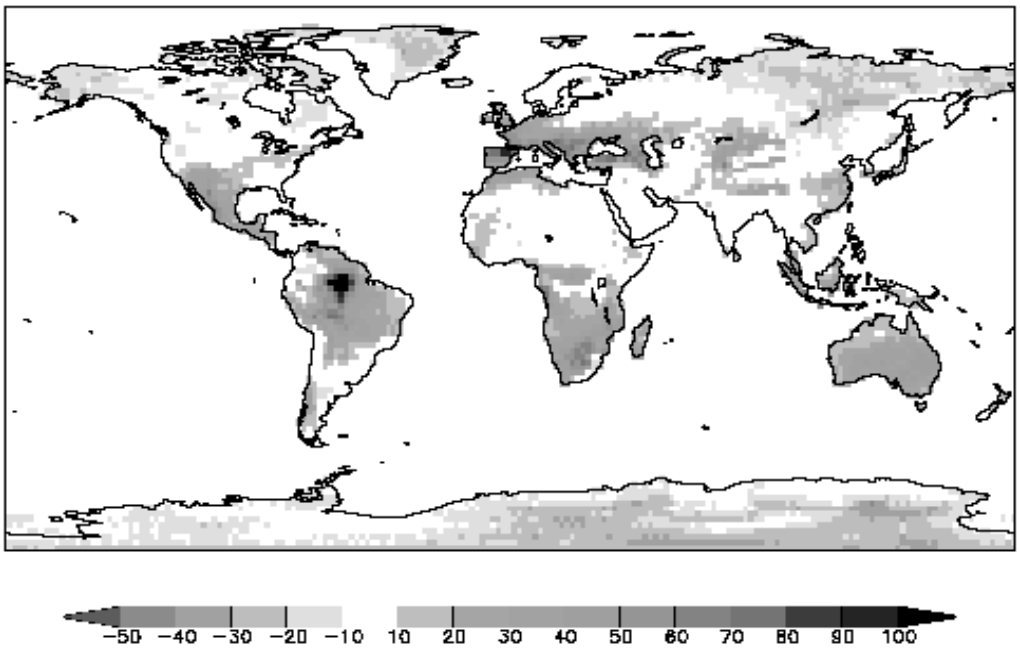

Figure 4.Projected drought according to the A1B model. Percentage change in average duration of longest dry period 30-year average for 2071–2100 compared to that for 1961–1990 (Source: IPCC, 2007).

The pattern of drought in the United States over the past decade is also of concern and illustrates several key points with regard to drought occurrence and patterns. As noted in Figure 3, the spatial extent of drought has been quite variable in terms of area affected over this period, with portions of the western and southeastern United States experiencing severe drought conditions in most of these years. A representative sample of the U.S. Drought Monitor maps from the period from 2000 to 2010 is provided in Figure 5. The U.S. Drought Monitor map is compiled weekly by the National Drought Mitigation Center (NDMC), the U.S. Department of Agriculture (USDA), and the National Oceanic and Atmospheric Administration (NOAA). Figure 5 illustrates the spatial dimensions of drought and its

severity in four years of the past decade to illustrate the point that drought is a national issue in the United States, thus requiring a national approach or policy that reinforces the need for a more consistent proactive approach for drought management. The series of weekly U.S. Drought Monitor maps from 1999 to current is available on the website of the National Drought Mitigation Center (http://droughtmonitor.unl.edu). Viewing these maps over any sequence of months during this period illustrates another important point regarding drought occurrence: the shifting epicenter of drought from month to month and from year to year for persistent droughts. Because of the long duration of drought events, the areas of greatest severity are continuously changing from month to month and year to year. Also of note from Figure 3 is that only one year (2010) in the sequence from 2000 to 2010 experienced minimal drought occurrence in the country. However, drought returned in 2011 (Figure 6) and affected most of the southern United States, stretching from Arizona to Florida, with the hardest-hit areas being Texas, Oklahoma, New Mexico, and Arizona.

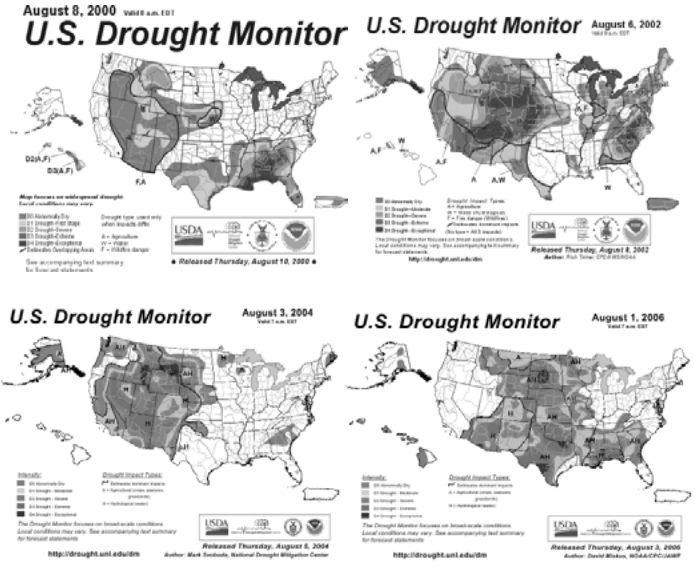

Figure 5. Weekly U.S. Drought Monitor maps for 2000, 2002, 2004, and 2006 (Source: U.S. Drought Monitor; http://droughtmonitor.unl.edu).

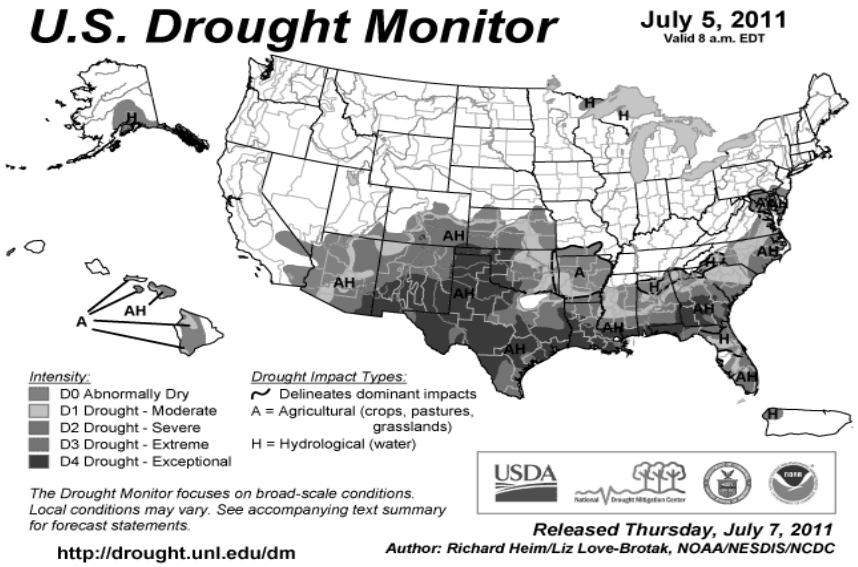

Figure 6. U.S. Drought Monitor for July 5, 2011 (Source: U.S. Drought Monitor; http://droughtmonitor.unl.edu).

Drought Risk Reduction

To reduce the impacts of drought there is an urgent need to focus attention on the identification of the most vulnerable sectors, population groups, or regions. A risk assessment of the historical and most recent impacts associated with drought allows us to quickly highlight these areas and implement mitigation measures that will improve the coping capacity (i.e., resilience) of these sectors, groups, and regions. This risk-based management approach is illustrated in Figure 7, the Cycle of Disaster Management, which is composed of the crisis management elements and the risk management elements. To build greater societal resilience, it is critically important for more emphasis to be directed at the risk management portion of this cycle.

The risk associated with drought (and other natural hazards) is a reflection of both a region's exposure to drought conditions and its vulnerability. Exposure is defined by the frequency and severity of historical drought occurrences and current trends. Vulnerability is defined by a long series of social factors, including population growth and migration patterns, land use changes, technology, urbanization, environmental degradation, water use trends, government policies, and environmental awareness of the population, to name a few. It is difficult to assess how trends in each of these and other factors affect vulnerability, but it is clear that each drought event overlays a society with vulnerabilities that are different from the previous event. Tracking these changes/trends is critically important as part of a drought planning and mitigation strategy.

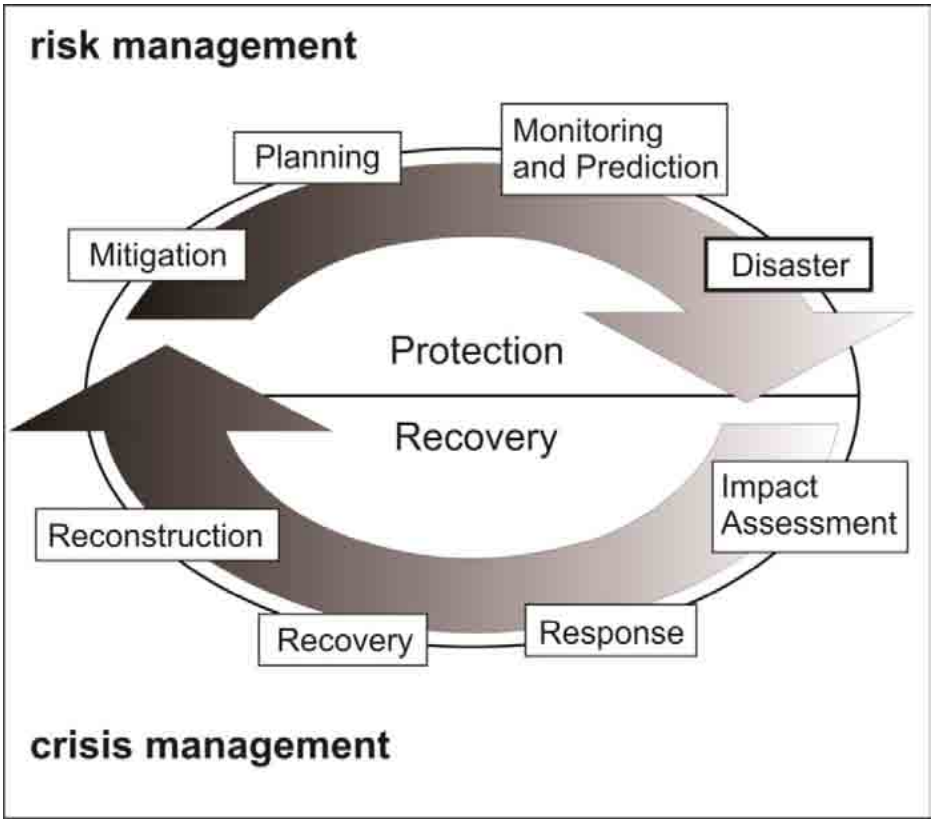

Figure 7. The cycle of disaster management reflects two components, crisis management and risk management. (Source: National Drought Mitigation Center).

Referring again to the types of drought in the context of drought risk reduction, as meteorological drought continues and begins to cause impacts in the agricultural sector and in water management (i.e., hydrological drought), there is less emphasis on the actual departure of precipitation from normal or expected and more emphasis on management practices that may increase the resilience of society to water shortages as manifested in the impacts that occur. For example, impacts on agriculture can

be substantially influenced by cultivation practices, crop type, irrigation efficiency, and so forth. Likewise, hydrological drought is affected by management practices that are associated with reservoir management and the management of other ground and surface water resources. Mitigating the impacts of drought is related to the proper management of resources in these sectors.

Status of Drought Planning in the United States

Drought planning can and should occur at all levels, from local to regional to national. Significant progress has been made in drought planning at the state level from the early 1980s, when there were only 3 states with drought plans, to today. At present, 47 states have drought plans, and 11 of those states are increasingly emphasizing mitigation as a key component of their plans (Figure 8). States in the southwestern and south-central portions of the country have made the greatest progress. Many other states have plans in place, but the emphasis of these plans is directed more toward response, i.e., reacting to crisis. As states move along the continuum from response to mitigation planning, there is an increasing need to deliver better and more timely information on drought status and early warning, including improved seasonal forecasts, to decision makers and other users. It is also important for these users or stakeholders to be involved in the development of products or decision support tools to ensure that their needs are being met.

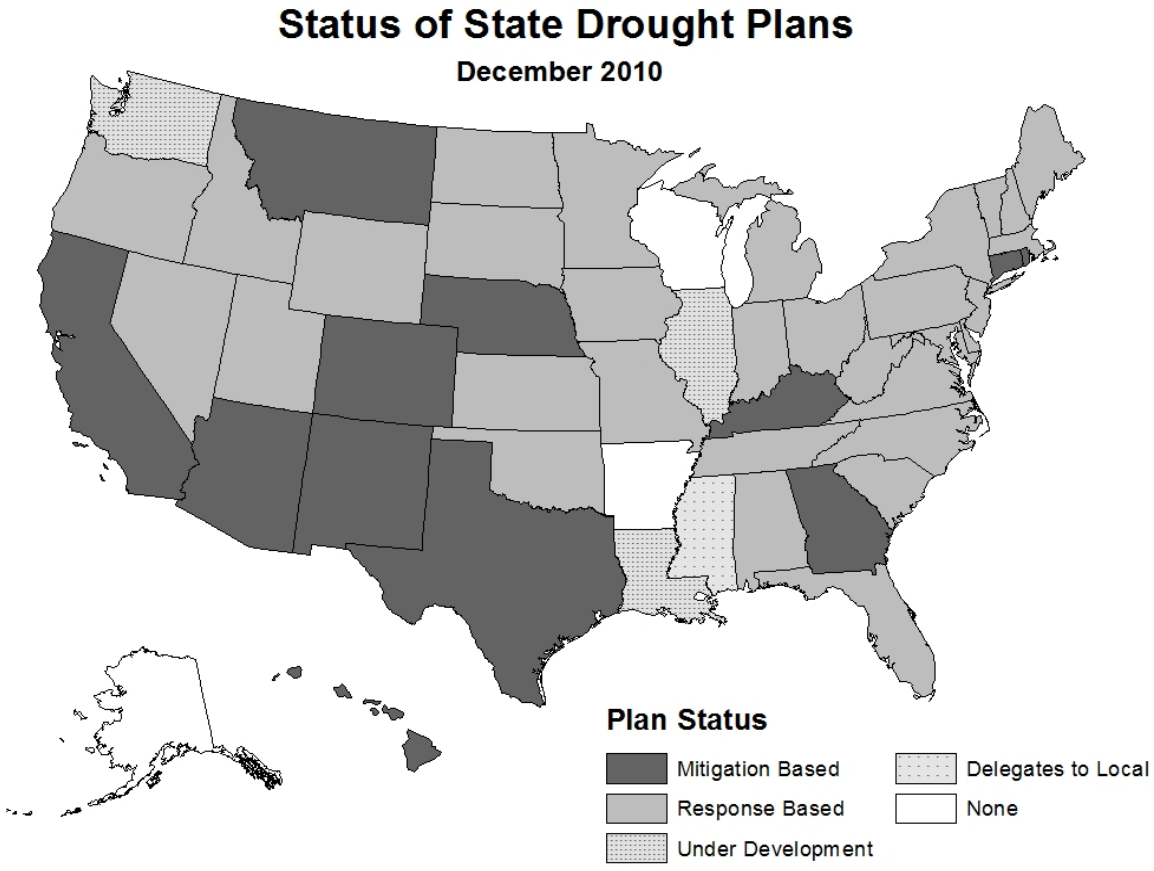

Figure 8. Status of drought planning in the United States, 2010 (Source: NDMC website, http://drought.unl.edu/Planning/PlanningInfobyState.aspx).

The NDMC has been working with states to stress the importance of developing a mitigation plan in order to be better prepared for future drought episodes. Most states have incorporated, in some form, a 10-Step Planning Process that was originally developed in 1991 (Wilhite 1991) and has been modified several times (Wilhite et al. 2000; Wilhite 2000; Wilhite et al. 2005) since its introduction in order to incorporate greater emphasis on risk-based management and mitigation planning. This model has been used by most U.S. states in the development of a drought mitigation plan. The key elements of a drought mitigation plan are:

(1) Monitoring, early warning, and information delivery systems, including integrated monitoring of key indicators, the use of appropriate indicators and indices, and the development of decision support tools;
(2) Risk and impact assessment, including conduct of vulnerability assessment and the monitoring and archiving of drought impacts;
(3) Mitigation and response measures to increase coping capacity.

Because of the increasing emphasis on drought risk management at the state level in the United States, there has been increasing pressure on the federal government to devote more attention to this approach as well. This bottom-up approach has been quite effective in initiating several bills introduced in Congress, including the National Drought Policy Act of 1998, which created a National Drought Policy Commission charged with making recommendations to the U.S. Congress on future approaches to drought management and the National Drought Preparedness Act, introduced in Congress in 2001, 2003, and 2005. Although this bill did not pass and become law, it did generate another bill, the National Integrated Drought Information System Act, which passed Congress in 2006 and was signed by the president later that year. This system (NIDIS) is currently being implemented throughout the country by NOAA with partners from other federal agencies, state and regional organizations, and universities.

Summary and Conclusions

The top ten challenges for progress in drought risk management were identified as follows.

(1) Drought is the 'Rodney Dangerfield' of natural hazards—i.e., it doesn't get respect because of the lack of structural impacts and the fact that loss of life is nonexistent or minimal in most instances.

(2) Drought monitoring/early warning is complex, requiring data from all elements of the hydrological system and the blending of this information for assessing the severity of drought and its potential impacts.

(3) Drought predictability is low in most cases, especially on a seasonal or longer basis, except where strong teleconnections exist to ocean sea surface anomalies.

(4) Decision-support tools and delivery systems are generally not available in many countries, and those that are available must be improved and tailored to the needs of users.

(5) Impacts are poorly understood and documented in almost all cases, further reducing understanding of the effects of drought on society and how investments in mitigation measures are justified as cost-effective.

(6) Drought relief discourages a risk-based management approach because it reduces self-reliance and increases reliance on government.

(7) Institutional inertia constrains change from crisis to risk management because federal and other agencies and ministries repeat the same practices and policies with each subsequent drought episode. Drought assistance programs are ingrained in the institutional structure of government.

(8) The effect of societal changes on vulnerability is poorly understood because of the lack of research on this critical element of risk-based management.

(9) Drought mitigation actions are less obvious to most decision makers because these measures are usually non-structural in nature.

(10) Political will for a national drought policy and drought risk management is weak at all levels of government because drought relief is often a pathway to re-election for officials and there is poor understanding of drought impacts and the proven cost-effectiveness of mitigation over relief.

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Green Revolution in Africa: The Role of National Drought Policy

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Abstract

Given the economic importance of agriculture in Africa, transforming the agricultural sector can mean a difference between improved livelihoods and staying trapped in hunger and poverty to the rural population. Unfortunately, agricultural productivity growth has been low due to a combination of limited use of improved agricultural technologies, mainly seeds and fertilizers; historical factors, including the legacy of the structural adjustment program; poorly developed markets; lack of political support; and climate change. This paper briefly examines these causes and the interventions being undertaken to address them. While acknowledging the critical role of improved crop varieties and access to finance and markets aimed at increasing productivity, the paper cautions the need to pay attention to climate variability, especially the incidence and severity of drought given that smallholder farmers rely on rain-fed agriculture. The paper concludes with an urgent call on African governments to develop and implement national drought policies as the basis for drought mitigation and/or adaptation.

Introduction

Agriculture is the mainstay of African economies, accounting for over 45 percent of the gross domestic product (GDP) and nearly 60 percent of export earnings. An estimated 76 percent of the 987 million Africans living in rural areas are employed in agriculture (FAO 2009). For the rural households, transforming the agricultural sector can mean a difference between improved livelihoods and staying trapped in hunger and poverty. This is because increasing agricultural productivity by 10 percent can reduce poverty by 4 percent in the short run and 19 percent in the long run (FAO 2010). Unfortunately, agricultural productivity growth on the continent has been low and virtually flat over time (Fig. 1). As a consequence, about 50 percent of Africans are living on less than $1.25 per day (World Bank 2009) and the absolute number of poor people nearly doubled from 200 million in 1981 to 380 million in 2005.

Evidence suggests a combination of limited use of improved agricultural technologies (mainly seeds and fertilizers), historical factors such as structural adjustment, poorly developed markets, lack of political support, and climate as the main causes of the low productivity growth of African agriculture. These factors are discussed briefly in the following sections.

Causes of Low Agricultural Productivity in Africa

Limited Use of Improved Seed and Fertilizers

Despite significant progress that has been made in the development of improved crop varieties with the potential of unlocking productivity growth, adoption rates have been low and lag far behind those in other developing and developed regions (Tripp 1998). The adoption rates for improved maize seed presented in Table 1 (Langyintuo et al. 2010) typify the case for most staple food crops in Africa.

The high price of improved seed, uncompetitive food grain markets, and poor extension information dissemination regarding the benefits of improved seed versus local land races have largely contributed to the low adoption rates (Ibid). This suggests that the advances made in genetic improvements hardly benefit smallholder farmers in the region. On the seed supply side,

governments' interference in the functioning of the seed sector, especially the monopoly on the production and distribution of foundation seeds, have also hindered the development of the sector (Maredia and Howard 2006). As a result, the adoption of certified seed varieties has become scare and their prices uncompetitive.

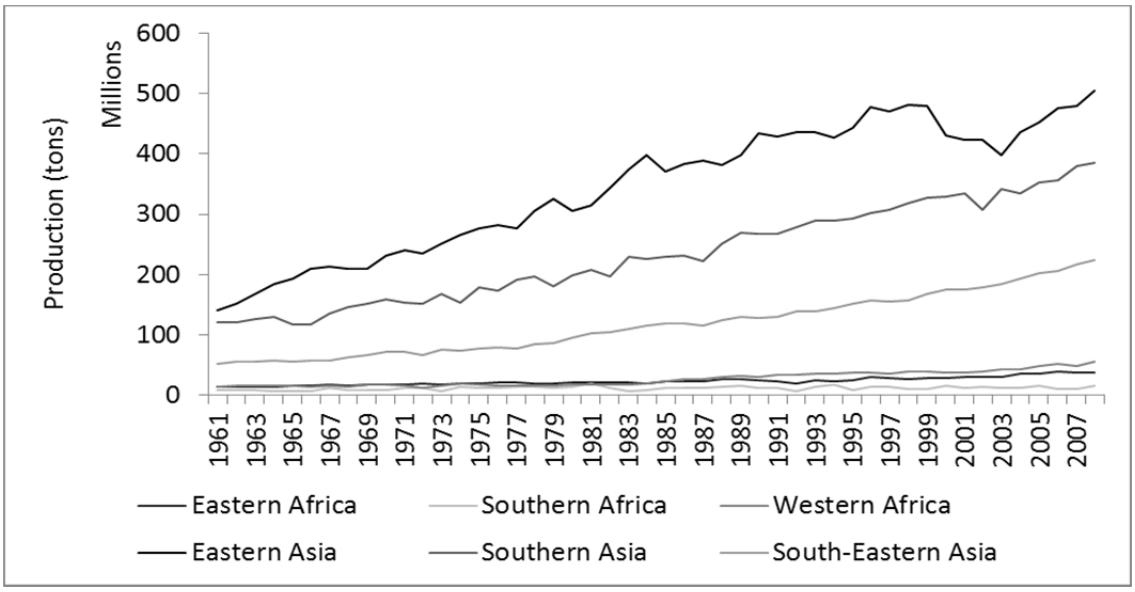

Fig. 1: Cereal Production over Time. Source: FAOSTATS (2010)

Table 1: Adoption Rate of Improved Maize Varieties in Selected Countries in Africa

Country	Area (million ha)	Seed demand (1000 t)	Adoption rate (% of area)
Ethiopia	1.7	42	19
Kenya	1.6	39	72
Tanzania	2.6	64	18
Uganda	0.7	17	35
Angola	0.8	19	5
Malawi	1.4	35	22
Mozambique	1.2	30	11
Zambia	0.6	14	73
Zimbabwe	1.4	34	80
Ghana	0.7	19	1
Mali	0.3	8	0.3
Nigeria	3.6	89	5
Total	17.3	427	28

Source: Langyintuo et al (2010).

In addition, the lengthy release period for varieties (sometimes up to 6 years) combined with the lack of coordination and harmonization of regional regulations have delayed and limited the benefits and regional spill-over of new varieties. Similarly, fertilizer use rates are low in Africa, averaging 8 kg per ha (Fig. 2) compared with 96 kg/ha and 101 kg/ha in Southeast Asia and South Asia, respectively (Morris et al. 2007), and over 145 kg per ha in the developed world (World Bank 2006). The low use of fertilizers among African farmers reflects a mix of underlying challenges of binding capital constraints, deep poverty, and poor infrastructure. Empirical evidence suggests that limited access to

knowledge on the financial profitability of fertilizers, the high price due primarily to variable global crude oil prices, and high domestic transaction costs constrain demand for fertilizers (Morris et al. 2007). Partly as a result of the limited use of fertilizers, Africa loses 4 percent to 12 percent of GDP from environmental degradation, 85 percent of which comes from soil erosion, nutrient loss, and changes in crops (Olsen and Barry 2003).

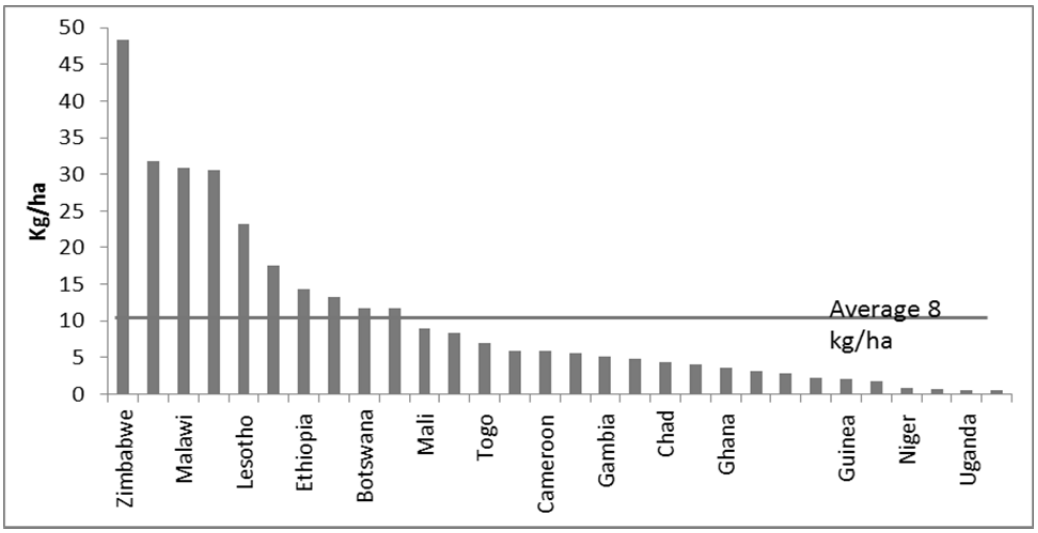

Fig. 2: Intensity of Fertilizer Use in Selected African Countries. Source: FAOSTAT (2003)

Apparent Lack of Political Will to Support Agricultural Transformation

Notwithstanding the importance of agriculture in driving the economies of African states, political will to support the sector appears weak. However, this seems to be changing with the adoption of the Comprehensive African Agricultural Development Program (CAADP) by African governments. In 2003, African Heads of State met in Maputo, Mozambique, and committed to invest at least 10 percent of their national budgets to agriculture in order to raise agricultural productivity to at least 6 percent and relieve the poverty and hunger of rural people as well as increase food production that will tend to bring down the cost of food imports (Maputo, 2003). While many of these pledges have yet to be realized, Figure 3 suggests that some individual countries have made substantial increases in their spending on agriculture.

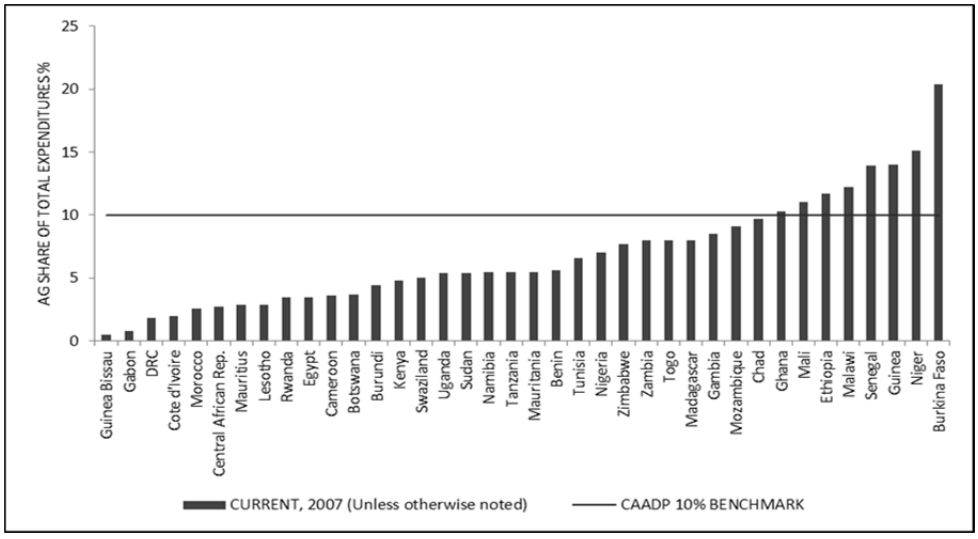

Fig. 3: Government Expenditure on Agriculture

In the past, subsidies were proven to be beneficial in increasing crop productivity and consequently farm household welfare. Several other studies have shown the potential of input subsidies in accelerating crop production (Crawford et al. 2006). For instance, in Kenya, Zimbabwe, and Zambia, impressive improvements in maize productivity were demonstrated during the 1980s when subsidies were available to farmers (Eicher et al. 1997). Similarly, cereal crop output in Ethiopia has dramatically increased over the past decade (FAO 2008). However, these positive results were generally not sustained with the advent of donor-driven structural adjustment programs (SAP).

Initiated in the 1980s by the World Bank and the IMF, SAP was designed to reduce the role of government, cut back on public sector expenditures, improve balance of payments, reduce government deficits, enhance macroeconomic performance, and help African countries to achieve higher economic growth rates. The key elements of the policy reform included macroeconomic reforms, privatization of government agencies, liberalizations of markets, removal of the government from the agricultural markets, and elimination of subsidies.

The effects of these market-led approaches continue to be a source of much debate. Because the policy reforms devalued currencies, reduced taxation on agriculture, and raised producer prices (Kherellah et al. 2002), it was widely believed that these efforts generated significant positive benefits for farmers selling traditional export crops like coffee and cocoa. But for smallholder farmers producing staple foods for domestic markets, the net effect has been largely negative as exemplified by the collapse of the hybrid-maize green revolution in eastern and southern Africa mentioned above. Competition from low-cost and often subsidized food imports, reduced access to credit at affordable rates, and the removal of input subsidies has led to a dramatic reduction in the adoption of modern crop varieties and fertilizers. In several cases, farmers, who had earlier adopted modern varieties, discontinued the uses of modern varieties and chemical fertilizers (Kosura and Karugia 2005).

Poorly Developed Inputs and Outputs Markets

One of the major outcomes of the SAP was the liberalization of markets where state marketing agencies were privatized, disbanded or reformed (Doward, Kydd and Poulton 1998). These reforms had negative consequences on agricultural development on the African continent. In a comprehensive review of SAP reforms and their effects on agricultural input and output markets, Kherallah et al. (2002) noted that economic growth in Africa, especially in agriculture, had stagnated, or declined, consistent with the general consensus that reforms have failed to spur agricultural growth (Spencer and Badiane 1995; Eicher 1999; World Bank 2006).

Limited Access to Finance

Agriculture is the most predominant activity in African economies, yet less than 3 percent of total commercial bank lending goes into the agricultural sector (Fig. 4). This is due mainly to high transaction costs because clients are predominantly small borrowers scattered over large areas in remote rural settlements, a time lag between investment needs and expected revenues, the lack of usable collateral, high covariant (weather and price) risks due to variable rainfall (as a result of lack of irrigation facilities) and pests and diseases, and underdeveloped communication and transportation infrastructure. As a consequence, farmers are unable to invest in improved technologies to increase crop productivity.

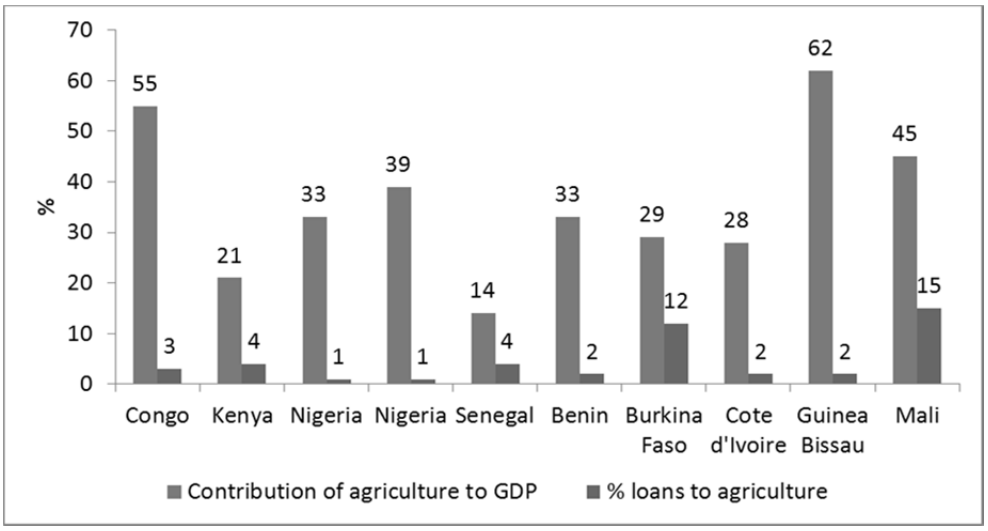

Fig. 4: Agricultural Lending as Share of Agricultural GDP in Selected African Countries

Climate Variability

Broadly speaking, the climate in Africa is predominantly tropical and classified into humid equatorial, dry, and humid temperate zones. There are, however, distinct climates resulting from regional variability and altitude. Cyclically climatic variability from year to year is also noticeable in the region. One of the most devastating climatic changes that affect agriculture especially livestock production is prolonged drought. Irrigation facilities are limited and the vast majority of farmers depend on rain-fed agriculture.

The direct effect of prolonged drought on crop production is the deprivation of crops of needed water for growth and the increased incidence of pest attacks on crops as a result of high temperatures (that are often conducive for a proliferation of pests). There is growing evidence that in the tropics and subtropics, crop yields are likely to decrease due to an increase in the temperature thereby leading to drastic reduction in crop yields and productivity by 0.4% per annum in addition to loss in species biodiversity (Cline 2007).

The effect of drought on crop productivity can also be indirect such as the impact of high temperatures, precipitation, sea level rise, atmospheric carbon dioxide content and incidence of extreme events on households and whole communities negatively affecting farming. Social impacts include increased chance of conflict over commodities, water resources and fertile lands (an increase in temperature is likely to reduce soil moisture, moisture storage capacity and the quality of the soil, which are vital nutrient for agricultural crops). Livestock are a store of wealth within African rural communities so if decimated by prolonged drought, households loose assets and their purchasing capacity diminishes: farmers sometimes sell livestock for cash to invest in farm inputs.

When drought is sever, it is common to observe complete abandonment of cultural traditions, loss of homelands, changes in lifestyle, and increased chance of health risks due to poverty and hygiene issues, all of which have implications for productivity growth. For instance, in the mid-1980s, late 2000s and 2010/11, droughts created 10s of millions of refugees in Africa as well as up to 60% mortality of livestock in eastern Africa alone.

Policies to Enhance Productivity Growth

To reduce poverty and hunger among millions of Africans, many African governments have embraced improving agricultural productivity as a major goal of their development policies but how best to

achieve that remains a challenge. We discuss below some policy interventions that have the potential of improving agricultural productivity. The expressed need to develop and implement national drought policies is highlighted.

Inputs and Outputs Market Policies

In support of national governments' efforts to improve crop productivity, the Alliance for a green Revolution in Africa (AGRA) in collaboration with development partners are supporting the development and deployment of improved, high yielding crop varieties through targeted grants to seed companies and research institutions. To create a cadre of well-trained crop and soil scientists to develop and maintain adapted crop varieties, AGRA is also sponsoring degree training at both the MSc and PhD levels. Under the AGRA's Program for African Seed Systems, agro-dealers are trained and capacitated financially (through targeted credit guaranteed schemes) to purchase seeds and agro-chemicals and retail to farmers in rural areas not serviced by established agri-business entrepreneurs. The guarantee scheme lowers the risk of borrowing allowing financial institutions to lower the interest rates for borrowers, which has implications for the prices agro-dealers retail their inputs to farmers.

Because most of the crops grown by farmers are staples and non-tradable while fertilizers are imported, currency devaluation often increase the price of fertilizers several times above output prices. Consequently, the value-to-cost ratio for fertilizer use has been declining creating a disincentive to the demand for fertilizers. AGRA is working with development partners to support governments streamline the importation of fertilizers to reduce the transaction costs of the fertilizers. Options of promoting local blending are also explored in some countries like Tanzania and Uganda with large deposits of phosphate rocks. Plans are advanced in setting up the African Fertilizer Agri-business Program (AFAP), joint effort between AGRA, the Bill and Melinda Gates Foundation, and United States Agency for International Development (USAID) with support from the African Union and the New Partnerships in Africa's Development (NEPAD)/Comprehensive Africa Agriculture Development Program (CAADP). AFAP would provide credit support to fertilizer development in Africa along the entire value chain. In 2006 African leaders convened an Africa fertilizer Summit in Abuja, Nigeria and declared that "Given the strategic importance of fertilizer in achieving the African Green Revolution to end hunger, the African Union Member States resolve to increase the level of use of fertilizer from the current average of 8 kilograms per hectare to an average of at least 50 kilograms per hectare by 2015". It is hoped that the renewed efforts by governments to support input use may result in positive impacts on crop productivity.

All these and related interventions notwithstanding, poorly developed input and output markets raise transaction costs for farmers and make it difficult to access improved seeds, fertilizers and other agricultural inputs. In addition, high tariff and non-tariff barriers reduce intraregional trade flows leading to greater price volatility. More open intra-regional trade between African countries offers important opportunities to exploit differences in comparative advantage, achieves greater scale economies in marketing and helps stabilize food supplies in the face of adverse weather events at country levels. Yet a World Bank 2008 report indicated that "Africa is the world's second most trade-restrictive region (after South Asia), … have among the world's fewest and weakest services trade liberalization commitments, …and neocolonial relationships continue to dominate trade ties." These policies have to change to allow farmers to effectively participate in the inputs and outputs markets. To advance agricultural policies that encourage investments, the AGRA Policy Program and development partners were working with governments of selected African countries to further the development and implementation of evidence-based policy processes.

Interlinked inputs and outputs markets combined with credit can help to overcome missing markets in the supply of credit to farmers for purchasing improved seeds and fertilizers (Poulton et al 1998). Marketing boards for cash crops have traditionally provided seeds and fertilizers to farmers on credit

and purchased back the produce from farmers at guaranteed prices after deducting the cost of inputs. Under this arrangement outputs, inputs and credit are all interlocked in one transaction (Jayne et al. 2002; Poulton et al 1998; Govereh et al. 1999).

In this way, the risk of default is low since the cost of inputs is deducted before the farmers receive payments for their delivered produce. Monitoring and supervision costs are also reduced since the input loan is delivered in kind to farmers to be applied on their crops. However, where farmers engage in side selling of their produce at harvest, monitoring costs and defaults may rise, unless there are strict contract enforcement rules. The cost of inputs may also be reduced under interlocked systems since farmers' demand for inputs are aggregated and ordered in bulk.

Access to finance

As noted earlier, one of the principal reasons why banks don't lend to agriculture is perceived high risks. To encourage banks to lend to agriculture, credit guarantees can be used. By covering part of the default risk, a lender's risk is lowered, which guarantees secure repayment of all or part of the loan in case of default (Levitsky 1997). Credit guarantees are useful in addressing challenges faced by farmers, especially those linked to insufficient collateral and poor credit history. Therefore, credit guarantee schemes can improve loan terms and facilitate access to formal credit. Additionally, by allowing loans to be made to borrowers that otherwise would have been excluded from the lending market, farmers and SMEs would be able to establish a repayment reputation in future (De Gobbi 2002).

Climate change adaptation and the need for drought policies

Addressing smallholder farmers' access to finance and (inputs and outputs) markets is necessary but not sufficient to ensure increased productivity growth under rain-fed conditions. For the most part, governments and development partners often respond to the problem of poor crop yields by investing in the generation of technologies, especially improved high yielding crops paying limited (when they sponsor the development of drought tolerant crop varieties) or no attention to climate variability. Evidence suggest that the impact of the adverse climate changes on agriculture is exacerbated in Africa by the lack of adapting strategies, which are increasingly limited due to the lack of institutional, economic, and financial capacity to support such actions.

This has the potential to lead to worsening food crisis and vulnerability among smallholder farmers on the African continent. Therefore, a better understanding of the potential impact of the current and projected climate changes on African agriculture and to identify ways and means to adapt and mitigate its detrimental impacts. This no doubt calls for the development and implementation of drought policies in Africa.

Conclusions

Agriculture is the main stay of the economies of African states yet productivity growth has been disappointingly low perpetuating hunger and poverty especially among the rural poor. A combination of low use of improved agricultural technologies (mainly seeds and fertilizers), historical factors such as structural adjustment, poorly developed markets, lack of political support, and climate change.

Under rain fed agricultural conditions in Africa, increasing agricultural productivity sustainability will remain an illusion if interventions are limited to improved crop varieties, soil fertility management technologies, access to output markets, and finance without adequate attention to climate change, especially drought. It is argued here that African governments should consider investing in the developing and implementation of national drought policies as the basis for interventions to mitigate and/or adapt to climate variability, especially drought.

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ELEMENTS OF NATIONAL DROUGHT POLICY IN SELECTED COUNTRIES

Elements of a National Drought Policy: The Australian Context

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Abstract

Agriculture in Australia has had a long history with droughts. Globally, governments have developed comprehensive responses to the impacts of droughts and other extreme climate events, but have struggled to effectively address the risks. This paper describes the context and evolution of the Australian National Drought Policy (1992). The objectives outlined in the drought policy remain but have received different emphases by government over time. Because of the inherent variability in agricultural production systems and the unpredictability of when and where droughts occur, it appears that a flexible approach is required to determine when to intervene, when to retract, and which aspect to support. Likewise, the information required by producers and governments changes with changing circumstances.

Agroclimatic Context

Australian agricultural production systems are diverse and include cropping systems, pastoral systems, and mixed farm enterprises. While the farming systems are diverse, a commonality between them is the need to manage financial, environmental, and social risk. At the tactical level, the major management focus is typically on a short-term, production and profitability basis. However, management decisions are often made within the context of longer-term resource conservation, economic, political, and lifestyle influences (Blacket 1996; Hammer 2000). A major risk factor that affects the biophysical, socioeconomic, and political systems is climate variability (Hammer 2000).

Australia has the lowest (that is, the driest) and one of the most variable rainfall patterns of all inhabited continents (Gray et al 2011). Climatic variability is one of the greatest sources of risk for Australian agriculture (Kimura and Anton 2011). Climate variability exposes decision-makers to considerable risk, because outcomes of decisions—such as crop rotation decisions, marketing strategies, infrastructure investment, and policy decisions that affect ecosystem management—cannot be confidently predicted. In addition, current production systems are unlikely to adapt to the changes in climatic extremes that are expected to result from climate change and that have already been observed in some regions of Australia. Despite the challenges of farming in Australia, agricultural activities cover about 60 percent, or 4.5 million km^2 of the continent, much of it in the dry, semi-arid rangeland regions (Fig. 1). Only around 0.4 percent of agricultural land in Australia is irrigated.

History of Drought

Australian agriculture operates in a highly unreliable climate (Laughlin and Clark 2000; Stone and de Hoedt 2000), which is characterized by frequent floods and intense, widespread droughts. These climatic extremes affect all types of agricultural production and present a challenge that farmers must manage to remain viable. There is a well-established relationship between El Niño events and drought in Australia, although not all drought events are El Niño related. El Niño events generally occur every two to seven years (Cane 2000; Meinke and Stone 2005). El Niño events typically result in severely reduced rainfall in winter and spring, particularly across eastern Australia where the majority of high-value cropping and livestock husbandry is practiced. Conversely, La Niña events can result in above average rainfall over much of Australia, although variability can occur between regions.

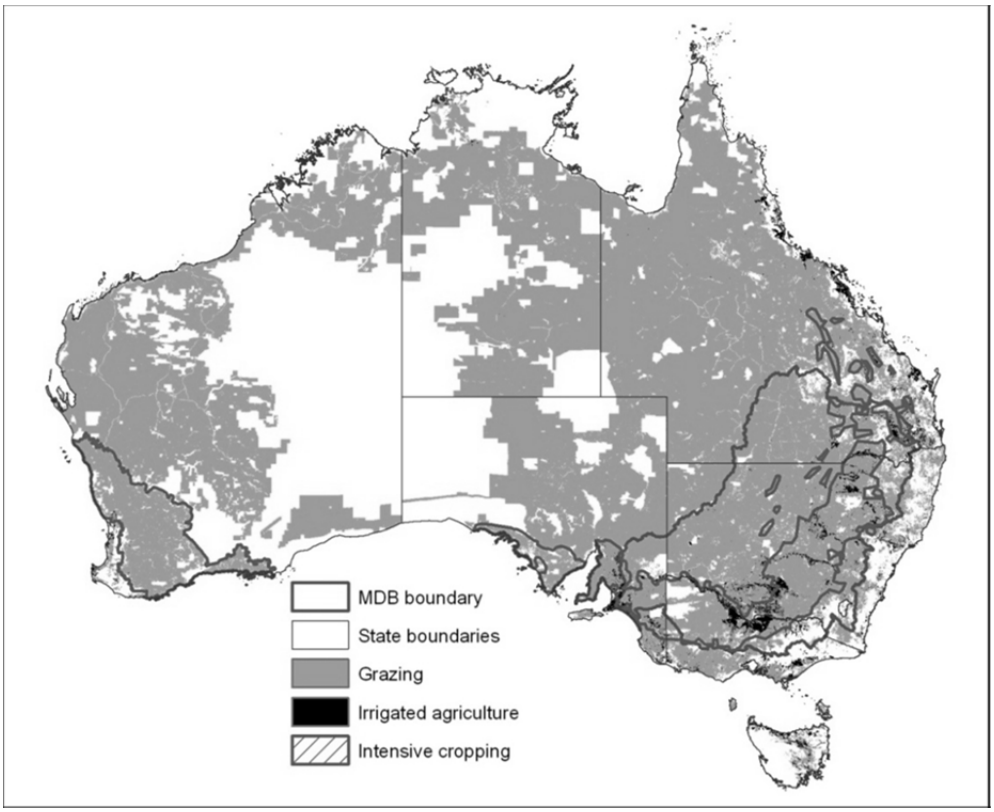

Figure 1. Agriculture in Australia

A drought can be defined as a prolonged, abnormally dry period with insufficient water for users' normal needs (BoM 2011). Meteorologists monitor the extent and severity of drought in terms of rainfall deficiencies, while agriculturalists rate the impact on primary industries. Drought disrupts cropping programs, reduces breeding stock, and threatens permanent erosion of the capital and resource base of farming enterprises.

Research by the Bureau of Meteorology (BoM 2011) indicates that severe drought affects some part of Australia on average once every 18 years. Some droughts are long-lived, while others are short and intense, causing significant damage (Table 1). Some droughts are localized, with other parts of the country enjoying plentiful rain. Some regional droughts are not related to El Niño events, and are therefore harder to forecast (Fig. 2).

Managing the Risk of Drought

Before 1992, the Australian Government did not have an explicit drought policy and assistance to affected producers was provided through a natural disaster relief program. In 1992, a National Drought Policy was established, with the objectives to:

- encourage primary producers and other sections of rural Australia to adopt self-reliant approaches to managing climatic variability
- maintain and protect Australia's agricultural and environmental resource base during periods of extreme climate stress
- ensure early recovery of agricultural and rural industries, consistent with long-term sustainable levels.

Table 1. Historic droughts in Australia (BoM 2011)

1864–66	• All states affected except Tasmania.
1880–86	• Southern and eastern states affected.
1895–1903	• The Federation Drought. Several years of generally below average rainfall followed immediately by one or two years of exceptionally low rainfall. Sheep numbers halved and more than 40 percent of cattle were lost. This was Australia's most devastating drought in terms of stock losses.
1911–16	• Loss of 19 million sheep and 2 million cattle.
1918–20	• Most parts of Australia in drought.
1939–45	• The Forties Drought. Loss of nearly 30 million sheep between 1942 and 1945. 1940 was one of the driest years on record across southern Australia.
1963–68	• Widespread drought, the last two years of which saw a 40 percent drop in wheat harvest, a loss of 20 million sheep and a decrease in farm income of $300–600 million.
1972–73	• Mainly in eastern Australia.
1982–83	• One of the most intense and widespread droughts on record. Total loss was estimated to have been in excess of $3 billion.
1991–95	• Particularly dry in parts of Queensland, northern New South Wales and parts of central Australia. Average production by rural industries fell by about 10 percent, resulting in a possible $5 billion cost to the Australian economy, The Commonwealth Government provided $590 million of drought relief between September 1992 and December 1995.
2002–07	• Winter crop production declined sharply in 2002–03 and, after recovering, declined again in 2006–07. The Murray–Darling Basin inflows were the lowest on record, severely affecting irrigated agriculture.

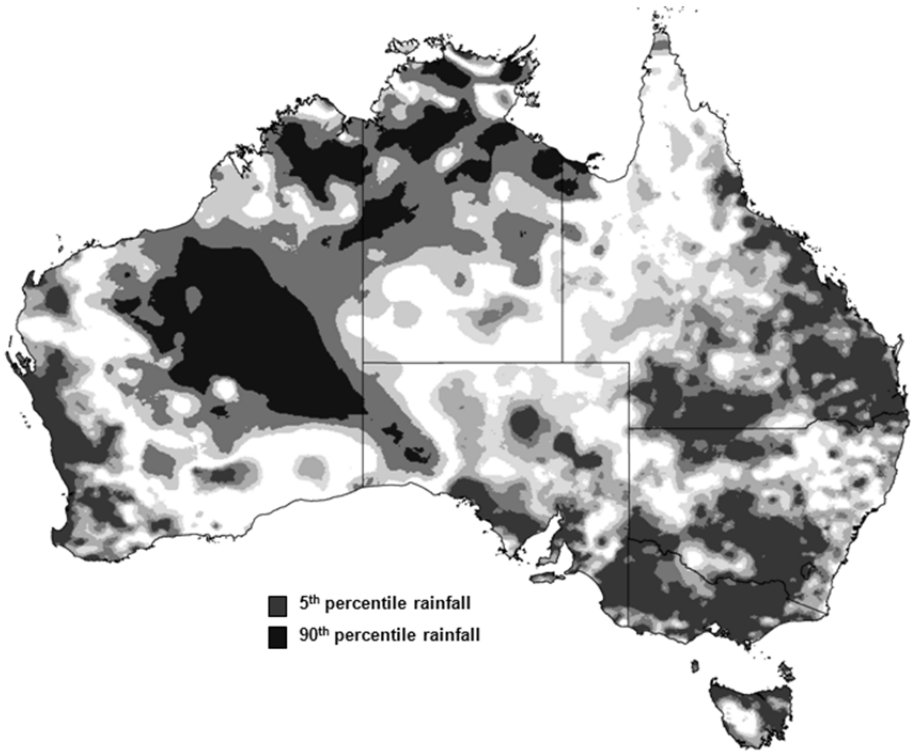

Figure 2. The 2002–2007 Drought in Australia

The 1992 policy shifted the emphasis away from drought being classified as a natural disaster and towards that of a normal component of the operating environment. Drought and, more broadly, climate variability were seen as an inherent business risk that producers needed to manage, as they would any other potential risk. This shift in thinking was intended to create a setting in which drought was considered a normal part of the Australian farming environment, with the core principle being to encourage producers to adopt self-reliant approaches for managing climatic variability and to prepare for drought.

The second objective is consistent with sustainable farming practice and is often addressed by government through natural resource management programs, such as providing conservation tillage, native vegetation management and soil retention.

While acknowledging the principles of self-reliance, the 1992 drought policy also recognized that there would be circumstances that were beyond the ability of farmers to manage alone (White and Walcott 2009). In these 'exceptional circumstances', governments could provide assistance to support otherwise viable farm enterprises through periods of 'severe downturns' in income, in effect underwriting the risks from droughts. This drought and exceptional circumstance policy was enacted through legislation, including the *Rural Adjustment Act 1992* and the *Farm Household Support Act 1992*.

Drought Assistance

Since the 1992 drought policy was enacted, it has been reviewed and its principles reinforced several times (see articles in Botterill and Wilhite 2005). The current criteria for exceptional circumstance (EC) events are:

- the event must be rare and severe and of a scale to affect a significant proportion of farm businesses in a region
- the event must result in a severe impact on farm production and income, and that the downturn in income is not a result of other issues, such as market prices
- the event must not be predictable or part of a process of structural adjustment.

The original framework for assessment of EC as defined in 1995 was based on six core criteria (White et al. 1998):

- meteorological conditions
- agronomic and stock conditions
- water supplies
- environmental impacts
- farm income levels
- scale of the event

EC would be declared when the combined impact on farmers was a rare and severe occurrence, and meteorological conditions would be the threshold condition. The threshold condition is assessed in terms of 'effective rainfall' and involves a 'rare and severe event'; rare being a 1 in 20 to 25 year event and severe being either more than 12 months duration or at least two consecutive failed seasons, depending on the nature of the production systems being considered. Although most commonly enacted as a result of a rare and severe drought, EC events may include a combination of events such as drought and frost.

Key to the decision-making process is the involvement of the National Rural Advisory Council, an independent body comprising agribusiness professionals who assess and help verify the on-ground

conditions in a region. In assessing an EC application, the Australian Government considers the scientific and economic advice provided by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). ABARES is a research bureau within the Department of Agriculture, Fisheries and Forestry that provides professionally independent research, analysis and advice to inform decision-makers on current and future policy challenges affecting Australia's primary industries.

The ABARES advice includes a scientific assessment of the rarity and severity of a meteorological event and an analysis of the event itself, including the effectiveness of rainfall and the impact it has or will have on specific production systems within a region. ABARES economic information is used to assess the impact on farm production and income.

ABARES draws on data supplied by government agencies such as BoM, the Australian Bureau of Statistics (ABS) and state agriculture departments; models such as soil moisture and crop and pasture growth; satellite-derived data such as vegetation greenness anomalies; and economic farm survey data from the ABARES Australian Agricultural and Grazing Industries Survey.

If a region is EC declared, farmers within it are eligible to apply for a range of assistance measures. Farmers in EC-declared areas may apply for income support (equivalent to the unemployment benefit) if they pass income and assets tests, and for business support (in the form of interest rate subsidies on operating costs) if the farmer can demonstrate that they operate a long-term viable enterprise. EC assistance is available for up to two years, with a review undertaken before the declaration period expires.

The 2002–2007 Drought

Australia has recently experienced one of its most severe droughts on record (Table 1). The most severe part of this drought, in terms of geographic extent and rainfall deficit, occurred between March 2002 and January 2003, and covered most of Australia's agriculturally productive regions. Indeed, the most important agricultural regions generally experienced severely deficient (5^{th} percentile) rainfall, with a number of regions recording their lowest rainfall on record.

The 2002–2007 drought, or 'big dry', was actually two separate droughts, each of about 12 months duration, 2002–03 and 2006–07, which resulted from two separate El Niño events. Crucially, there was no significant wet period between the two events to alleviate the rainfall deficiencies. Not only did the 2002–2007 drought significantly reduce farm production during the event but ongoing effects continued to be felt in many regions following the return of 'normal' rainfall patterns. For example, soil moisture was severely depleted in many areas and by mid-2010 water storages had not yet returned to pre-drought levels. Irrigated industries that rely on water storages were particularly affected as major reservoirs in the Murray–Darling Basin, Australia's most important irrigation region, fell to 17 percent of capacity in 2003, and remained below pre-drought levels until late 2010 (Figure 3).

The recent drought resulted in a record number of applications for EC assistance, with around 70 per cent of Australian agricultural land receiving some level of support by 2007. Because of the persistence of the drought, additional measures were developed to provide ongoing support for regions that had clearly not recovered from the impacts of the drought after their initial two years of support came to an end. Assistance packages included exit grants for farmers who had been affected by extreme events and who wished to sell their property. Support was also available in the form of advice and retraining. By mid-2010, the Australian Government had paid approximately $4.4 billion in direct drought assistance to affected farmers.

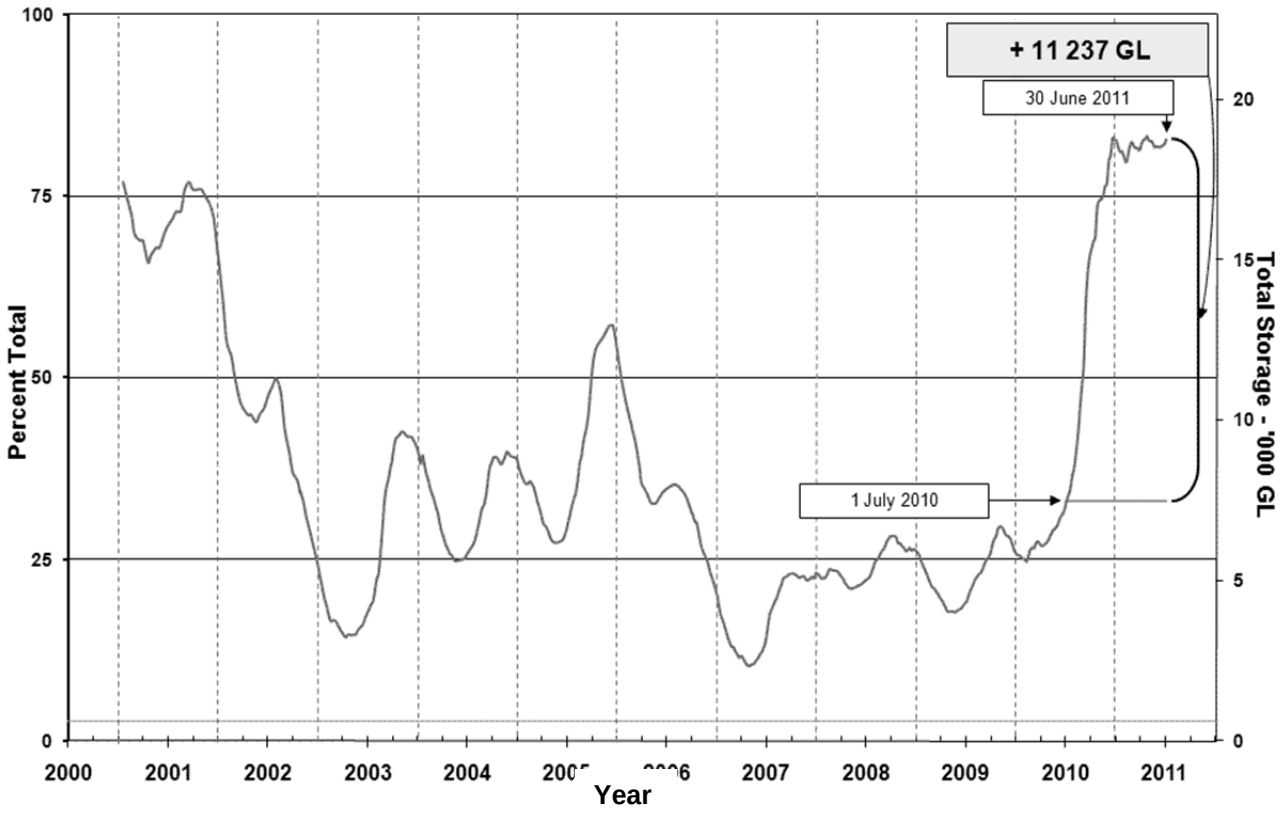

Figure 3. Water Storage Levels in the Murray–Darling Basin (NSW, Victoria and Queensland)

Review of the National Drought Policy

Following the onset of the 2002–2003 drought, a number of national drought workshops were held around the country to discuss with stakeholders the efficiency of the measures dealing with drought and to consider improvements to the delivery of drought assistance. One of the issues raised was that the current system of applying for EC support was complex and time consuming and often led to support being provided well after the worst impacts of the drought had been experienced.

Another concern was that the application process was cumbersome and that the state and territory governments who prepared the applications didn't have access to consistent data and information. This meant that before the Australian Government could assess an EC application, it needed to spend significant time and resources to analyze and verify the integrity of the data being used in the application, leading to further delays.

To address these concerns, Australian agricultural ministers, through the Primary Industries Ministerial Council (PIMC), agreed to develop a national monitoring system to assist in the development of EC applications and to facilitate decision-making for government intervention and policies related to drought and other climate impacts. It was envisaged that such a system would provide an agreed set of data for use by both the EC applicants and assessors, and that these data would be readily available via the internet.

The National Agricultural Monitoring System

To meet the agreed PIMC objectives, ABARES undertook the design, development and ongoing service delivery of the national monitoring system. The rationale behind this system, called, the

National Agricultural Monitoring System (NAMS), was to automate the creation of a report that formed the basis of an EC application via the internet. The intent was to streamline the application and assessment process for EC through the online collation of agreed and nationally consistent datasets.

Successful deployment of the system reduced the time and cost associated with assessments and made the process publicly transparent and equitable. NAMS provided up-to-date climatic and production information that helped identify regions that might be coming into drought, and also provided climatic and production information that could be used by decision-makers and producers to better prepare for and manage climate risks. This addressed the key issue of many producers not being fully aware of the variability in climate for their locality (White and Karsies 1999).

To simplify and streamline the existing EC application process, the NAMS website was designed to produce reports providing a complete set of contextual, climatic, production and economic analyses (Bruce et al. 2006). From this base, state and territory governments added their own interpretive text to the provided analyses and any additional supporting information. The strength of this approach was the standardization of the analyses used for all applications and the transparency of the process through public access to all the analyses used (Leedman et al. 2008).

2008 National Drought Policy Review

In early 2008, the PIMC met specifically to consider further improvements to the National Drought Policy in the context of responding to climate change, enhancing productivity and improving market access. Ministers agreed that current approaches to drought and EC were no longer the most appropriate in the context of a changing climate and agreed to improve the policy to create an environment of self-reliance and preparedness, and to encourage the adoption of appropriate climate change management practices.

A comprehensive review of the National Drought Policy was undertaken, comprising three separate assessments (DAFF 2011):

- an economic assessment of drought support measures by the Productivity Commission (PC)
- an assessment by an expert panel of the social impacts of drought on farm families and rural communities
- a climatic assessment by BoM and the Commonwealth Scientific and Industrial Research Organization (CSIRO) of likely future climate patterns and the current EC criteria of a 1 in 20 to 25 year event.

A key finding of the PC report was that the National Drought Policy's EC declarations and related drought assistance programs have not helped farmers improve their self-reliance, preparedness and climate change management. Most farmers are sufficiently self-reliant to manage climate variability, with about 70 per cent of farms in drought-affected areas receiving no assistance.

The panel set up to assess social aspects (Social Panel) noted that existing policy responses were not working in all cases and that EC policy had created feelings of division and resentment. The Social Panel considered that there is a role for governments and that future policy should seek to move people towards an acceptance of, and planning for, drought (SP 2008).

The BoM/CSIRO assessment (Hennessy et al. 2008) indicated that observed trends in exceptionally low rainfall years are highly dependent on the period of analysis, due to large variability between decades. If rainfall were the sole trigger for EC declarations, then the mean projections for 2010-2040 indicate that more declarations would be likely, and over larger areas in some parts of Australia. Projected increases in the geographic extent and frequency of exceptionally low soil moisture years

were slightly clearer than those for rainfall. If soil moisture were the sole criterion for EC declarations, then the mean projections indicate that more declarations would be likely by 2030. The BoM/CSIRO assessment further indicated that the current EC trigger, based on historical records, has already resulted in many areas of Australia being drought declared in more than 5 per cent of years, and that the frequency and severity of droughts are likely to increase. The principal implication of the findings of this study is that the existing drought trigger is not appropriate under a changing climate (Hennessy et al. 2008).

In response to this review, the Australian Government, in partnership with the Western Australian Government, implemented a pilot of drought reform measures in part of Western Australia, which commenced in July 2010. The pilot is testing a range of measures that are designed to help farmers move from a crisis management approach to a risk management approach, and to better support farmers prepare for future challenges. A key aspect of the drought reform measures is training for farmers to help them prepare strategic business plans that integrate risk management and preparedness. Grants are also available for strategic plan activities that help farm businesses prepare for the impacts of drought, reduced water availability and a changing climate, and for activities with a natural resource management focus that have broader public benefits. The pilot will continue until June 2012 and is currently being reviewed by an independent panel comprising agribusiness professionals. The review will examine the early outcomes and make recommendations to government about how individual programs might be improved.

Drought Triggers

Drought decision points, or triggers, are the threshold values of an indicator that distinguish a level of drought and potentially determine when management actions and/or government intervention should begin and end. Ideally they should specify the value, time period, spatial scale, drought level, and whether conditions are progressing or receding (Sims et al. 2009).

To be effective, the triggers should ideally meet a number of criteria (Cash et al. 2003), although there may be trade-offs between them:

- salient—they serve the needs of decision-makers, and are applicable at appropriate levels, cost-efficient and easy to administer
- credible—the measures are scientifically and technically adequate, satisfy valid sampling, statistical and consistency methodologies, have historical data available for identifying trends and have accessible and accurate data
- legitimate—they respect stakeholders' values, are unbiased and fair, relate unambiguously to defined issues, have relative simplicity for public understanding of outputs, and have wide acceptance of the integrity of the measure.

The National Drought Policy has an entry threshold of 5th percentile rainfall (that is, rainfall in the lowest 5 per cent of the historic record), combined with a scientific and economic assessment of the production conditions within the region. In determining the initial rainfall threshold, applicants have the ability to set their own beginning and end time for a drought event, within the constraints of the event being at least 12 months long. A 'moving window' threshold such as this can have unintended consequences, as there are no longer only five 'exceptional' (1:20) events in the 100 years, there are a possible 60 (simply because in 100 years, each having a possible 12 beginning months for an event, there are possibly 12 x 5 the number of 'exceptional' events). While this does not occur in practice because most events last longer than a month, it can unintentionally increase the frequency of 'drought' events.

An important, sometimes neglected, aspect of the drought declaration framework is to specify when the declaration should finish (Stafford Smith and McKeon 1998). In principle, decision points should

specify thresholds for both entering and exiting drought declarations, which may be quite different. Exit decision points should be designed to accommodate the desired management outcome. The current EC guidelines use an exit threshold based on whether or not producers have begun to carry out typical farm practices.

Realities of Implementation

Despite good intentions of the National Drought Policy objectives, the recent social, economic and meteorological assessments highlight some difficulties in implementing the policy intent. These assessments clearly indicate that the current EC declaration process is not delivering a drought preparedness and risk management approach and that the current EC trigger is not appropriate under a changing climate (Hennessy et al. 2008). The economic assessment highlighted that the application of the EC criteria has failed to distinguish between droughts defined as those expected to be managed and those beyond the ability of the most prudent farmer to manage (PC 2009).

While the current EC criteria use a range of variables, in practice the diversity of the country and variation in production systems require a significant amount of flexibility to deliver the intended results. For example, assessing a region that contains irrigated horticulture and mixed cropping and grazing systems can be quite complex. A single criterion with insufficient flexibility to account for this diversity may not always deliver consistent outcomes (White et al. 1998). This is because the different systems use rainfall in different ways and at different times, which requires individual measures (White and Walcott 2009). Furthermore, the different industries differ in their requirements and timing for government assistance, depending on whether they need funding for sowing the next crop, for rebuilding their flocks/herds, or for current expenditure.

Under the current EC process, while declarations are made in a relatively timely manner, determining the end of a declaration is problematic to the point where some regions have been EC declared for 14 out of 17 years (PC 2009) (Figure 4). Under the National Drought Policy, EC regions were to be declared for up to 2 years, the premise being a year of assistance and a year to recover. At the end of the declaration period, EC assistance would cease for a region.

During the prolonged 2002–2007 drought, a new review process was implemented to assess whether a region had a chance to recover from the lingering drought or if an extension of the EC declaration was warranted. The EC review criteria differ from the EC criteria and considers whether seasonal, agronomic and resource conditions have provided an opportunity for the majority of producers to begin to carry out typical farm management practices relevant to their enterprise type and production cycle (DAFF 2011).

Due to the cumulative effects of a prolonged event such as the 2002–2007 drought, determining the opportunity for recovery based on whether producers had begun to carry out typical farm practices was challenging in some regions. The prolonged drought meant that in many areas water storages and soil moisture remained depleted for some time, despite a return to normal climatic conditions. In addition, after many years of drought and failed production, producers in some regions had become more risk averse and found it difficult to take the opportunity to carry out typical risk management practices, despite favorable conditions.

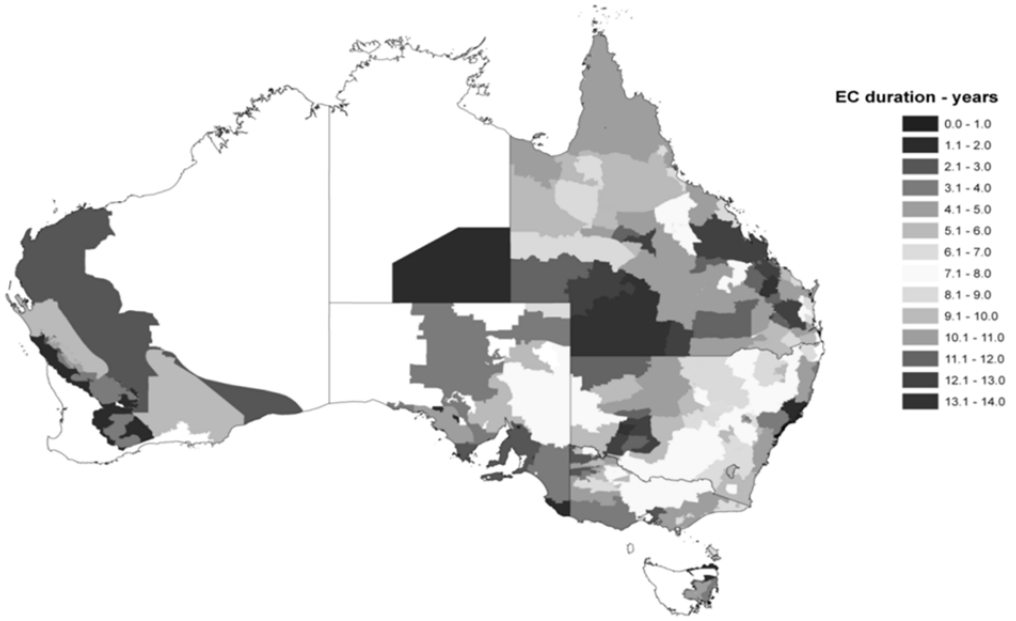

Figure 4. Duration of EC Declarations, 1992–2010

Role of Government

Although climate risk management in agriculture is ultimately the responsibility of farmers and agribusinesses, the public sector has a key role to play in developing policy that addresses inadequacies and failures in current risk management strategies. Ideally, government should adopt a holistic approach to policy development by considering not only the specific risk addressed by a given policy, but also the policy impact on, and links with, other related risks (OECD 2009). Nevertheless, there are occasions, such as large floods, fires, and earthquakes, when governments are called on to directly help those worst affected and this appears to apply to droughts in practice.

The agricultural impact and effective management of extreme events such as droughts is of particular importance to government. Australian drought policy has historically provided income support and interest rate subsidies to farmers and agribusinesses affected by droughts (Kimura and Anton 2011). However, the treatment of droughts as 'exceptional' delays the development of farm systems that are adaptive and resilient to changing climate risks, and encourages risky practices (for example, overstocking). An important Australian Government initiative has been to move away from a crisis management approach for droughts to an increased emphasis on climate risk management. This initiative will focus on enhancing the ability, preparedness and responsibility of farmers to manage climate risks (Gray et al. 2011).

The economic assessment of government drought support identified that governments should commit to a long-term reform path that recognizes that the primary responsibility for managing risks, including from climate variability and change, rests with farmers (PC 2009). However, there is a role for government in facilitating access to appropriate information and tools to support risk management and decision-making. To this end, research, development, extension, professional advice and training to improve farmers' business management skills and build self-reliance warrant significant government funding where they deliver a demonstrable community benefit. There is a clear need and role for government to continue to provide information and tools for risk management decision-making. However, similar recommendations from previous reviews of the National Drought Policy have not been adopted (PC 2009).

Key recommendations from the climatic assessment of drought highlighted that farmers and their suppliers need user-friendly, reliable and up-to-date location-specific information on historical climatic conditions and future climate variability (Hennessy et al. 2008). Key requirements include information on the risk of drought on timescales from seasons to decades, with specific needs including improvement of drought monitoring capability and online climate information. Provision of information and tools, such as the NAMS, for the decision-making process has been integral to the consistent and transparent implementation of the Australian National Drought Policy in recent years.

Information and Tools

The ABARES tools, models and information systems such as the NAMS, the Monitor, the Rainfall Reliability Wizard and GrowEst (ABARES 2011) provide decision-makers with ready access to information on climate variability, water availability, economic indicators and the impacts on agricultural production systems. These tools and systems support the assessment of drought-affected regions and ensure an equitable assessment process by providing consistent, quality-controlled data. As well as supporting the drought assessment process, the information is used to see where production conditions are deteriorating due to adverse climatic conditions and to help identify where intervention may be necessary.

The NAMS was used extensively by the Australian Government and the Department of Agriculture, Fisheries and Forestry (DAFF) for decision-making for EC and within the broader context of climate impacts. With substantial areas of the country remaining drought declared by 2009, NAMS was withdrawn from public access and resources were directed elsewhere. As DAFF needed a replacement system, ABARES developed and maintained an internal system, the Monitor. Since 2009, the Monitor has been heavily used to support the ongoing implementation of the drought policy and DAFF's assessment and review of EC regions. Without systems like the NAMS and its successor, the Monitor, the recent assessments and reviews of drought-affected regions across Australia would have been significantly more difficult to implement.

The Monitor is undergoing a redevelopment to improve its operational functionality and will be released to the general public to assist a broader range of government decision-makers, industry groups and producers with risk management decisions for climate variability. In this context, the Monitor will add significantly to the tools and information being provided for preparedness and risk management for Australian agriculture.

A significant knowledge gap still remains in terms of projecting future climate change and variability and their impacts on agriculture. Most importantly, this information needs to be communicated to decision-makers to inform future policies and support better risk-management practices.

Conclusions

Recurring drought is a natural component of the Australian climate. The Australian Government has a longstanding National Drought Policy based on preparedness and risk management. While recent reviews have highlighted some difficulties with the practical implementation of the policy, particularly in a changing climate, the intent remains valid.

Effective management of current and future agricultural climate risks will require continued public sector investment and involvement in agricultural research, development and extension. Research into climate change mitigation and adaptation options and the development and extension of strategies, information, tools and practices will be vital in providing farmers with effective solutions to climate risks (Gray et al. 2011).

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Elements of National Drought Policy in USA

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Abstract

After prolonged drought events, especially in the western United States, in the last few decades of the 20th Century, Congress created the National Drought Policy Commission (NDPC) to develop a comprehensive national drought policy. The NDPC held fact-finding hearings around the country to better assess stakeholder needs and to coordinate policy issues. A National Drought Policy Act was developed with preparedness as the foundation. The Act had five major goals, each with specific recommendations. The Act was presented to Congress in 2000, during an election year, as the National Drought Preparedness Act.

Introduction

Drought is a normal part of the climate for virtually all regions of the United States, but it has been of particular concern in the West, where any interruption of the region's already limited water supplies over extended periods of time can produce devastating impacts on numerous economic sectors. In fact, in 2011, more than 90 percent of the state of Texas was suffering from “extreme to exceptional” drought conditions. State agriculture officials estimated a record $5.2 billion in commodity losses due to the 10-month drought. Historical records show that drought occurs somewhere in the West almost every year and frequently throughout the remainder of the U.S. (http://www.ncdc.noaa.gov/oa/reports/billionz.html).

Despite the vagaries of the weather, stewardship of the land and natural resources is of vital importance for environmental quality, economic profitability and socio-economic equity (Feenstra 1997). A basic natural resource for agriculture as well as for rural and urban community needs is an adequate source or supply of water. If water is sufficiently available, agriculture and society can cope with drought. If water is mismanaged or is extremely limited, agriculture and society will face well-documented crises during drought. The United States did attempt to implement a national drought policy to better prepare the nation with a comprehensive and coordinated drought management strategy. This paper will present the background, process, and outcome of this effort by the National Drought Policy Commission.

Western Drought Coordination Council

In a series of actions, the Western Governors' Association (WGA) responded to the serious drought episodes of the 1970s through 1990s by preparing a *Drought Action Plan of 1996*, which became the framework for a number of specific drought actions. The plan stated "The western governors believed that a comprehensive, integrated response to drought emergencies is critical...It is important to work together and cooperatively with other affected entities to plan for and implement measures that will provide relief from the current drought and prepare for future drought emergencies." The WGA and a separate federal drought initiative led to the formulation of a partnership called the Western Drought Coordination Council (WDCC). Its mission was to develop and implement model drought policies and management/mitigation measures that reduce impacts associated with droughts and that promote economic and environmental sustainability in the western states.

While the objectives of the WDCC were focused on the western states, they brought attention to the entire nation regarding a comprehensive vision of drought management (WDCC 1999). The objectives included the following: to encourage and help states, local, and tribal governments to develop and implement drought preparedness and mitigation programs and plans by establishing and maintaining a clearinghouse of information on techniques and procedures for drought monitoring and prediction, response, planning, and mitigation; to identify and make recommendations on drought issues, legislation, and program implementation at the state, regional, and national levels; to improve information exchange and coordination at all levels of government by facilitating the development and implementation of an efficient drought monitoring and information delivery system; and, to heighten awareness and understanding of regional drought management and policy issues and promote the efficient use of water in the West. Key elements of a drought plan include the following:

1) Monitoring, Assessment, and Prediction
2) Preparedness and Mitigation
3) Response
4) Communications

To be effective, a national policy must be enacted, which provides for a comprehensive, coordinated, and integrated approach to future droughts. The WDCC recommended that a National Drought Policy Commission (NDPC) should be established to raise awareness of drought issues at the national level in order to provide specific ideas, which Congress should then consider in national legislation for an effective national drought policy.

National Drought Policy Commission (NDPC)

In 1998, Congress passed the National Drought Policy Act. The Act stated that this nation would benefit from a national drought policy based on preparedness and mitigation to reduce the need for emergency relief. It acknowledged that this country had no consistent, comprehensive policy driving the federal role to help reduce the impacts of drought. The Act also created the National Drought Policy Commission to advise Congress on how best to:

1) Integrate federal drought laws and programs with on-going state, local, and tribal programs into a comprehensive national policy to mitigate the impacts of and response to drought;

2) Improve public awareness of the need for drought mitigation; and,

3) Achieve a coordinated approach to drought mitigation and response by governments and non-governmental entities, including academic, private, and non-profit interests.

The Commission emphasized the belief that a national drought policy should use the resources of the federal government to support but not supplant nor interfere with state, tribal, regional, local, and individual efforts to reduce drought impacts. The guiding principles of a national drought policy should be:

1) Favor preparedness over insurance, insurance over relief, and incentives over regulation,
2) Set research priorities based on the potential of the research results to reduce drought impacts, and,
3) Coordinate the delivery of federal services through cooperation and collaboration with nonfederal entities.

This policy required a shift from the current emphasis on drought relief. It meant that there must be an adoption of a forward-looking stance to reduce this nation's vulnerability to the impacts of drought. This proactive concept was also the conclusion reached by the Senate Task Force on Funding

Disaster Relief in March 1995, among other entities. It was universally supported within the Commission and by the overwhelming majority of people who submitted testimony at public hearings before the Commission.

Commission Findings

At its most severe, drought creates vast, windblown dust bowls eroding the landscape, damaging terrestrial and aquatic wildlife habitat, contributing to widespread wildfire, causing hundreds of millions of dollars in losses, and dashing hopes and dreams. Drought may be the last straw in driving farm and ranch families off their land and livestock producers out of business. It brings hardship to water-dependent enterprises and affects all sectors of society. Public hearings were held during the Commission around the country to gather facts about the impact of droughts on society. Drought definitions were one difficult example. The public perceived "drought" as a serious departure from normal water conditions. Public declarations of drought are often triggered by specific and well-defined conditions, such as a specific reservoir elevation on a specific date. These "drought triggers" become the practical definition of drought for a particular region and for specific issues. Defining these triggers is an inseparable part of planning for and responding to droughts. Once these triggers are defined, a region is much better able to estimate the costs, expected frequency, and risks of drought response.

The Commission found that in reality, drought is defined differently in different situations. For example, two months without rainfall during the growing season may result in serious drought conditions for farmers and homeowners in the eastern half of the country. The same dry period may be normal for those in the West, where water users may be more concerned with reservoir levels, which in turn are dependent on winter snow pack levels. A national drought policy must therefore define drought so that it meets the needs of diverse water users and for diverse functions. It must be flexible enough to include a variety of drought situations. It must also be specific enough to distinguish between those situations that are true drought emergencies and those that are normal cyclical conditions.

As of June 1999, 30 states had drought plans, with most of those oriented to relief rather than preparedness. The assessments found that in most states, drought responsibilities are normally located in the agencies that house the functions of agriculture, natural resources, water management, environment, or emergency management. The study also found that 88 drought-related federal programs were funded within the past ten years. Seven of these programs provided assistance for drought planning, 42 for drought mitigation, 22 for drought- related monitoring/prediction and research, and 47 for response. These numbers totaled more than 88 because some programs cover more than one facet of drought. For example, some of the mitigation programs also contained drought planning and response elements. Consequently, the multitude of federal programs caused problems for state, county, and tribal governments that often made governmental transactions but still have to deal individually with separate federal agencies for any number of drought-related issues. Further, the array of state, federal, and other drought-related programs can be intimidating and frustrating for those who had to access the services offered by the programs, but who do not deal with government agencies on a regular basis.

From the public hearings, more than one hundred people testified on behalf of urban and rural water associations, tribes, federal agencies, state and county governments, municipalities, livestock producers and farmer associations, and conservation groups. A clear assessment of the findings became very conclusive from all sectors of society affected by drought. Preparedness, including drought planning, plan implementation, proactive mitigation, risk management, resource stewardship, consideration of environmental concerns, and public education must become the cornerstone of a national drought policy. To ensure preparedness, there must be fundamental principles of a national drought policy. There must be an adequate national observation network to provide the basis for an

effective drought monitoring program. A national drought information "gateway" needs to be accessible to the entire user community. The benefits of high quality research must be focused on information and technology that are fundamental to drought preparedness, with research results as well as the transfer of technology more effectively implemented in drought programs.

It also became clearly evident from the public hearings that even the best preparedness measures were not adequate to address all drought related risks. Risk management is another component of a proactive planning strategy. Insurance is one option, although it is generally limited in drought situations in the business communities. However, crop insurance has been a central component of U.S. agricultural policy for decades, covering only major field crops in all locations of the country. In the public hearings, farmers, livestock producers, and vegetable growers from across the country urged that a more comprehensive crop insurance program is needed. Another point that was clearly emphasized in the public hearings around the nation was the need for a safety net of emergency relief to help overcome the impact of extreme droughts or the impact of multi-faceted disasters. The key issues to be addressed, however, are efficient and responsive emergency measures that focus on the needs of the communities affected by the disasters. The Federal Emergency Management Agency (FEMA) was noted for its effective, proven model of organizing and providing emergency assistance during most catastrophic natural disasters (except droughts). One reason for FEMA's success is the agency can draw on annual appropriated funds to pay for disaster assistance as opposed to requesting congressional disaster relief funds after a disaster occurs.

Finally, the need for coordination among federal drought-related programs was a strong and recurring theme in much of the testimony at the hearings and in written comments submitted independently to the commission. The report prepared by the Western Drought Coordination Council also strongly suggested establishing a federal drought coordinating body. As mentioned earlier, with 88 federal programs dealing with drought in different federal agencies, there was no coordination; and, in fact, there was duplication among programs without any knowledge of other activities. There was no central point of contact concerning federal programs and, consequently, no contact for people to help access programs, information, products and services. Collaboration is also a key part of the education process. From the deliberations, public education is a key element in successful drought preparedness. Many people are made aware of the need for water conservation and other measures during drought. But once drought is over, old habits tend to dominate. Workshops, newsletters, public service announcements, press releases, town hall meetings, school curricula, and interactive participatory decision-making processes are all included in education programs. These techniques and others provide communication links among organizations that provide assistance and the people whom they serve. Such techniques also help increase awareness of the value of preparedness to reduce costly impacts of droughts.

Hands-on training and technical assistance programs can help people formulate and implement plans to mitigate human and environmental impacts. Such programs can help farmers decide whether to include drought-resistant crops, on-farm wells, crop insurance, conservation systems, restoration of wetlands and wildlife habitat, and other important factors into their risk-management strategies. They can help farmers install water management practices and gain a basic understanding of the soils and climate conditions in their areas and the types of crops and plants suitable to those sometimes changing conditions. Such assistance can also help them understand complicated marketing options and other methods to manage risks. Training and technical assistance programs can help communities as they determine their own priorities for incorporating drought concerns and the need to protect environmental resources into on-going community planning and comprehensive water management plans aimed at ensuring safe, adequate drinking water (urban and rural) as well as water needed to fight fires.

In the arena of water supplies, the border between the U.S. and Canada cuts across natural drainage basins. Thus, the actions of one country can affect the other, and the impacts of drought can cross

the border. Although drought is a serious issue in the Columbia River and Great Lakes basins, the two countries have strong working relationships on these issues. The International Boundary and Water Commission (http://ibwc.state.gov/home.html) monitors allocation of water from the Colorado and Rio Grande rivers between the United States and Mexico. There is a need for watershed planning of the entire river basin, which is located in both the United States and Mexico.

Commission Recommendations: National Drought Policy Act

The commission evaluated all the findings and concluded that the United States clearly needed to embrace a national drought policy with preparedness as it fundamental core. The NDPC recommended that Congress pass a National Drought Preparedness Act, which would establish a nonfederal/federal partnership through a National Drought Council (NDPC 2000). The primary function of the Council would be to ensure that the goals of the national drought policy are achieved. Five goals and specific recommendations were developed by the NDPC for implementation in the national drought policy. The following summarizes the goals and recommendations of the National Drought Policy Act.

Goal 1: Incorporate planning, implementation of plans and proactive mitigation measures, risk management, resource stewardship, environmental considerations, and public education as the key elements of an effective national drought policy.

Specific Recommendations:

- Congress should adequately fund existing drought preparedness programs.
- The President should direct appropriate agencies to find an effective way to meet the drought planning needs of those areas not traditionally served. Congress should fund these agencies' efforts to better serve the needs of the eastern part of the country.
- The President should direct all appropriate federal agencies to cooperate fully and to provide all assistance possible to encourage development or revision and implementation of comprehensive drought preparedness plans by states, localities, tribes, regional entities such as watershed and river basin organizations, and the private sector.
- Federal agencies providing drought planning assistance should encourage state, local, regional, and tribal planners to use or adapt existing planning materials and resources. These include materials developed by the National Drought Mitigation Center, the Army Corps of Engineers, the U.S. Department of Agriculture, the Western Drought Coordination Council, the states, and urban and rural water districts.
- The President should direct all appropriate federal agencies to develop and implement drought management plans for federal facilities such as military bases, federal prisons, and large federal office complexes in the United States. These plans should be coordinated with local and state drought planning and mitigation measures.
- The President should direct all appropriate federal agencies to study their programs for potential impacts on drought. Where such potential exists, the agencies need to integrate a national drought policy into their programs.
- The President should direct federal agencies with water resource management programs to develop and promote comprehensive public awareness efforts as part of an on-going public awareness strategy.

Goal 2: Improve collaboration among scientists and managers to enhance the effectiveness of observation networks, monitoring, prediction, information delivery, and applied research and to foster public understanding of and preparedness for drought.

Specific Recommendations:

- The President should appropriately direct and Congress should authorize and fund a viable plan to maintain, modernize, expand, and coordinate a system of observation networks, cooperating with states to develop and improve baseline historical data sets that meet the needs of the public. Priority needed to be placed on filling the gaps on tribal lands and in rural America.
- The President should direct and Congress should authorize and fund the continuation of the U.S. Drought Monitor, http://drought.unl.edu/dm, and, for exploration of opportunities for its improvement and expansion.
- The President should direct and Congress should authorize and fund the continuation of Drought Predictions/Outlooks, http://www.cpc.ncep.noaa.gov/products/expert_assessment/season_drought.gif, and for development of techniques to improve their accuracy and frequency.
- The President should direct and Congress should authorize and fund a comprehensive information gateway (possibly through expansion of the National Drought Mitigation Center's website, http://drought.unl.edu) to provide users with free and open access to observational network data and drought monitoring, prediction, impact, assessment, preparedness, and mitigation measures. Links among federal and nonfederal sources are critical.
- The President should direct the appropriate federal agencies to develop an effective drought information delivery system to communicate drought conditions and impacts to decision makers at the federal, regional, state, tribal, and local levels and to the private sector and general public. The systems should include near real-time data, information, and products developed at each of these levels and integrated in an appropriate fashion to accurately reflect regional and state differences in drought conditions.
- The President should direct appropriate federal agencies to expand technology transfer of water conservation strategies and innovative water supply techniques as part of drought preparedness programs.
- The President should direct and Congress should continue to adequately fund existing and future drought-related research. Existing competitive research grant programs should give high priority to drought. Areas of research should include topics that will either conserve water or make more water available for needs during drought.
- The President should direct and Congress should fund completion of the soil survey on all lands, with special and immediate emphasis on tribal lands.

Goal 3: Develop and incorporate comprehensive insurance and financial strategies into drought preparedness plans.

Specific Recommendations:

- Congress should authorize and fund the U.S. Department of Agriculture to evaluate different approaches to crop insurance, including a cost of production plan. The evaluation should assess whether the approaches are practicable and prudent for all farmers, ranchers, and other stakeholders in all regions of the country and whether they set standards that encourage efficient water use.
- The U.S. Department of Agriculture, in cooperation with state and local governments and the private sector, expand training to rural communities, farmers, and ranchers across the country on various financial strategies.
- The Small Business Administration, through its private-sector partners, provides information and training to small business owners on developing financial and business management strategies.

Goal 4: Maintain a safety net of emergency relief that emphasizes sound stewardship of natural resources and self-help.

Specific Recommendations:

- Congress should authorize the Secretary of Agriculture to implement the Department of Agriculture's emergency programs.
- Congress should amend the appropriate U.S. Department of Agriculture's emergency programs to include livestock needs during drought.
- The Department of Agriculture should establish a single procedure to trigger, in a timely fashion, all of the Department's disaster programs.
- Emergency assistance acknowledges, encourages, and rewards natural resource stewardship and self-help without discriminating against those truly in need.
- Congress should appropriate an annual fund, similar to the Federal Emergency Management Agency (FEMA), for non-farm drought emergencies that affect tribes, communities, businesses, and the environment.

Goal 5: Coordinate drought programs and response effectively, efficiently, and in a customer-oriented manner.

Specific Recommendations:

- The President should immediately establish an interim National Drought Council through an executive order and in combination with a Memorandum of Understanding that provides adequate staffing and funding. Congress should create a long-term, continuing National Drought Council. Both should be composed of federal and regionally diverse non-federal members.
- The President should appoint the Secretary of Agriculture as co-chair of the interim National Drought Council, with a non-federal co-chair elected by the non-federal interim Council members. Congress should designate the Secretary of Agriculture as the permanent federal co-chair of the long-term Council, with a non-federal co-chair elected by the non-federal Council members.
- The President should request and Congress should provide administrative funding to support the interim and long-term National Drought Councils.
- The interim and long-term National Drought Councils will be responsible for coordinating the following:

    - Timely and efficient delivery of existing federal drought programs.
    - Cooperation and participation among federal, state, local, and tribal interests and private water systems in federal drought assistance opportunities by example and through facilitation.
    - Program assessments of drought-related assistance efforts.
    - Determination of which regions have the most pressing need and greatest opportunities to coordinate and implement drought preparedness assistance programs, recognizing the special drought preparedness needs of tribes, small rural water districts, and small self-supplied water users.
    - Development of an array of coordination strategies to provide support for state, local, and tribal drought planning and mitigation measures.
    - Support of state, local, and tribal initiatives to coordinate with current regional drought planning entities, perhaps within watersheds or river basins, or to establish new regional entities.

- An assessment of major river basin initiatives and state programs to determine which methods have proven most effective in reducing conflicts over water.
- A survey of user groups to ascertain drought monitoring, prediction, and research needs and expectations. Development of a handbook of emergency drought preparedness measures.
- Establishment of drought impact assessment teams of federal, state, and other experts who are responsible, after drought events occur, for analyzing the causes and aggravating factors that contribute to drought and its social, economic, and environmental impacts.
- Development of a handbook on water supply techniques, including traditional and non-traditional strategies.
- Advocacy of drought-related educational training programs within universities, agencies, and public sector programs.

The co-chairs should report to the President and Congress annually on the progress of these activities. Finally, the commission recommended that Congress provide federal departments and agencies with appropriate authority and funding needed to carry out the recommendations in the report. Consideration should be given to the costs and benefits associated with drought preparedness, mitigation, and response measures.

Congressional Legislation for the National Drought Policy Act

The National Governor's Association (NGA) sponsored a bill in Congress to enact a permanent National Drought Preparedness Act in order to carry out the five goals described above. Congressional hearings were held during the summer of 2000, with widespread support for this legislation. The Senate was the first to act on the legislation and voted for passage of the National Drought Policy Bill. The House of Representatives continued to deliberate on the bill with committee hearings during the summer but failed to vote on the bill before summer recess and prior to the preparation for fall elections. The bill never came to a vote in the House prior to the Presidential and Congressional election in November 2000. The election resulted in a major change in congressional control and priorities. As a result, the Drought bill never passed. The NGA made several attempts to re-introduce the complete National Drought Preparedness Act in Congress in the early 2000's but each attempt failed to gain sufficient support for passage.

Lessons Learned

From the years of work that went into The Western Governors' Association (WGA) Drought Action Plan, the partnership called the Western Drought Coordination Council (WDCC), and the two years of dedication to the National Drought Policy Commission, valuable lessons were learnt. The most valuable lesson that was learned, that others might follow, was that collaboration, coordination, and commitment are three keys to successful development of a national drought policy. Collaboration in this sense is the common effort among agencies (both federal and non-federal) to learn to work together to accomplish the necessary and desired goals. It was mentioned that many agencies had drought programs, but prior to the NDPC, there was very little discussion among agencies about who had responsibility for what activity related to drought. No agency really knew what the other agency was doing. The NDPC brought all federal/nonfederal agencies together for a common cause to collaborate on the urgent need for a more efficient proactive system. Coordination then became easier to define and to establish, making a more dedicated system to function more efficiently and to service the public more effectively. Finally, commitment refers to the individuals in each of the agencies and institutions who were entrusted with the authority, confidence and perseverance to help gather the facts, listen to all the stakeholder needs, prepare the documents and remain focused until the end to achieve some significant and desired results.

Achievements

Although the ultimate goal of a national drought policy was not achieved, some of the important recommendations have been adopted.

- While unfunded, the U.S. Drought Monitor has continued to be produced and improved with increased partnerships among participating institutions. Recognizing that drought and water issues cross international boundaries, a North American Drought Monitor was developed and implemented with authors from Canada, the United States, and Mexico contributing respective country components. Training sessions were conducted to ensure the appropriate blending procedures across the international boundaries.

- Similarly, the National Weather Service undertook responsibility for issuance of Drought Outlooks, which are published routinely along with statistics of forecast accuracy.

- The National Drought Mitigation Center (NDMC) has continued to provide drought planning assistance to state, local, regional, and tribal planners.

- The National Integrated Drought Information System (NIDIS) Act was signed into law in 2006 (http://www.drought.gov/portal/server.pt/community/what_is_nidis/207) The NIDIS Act calls for an interagency, multi-partner approach to drought monitoring, forecasting, and early warning, led by the National Oceanic and Atmospheric Administration (NOAA). In late 2007, NIDIS launched the U.S. Drought Portal, or drought.gov, a website that pulls together many federal, state, and academic resources for monitoring drought. This was a major recommendation of Goal 2.

- The U.S. Department of Agriculture Farm Bill (Food, Conservation, and Energy Act of 2008)adopted the U.S. Drought Monitor as a single trigger for disaster programs by authorizing the Livestock Forage Disaster Program Grazing Loss because of drought on owned or leased grazing land or pastureland that is physically located in a county experiencing as follows:

    - D2 intensity for at least 8 consecutive weeks during the normal grazing period will be eligible to receive payment equal to 1 monthly payment;
    - D3 intensity during the normal grazing period will be eligible to receive a payment equal to 2 monthly payments;
    - D3 intensity for at least 4 weeks or D4 intensity during the grazing period will be eligible to receive a payment equal to 3 monthly payments.

- USDA organized a Drought Committee, chaired by the Farm Service Agency/Risk Management Agency, to monitor U.S. drought conditions and used the U.S. Drought Monitor as the trigger to coordinate emergency assistance programs.

Conclusions

The National Drought Policy Commission (NDPC) was created to advise Congress on how best to develop a comprehensive national drought policy to mitigate the impacts of and respond to drought; to improve public awareness of the need for drought mitigation; and, to achieve a coordinated approach to drought mitigation and response by governments and nongovernmental entities. Hearings were held around the country to listen to stakeholder needs. The commission prepared a report for Congress with five basic goals of a national drought policy. These included: 1) planning and implementation of plans for proactive mitigation measures, risk management, resource stewardship, environmental considerations, and public education; 2)enhanced effectiveness of observation networks, monitoring, prediction, information delivery, and applied research, and promote public understanding of and preparedness for drought; 3) incorporate comprehensive insurance and financial

strategies into drought preparedness plans; 4) maintain a safety net of emergency relief that emphasizes sound stewardship of natural resources and self-help; and, 5) coordinate drought programs and response effectively, efficiently, and in a customer-oriented manner. While Congress failed to pass the National Drought Policy Act, some of the recommendations in the NDPC report have either been implemented or individually enacted.

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DROUGHT PLANS IN SELECTED COUNTRIES/REGIONS

Drought and Drought Policy in Brazil

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Abstract

The Brazilian Northeast, especially its semi-arid area, traditionally suffers from recurrent droughts that affect heavily its population, economy and environment. According to the IPCC AR4 report and other studies, climate change will impact heavily on this region, with more frequent and intense droughts, and increasing water deficit, that may lead some areas to desertification.

In this article, the authors discuss the problems of droughts in the Northeast and the rich experience of societal and governmental response, particularly in the last two decades, which has increased regional resiliency and improved capacity to cope with the phenomenon. Institutional developments in the state of Ceará have contributed to improve governmental capacity to prepare, plan and respond to drought events.

The Drought Prone Northeast Brazil: The Context

Brazil's semi-arid lands comprise most of the Northeast region of the country. With a total area of 1.5 million square kilometers and a total population of 53 million inhabitants (28 percent of the Brazilian population), it occupies the interior of 10 states, some of them, like Ceará, with more than 90 percent of the territory considered as semi-arid. It also includes the northern part of the state of Minas Gerais, which is one of the Southeast states. Population density is 35 inhabitants/km^2.This population density is considered high for semi-arid regions. As a whole, the semi-arid territory, also known locally as the Sertão, covers an area of 900,000 km^2. The region is located in the Northeast part of Brazil, along the Atlantic coast. Figure 1 below shows the Northeast with its semi-arid interior.

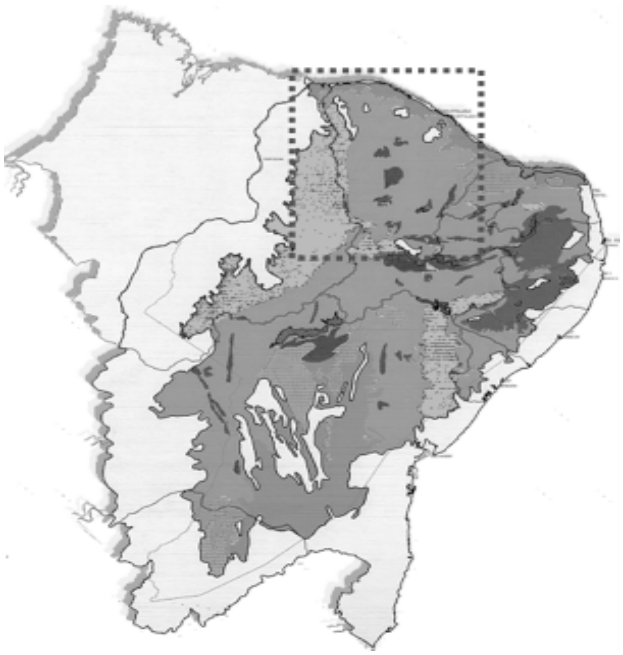

Figure 1.The Northeast and the Semi-arid Region of Brazil. Ceará state is delimited by the dashed-line contour.

It is a drought prone region, with an average of one drought occurring each 7 years. The quantity of rainfall is not low, compared to some temperate humid areas: about 800 mm per year. However, as a tropical region, the rates of evapotranspiration (ET) are very high, reaching more than 2,000 mm per year, which renders a deficit of humidity in the region. In addition to that, rainfall is concentrated in 3-4 months of the year, the only months when there is water surplus. During the rest of the year, only irrigated agriculture is possible because of these large water deficits.

Even during the rainy season – mostly from February to May in the northern part of the Northeast – there is the problem of irregularity of distribution, both in time and in space. Most of the rainfall may happen in one month, and sometimes dry spells during the rainy season may compromise agricultural activity.

The modern history of Brazil, after the arrival of the Portuguese in 1500, started in the 16th century in the Northeast Atlantic coastal zone. This is a narrow zone that is covered by a tropical Atlantic forest. Here the exploitation of the Brazil wood and later the sugar cane plantations constituted the first economic cycles of the country. Cities like Olinda, Recife and Salvador, this last one the capital of Brazil until the end of the 18th century, developed in this zone. In the 17th century, the occupation of the contiguous hinterland, the Sertão, with the establishment of large cattle farms, created a complement for the economy of the coastal zone. It exposed the new occupants to the phenomenon of the frequent droughts that hit this zone and since ancient times impacted on the lives of the indigenous populations. As a consequence of this history, the Northeast and in particular the Sertão became a densely populated region of Brazil, increasing regional vulnerability to the high variability of its climate.

Brief History of Droughts and their Impacts

The first register of a drought by the European colonizers dates from the 16th century and mentioned the impact on the local indigenous populations who fled from the interior to the coastal zone in search of water and food. However, the more frequent registers started in the 18th century, coinciding with the increase of the occupation of the Sertão. The most famous drought is the 1877-79 event. It was an extreme event that prolonged itself during 3 years. At the time, the population of the Sertão was increasing, with many cattle farms having been established. In addition to cattle, the production of cotton, stimulated by the American civil war, became an important economic activity. The region, however, still lacked infrastructure, having no roads and no water storage capacity. The impacts of that drought, which are well documented in the literature and marked profoundly the culture of the people of the region, were tremendous. About one third of the regional population, circa 500,000 people died of thirst, starvation and malnutrition. Most of the cattle perished. That drought marked profoundly the economy and the society of the Northeast, and finally triggered some of the initial policies the country adopted to face the problem (Magalhães et al, 1988).

After 1877, other famous droughts followed, some of them were catastrophic. There were severe droughts in 1900, 1915, 1919, 1932, 1958, 1970-83, 1987, 1998, 2003, and 2010. Impacts were huge, but there was learning and preparedness during the period. With the increase in population and human activities, the environment ess resilient and the region became more vulnerable. During the first 60 years of the XX century, droughts continued to cause significant human losses. During the second part of the century, human losses were avoided but still significant social impacts were recorded (Magalhães and Glantz, 1992).

Drought, Society, and Poverty

Social vulnerability to droughts in the Semi-arid Northeast reflects the fact that most of the population of the Sertão is poor. It is the poorest region in Brazil, with a majority of people who have no assets and depend on precarious employment in agriculture. In the middle of the 20th century, rainfed

agriculture responded for more than 30 percent of the regional gross domestic product (GDP) and more than 40 percent of the workforce. People employed in agriculture had only their labor to sell, and no other assets at all. In case of a drought, for some time, if it were a light drought, they would be "protected" by the land owners who employed them within their properties. But in case of more serious droughts, even the land owners were hit and could no longer support their labor force. These people would become suddenly unemployed, being totally vulnerable to the droughts.

During the second half of the 20th century, there was a change in the social organization of the Sertão, and the workers reduced their dependency on land owners, which also meant that they lost their protection even in the case of light droughts. Public policy was the only hope.

Historically, drought profoundly shaped the society of the Northeast. It impacted on the economic activities, on the environment, and on people's lives. Droughts became an embedded part of the local culture, of music and literature, of religion, of economic behavior (the risk of droughts being a major determinant of investment decisions in agriculture). Because of poverty, the social impacts of droughts became dominant. The millions of poor people of the Semi-arid were, and continue to be, the most hit by the droughts.

Brief History of Drought Policies

Brazil was awakened to the need to respond to droughts with the extreme drought of 1877. This was an ENSO related event that affected many parts of the world, such as Africa, India and China, and caused immense human suffering. In the Northeast, as seen above, its consequences were disastrous.

The initial government response to the Northeast droughts was (a) to relieve the suffering of the population during the drought emergency, with food and water distribution, (b) to build capacity to store water, and (c) to build transport infrastructure. In fact, the attempts to distribute food and support the affected population were limited by the lack of infrastructure, so this became an important goal by the end of the 19th century. At the time, Brazil was a monarchy with strong central government based in Rio de Janeiro and provinces and local governments that were weak and depended mostly on the central government for investment decisions. The Emperor of Brazil decided, after the 1877 drought, to build the first big reservoir or "açude" (the Portuguese word for "dam"). The construction started in 1886, in the state of Ceará, and ended in 1906, when the country was already a Republic. In 1909, the Federal Government created the Federal Inspectory for Works against the Droughts, which later became DNOCS – the National Department of Works Against the Droughts. Along its history, DNOCS built a network of big açudes that, together with other açudes built in cooperation with state governments and landowners, created an effective capacity for storage of water that reduced significantly the vulnerability of the Northeast to the droughts, as long as access to water was the limiting factor.

At same time, an infrastructure for transportation was built, including rail roads, in the beginning of the 20th century, and a network of highways and local roads that facilitated transportation of people and goods and allowed for the easy access of government people to provide aid to the stricken population in case of droughts.

The presence of such water and transport infrastructure explains the fact that, in the second half of the 20th century, human death caused during drought episodes was virtually eliminated. Animal death was reduced, as well, as it became easier to transport cattle to safer places, during the droughts. But high poverty rates still kept the population highly vulnerable. During a drought, the high number of unemployed rural workers required the government to respond. Usually, government would create "work fronts", or "emergency works", with the aim to offer jobs to the unemployed workers, thus providing them with an income necessary for acquiring basic goods, especially food. This was done

within the government's civil defense structure, which included a central organization in Brasilia (with the Ministry of Interior, now Ministry of National Integration), a regional coordination with SUDENE – Superintendency of the Development of the Northeast, and execution by the states (where there were state civil defense institutions) and federal organizations such as DNOCS and the Army.

During the 1979-83 drought, for example, emergency works resulted in the creation of more than 3.0 million jobs in 10 states of the Northeast. One million of the jobs were offered in the state of Ceará, which is usually the most affected state (Magalhães et al, 1988). There was the policy to offer a low salary (below the country's minimum wage), in part because of budget restrictions, in part because there was a concern to avoid competition in the regional labor market. In other words, the emergency works should not stimulate the workers not to seek other opportunities. This policy yielded good results, in terms of providing an income for the affected poor population, but there were many weaknesses that were the focus of much criticism, such as political appropriation, low salaries, workers exploitation and low quality of constructions (mainly small dams, wells and other works).

There has been much discussion in the Northeast on what kind of works to build. In some cases, like in the droughts of 1932, 1951, and 1958, the policy was to go for big works, such as big dams that would result in something useful to reduce future vulnerability. Several big dams and highways were built. This kind of work usually required the displacement of the workers and their separation from the families, which caused many problems and criticisms. Also, the works ended up being built not during the drought, but in subsequent years, because of their complexity and long term duration of construction. But many of these works are still rendering their services today.

In other occasions, like 1979-83, there was the policy to build mainly small works, such as small dams, wells and urban improvements. This required less displacements but, as indicated above, were also the object of much criticism. One of them was the lower quality of the small dams which would not resist flooding during the rainy season. In all cases, however, the objective was to create Keynesian employment to provide income for the workers and to sustain a certain level of aggregate demand for goods and services in the local economy. In general, this objective was attained.

The drought of 1987 provides an interesting example (Magalhães 1991). In 1985, there had been a change in the Brazilian government, with the end of the military regime. The new democratic government did not respond immediately to the drought, even after the states had declared the emergency situation. According to the civil defense mechanisms, in order for action to be taken by the government in case of drought, the state has to declare a "state of emergency" and this has to be recognized by the federal government.

In 1987, the Federal Government did not react on time, and this forced the states to take the lead. During the last decades, during the second part of the 20th century, the subnational governments had improved their institutions and capacities to do public policies, and some were waiting for an opportunity to show up. The state of Ceará advanced in this process and introduced changes in the way the emergency works were done. Based on the criticisms of 1979-83, it was decided to avoid appropriation by local politicians and to combat clientelism, and at the same time to assure voice to local communities and the rural workers themselves.

Each municipality should organize a community group that would, according to certain criteria, appoint the workers affected by the drought. From each family, only one worker would be employed, in order to leave room for other activities and, in particular, to keep children going to school instead of hiring them in the emergency works. The works themselves should be identified by the communities, they should be useful to them, and should be built in a short distance to the place where they lived. Once decided which works and what workers, the government, through its several sectorial organizations, would execute the investment, under the surveillance of the community.

This approach was successful. It served the goals of the emergency action and left some good results for the community. It was decided, for instance, that some workers of each community should be trained as health agents, who would receive training from the state's health institutions and would work with the community on basic health issues. With the end of the drought, the state government decided to continue and expand this action. A few years later, the federal government decided to extend the experience to all states in Brazil (Tendler 1998).

This strategy, then, changed the approach of drought policy from top down to bottom up, while keeping a role for the government institutions in the approval of projects and in their execution.

Regional Development Policies, Social Policies, and their Effect on Vulnerability to Drought

In addition to drought oriented policies, regional development policy in the Northeast had a significant impact in reducing economic and social vulnerability to droughts. Since the 1950s there was a deliberate goal to foster regional development and reduce regional dependency to traditional agriculture that was more vulnerable to droughts. The participation in agriculture in regional GDP was reduced from 30 percent, in the sixties, to 7 percent in 2010. The manufacture and services sector increased their participation. At the same time, rural-urban migrations increased urbanization, and the percentage of the population living in rural areas was decreased from 66 percent in 1960 to 27 percent in 2010. The economy and the population of the Northeast became less dependent on rainfed agriculture, and this helped to reduce vulnerability and the impacts of droughts on the economy and on the population. However, as mentioned before, droughts still represent a serious social problem because of poverty and the fact that rain fed agriculture is still an important area of employment in the rural Northeast.

During the second half of the 20th century there were new social policies that helped in the transfer of income for the poor in the Northeast. There is a system of transfer of funds from the federal to the municipal governments, and this in general is translated in an increase in job opportunities in the public sector of the small municipalities. Also, after the 1970s, the federal government established some systems to assure a retirement income for the aged population, in particular those who were rural workers, independent of their contribution to the system. It means that all aged person has an income and is out of extreme poverty. And more recently, in the 21st century, Brazil adopted a widespread system of cash transfers to the poor families, most of them living in the Northeast. These three systems together explain the fact that, notwithstanding the serious meteorological drought of 2010, the social repercussion of the phenomenon was minimal, and there was no need for the government to offer emergency jobs as in previous droughts.

The Case of the State of Ceará

In this section, we will discuss briefly the experience of the state of Ceará. This state has assumed a pioneering role in regard to drought policies, including drought preparedness and drought response.

Drought Early Warning

– *Living in the Semiarid and Climate Change*; *Participative Management*; and *Environmental Citizenship*.

Precipitation Index
Most of the rainfall in Ceará falls in the February-May wet season, which on average accounts for about 70 percent of the rain of the whole year. The rainfed-based farmers await the beginning of the rainy season to start planting either maize or beans. Thus, we chose the period of February to May to compute the Standardized Precipitation Index (SPI) for the eight homogeneous precipitation regions of

the state (See Figure 2).

The SPIs are computed for the period of Feb-May using data from a network of 549 rain gauges. The results are shown in Figure 2. The figure shows at the right-top the regions of Ceará State, and at the right-bottom the legend of the SPI. The same figure shows at its bottom the NINO34 and the DIPOLE indexes, which demonstrate the role of both Pacific and Atlantic Oceans in the precipitation regime of Ceará State.

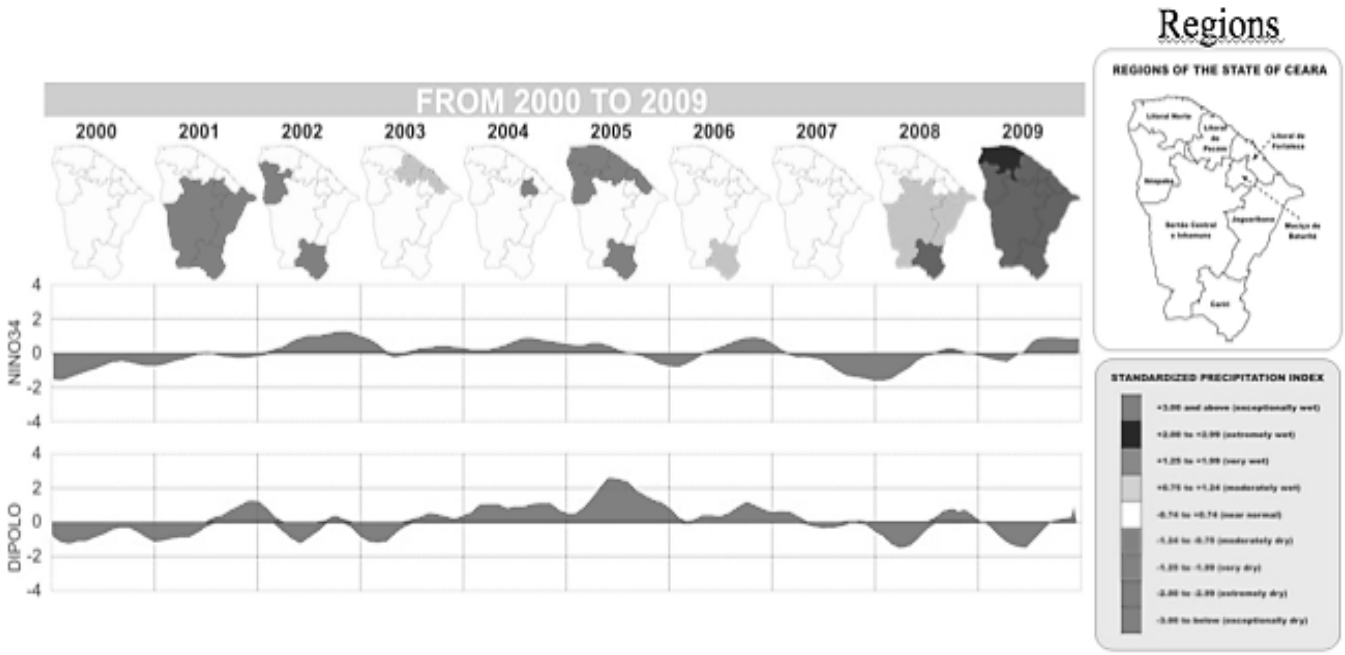

Figure 2.Ceará: SPIs for February to May Rainfall from 2000 to 2009. NINO34 and DIPOLE indexes are shown at the bottom of the figure.

Agricultural Drought Monitoring

Agriculture drought monitoring is carried out through field visits and soil moisture modeling. The latter anticipates the regions of the state that are prone to high losses. Figure 3 shows, based on soil moisture modeled conditions, the regions of the state that might have maize yield below average (dark gray), near average (light gray) and above average (gray). On the graphs below in Figure 3, results are given for two specific locations. The black line is the result of soil moisture simulation: when this curve is below the lowest curve shown in the lightest gray tone (bottom curse), between the lightest gray tone and the curve just above and above this curve, the yield will be above, around or below the average, respectively.

Hydrological Drought Monitoring

Since all rivers of Ceará are intermittent, hydrological drought monitoring is based on daily reservoir level information. Figure 4 displays the Hydro Portal of the state in the internet. This Portal brings updated information regarding the 134 main reservoirs of the state. Main user of this information is the state water management agency and this information orients the agency´s decisions on water use.

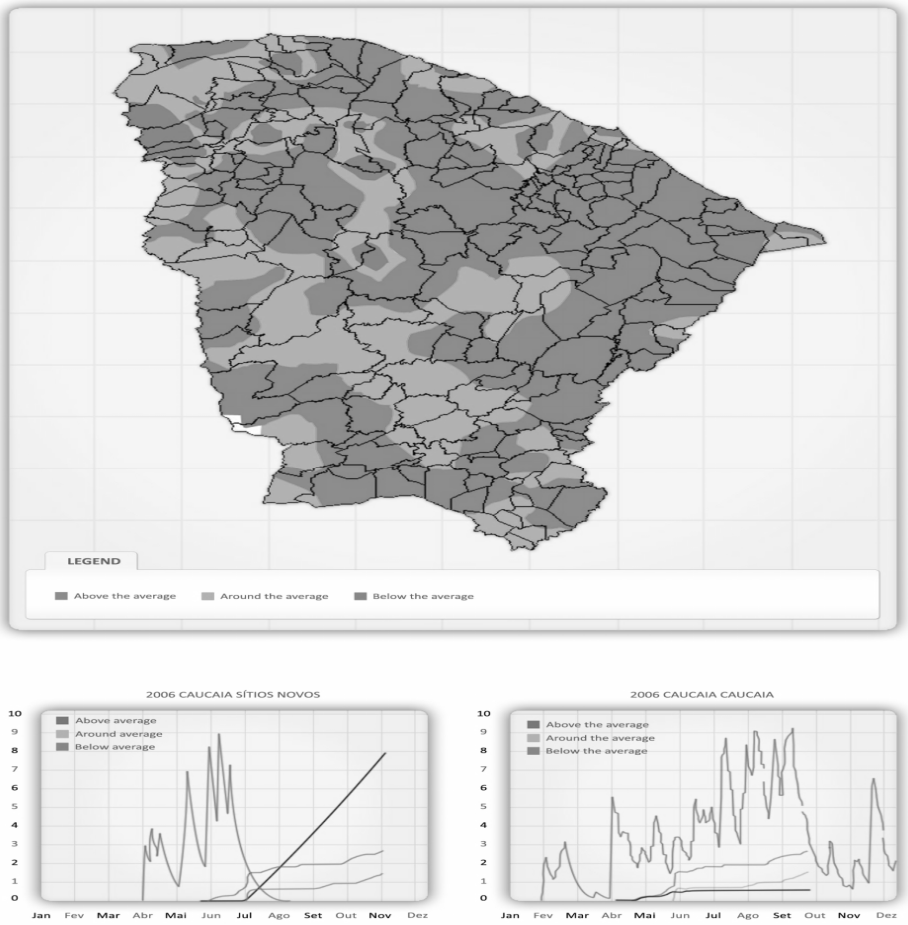

Figure 3. Maize Yield Monitoring for Ceará State. Three categories for yield on map (top): Above average, gray; Near average, light gray; Below average, dark gray.

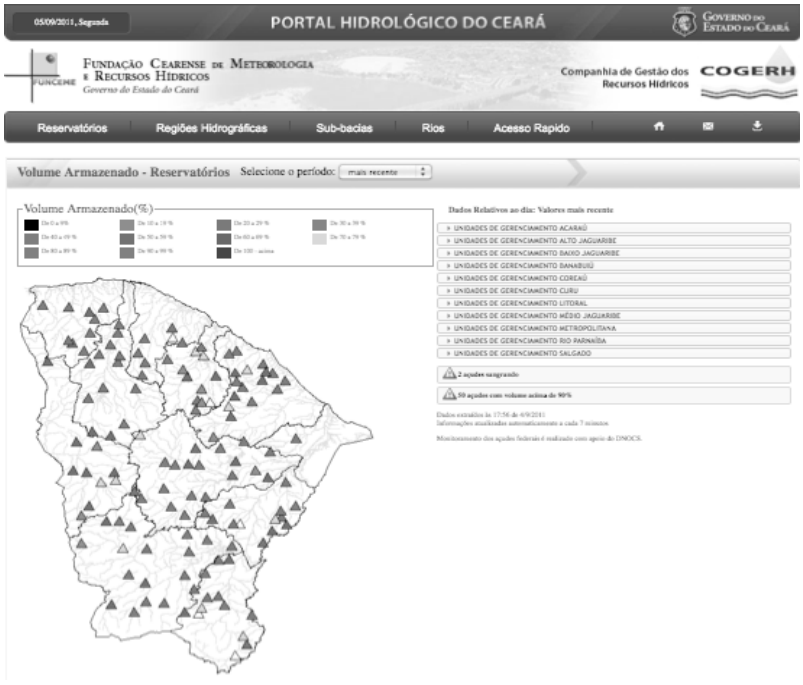

Figure 4.Hydro Portal of the State of Ceará.

Drought Prediction

Downscaling Project
The state of Ceará has invested in the development of a strong technical capability to understand and predict climate variations, and their impacts. Since its inception, the International Research Institute for Climate and Society (IRI) has been an active partner and facilitator of the research and implementation of climate models at FUNCEME, the state's meteorological foundation. This research has led to the recognition that Ceará is one of the few places in the world where significant skills in seasonal to inter-annual prediction of climate may exist. Further, and as important, there exists political will among key decision makers to use climate information regularly to reduce the recurrent stresses to the poor rural producers, as well as generally to rationalize water allocation policies.

Seasonal Climate, Streamflow Forecasts & Crop Yield Forecasts
Since 2002, national, regional and international meteorological centers meet in the beginning of the wet season to issue a seasonal climate forecast for the Brazilian Northeast. The so-called consensus forecast is a mix of objective forecasts based on statistical and dynamical models and expert's subjective judgment. The final product is a set of probabilities assigned to three precipitation categories: below normal, normal, and above normal.

A preliminary evaluation study of these forecasts was carried out by FUNCEME with focus on the hydrologic use of the climate information. More specifically, the study evaluated the ensemble precipitation forecasts obtained by one of the regional climate models used at FUNCEME. The goal was to compare basin-averaged observed and forecast precipitation series over several river basins within the State of Ceará. Results based on the 2002-2005 forecasts, issued on December of previous years, show that the quality of these forecasts varies across the state, and that these forecasts provide valuable information, in terms of total amount of precipitation during the rainy season when compared to climatological data. Best results were found for the Salgado and Alto Jaguaribe River sub-basins.

The application of the climate precipitation forecast to specific economic sectors is not straightforward. Because of this, FUNCEME has developed a forecast system tailored to the water resources sector, which provides monthly and seasonal inflow forecasts for the main reservoirs within the state. This streamflow forecast system is based on the climate ensemble precipitation forecasts obtained by two regional climate models (RAMS and RSM), both run at FUNCEME. These precipitation forecasts are used to feed a calibrated hydrological model (SMAP) to provide monthly and seasonal inflow forecasts to the most important reservoirs within the state.

A recent forecast verification study for the Orós reservoir, based on the 2002-2011 period, concluded that the information provided by the forecast system may be of great value to reservoir operation, although the short record length does not permit general conclusions because of the probabilistic nature of the forecast. Figure 5 shows the observed values and RSM climate forecast statistics for precipitation and inflows for Orós basin, period 2002-2011 (percentiles 0.25, 0.50 and 0.75, minimum and maximum and observed values for both precipitation and inflows). Figure 5 shows similar results for the RAMS model, period 2007-2011.

More recently, FUNCEME is developing a forecast system tailored to the agriculture sector, which provides, based on the seasonal forecast system and an agro-climatic zoning, information regarding what, where and when to plant.

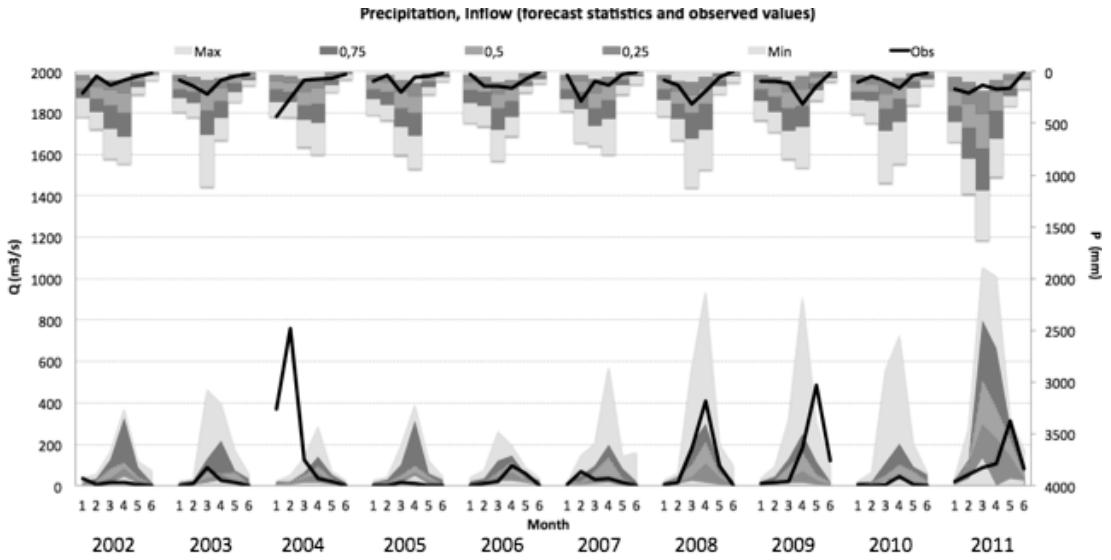

Figure 5. Observed Values and RSM Climate Forecast Statistics for Precipitation and Inflows for Orós Basin, Period: 2002-2011.

Communication of Drought Information

During and after the rainy season, information on meteorological, agricultural and reservoir levels is communicated to decision makers and to society through the web, press releases or TV. Also, every year, after the rainy season, when, for example, the occurrence of long dry spells already affected crops, public hearings are organized by a committee of water resources and agriculture of the legislative branch of government to discuss the situation of the farmers and propose policy measures.

Relief Programs

Several variables are monitored during the rainy season, after which an index named Municipality Watch Index (IMA) is composed by IPECE, the State Research Institute. Calculated since 2004, IMA is an index that measures the vulnerability of each of the 184 municipalities of the state in relation to climatic and agricultural issues. It considers 12 indicators: 1. Agricultural productivity per hectare; 2. Agricultural production per capita; 3. Use of harvested area with subsistence farming; 4. Crop shortfall; 5. Proportion of families benefiting from "*Bolsa Família" (a cash transfer program to poor families)*; 6. Number of "*Seguro Safra" (crop insurance)* per 100 rural residents; 7.Climatology; 8.Standard deviation of rainfall; 9.Runoff; 10.Rainfall distribution index; 11.Aridity index; 12.Coverage rate of urban water supply.

The municipalities with high vulnerability will receive first attention of state relief programs, such as the "Seguro Safra" (Crop Insurance). The goal of this program is provide income security to farmers in case of droughts or floods. This program was established by the federal government as part of the National Program for Strengthening of Family Farming (Pronaf). It is given to the farmers of the semi-arid regions of Brazil who lost their crops due to droughts or excess rains. The crops covered by this program are beans, corn, rice, cassava and cotton.

Long-Term Programs

Several long-term programs/projects have been implemented in Ceará in order to reduce the impacts of droughts on the inhabitants of the "Sertão". Some of these programs/projects are listed below.

PRODHAM – Hydro-environmental Development Project. This is a project under the responsibility

of the state Secretariat of Water Resources, financed by the World Bank. PRODHAM was designed to develop, in a pilot and experimental manner, integrated and sustainable actions for recovery and preservation of environmental resources in hydrographic micro-basins in the semi-arid regions of the state. Those actions included the construction of 3,332 successive dams, 27 underground dams, 470 plate cisterns; implantation of 47.6 ha of reforestation and riparian forest, 2.2 ha of dry farming, 129,928 m of terracing, 70,682 m of surrounding stone barriers, 3,810 m of vegetation barriers; and recovery of 5.3 ha of degraded area. The following economic activities were also introduced or tested: apiculture, handcraft and agro-forest-pastoral system. In association with the actions referred to above, events were held to promote human and institutional development in 44 assisted communities, in addition to environmental education training, which allowed local communities empowerment and an environmental recovery process associated with economic development in four selected hydrographic microbasins. This is an ongoing experience that has already showed positive results in terms of water and natural resources improvement and combat to desertification (Ceará 2010b).

Community based Development - São José Project – The main objective of this program is to mitigate rural poverty and reduce vulnerability to droughts in Ceará. It was created in 1995 with the aim of improving living conditions of poor families in rural areas of the state, raise quality of life and increase generation of employment and income for the poor. Main actions so far include rural electrification, community water supply systems, agricultural mechanization, rural housing in settlement areas, and other productive projects. Specific projects are implemented under the direct responsibility of communities (Araujo 2003; Santos 2010).

State Program of Action to Combat Desertification and Mitigating the Effects of Droughts: **PAE/CE**. This project is linked to the UNCCD – United Nations Convention to Combat Desertification. Through this project, that aims to improve human welfare and sustainability in the semi-arid, the state coordinates actions that are undertaken by different agencies in the areas of environmental protection, social policies, economic development and poverty reduction. The project involves four components: *1) Natural Resource Management and Sustainable Production*; *2) Living in the Semi-arid Region and Climate Change*; *3) Participative Management*; and *4) Environmental Citizenship* (Ceará, 2010a).

Institutions for Drought Policy

Drought policy in Brazil involves the three levels of government: federal, state and local. However, the Federal Government has the principal responsibility in regard to the coordination and financing of the system of civil defense. Since the second half of last century, the subnational governments, particularly the states, have assumed a more prominent role in planning, financing and implementation of actions aiming to reduce vulnerability to droughts.

Though the phenomenon of a drought is a well-established meteorological event, actions to reduce vulnerability to droughts must in fact go beyond the direct response to drought episodes. As seen above, Brazil in general, and some states in particular, have a long time experience and institutions that deal with droughts. One of the outcomes of this experience is that dealing with droughts should not be a responsibility of drought, or climate or civil defense institutions alone, but in fact it should be a responsibility of a broader set of institutions that deal with social, development and environmental policies.

Conclusions and Lessons

a) As a result of drought and development policies, the Northeast of Brazil has reduced its economic and social vulnerability to droughts.
b) Environmental vulnerability, however, has increased, due to increased human pressure on the natural resources of the Semi-arid Northeast

c) Though the social impacts of droughts have decreased, due to social and economic policies, there is still a large group of the rural poor population that is vulnerable. This group continues to depend on social policies, especially on cash transfers.
d) Climate risk should be considered as a dimension in economic, environmental and social public policies. This is an area where there seems to be increasing awareness but still little concrete actions.

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Drought Management Plans in Spain

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Abstract

In this article, we present the policy framework to develop, implement, and revise drought management plans in Spain. First, we consider the European policy framework, the implementation in Spain, and discuss some challenges that remain to be faced. Secondly, we present the status of the drought management plans in Spain and summarize the indicator system and the actions suggested in different levels of drought and water scarcity. Finally, we report some conclusions and look to the future of drought management in a changing climate.

Policy Framework

The Water Framework Directive

In Spain, as in all European Union member states, the primary legal instrument to address water scarcity is the 2000 Water Framework Directive (WFD) (Ref, Table 1). Hering, et al. (2010) state that the framework "changed water management in all member states of the EU fundamentally, putting aquatic ecology at the base of management decisions" and a move from management by administrative borders to management by hydrological catchment with the goal of ensuring ecosystem integrity. The ambitious nature of the WFD inevitably means that there is room for improvement. Next year the Blueprint to Safeguard Europe's waters will be released (Table 1). The introduction of the WFD provided the first coherent legal tool to address water scarcity by requiring long-term planning on water resources and measures to take this forward. The WFD sets a framework for the comprehensive management of water. In particular, Article 11 requires the implementation of a programme of measures taking into account water quantity issues and measures to promote efficient and sustainable water use. It also requires systematic control over the abstraction of surface and ground water. Furthermore, Article 9 and Annex III require Member States to take into account the principle of recovery of the costs of water services, including environmental and resource costs. The WFD requires Member States to ensure, at the latest by 2010, that water-pricing policies provide adequate incentives for users to use water resources efficiently and that the various economic sectors contribute to the recovery of the costs of water services. Regarding droughts, Article 13.5 of the WFD requires River Basin Management Plans (RBMPs) to be supplemented by the production of Drought Management Plans (DMPs) where there is a risk of drought. These should include indicators and thresholds, measures to be taken and an organizational framework to deal with drought, including information on prolonged droughts.

In 2007 the Commission published a Communication on water scarcity and droughts, with three follow-up reports to 2011. The special communication on water scarcity and drought promotes a wide range of actions -- from fiscal and regulatory to long-term integrated planning. Progress is seen in some Member States, especially in Spain, but further action is needed. A special Expert Group on Water Scarcity and Drought provides advice on a number of activities necessary to develop and implement drought management plans at the water district level. Key responsibilities to be auctioned before 2012 include: (a) Support the definition of commonly accepted indicators for water scarcity and for droughts in Europe including the demonstration of the added value of these indicators; (b) Exchange information among river basin management plans and with international for a; (c) Contribute to the development of the European Drought Observatory (EDO) under development at Joint Research Centre of the European Commission (JRC); and (d) Support the creation of Drought Risk Maps, through commonly agreed methodology and scales..

Table 1. EU Water Framework Directive (Source: EU WFD, 2000)

Year	Issue
2000	Directive entered into force (Art. 25)
2003	Transposition in national legislation (Art. 3) Identification of River Basin Districts Authorities (Art. 23)
2004	Characterization of river basin: pressures, impacts and economic analysis (Art. 5)
2006	Establishment of monitoring network (Art. 8) Start public consultation (at the latest) (art. 14)
2008	Present draft river basin management Plan (Art. 13)
2009	Finalize river basin management plan including program of measures (Art. 13 and 11)
2010	Introduce pricing policies (Art. 9)
2012	Make operational programs of measures (Art. 11)
2012	Support the creation of Drought Risk Maps and assessment, contributions to European Drought Observatory
2012	Blueprint to safeguard Europe's waters
2015	Meet environmental objectives (Art. 4)
2021	First management cycle ends (Art. 4 and 13)
2027	Second management cycle ends, final deadline for meeting objectives (Art. 4 and 13)

The EU Communication on Water Scarcity and Droughts

On 18 July 2007, the European Commission published a Communication on water scarcity and droughts [COM(2007)414], which presented a set of policy options at EU, national and regional level to address and mitigate water scarcity and droughts within the Union. It identified key challenges focused on the need to fully implement the WFD, especially the provisions on water tariffs and compulsory metering, River Basin Management Plans and Drought Management Plans. In addition the Communication set a framework for moving towards sustainable land-use planning, established priorities to water-saving and water-efficiency measures and called for further integrating water issues into all sectorial policies.

Looking into the future, a guidance document on incorporating climate change in the second and third river basin management cycles was adopted by the Water Directors in December 2009. It includes a specific chapter on adaptation measures related to water scarcity and drought problems. Also in March 2009 the Commission published 'Regions 2020 - Climate change challenges for European Regions' which also addressed the effect of climate change of water scarcity and droughts.

The second follow-up Communication was published in May 2010 (COM(2010)228), which drew on additional analysis by the European Environment Agency. It concludes that the efforts to protect Europe's water resources were insufficient (EEA 2009). The Communications clearly states that moving from 'crisis response' to 'risk management' in the context of water management is the way to improve society's resilience to water scarcity and droughts. Member States across the EU have begun identifying the areas or entire basins affected by drought or suffering permanent or semi-permanent water scarcity. Specific Drought Management Plans could be developed as supplements to the River Basin Management Plans, as some member states including Spain request, however this is yet to be decided. Due to the severity of the water scarcity problem in many regions of Spain, the basin authorities are already monitoring drought and have developed special plans for action during drought conditions based on indicators.

Some have questioned the WFD's appropriateness for improving drought preparedness and mitigation (Rossi 2009). The true challenge, as has been identified by Quevauviller et al. (2005), is to translate these scientific findings into policy making processes.

Spain Facing EU Policy

Historically, the urban, cultural, and agricultural development in Spain has demonstrated a profound knowledge of adaptation strategies to drought, water scarcity, and precipitation variability. The Spanish water codes and statutes -- including drought management plans -- are developed under the Spanish Constitution (1978) and the European Union Water Framework Directive (2000). The Law of the National Hydrological Plan (2001) explicitly ordered the development of Special Drought Management Plans for all basins and Drought Emergency Plans for all urban water supply systems serving more than 20,000 inhabitants. The majority of cities and all hydrological districts have already completed the plans although not all have been publicly reviewed -- a requirement of the WFD. Drought Management Plans are mainly targeted to identify the conditions and schedule the activation of tactical measures to prevent or mitigate drought effects. Therefore, measures involved are mainly water demand management or water conservation measures and, with the progressive application of WFD schedule, measures to achieve and comply with good environmental status (Acreman and Ferguson 2010).

Spain has the opportunity to develop integrated drought management plans that incorporate the extensive national experience in hydrological management with the new environmental challenges. The action is based on three main instruments (Garrote et al. 2007; Garrote et al. 2008): (a) A drought monitoring system based on drought indicators for each Basin Authority and for the entire country; (b) Special Drought Management Plans for Basin Authorities; and (c) Emergency Drought Plans for urban water supply systems serving more than 20,000 inhabitants (e.g., to ensure that a proactive approach is adopted for drought management in urban water supply, avoiding the need to implement improvised emergency measures under the pressure of imminent water shortages.)

The National System of Drought Indicators was developed during 2006 by the Spanish Ministry of the Environment. It is currently operational, and may be accessed on the web page of the Ministry of the Environment, in the National Drought Observatory. The system of indicators is a general reference for Basin Authorities for formal declaration of drought situations, which can activate drought emergency measures with legal constraints or specific budget application.

Nevertheless, there is still room for improvement on how to ensure water for ecosystems as a priority. Drought is a major risk for ecosystems health (both aquatic and terrestrial) since it affects total volume of water, high and low water levels, timing of flooding, temperature. Many of these elements can be viewed under the overall heading of ‘environmental flows’ and minimum environmental flows can be considered an objective of the WFD. Under drought conditions research indicates that the vast majority of freshwater ecosystems in Europe experience significant ecological changes, for both river ecosystems and wetland ecosystems, in particular due to changes to flow regimes. The question of how to conciliate ecosystem protection and drought management in Spain remains a challenge. In particular regarding exceptions, “prolonged droughts” may be introduced in the WFD as “force majeure” events. The conditions under which exceptional circumstances are or could be considered have to be stated through the adoption of the appropriate indicators. Contingency drought plans must face these issues.

Drought Management in Spain

Drought and Water Scarcity: Overlapping Issues

Drought, water scarcity and aridity are overlapping issues in Spain. Water resources in Spain are limited, scarce, and highly irregular in space and time. The potential use of surface water under the natural regime is only 7 percent of total natural resources. The availability has increased to 40 percent due to the intensive development of hydraulic infrastructure during the 20th century. Groundwater use is also intensive in many areas of the country, and it contributes to an additional 10

percent of the total available resources. Water use in Spain is mainly for agriculture (over 68 percent of water demand), but other economic and social water demands are rapidly increasing, such as tourism (current urban demand is 13 percent) and ecosystem services. With limited and scarce water resources and demand rising due to demographic shifts, economic development and lifestyle changes, water management problems are significant even without drought events.

Water demand already exceeds water availability in many water districts in Spain – such a situation imposes a strain on ecosystems and indicates the need for a policy-sensitive approach (Iglesias et al. 2009). The average annual potential water availability per capita considering the total freshwater resources in is less than 3000 m3 per capita and year, the smallest of all Mediterranean countries in Europe (Tables 2 and 3). In some water districts demand is above the available resources, and water scarcity crises are common (Tables 2 and 3). The difficulty in forecasting highly variable rainfall multiplies the challenges faced by water resource managers and increases the likelihood of water conflicts.

The country's overall socio-economic model places available water resources under considerable stress. In many cases, agriculture is responsible for water imbalances because it accounts for more than 50 percent of water use in most countries (FAO 2011). Thus, other economic uses of water – urban, energy and tourism – are imposing further challenges for meeting ecosystem services and increasing conflicts among the affected parties. Some of the potential solutions to these problems – such as changes in infrastructure or limitations of irrigation – are not accepted by all social sectors. Water resource managers face the challenge of ensuring the future sustainability of water resources while maintaining strategic agricultural, social and environmental targets. Climate change imposes an additional challenge, and understanding its implications and policy requirements is a complex process, as we shall see.

Table 2. Water Resource Indicators: 2008 Total Freshwater Resources, Available Resources, Use, and Water Availability in Selected Southern European Countries (Source of data: FAO 2011)

Country	Total area (x 10^3 km^2)	Popula-tion (million)	Rainfall (mm/yr)	Internal usable water resources (km^3/yr) (a)	Usable water resour-ces (km^3/yr) (b)	Internal ground-water (km^3/yr) (c)	Total water use (km^3/yr)	Total water use (% Renew-able)	Potential total usable water resources per capita (m^3/capita per year)
France	552	60	867	178.50	203.70	100.00	35.63	17	3,395
Greece	132	11	652	58.00	74.25	10.30	7.99	11	6,750
Italy	301	57	832	182.50	191.30	43.00	43.04	22	3,356
Spain	506	41	636	111.20	111.50	29.90	35.90	32	2,720
Turkey	770	71	593	227	213	69	37	18	3,000

(a) The values refer to both regulated and unregulated water. Real available water resources in all cases are a fraction of these values.
(b) These values include transboundary water
(c) A proportion of these values is included in the total renewable water resources.

Table 3. Total Freshwater Resources, Available Resources, Demands, and Water Reliability in the Hydrological Basins of Spain (Source of data: Garrote et al., 2007)

	Total Fresh-water Resources (km3)	Availabler esources (km3)(a)	Reservoir capacity (km3)	Regulated water (%)(b)	Demand (% of available resources)	Irrigation demand (% of total demand)	Pop. (millions)	Total resources per capita (m3/ person)
Norte	44.2	6.8	4.4	15	37	42	6.7	6,542
Duero	13.7	8.1	7.7	60	47	93	2.2	6,071
Tajo	10.9	7.1	11.1	65	57	46	6.1	1,784
Guadiana	5.5	3.0	9.6	54	85	90	1.7	3,298
Guadalquivir	8.6	3.6	8.9	42	104	84	4.9	1,755
Sur	2.4	0.54	1.3	21	268	79	2.1	1,135
Segura	0.8	0.7	1.2	90	253	89	1.4	590
Júcar	3.4	2.0	3.3	58	149	77	4.2	819
Ebro	18.0	13.0	7.7	72	80	61	2.8	6,509
Catalonia	2.8	1.1	0.8	40	122	27	6.2	451
Balearic Is.	0.7	0.3		45	96	66	0.8	785
Canary Is	0.4	0.4		102	102	62	1.7	241
SPAIN	111.2	46.6	56.1	42	76	68	40.1	2,728

(a) Surface and groundwater.
(b) Regulated water: rate of available resources from total natural resources.

Drought can have serious effects on the economy and the environment of Spain and on the population's well-being. The major drought of the mid 1990s affected over 6 million people, almost ten times more than the number of people affected by floods in Spain during the last fifty years. The economic damage caused by drought in Spain during the last twenty years is about five times more than in the entire United States (EM-DAT 2011). Drought events affect water supplies for irrigation, urban, and industrial use, ecosystem's health, and give rise to conflicts among users that limit coherent integrated water resource management. The reduction of wetland area (from over 1200 km2 in the 1970s to less than 800 km2 in 2000, excluding the Guadalquivir marshlands) has been in part related to recurrent drought episodes and surface water scarcity, and amplified by the excessive groundwater pumping to compensate for these problems. In addition to water scarcity, droughts also cause water quality problems, since water quality parameters deteriorate during drought due to lack of dilution and water may not be acceptable for human consumption.

Drought Indicators System

The basis of any drought management plan is a robust system of drought indicators that can identify and diagnose anomalies in water availability and can provide the basis for early detection of drought episodes. Drought characterization in highly regulated systems is complex and calls for multiple indicators. For instance, SPI and other rainfall-based indices have been used with important limitations when applied in isolation, especially over short time periods. These indices show little correlation with water shortage situations, since water storage plays an important role in water resources management. Therefore, a more complex system of indicators is required in order to identify situations when there is risk of water shortages.

A comprehensive study of hydro-meteorological time series and drought indices in the basin is required for the definition of a drought indicators system. The methodology adopted is based on the analysis of water demand units. For each of them, a list of variables is selected to characterize the evolution of available water resources, such as water stored in reservoirs, piezometric levels in aquifers, river flow in stream gauges, rainfall in precipitation gauges, etc. Historic time series compiled for each variable are normalized on a scale from 0 to 1, with 0 corresponding to the minimum historic value, 1 to the maximum and 0.5 to normal conditions. The functions to relate variables and indicators are chosen to characterize the risk of water shortages and are validated

through the analysis of historic values and drought episodes. Individual demands are grouped in water resources systems, obtaining average values of the indicators which are representative of the global situation of each system. Usually a weighted average is selected as the averaging procedure, with weights proportional to the relative importance of each demand unit. The system of indicators is in continuous revision, taking into consideration the availability of new information and the progress in knowledge of the hydrologic behavior of the basins.

The hydrologic state of every system as measured by the indicators is classified into four categories: Normal, Pre-alert, Alert and Emergency conditions. The normal condition corresponds to situations in which there are no risks of water shortages in the near future. The pre-alert condition is declared when monitoring shows the initial stage of drought development, which corresponds to moderate risk (i.e. greater than 10 percent) of consuming all water stored in the system and not being able to meet water demands. The alert condition is declared when monitoring shows that drought is occurring and will probably have impacts in the future if measures are not taken immediately. There is a significant probability (i.e., greater than 30 percent) having water deficits in some time horizon. Finally, the emergency condition is declared when drought indicators show that impacts have occurred and supply is not guaranteed if drought persists. The current values of the system of indicators are published quarterly by the National Drought Observatory, and can be accessed in the Web page of the Ministry of the Environment.

Special Drought Management Plans

The elaboration of the Drought Plan is the result of a complex process in which user participation is encouraged and stimulated. Once the Plan is drafted, it is submitted to public scrutiny, and concerned individuals and social or political groups can make allegations that are discussed and negotiated in the Water Council, where a majority vote is required for acceptance. If the drafted plan obtains a favorable vote, it is formally approved and is legally binding to all stakeholders.

The objective of Special Drought Management Plans is to anticipate drought situations and to plan solutions to satisfy water demands and to comply with environmental requirements. They are based on a deep knowledge of water resources and their capacity to be stressed under water scarcity situations, a catalogue of measures to reduce drought impacts for each drought condition and an adequate administrative framework for the implementation of measures, allowing for the coordination of the administrative units involved. In addition a plan for public participation needs to be implemented to guarantee cooperation of all users involved and to disseminate important information.

Management Actions

The basin drought policy is summarized as a list of possible actions to be taken in case of drought. The catalogue of possible actions is restricted by the legal competences that are attributed to Basin Authorities, but the resulting list includes a great number of actions of very diverse nature, like the examples presented in the following categories:

(a) Internal operation. Within the Basin Authority, most frequent measures include intensification of monitoring, prevention of leaks, or revision of rules for the operation of infrastructure.

(b) Water uses. Demand management measures include: information dissemination and user involvement, promotion or enforcement of water savings, prohibition of certain uses, temporary exemption of environmental obligations, etc.

(c) Water resources. Drought measures focus on conservation and protection of stored resources, activation of additional resources or monitorization of indicators of water quality.

(d) Institutional. The President of the Basin Authority may appoint committees or task forces to address specific issues, usually in conjunction with affected users, or enhance cooperation with other organizations or stakeholders.

(e) Legal. There are a number of legislative measures that can be adopted, ranging from the official declaration of emergency due to drought, to a long list of possible palliative measures with different objectives: subsidy, restrictions, emergency works, etc.

Measures are grouped according to different severity levels that describe severity (i.e., pre-alert, alert, and emergency). The severity levels are determined by established thresholds of indicators that trigger groups of measures in response to the objective of each level (Table 4).
In the emergency level, the main priority is to satisfy drinking water demands and all structural and non-structural measures of high economic, social, or environmental cost are designed and taken in order to minimize water restrictions for urban demand.

Monitoring is a key component of the plan (Wilhite 2005). Continuous improvements of technology in instrumental monitoring devices (i.e., gauges, piezometers, etc.) play a key role for accounting of resources. Drought indices adequately calibrated represent local features of the water resources system of the basin they can be used as auxiliary tools for drought monitoring and forecasting (Wilhite 2005). Realistic models appropriate for water management need to be incorporated in monitoring and early warning system (Rossi, 2009). Finally, scientific advances in understanding variations of the climate system offer an opportunity to develop prediction methods.

The drought management is implemented by the water management responsible authorities, in general at the basin level. These planning bodies develop and use management plans that incorporate: demand and supply analysis and projections, contingency and preparedness plans, and scenario analysis for drought. In an optimal situation, permanent monitoring provides indicators that can trigger specific drought management actions. These indicators ideally include: hydrological, socio-economic, and environmental aspects. In general, drought management plans include measures that respond to different drought severity levels.

Table 4. Summary of a Planning Framework for Risk Management of Water Scarcity

	Preparedness	Pre-Alert	Alert	Emergency
Monitoring indicators	Indicators show a normal situation	Indicators show initial stage of danger; no observed impacts (meteorological drought)	Drought is occurring and impacts will occur if measures are not taken (meteorological and hydrological drought)	Drought is persistent and impacts have occurred; water supply is not guaranteed (socio-economic drought)
Objective of the plan in each stage	To ensure that a preparedness and early warning plan is in place	To ensure acceptance of measures to be taken in case of alarm or emergency by raising awareness of the danger of drought	To overcome the drought situation and to guarantee water supply while emergency measures can be put in place	To minimize damage, the priority is drinking water
Measures	Development of a management plan and strategy for revision and review Implementation of a monitoring and early warning system Integration with development and land use policies	Low cost, indirect, voluntary Non-structural directed to influence water demand and avoid worse situations Focus on communication and awareness Intensification of monitoring and evaluation of worse case scenarios	Low cost, direct, coercive, direct impact on consumption costs Non-structural directed to specific water use groups Water restrictions for uses that do not affect drinking water Changes in management Revision of tariffs Rights Exchanging Centers	High cost, direct, restrictive, approved as general interest actions Structural, new infrastructure, intra-basin, inter-basin and transboundary transfers Non-structural, such as permission for new groundwater abstraction points Water restrictions for all users, including urban demand

Conclusions

This paper shows that policies need to be successfully balanced between a larger framework and local concerns to achieve a true integrated drought management plan, which will require striking a balance between human resource use and ecosystem protection (Farmer, 2011). This has special relevance in Mediterranean countries where water policies are often centuries old and socially embedded. In this assessment we find reasons to be optimistic given the important role that EU policy has in establishing water management priorities (Iglesias et al., 2011). There are, however, also reasons to be pessimistic. It remains to be seen whether the current structural water shortages that exist in Spain, will be successfully addressed given the high social and environmental costs associated with further water resources development.

Developing and implementing drought management plans is inherently challenging due to limitations in the participatory processes and the exhaustive data requirements for defining drought levels. Uncertainties in climate change science and long planning horizons add to the complexity of adaptation decision-making. The reality of climate changes renders it impossible to use the past as an indicator for the future (Giorgiamd Lionello 2008; Vorosmarthy et al. 2010).

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Drought Plans in China

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Abstract

Due to the complexities of drought and its impacts on many sectors, an effective and efficient risk management approach requires the comprehensive participation and coordinated efforts of government, relevant sectors, stakeholders, and the public. China has a long history in fighting against drought and has developed a series of drought policies and plans. This paper presents an overall view on the principles, mechanisms and actions of that framework for various entities in the central, provincial and local levels follow for drought risk management in China. Some future improvements in the drought plan are also suggested.

Introduction

Recently, drought has been receiving more and more attention around the world because of its remarkable impacts on many key sectors of the society, particularly on the agricultural and water resources sectors, which is very crucial for a country like China with a population of 1.3 billion and on the way of industrialization. Drought ranks first among all natural hazards in China, accounting for about 55 percent in the occurrence frequency of the observed hazards. It is now fully understand that drought is a natural part of the climate of China.

Given the increasing temperatures in recent decades, Northeast China, North China and Southeast China have experienced a significant trend of dryness (Li et al. 2002). It is found that all of the four most severe droughts in China since 1950s occurred in the 20th century when measured in terms of a comprehensive index that is associated with the precipitation shortage or deficiency, duration of the event, and its spatial coverage (Ren et al. 2011). For instance, from September 1998 to May 1999, the worst drought in six decades in North China led to a significant reduction in wheat production and to significant fluctuations in the food market. Fortunately, unlike floods which usually occur in several hours to 1-2 days and then cause severe damages over a short timescale, drought develops slowly. However, its cumulative effect on the agricultural and water resources sectors is equally significant but less dramatic because of its slowly evolving characteristics. Because of its slow onset, there is sufficient time to implement mitigation measures; however, these are more effective if implemented in advance of the drought. History has shown that with effective management, proper planning and responsiveness, the impacts of a drought can be substantially minimized.

Drought plans have been developed in different levels of government of China to meet this purpose. As the highest legislature of China, the National People's Congress made the Water Law of the People's Republic of China in 2002 and the Meteorological Law of the People's Republic of China in 2004, both of which involves in the prevention and control of drought to meet the needs in national economic development and in the livelihood of the people. At the state administration level, the State Council of China released the Regulation on the Administration of Weather Modification in 2002, Regulation on Drought Control in 2009 and Regulation on the Defense against Meteorological Hazards in 2010. At the lower level, the General Office of the State Council issued the State Flood and Drought Plan in 2006 and State Meteorological Hazards Plan in 2010, respectively. Those policies and plans were designated to outline the roles of government during a drought, to facilitate planning, and to provide a framework for action and cooperation in drought management among many local, provincial, and national agencies with drought-related responsibilities. This paper gives an overall introduction on the drought management plans of China and the policies and plans mentioned above.

General Provision of Drought Plan and Definition of Drought

Drought is a complex climatic phenomenon. From an operational point of view, drought can be approached from several perspectives, e.g., meteorological, agricultural, hydrological, and socioeconomic droughts. Meteorological drought is mainly due to the deficiency of precipitation over an extended period of time. Hydrologic drought is characterized by extreme low flows of streams, low water levels in reservoirs and declining groundwater levels, but does not necessarily severely influence the production of crops. Agricultural drought occurs when soil moisture is insufficient to meet the needs of a particular crop during its growing season. Socioeconomic drought occurs when the demand for an economic good exceeds the supply as a result of a weather-related shortfall in water supply. Agricultural, hydroelectric generation, wildfire and water supply impacts are some of the most obvious effects of drought. The drought management plans are formulated to deal with any one or some of the above droughts as it relates to the condition and operation of community water systems, aquatic habitat, agricultural production, industrial water supply, water quality of a recreational stream, or other water use.

Purpose of the Drought Plan

The purpose of the plan is to provide China with a framework for an integrated approach to minimize the impacts of drought on its people and natural resources. The plan outlines both long- and short-term measures to be taken to make sure the impacts of drought are minimized. To accomplish this goal, the drought plan:

1) Identifies the local, provincial, state sector entities and non-governmental organizations that are involved with drought management and defines their responsibilities.

2) Defines a process to be followed in addressing drought related activities, including monitoring, early warning, impact assessment, emergency response, hazard relief and recovery, and logistic supports.

3) Identifies long and short term activities that can be implemented to prevent and mitigate drought impacts.

Principles of Drought Management

In order to make those plans as valuable and effective as possible, it recognizes the following principles to be followed by all involved entities and by all the efforts on drought management:

1) The highest priority for drought management is to assure the safety of human lives and protect the property of the public from the impact of drought.
2) The proactive prevention first, through the integration of engineering and non-engineering measures, is adopted for the drought risk management.
3) The state shall, with respect to drought management, adopt a system which combines unified administration at various levels and by various departments, but with the major responsibility on the local authorities.
4) The efforts on drought prevention and mitigation should be made in accordance with the related law and in an efficient and sustainable approach.

Driving Mechanism for the Drought Plan and Unified Leadership of Government Authorities

With years of experience in drought reduction and relief, the Chinese government has established a hazard reduction and relief mechanism geared to the nation's situation which is characterized by the central leadership, departmental responsibility and hazard administration at different levels and with

major responsibility on local authorities, and the active self-reliance of the public community. Under the unified leadership of the State Council, the central authority responsible for coordinating and organizing drought reduction and relief is the State Flood and Drought Control Headquarters. National Hazard Reduction Committee and National Hazard Control and Relief Coordination Office also play an important role in providing guidance on drought reduction and relief. Local governments have set up corresponding coordination offices to handle drought reduction and relief. If necessary, the People's Liberation Army, the Armed Police, firemen, as well as policemen will take part in drought relief. Social groups, non-governmental organizations and volunteers will also join the effort.

The leading role of the government is crucial in making sure the process for reducing drought impacts is effective and efficient. State Flood and Drought Control Headquarters of China is responsible for organizing and coordinating hazard preparedness and mitigation efforts which include the formulation of laws, regulations and rules related to the drought reduction, designation and implementation of water resources re-allocation plans among the provinces or the major river catchments in China, and coordination on the drought management measures taken by different departments or agencies.

Linkage Among Governmental Agencies

Drought is an insidious hazard of nature, but cannot be viewed as merely a physical phenomenon due to its comprehensive impacts on many aspects of the nature and human beings. In this regard, the drought mitigation and relief depends on the coordinated efforts of relevant agencies of government. In China, the governmental agencies involved in the drought management include Ministry of Hydrology, Ministry of Agriculture, Ministry of Civil Affairs, Ministry of Health, Ministry of Finance, Ministry of Commerce, State Forestry Administration and the China Meteorological Administration. A series of working mechanisms, such as the timely drought-related information sharing system and multi-agency consulting meeting, are set out by the drought plan to assure the well-coordinated responses and linkages among those agencies for the risk reduction in the case of the drought occurrence.

Participation of the Stakeholders and Public

Effective and efficient drought risk management is difficult to accomplish without the comprehensive involvement of stakeholders and the public. Non-governmental organization and volunteers are encouraged to join the efforts of drought management. The agriculture insurance services have been proved to be a useful approach of risk transfer for drought relief and recovery. Charities also play an active role in drought relief, and the government has adopted measures, in terms of the preferential taxation system, to encourage public donations. Capacity building in self-reliance of the public from the drought impact has recently received more attentions from the government. Relevant training opportunities and financial assistances are offered to the public to enhance their self-reliant capability in alleviating the impact of drought.

Measures on Drought Management and Monitoring and Early Warning

Promotion in Integrated Drought Monitoring System
A comprehensive and integrated drought information system is the foundation of drought management. While improving the existing meteorological and hydrological observation network, China has paid more attention on increasing the spatial resolution of monitoring by the deployment of more automatic weather station, and on collecting more elements related with drought, such as soil moisture, land vegetation condition and water coverage of major rivers and lakes in China, through the utilization of hydroprobes and remote sensing instruments. Based on the output of land models and agriculture growth and hydrological models, numerical modeling provides insight into the different condition of soil wetness/dryness in different vegetation covers and into the impacts of precipitation shortage on agricultural and hydrological sectors. A series of indices have been developed to

evaluate the magnitude and spatial coverage of drought and the severity of the impact on the societal and economic sectors. Using these indices, meteorological drought can be classified into drought-free, slight, moderate, severe and extreme. In addition, drought-related loss information from the key societal sectors should be collected routinely to validate the drought monitoring products. For the purpose of risk management, the drought mapping system should be produced and updated regularly on a town and community data basis.

Production of Drought Outlook and Early Warning

The seamless forecasting products in 1-3 days, weekly, extended range (10-15days), monthly, seasonal and interannual timescales for precipitation and temperature, sometimes for wind as well, are essential for the drought outlook. These help to form the basis for an integrated monitoring system. The outputs of numerical models are applied to drive the component models of agricultural and hydrological sectors for impact assessment. At present, it is still hard to produce the drought outlook in a completely objective way because of the complexity of drought monitoring and its impacts. A consultative meeting is established to address this issue between the different levels of meteorological services and between the experts of meteorology, agriculture, hydrology and even administration management. The outlook gives the estimation on the trend of drought with a category of beginning, development, persistence, worseness, alleviation, relief and termination in the operational product of National Climate Center in China.

When a drought is expected to occur or strengthen, early warning should be issued with a rank estimated according to the severity and trend of the drought. There are three warning ranks for the meteorological drought in China, of which the criteria are presented in Table 1. The drought warning usually consists of the rank, the start time, domain likely to be impacted, caution notes, and prevention and mitigation measure to be taken.

Table 1 Operational Criterion for the Meteorological Drought Ranks in China

Ranking	Criterion
I	Severe drought occurs in most domain of more than 5 provinces and extreme drought are observed in at least two of them or two metropolis of them, and such situation is expected to maintain or worsen.
II	Severe drought occurs in most domain of 3-5 provinces and extreme drought are observed in at least one of them or one metropolis of them, and such situation is expected to maintain or worsen.
III	Severe drought occurs in most domain of 2 provinces and such situation is expected to persist or worsen.

Dissemination of Drought Warning

By means of the meteorological early warning information release platform covering both urban and rural communities of China, the drought early warning can be distributed accurately and promptly through either the traditional mechanisms or advanced communication channels, such as rural louder speaker, radio, television, newspaper, cell-phone, the Internet and electronic screens so on.

Preparedness for Emergency Response

In some cases, the meteorological drought does not necessarily lead to the agriculture drought or hydrological drought, although the significant deficiency of precipitation is a pre-condition and precursor for the latter two droughts. When the drought warning is released or received, the relevant institution and agencies will examine the influence on their own sectors as soon as possible and then decide the appropriate actions for emergency response. The meteorological sector will check the condition of relevant instruments, human resources, and plans to put in place the actions of emergency response. The agricultural sector will evaluate the possible impact of drought on the crop growth and production and then prepare some tailored measures for the drought risk management. The hydrological sector will check the relief material reserve system and the condition of irrigation

projects as well as the expert team to make sure water resources reallocations can be carried out for drought mitigation as the need arises.

Drought Emergency Response

The emergency response of the central government of China for unexpected natural hazards is classified into three levels: state overall emergency response plan, state specialized emergency response plan, and departmental emergency response plans. Detailed measures and working regulations are worked out by the relevant government departments in line with the specialized plans and their respective responsibilities.

Initiation of Drought Emergence Response
As one of the state specialized emergency response plans, drought emergency response is usually initiated by State Flood and Drought Control Headquarters. There are four levels for drought emergency response set with respect to the magnitude of drought. The criteria are presented in Table 2.

Table 2. Operational Criterion for Drought Emergency Response Levels in China

level	Criterion
I	Severe drought occurs in several provinces or extreme drought in several metropolis
II	Extreme drought occurs in 1 province or severe in several metropolises
III	Moderate drought occurs in some moderate cities or severe drought in a metropolis
IV	Slight drought occurs in several provinces

Under the unified leadership of the State Council, the relevant departments, e.g., China Meteorological Administration, Ministry of Agriculture, Ministry of Hydrology and Ministry of Civil Affairs, each with a different focus, shall act in coordination and launch emergency response plans to guide drought control and relief work. The governments of the affected areas shall immediately start emergency response measures and set up a local drought emergency response command with the heads of the local governments serving as the chief commanders, and leaders of relevant departments as members, to jointly draw up emergency plans and measures, organize field emergency response work, and report hazard details and work progress to governments of higher levels and relevant departments.

Systems for Hazard Emergency Response
A series of systems have been set up for the hazard emergency response, including hazard information release mechanism, emergency relief materials reserve system, hazard early warning, consultation and information sharing system, major hazard rescue and relief joint coordination mechanism and emergency social mobilization mechanism. Those systems and mechanisms are also applicable to drought emergency response.

1) *Hazard information release system*. Following the principle of "being prompt and precise, open and transparent," the central and local governments are expected to work in earnest on the emergency information release work relevant to the drought, offering through authorized releases, press releases, interviews and press conferences to the public prompt information on the hazards and their developments, progress of emergency response work, hazard prevention, and knowledge on hazard prevention and other information, thus ensuring the public's rights to know and supervise.

2) *Relief materials reserve system*. China has built a relief materials reserve network based on special storehouses. The country has now ten such storehouses for daily necessities at the

central level, and storage centers for relief supply. Coupled with the reserve relief supply centers established in some provinces, cities and counties, a preliminary hazard control and relief materials reserve system has taken shape. To guarantee the timely purchase of relief supplies, for instance, the water pump for drought relief, a list of commissioned relief supply manufacturers is established, and emergency purchase agreements signed with them for the supply of relief materials in case of emergency.

3) *Hazard early warning, consultation and information sharing mechanism*. A hazard early warning, consultation and information sharing mechanism has been established, involving such relevant departments as civil affairs, land and resources, water resources, agriculture, forestry, statistics, and meteorology. To offer timely and effective support for the decision-making of the central government and local departments, China has initiated the construction of a hazard information database and launched a public platform of national geographical information and a hazard information publishing and sharing system, as well as a platform for national hazard reduction and risk management information.

4) *Joint coordination mechanism for major hazard rescue and relief*. In the wake of a severe drought, relevant departments will conduct their functions and dispatch in a timely manner relief to hazard-hit areas working groups composed of personnel from these departments to gather first-hand information and guide hazard control and relief work on the spot. The groups are also required by the State Council to coordinate with the relevant departments to map out rescue plans, help with hazard relief work, and prevent possible secondary hazards.

5) *Public mobilization mechanism for hazard emergency response*. A preliminary public mobilization system is now in place, focusing on efforts for rescue, search, first aid, relief, donation and other work. The government also gives full scope to non-government organizations, such as mass organizations, the Red Cross, self-governmental organizations at the grassroots level and individual volunteers in the fields of hazard prevention, emergency rescue, relief and donation work, medical, hygiene and quarantine work, post-hazard reconstruction, psychological support and other aspects.

Actions of the Relevant Sectors

Following the above-mentioned systems and mechanisms, the relevant sectors take the coordinated actions to minimize the impact of drought.

<u>State Flood and Drought Control Headquarters</u>

- Organize and coordinate the drought relief efforts at the state level
- Report the situation to the central leadership
- Chair the drought consulting meeting among the relevant agencies
- Dispatch the expert team to the drought regions to put forward guidance and advices on local mitigation and relief measures
- Coordinate the water resources supply across provinces

<u>Local Government</u>

- Organize and coordinate the drought relief efforts at the local level
- Put in place the measures on mitigation and relief decided by the upper level in the emergency response condition
- Report the situation to the upper-level leadership

<u>Meteorology</u>

- provide drought monitoring and outlook products with higher frequency as needed
- Release early warning and guidance on drought impact mitigation

- Collect the information of drought impacts
- Conduct weather modification to increase the precipitation in the drought area

Hydrology
- Evaluate the impact of drought on water resources, particularly on the drinking water system, water supply to agriculture and industry sectors and water-electricity production
- Enhance the collection of hydrological information
- Increase water supply from the under ground water source and re-allocate the water resources for drought mitigation

Agriculture
- Assess the drought impact on agriculture
- Provide technical guidance to farmer for mitigating drought impacts on crops production

Forestry
- Identify major vulnerable areas of concern, and develop mitigation and response alternatives for drought impacts on wildfire occurrence
- Enhance wild-fire monitoring and make preparedness for firefighting

Civil Affairs and Finance
- Allocate fund and goods for drought relief
- Collect drought-inducing loss or damage information
- Coordinate the stakeholder and NGOs and groups to join the drought relief

Transportation
- Provide the navigation information on the waterways in the drought regions and assess the impact of drought on the commercial shipping
- Keep the road, railway and waterway clear for the transportation and delivery of relief materials

Public health
- Make preparedness to deal with the drought-rising food and water security risk communication
- Keep the communication channels in a good condition for the distribution of drought information and mitigation measures to the public

Private Sectors and Groups
- Evaluate the risk of water shortage for the water self-supplier and prepare for the proactive measures on drought risk management
- Appeal for donation to the drought relief

Termination of Emergency Response
When the drought impacts are greatly weakened or effectively controlled, the central authority or local authority can announce the termination of drought emergency response in the corresponding region.

Drought Recovery and Reconstruction

Drought Rescue and Fund Appropriation
The hazard rescue system established by Chinese government basically guarantees that people affected by a hazard can receive aid within 24 hours. They are supplied with "food, clothing, clean water, temporary housing, medical treatment and schooling." According to the hazard relief emergency fund appropriation mechanism, the financial assistances related with drought rescue and recovery include funds for daily life, funds for severe flood control and drought combat, funds for inland waterway channel rush-repair, funds for medical rescue, funds for culture, education and

administration endeavors, and funds for hazard relief in agriculture and forestry. With the support of state financial subsidies and policies, the insurance enterprise also plays a more and more important role in drought rescue and recovery, especially in the agricultural and forestry sectors by covering losses resulting from drought.

Designation of Reconstruction Plan
Unlike the flooding, in China drought usually does not lead to damage of house or basic infrastructures, and the loss of lives, but impedes the societal and economic development. The importance of recovery and reconstruction from a drought is to build a suitable development plan for the society and the economy with the water resources condition and the drought situation fully taken into account. For instance, the water-saving agriculture and industry strategy should be adopted for a region where drought occurs frequently.

Training and Practice on Drought Risk Management
Disaster reduction capability building in communities and officials is being carried out in an comprehensive way. Specialized training opportunities are offered to the farmer to enhance their capabilities in drought preparedness and sustainable farming. In Northwest of China, many rural families have learned to build a water cellar to prevent the impact of drought. Guidance also is given to the community in the semi-arid and arid regions of China on how to develop their own drought plan and how to take some effective measures to enhance self-reliance capability. Hazard risk management and emergency response are incorporated into the training program for the leading officials. Since 2006, four training courses have been held on flood control and drought combat for big city- and provincial-level administrative officials in charge of flood control and drought combat. Some adjustment in the development strategies on the local agriculture and industry can be made from a drought risk management perspective.

Research and Development
Great importance is attached to the role of science and technology in drought prevention and reduction. A number of scientific and technological projects associated with the drought prevent and risk management have been listed in the National Science and Technology Program, National High-tech R&D Program (863 Program) and key projects supported by the National Natural Science Foundation of China to uplift the capability in drought risk management. The International Drought Risk Relief Center of the Ministry of Civil Affairs was established to enhance the R&D in drought relief.

Summary

Based on the drought-related laws, regulations and hazard risk management plans issued in China, an overall framework for action and coordination that the various entities in China follow for the purpose of drought prevention, mitigation and relief is presented in this paper. Here drought is mainly approached as a period of significant deficiency of precipitation and its impacts on agriculture, hydrology, societal and economic sectors. The importance of risk management is emphasized. It should be recognized that needs and responses to drought will change over time, at different places and for different entities. Drought affects users differently due to the users' dependence on water, the source involved, the type of drought, the impacted area, storage development and many other factors. Therefore, solutions to these many situations must vary.

Future plans should pay more attention to the proactive measures to be taken for the drought prevention. Full participation by public water systems, industry, the agricultural community, and other users should be allowed to involve in this efforts to strengthen the effectiveness and efficiency of the drought plan.

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National Drought Policies in the West-African Sahel Region: An Integrated National and Regional System

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Introduction

The Sahel represents the southern edge of the Sahara Desert, extending at least 4,500 km from Cape Verde through Senegal, Mauritania, Mali, Burkina Faso, Niger, and Chad, and is limited to the south by the less arid Sudano-Sahelian belt (UNEP & ICRAF 2006). It is a transitional zone between the arid Sahara and the tropical green forest that borders the maritime coast. The vegetation cover of the Sahel is composed of bushes, grasses, and stunted trees that increase in density as one moves southward (CILSS, 2004). It is, however, difficult to give precise latitudinal limits to the Sahel since these are subject to fluctuations, depending on rainfall patterns.

West-African Sahelian region is a drought prone region. Sahel rainfall is concentrated in a very small period and characterized by strong inter-annual and irregular variability (Le Barbé & Lebel 2007, CILSS, 4). The cumulative annual rainfall varies between 200 mm and 600 mm and agriculture, predominantly rainfed, depends on 3 to 4 months of summer rainfall. Several major droughts, accompanied by large-scale famine, occurred since the beginning of 20th century, the period documented by the first rain gauges in the Sahel. Severe persistent dry years started in 1971 and continued until 1993. So, the Sahel region has experienced a long period of drought, never seen anywhere else in the world during the 20th century: the rainfall was deficient by an average of over 20 to 30 percent (Hulmeet al. 2001) and river discharge 30 to 60 percent. During these severe droughts, thousands of people and millions of animals died (Glantz 1996). The most severe rainfall deficit, in this period, was recorded in 1984 and drought severely affected all Sahelian countries from Mauritania to Ethiopia (Hulme 2001). This particular severe drought caused for the first time, in the living memory, stopping the Niger River flow. More recently, in 2005 and 2010, famine struck some Sahelian countries, mostly Niger.

In response to this situation, the Heads of States of nine Sahelian countries, Burkina Faso, Cape Verde, The Gambia, Guinea Bissau, Mali, Mauritania, Niger, Senegal (Figure 1), decided, in 1972, to join their effort and create the Permanent Interstates Committee for Drought Control in the Sahel (CILSS) as a coordination regional body for drought monitoring and supporting national policy implementation. The Executive Secretariat of CILSS is based in Ouagadougou, Burkina. Also, in 1973, The United Nations Sahelian Office (UNSO) was created to address the problems of drought in the Sahel region following the West African Sahel drought of 1968-73. In the 1990s, the United Nations Convention to Combat Desertification (UNCCD) was adopted and UNSO became the United Nations Development Programme's Office to Combat Desertification and Drought, as its scope broadened to be global rather than only focused on Africa. Thus, for more than 30 years that the region has been dealing with severe droughts, a well-integrated national/regional system is operating. The present extended abstract analyzes some practices and achievements regarding drought management in the Sahelian region. What are the achievements in terms of national drought risk management policies in the region? What is the current status of national drought policies in the Sahel?

Figure 1. Member States of the Permanente Inter-state Committee for Drought Control in the Sahel

Drought Risk Management in the West-African Sahelian Region

The management of the crisis associated with drought has undergone profound changes in recent decades. After the great drought during1973-1974, drought management mainly consisted in free distributions of food by government agencies and parastatals. Gradually, as a result of changes in food aid policies of major donors, drought management has been transformed. It moved from just being considered as emergency interventions to becoming a central pillar in development programs. Today, most of national drought prevention and crisis management plans in the Sahel are made up of three components: information, consultation/coordination, and intervention. The information component focuses on monitoring and early warning; the consultation/coordination goes into the preparation to respond to a probable drought. Finally, the development of resilience to drought risk has been integrated in to the general programs against poverty. The following sections summarize the status of drought early warning system, the preparedness, response, and resilience in the Sahelian West-Africa.

Drought Monitoring and Early Warning

This segment of the system is the most complete and operational one. The drought Early Warning in West-Africa is based on multiple information systems, focused on a certain number of parameters [agricultural production, meteorological information, market prices and health and nutritional status of vulnerable populations (children), etc.]. It is a well-integrated Regional/National system. CILSS coordinates, through two main structures. The regional component, the AGRHYMET Regional Center, is a specialized institution of CILSS and based in Niamey, Niger. It is in charge of collecting and processing data and disseminating information on hydro-meteorological situation for the entire region. The AGRHYMET is also in charge of building technical capacities through training and transfer of tools and methods adapted to the Sahelian countries in climatology, agrometeorology, hydrology, information technology, crop protection, GIS, and remote-sensing. AGRHYMET plays also

the role of strengthening interstate co-operation by sharing methodologies and technologies between member states. AGRHYMET is complemented by a second regional structure on prevention and management of food crises in West Africa, which is called PREGEC (a French acronym which stands for Prévention et Gestion des Crises alimentaires en Afrique de l'Ouest). PREGEC is a regional coordination framework for drought risk management. It is led by CILSS, but also includes other regional and international organizations on food security management (FAO, WFP, FEWS NET, NGOs) and development partners of CILSS (European Union, USAID, MIFRAC, CIDA, Italian Cooperation).

At the national level, multidisciplinary working groups (GTP a French acronym which stands for Groupe de Travail Pluridisciplinaire) represent, in each country, the national component of the monitoring system. The GTPs at the national level are coordinated in most cases by the national meteorological service. They include hydrological, crop protection, agricultural research and/or extension, livestock and pastoralism, national TV and radio coverage, rural development NGOs, and many other services. The GTP is in charge of the national biophysical data collection in different fields. GTP, a technical monitoring system, is completed by the National Early Warning System (CN/SAP a French acronym which stands for Comité national du système d'alerte précoce). For example, in Niger, the National Early Warning System was established in August 1989 by a Presidential Decree. In 1990, a Permanent Secretariat (SP/SAP) was created. As GTP, the SAP component also includes different services as the agricultural statistics services and food security analysis units. All these components (AGRHYMET, PREGEC, GTP, SAP and other NGOs) are integrated within a regional/national drought monitoring and early warning system.

The monitoring system is based on the use of ground-based data and satellite estimates, agrometeorological and hydrological models. Information and data are shared between the national and regional components. Mainly, ground-based data come from GTP and satellite based products from the regional component. Most recently, in the framework of the AMESD project, all West African countries have been equipped with satellite receiving stations and AGRHYMET is backstopping them, through training workshops, in the exploitation and maintenance of those stations. With the satellite derived indicators (rainfall estimates, vegetation indices), it is now possible in each country and the Sahelian region, in particular, to assess crops and natural vegetation status every 10 days during the main agricultural season. The most active period of the drought monitoring activities spans from May to October and is conducted as follows.

It starts in May with a regional hydro-climatic outlook forum. The national and regional components of the system participate in this forum and produce consensual seasonal rainfall and hydrological forecasts for the whole region. According to the form outputs, some policies are established regarding the rainy season management. For example, specification and advice for the choice of crop varieties are made based on forecast information on early or late onset and the length of the rainy season. If a potential wet rainy season is expected, it is advised to promote the use of plateau area for agricultural activities instead of shallow area, and recommendations are made to use the necessary fertilizers. If a potential dry year is more likely, shallow area and the practice of soil and water conservation techniques (Half-moon and Zaï in particular) are recommended. One of well-known successful experiences of the GTP achievements, in term of Hydro-agrometeorological advice, is called the "Mali Experience."

Then, each 10 days, a briefing is held both at the regional and national scales. The objective of the 10-day briefing is to analyze the rainfall situation (both from rain gauge and satellite data); the hydrological situation; the progress of sowing and crop water satisfaction (field data and agrometeorological models are used); the biomass situation (based mainly on satellite based vegetation indices). Periodical bulletins are produced at the regional and the national level. At the national level, a 10-day bulletin is produced in most countries, but at the regional level a monthly bulletin is produced. At any time, a special warning bulletin could be produced both at the national

and the regional levels. The decisions of the national authorities are based both on the regional and national information.

In early September, midterm review of the rainy season is made, which consists of a qualitative assessment of crop forecasting and early identification areas representing a risk of deficit in food and biomass production (Figure 2). A regional consultation meeting is organized to schedule joint (CILSS and national components, supported by FAO and FEWS NET) assessment field missions, in order to evaluate the crop situation in each country.

In October, joint pre-harvest assessment field missions (National components, CILSS, FEWS NET, FAO, and WFP) are conducted in all the countries to evaluate the situation in each country.

In early November, an annual regional consultative meeting is organized with the participation of all the stakeholders, including donor organizations. This meeting aims to validate the preliminary results of crop production. After discussing the results of the monitoring activities during the rainy season and those of the pre-harvest assessment missions, a "Statement on the agricultural and food prospects in the Sahel and West Africa" is issued at the end of this meeting, in which a provisional food balance is established, and potential risk zones and vulnerable populations are identified. This consensus statement is widely disseminated among all food security stakeholders in the region and also posted on the CILSS and AGRHYMET websites.

A final consultative meeting in December allows the participants of Food Security in the Sahel and donors to make an overall assessment of agricultural and food situation in the region and produce synthesis of relevant information for better decision making.

It should be noted that strong national meteorological and hydrology services in the countries play a key role in this system as well as a reliable system for collecting agricultural statistics data.

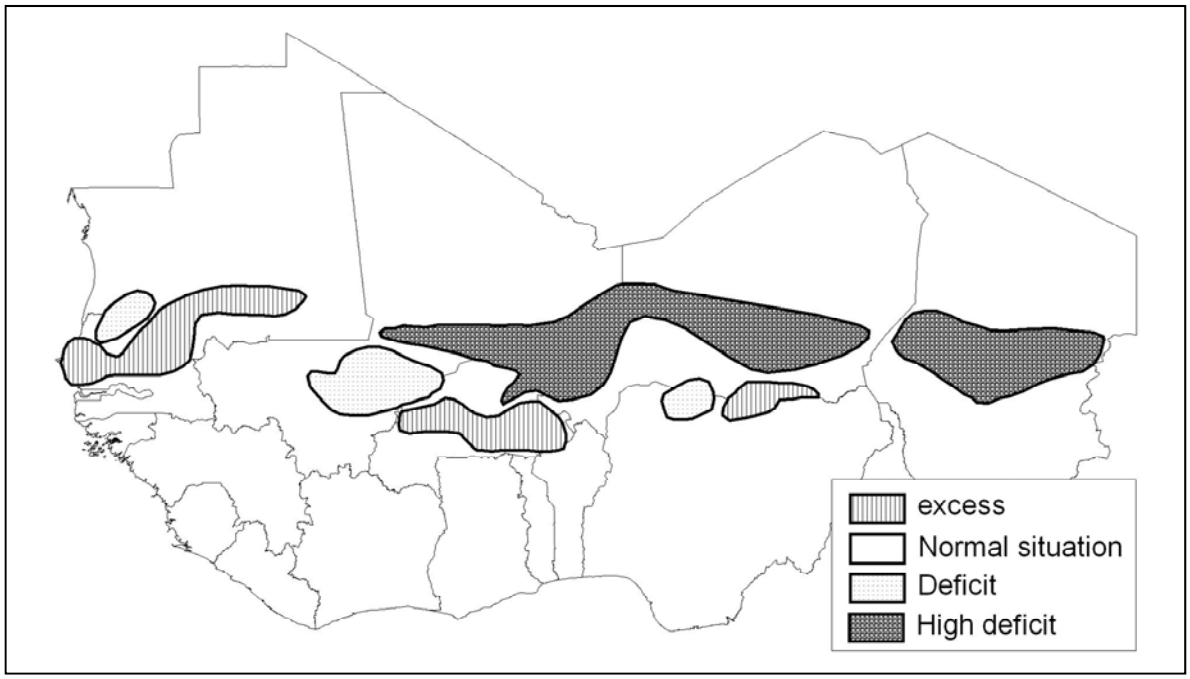

Figure2. Food and Biomass Production Outlook, made in September 2009 (AGRHTMET 2009). The CILSS system (PREGEC and AGRHYMET) maintain a relatively good monitoring system to alert food crises. However, the system's ability to mobilize donors on repeated crises has declined over "the past decade."

Preparedness

When, in the process of rainy season monitoring, a significant rainfall deficit is expected, the actors in drought management start to organize themselves, before a food crisis occurs. The preparation process includes a number of steps. A first step involves consultation and coordination. This is illustrated, in most countries, by the existence of joint bodies comprising representatives of national government and donors. These bodies have a mandate to manage one or more mutual fund(s) specific to the food security policy in the short term. Their institutional coordination varies by country: Office of the President; Prime Minister, Ministry of Finance, Ministry of Rural Development, etc. These instances are relatively less opened to civil society organizations (NGOs, socio-professional organizations) which, however, play an increasingly important role in mitigating food crisis. They also do not fully involve local governments in the decision making process, although this situation is evolving (PREGEC).

Also, maintaining food stocks plays an important role in preparation to face a drought situation. It allows ensuring the availability and stability of food supply. Food stocks are of several types:

- private stocks, held by households, traders and secondarily by NGOs;
- farmer stocks, maintained at cereal banks, which are usually created with the support of projects or NGOs;
- public stocks, essentially made from the National Food Reserve. It is with the national food stock that national authorities have to deal with the food situation in case of food crisis, until the intervention of the international community. For example, in Niger it is the Office of food products (OPVN a French acronym stands for l'Office des produits vivriers du Niger) which is responsible for maintaining the national food security and logistics of food aid, through a contract plan. However, this stock has been decreasing constantly since 1991 (Figure 3).

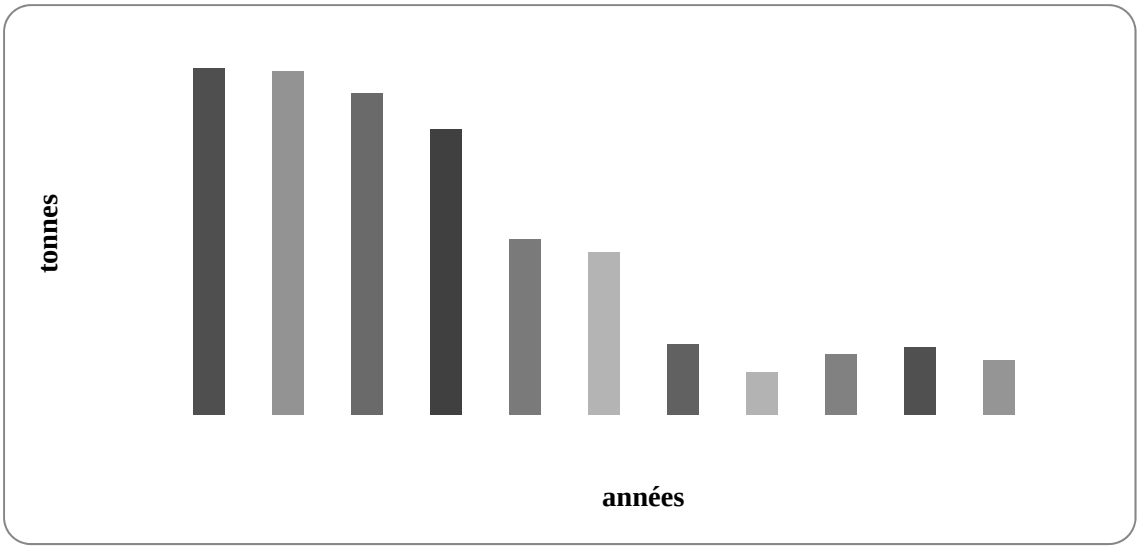

Figure 3. Evolution of Food Stocks in Niger (OPVN stock) between 1991 and 2001 (source: SAP/GC)

Response to Drought Events

Drought crisis management is conducted in a classical way. Three main elements constitute this step: evaluation of the situation; mobilization of stocks, mobilization of donors and various national and regional actors; and regulation of the regional transboundary trade.

Regional meetings are organized to harmonize the criteria for assessing the food crisis situation (for example, indicators of nutritional status, family livelihood, etc.) and to improve the reliability of the information. From the analysis of the food situation, consultations are held between the various stakeholders to assess the aid needs in terms of quantities, qualities, types of aid, areas and populations involved, logistical aspect, delivery period etc. All of these elements constitute the guidelines for donors and national authorities. To avoid duplication and actions that would induce changes in the eating habits of affected populations, consultation meetings among donors are organized. These consultation meetings also help avoid competition with local products and promote regional trade in cereals. The network of food crisis prevention (PREGEC), coordinated by CILSS, is heavily involved in coordinating the consultation and the implementation of a Charter of food aid which defines a set of principles that engage donors (individual donor states and international institutions) and beneficiary states (which are affected countries).

A second important element in the response to a drought event consists in physical stocks of food in almost all the countries. This stock is mobilized for free food distribution (proportional to the magnitude of the crisis) or sale with subsidized prices, commonly known as low-cost sales. This stock is often supplemented by one or more funds to support: first, in years of serious food crisis food importation and guarantee the free distribution; secondly, in case of limited food crisis, it is used to support mitigation projects requiring intensive labor (erosion control measures, development of wetlands, maintenance of tracks, etc..), the replenishment of cereal banks, the supply of livestock by-products, etc.

In case of a prolonged dry spell, some countries in the region (including Burkina-Faso; Senegal, Mali) conduct cloud seeding operations. For this specific area, the national components are more operational than the regional component. A regional component (APENS, Appui aux programmes d'ensemencement des nuages) is under development.

Today, food security in West Africa is highly dependent on the regional market. Trade has become an essential component of any food security strategy in the region because it contributes to increasing availability and reducing supply variability. That is why it is extremely important to adopt the ECOWAS Policy to promote transboundary exchange (ECOWAS policies). Monitoring and analysis of nutritional and health indicators are also important aspects. Also, some policies should be applied to alleviate drought impacts in the livestock sector. For example, an interstate agreement to facilitate a transboundary transhumance is one of the responses. The final objective is to make sure that mechanisms to regulate regional and transboundary natural resource management are in place.

Mitigation/ Recovery

Given the interactions between drought risk, food insecurity, and the various dimensions of poverty, national strategies for drought management are now integrated in the global strategy against poverty and sustainable development. Also, we should note that after the second food big shock in early 1980s, food self-sufficiency policies were adopted by most of the governments. Today, another concept, "food security," has evolved. This new concept is broader, covering national food production, commercial imports, and food aid.

Main Drought Mitigation Policies

Just as AGRHYMET is assigned the monitoring and early warning responsibilities, as well as capacity building of national technical services, CILSS has also created the Sahel Institute (INSAH) with the mission to promote and coordinate research towards drought resilience in member countries. Thus, this second branch of CILSS helps the National Agricultural Research Institutes to undertake research activities in the areas of plant breeding for drought resistance, agronomical practices to optimize water use, crop protection, etc. In this regard, international research networks and institutes

(CORAF/WECARD, R3S, TROPSOILS, INTSORMIL, ICRISAT, IITA, ADRAO (now AfriaRice), CIRAD, CERAAS, etc.) play an important role in training the national scientists and supporting their research activities. CILSS has also implemented multi-country projects that promote soil and water conservation techniques (half moons, Zaï, stone lines, etc.), reforestation programs, and small scale irrigation schemes (e.g., PRAPIS). Socioeconomic aspects were also considered through the population and development program of INSAH, where the interactions between population dynamics and droughts were studied. Most recently, drought management system in CILSS countries has also included the health dimension in drought mitigation efforts, and CILSS is currently implementing a project on the monitoring of nutritional policies and strategies.

Reference Documents

The evolution of events at the international level, namely the rise in global food prices, the momentum at the UNFCCC climate change negotiations and UNISDR have led many countries, including those in the Sahel, to revise or draft national agricultural and environmental policies, in which drought resilience measures are at the forefront. Those policies include the national agricultural investment plans (NAIPs), promoted by AU/NEPAD and the regional economic commissions (ECOWAS in West Africa), national environment protection plans, national disaster reduction strategies, national adaptation plans (NAPAs), etc.

Example 1: Mali Case-some institutions and structures involved in drought impact management.
In West Africa, national institutions in charge of the management of food crisis are relatively centralized and placed under the direct responsibility of governments of countries receiving the aid. In Mali, for example, at Ministerial level a structure in charge of inter-ministerial coordination of drought management, called the Steering Committee and Coordination System for Food Security (COCSSA), is established. This committee is included in the responsibilities of the Prime Minister at the ministerial level and includes:

- Ministry of Finance and Trade;
- Ministry of Rural Development;
- Ministry of Natural Resources;
- Ministry of Territorial Administration;
- Ministry for Industry;
- Ministry of Transport;
- Ministry of Health.

Also, there are a number of technical agencies responsible for specific aspects of food security management. For example:

a) Support Unit for Local Development
b) The National Office for Agricultural Products (OPAM)
c) Market information system (MIS) Agricultural Market Observatory (OMA, Le Système d'Information du Marché (SIM) Observatoire des Marchés Agricoles (OMA)
d) The Early Warning System (SAP, Le Système d'Alerte Précoce) plays an important role in managing drought risk. The SAP is responsible for identifying areas and populations facing a risk of food and nutrition crisis, determining the type of aid to provide; indicating the best possible uses. The SAP evaluation is expressed in six situations that require monitoring and appropriate interventions:

    - Normal situation where there is nothing to report (RAS, rien à signaler);
    - Slight Socio-economic difficulties (LED, difficultés socio-économiques légères);
    - Severe socio-economic difficulties (DES, difficultés socio-économiques sévères);
    - Food difficulties (DA, difficultés alimentaires);

- Food crisis (CA, crises alimentaires);
- Famines (Fa, Famines).

e) The Planning and Statistics Unit of the Ministry of Agriculture (CPS, La Cellule de Planification et de Statistique du ministère du développement rural)
f) The Planning and Statistics Unit of the Ministry of Health (La Cellule de Planification et de Statistique du Ministère de la Santé)
g) The National Agricultural Research program (PNRA, Le Programme National de la Recherche Agricole).

Example 2. The national food crisis prevention and management policy of Niger.
In Niger, it was in August 1989 that the National Early Warning System (CNSAP) was created by a presidential decree. In 1990, a Permanent Secretariat (SP / CNSAP) was established. Due to recurrent food crises recorded since 1998, the government, with the support of key regional and international partners, has set up a national crisis management and prevention system.

The Poverty Reduction Strategy (PRS) is the reference document for all interventions in the field. But, it is the Rural Development Strategy (RDS) that sets the broad guidelines, the institutional framework, and the policy instruments. The national crisis prevention and management includes a national advisory committee, a partnership framework of donors, technical structures and tools of intervention.

This national prevention and management of food crisis has become essential to better coordinate and better manage the actions of different actors in food aid for the benefit of vulnerable populations. This coordination structure reports to the Prime Minister's Office through a National Committee for Prevention and Management of Food Crises (CNPGCA), which has an advisory role. CNPGCA in addition, relies on the following structures:

- A Partnership Framework Governments-/-Donors, called Joint Consultative Commission. This Commission includes Governments of Niger and major donors that have signed an agreement framework.
- The Food Crisis Unit which is responsible for the coordination of food aid and supervision of interventions to mitigate the crisis. The CCA is the executive body of the system.
- The Coordination Unit of the early warning system which is responsible for producing, processing and disseminating information about food security and identifying vulnerable areas and actions to prevent or mitigate the food crisis.
- The Office of Niger's food products (OPVN) which is responsible for maintaining the national food security and logistics of food aid through a contract plan.
- The National Food Reserve (SNR) of 110,000t which is composed of:
  - National Security Stock (SNS) of 60000t;
  - Food Security Fund (FSA) of 50000t. The National Stock Reserve (SNR) is used to face severe drought, earlier before the mobilization of regional and international aids.
- Fund Response: It is used for actions to mitigate crisis and acts as a relay for development operations.

Conclusions

In the West-Africa Sahelian Region, the drought situation is a recurrent phenomena, and it still has some disaster impact in the region. Although an integrated national/regional monitoring system is fully operational, the system has less capacity in terms of proactive response in case of drought occurrence. The absence of internationally recognized criteria to qualify a famine does not facilitate earlier actions. The system still has to move from logic of humanitarian assistance to an effective

logic of prevention and development. Since the Sahelian has been dealing with drought situation for more than 30 years, the regional experience should be a suitable case study.

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Acronyms

CILSS: Permanent Inter-state Committee for Drought Control in the Sahel
CIDA: Canadian International Development Agency
CORAF/WECARD: West and Central African Council for Agricultural Research and Development
ECOWASS: Economic Community of West African States
FAO: Food and Agriculture Organization of the United Nations
FEWSNET: Famine Early Warning Systems Network
GEF: Global Environment Facility
ICID: International Commission on Irrigation and Drainage
IPCC: Intergovernmental Panel on Climate Change
NAP: National Action Programme
NAPA: National Adaptation Programmes of Action
NGO: Non-governmental Organization
PRSP: Poverty Reduction Strategy Paper
UNCCD: United Nations Convention to Combat Desertification
UNDP: United Nations Development Programme
UNFCCC: United Nations Framework Convention on Climate Change
UN-ISDR: United Nations International Strategy for Disaster Reduction
USAID: United States Agency for International Development
UNSO: United Nations Sahelian Office
UNEP: United Nations Environment Programme

TOWARDS A COMPENDIUM ON

NATIONAL DROUGHT POLICY

Essential Elements of National Drought Policy: Moving Toward Creating Drought Policy Guidelines

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Abstract

The development and implementation of a drought policy is intended to alter a nation's approach to drought management. A national drought policy should establish a clear set of principles or operating guidelines to govern the management of drought and its impacts. The policy should be consistent and equitable for all regions, population groups, and economic sectors and consistent with the goals of sustainable development. The overriding principle of drought policy should be an emphasis on risk management through the application of preparedness and mitigation measures. The policy must reflect regional differences in drought characteristics, vulnerability, and impacts. The goal of the policy is to reduce risk by developing better awareness and understanding of the drought hazard and the underlying causes of societal vulnerability.

Climate change and 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. This paper presents an overview of drought planning and policy that can provide a model for nations to use to improve their level of preparedness for drought with the ultimate goal of reducing societal vulnerability to this pervasive natural hazard

Introduction

Drought results in significant economic, social, and environmental impacts throughout the world. These impacts vary significantly between developed and developing countries. However, a common thread between all countries is the almost total reliance on a reactive, crisis management philosophy for drought management. This approach has been demonstrated to be ineffective and untimely in previous drought response efforts and may actually increase vulnerability to future drought episodes by increasing reliance on governmental or donor assistance.

Associated with the crisis management approach is the lack of recognition that drought is a normal part of the climate. Climate change and 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.

Drought Policy: Characteristics and the Way Forward

As a beginning point in the discussion of drought policy, it is important to identify the various types of drought policies that are available and have been utilized for drought management. The most common approach, and the one most often followed by both developing and developed nations, is post-impact government (or nongovernment) interventions. These interventions are normally relief measures in the form of emergency assistance programs aimed at providing money or other specific types of assistance (e.g., livestock feed, water, food) to the victims (or those experiencing the most severe impacts) of the drought. This reactive approach is seriously flawed from the perspective of vulnerability reduction since the recipients of this assistance are not expected to change behaviors or resource management practices as a condition of the assistance. For example, livestock producers that do not maintain adequate on-farm storage of feed for livestock as a drought management strategy will be those that first experience the impacts of extended precipitation shortfalls. These producers will be the first that turn to the government or other organizations for assistance in order to maintain herds until the drought is over and feedstocks return to adequate levels. This reliance on the government for relief is contrary to the philosophy of encouraging self-reliance through producer investment in creating improved coping capacity. Government assistance or incentives that encourage these investments would be a philosophical change in how governments respond and would promote a change in the expectations of livestock producers as to the role of government in these response efforts. The more traditional approach of providing relief is also flawed in terms of the timing of assistance being provided. It often takes weeks or months for assistance to be received, at times well beyond the window of when the relief would be of greatest value in addressing the impacts of drought.

A second type of drought policy approach is the development of pre-impact government programs that are intended to reduce vulnerability and impacts. In the natural hazards field, these types of programs or measures are commonly referred to as mitigation measures. Mitigation in the context of natural hazards is different from mitigation in the context of climate change, where the focus is on reducing greenhouse gas (GHG) emissions. These types of measures are numerous but appear to be less obvious to many when associated with drought since impacts are generally non-structural. These measures would include establishing comprehensive early warning systems, improving seasonal forecasts, increasing emphasis on water conservation (demand reduction), increasing or augmenting water supplies through greater utilization of ground water resources, constructing reservoirs, interconnecting water supplies between neighboring communities, drought planning, and awareness building and education. A more exhaustive list of these measures was compiled through a survey of states and other entities in the United States following several drought episodes in the late 1980s and early 1990s (Wilhite and Rhodes 1995). Insurance programs, currently available in many countries, would also fall into this category of policy types.

The final type of policy response is the development and implementation of preparedness plans and policies, which would include organizational frameworks and operational arrangements developed in advance of drought and maintained in between drought episodes by government or other entities. This approach represents an attempt to create greater institutional capacity focused on improved coordination and collaboration within and between levels of government and with stakeholders in the plethora of private organizations with a vested interest in drought management (i.e., communities, natural resource districts or managers, utilities, agribusiness, farm organizations, and others).

Principle Elements of a Drought Risk Reduction Policy Framework

Drought policy options should be provided in each of four principle areas: (1) risk and early warning, including vulnerability analysis, impact assessment, and communication; (2) mitigation and preparedness, including the application of effective and affordable practices; (3) awareness and education, including a well-informed public and a participatory process; and (4) policy governance,

including political commitment and responsibilities (UNISDR 2009). Another important component of this framework is the inclusion of policy options for emergency response and relief. In all cases, when severe drought occurs, governments and other organizations must provide some form of emergency relief to those sectors most affected. It is critically important, as a part of a drought risk reduction policy, for this assistance to be provided in a form that does not run counter to the goals and objectives of the national drought policy, which would include a strong emphasis on the sustainability of the natural resource base.

Drought planning, as an integral part of drought policy, can take many forms and approaches. It is important to note that planning must occur on multiple government levels from local to national, and the objectives of these policies at the local, state, or regional levels must reflect the goals of national drought policies. Stakeholders must be engaged at all levels. Drought planning should also occur at the river basin scale, so the result may be overlapping authorities with political jurisdictions.

Drought planning can be defined as actions taken by individual citizens, industry, government, and others before drought occurs with the purpose of reducing or mitigating impacts and conflicts arising from drought. It can take the following forms: response planning or mitigation planning. In the United States, where drought planning at the state level has become widespread over the past 25 years, most state drought plans first began as response plans—i.e., reactive plans that implemented actions when drought emerged, often with the goal of formulating requests for assistance from the federal government, most often the U.S. Department of Agriculture. Over the past 10 years, there has been an impressive shift of emphasis toward mitigation planning by many states. Currently, 47 of the 50 U.S. states have drought plans, and 11 of these states are placing an ever-increasing emphasis on mitigation as a primary means of reducing societal vulnerability. Interestingly, a greater emphasis on mitigation planning has necessarily resulted in increased pressure for scientists to provide more timely information in the form of better seasonal forecasts, improved decision support tools, and higher resolution analysis for natural resource managers, government officials, and policy makers.

One of the tools that has been instrumental in providing guidance in the development of drought preparedness plans in the United States is a 10-step planning process originally proposed in 1991 (Wilhite 1991) and subsequently modified on numerous occasions to incorporate a greater emphasis on mitigation in the planning process (Wilhite et al. 2000; Wilhite et al. 2005a). These steps are listed in Figure 1.

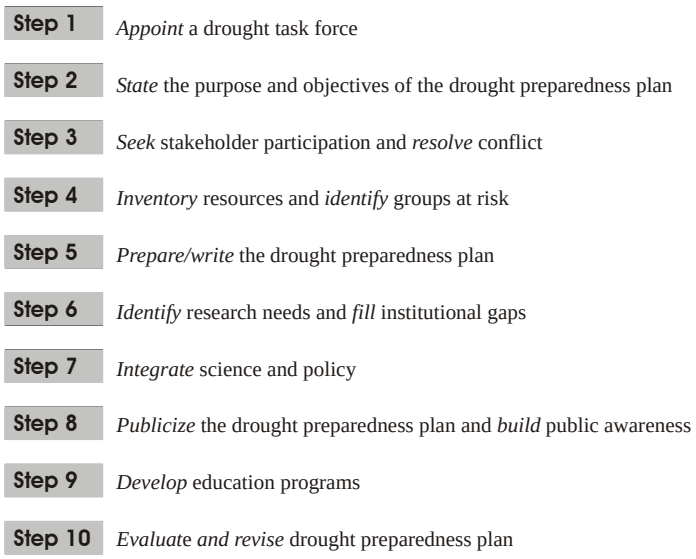

Figure 1. The 10-Step Planning Process (Wilhite et al. 2005a)

In brief, Steps 1-4 of the 10-step planning process focus on making sure the right people are brought together, have a clear understanding of the process, know what the drought plan must accomplish, and are supplied with adequate data to make fair and equitable decisions when formulating and writing the actual drought plan. Step 5 describes the process of developing an organizational structure for completion of the tasks necessary to prepare the plan. The plan should be viewed as a process, rather than a discrete event that produces a static document. A risk assessment is undertaken in conjunction with this step in order to construct a vulnerability profile for key economic sectors, population groups, regions, and communities. Steps 6 and 7 detail the need for on-going research and coordination between scientists and policy makers. Steps 8 and 9 stress the importance of promoting and testing the plan before drought occurs. Finally, Step 10 emphasizes revising the plan to keep it current and making an evaluation of the plan's effectiveness in the post-drought period. Although the steps are sequential, many of these tasks are addressed simultaneously under the leadership of a drought task force and its complement of committees and working groups. These steps, and the tasks included in each, provide a "checklist" that should be considered and may be completed as part of the planning process.

The organizational structure proposed in support of this 10-step planning process is shown in Figure 2. This structure includes the formation of a drought task force to coordinate the drought planning process, both during the development stage and the implementation stage, and a monitoring committee and a risk assessment committee. This structure has worked effectively in most states, although it has been modified or adapted to the specific needs of each of the states with drought plans.

The description of the 10-step process below is summarized from Wilhite et al. (2005a), which is available on the NDMC's website (http://drought.unl.edu/planning).

Step 1: Appoint a Drought Task Force

A key political leader initiates the drought planning process through appointment of a drought task force. Depending on the level of government developing the plan, this could be the president or prime minister, a provincial or state governor, or a mayor. The task force has two purposes. First, the task force supervises and coordinates development of the plan. Second, after the plan is developed and during times of drought when the plan is activated, the task force coordinates actions, implements mitigation and response programs, and makes policy recommendations to the governor or other appropriate political leader.

The task force should reflect the multidisciplinary nature of drought and its impacts, and it should include appropriate representatives of government agencies (provincial, federal) and universities where appropriate expertise is available. For states, the governor's office should have a representative on the task force. Environmental and public interest groups and others from the private sector can be included on the task force (see Step 3), as appropriate. These groups would be involved to a considerable extent in the activities of the working groups associated with the Risk Assessment Committee discussed in Step 5. The actual makeup of this task force would vary considerably depending on the principal economic and other sectors affected, the political infrastructure, and other factors. The task force should include a public information official that is familiar with local media's needs and preferences, and a public participation practitioner who can help establish a process that includes and accommodates all stakeholders or interest groups.

Step 2: State the Purpose and Objectives of the Drought Plan

As its first official action, the drought task force should state the general purpose for the drought plan. Government officials should consider many questions as they define the purpose of the plan, such as the following:

- Purpose and role of government in drought mitigation and response efforts;
- Scope of the plan;
- Most drought-prone areas of the state/nation;
- Historical impacts of drought;
- Historical response to drought;
- Most vulnerable economic and social sectors;
- Role of the plan in resolving conflict between water users and other vulnerable groups during periods of shortage;
- Current trends (e.g., land and water use, population growth) that may increase/decrease vulnerability and conflicts in the future;
- Resources (human and economic) that the government is willing to commit to the planning process;
- Legal and social implications of the plan; and
- Principal environmental concerns caused by drought.

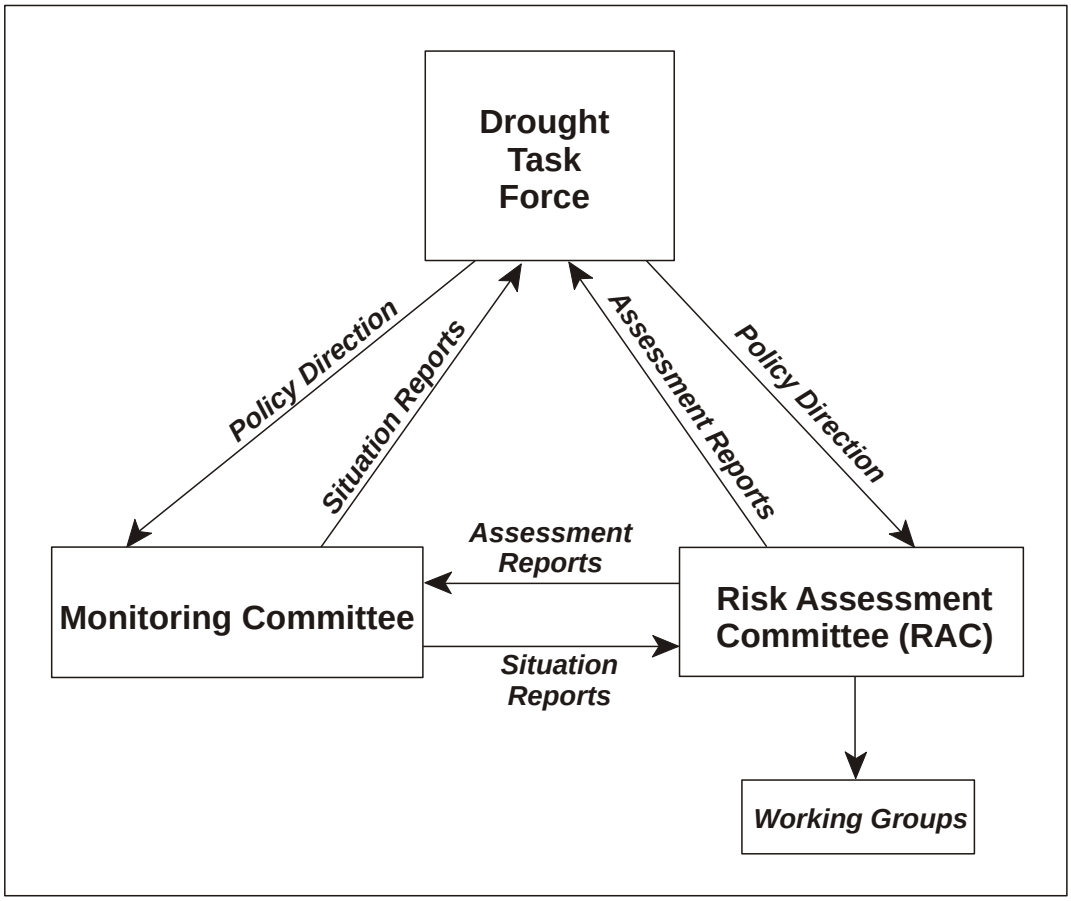

Figure 2. Drought Task Force Organizational Structure (Wilhite et al., 2005a)

A generic statement of purpose for a plan is to reduce the impacts of drought by identifying principal activities, groups, or regions most at risk and developing mitigation actions and programs that alter these vulnerabilities. The plan is directed at providing governments with an effective and systematic means of assessing drought conditions, developing mitigation actions and programs to reduce risk in advance of drought, and developing response options that minimize economic stress, environmental losses, and social hardships during drought.

The task force should then identify the specific objectives that support the purpose of the plan. Drought plan objectives will vary within and between countries and should reflect the unique physical, environmental, socioeconomic, and political characteristics of the region in question. For a provincial, state, or regional plan, objectives that should be considered include the following:

- Collect and analyze drought-related information in a timely and systematic manner.
- Establish criteria for declaring drought emergencies and triggering various mitigation and response activities.
- Provide an organizational structure and delivery system that assures information flow between and within levels of government.
- Define the duties and responsibilities of all agencies with respect to drought.
- Maintain a current inventory of government programs used in assessing and responding to drought emergencies.
- Identify drought-prone areas of the state/region/nation and vulnerable economic sectors, individuals, or environments.
- Identify mitigation actions that can be taken to address vulnerabilities and reduce drought impacts.
- Provide a mechanism to ensure timely and accurate assessment of drought's impacts on agriculture, industry, municipalities, wildlife, tourism and recreation, health, and other areas.
- Keep the public informed of current conditions and response actions by providing accurate, timely information to media in print and electronic form (e.g., via TV, radio, and the World Wide Web).
- Establish and pursue a strategy to remove obstacles to the equitable allocation of water during shortages and establish requirements or provide incentives to encourage water conservation.
- Establish a set of procedures to continually evaluate and exercise the plan and periodically revise the plan so it will stay responsive to the needs of the state or region.

Step 3: Seek Stakeholder Participation and Resolve Conflict

Social, economic, and environmental values often clash as competition for scarce water resources intensifies. Therefore, task force members must identify all citizen groups (stakeholders) that have a stake in drought planning and their interests. These groups must be involved early and continuously for fair representation and effective drought management and planning. Discussing concerns early in the process gives participants a chance to develop an understanding of each other's viewpoints, and to generate collaborative solutions. Although the level of involvement of these groups will vary notably from location to location, the power of public interest groups in policy making is considerable. In fact, these groups are likely to impede progress in the development of plans if they are not included in the process. The task force should also protect the interests of stakeholders who may lack the financial resources to serve as their own advocates. One way to facilitate public participation is to establish a citizen's advisory council as a permanent feature of the drought plan, to help the task force keep information flowing and resolve conflicts between stakeholders.

State or provincial governments need to consider if district or regional advisory councils need to be established. These councils could bring neighbors together to discuss their water use issues and problems and seek collaborative solutions. At the provincial level, representatives of each district council should be included in the membership of the provincial citizens' advisory council to represent the interests and values of their constituencies. The provincial citizens' advisory council can then offer recommendations and express concerns to the task force as well as respond to requests for situation reports and updates.

Step 4: Inventory Resources and Identify Groups at Risk

An inventory of natural, biological, and human resources, including the identification of constraints that may impede the planning process, may need to be initiated by the task force. In many cases, much information already exists about natural and biological resources through various provincial and federal agencies. It is important to determine the vulnerability of these resources to periods of water shortage that result from drought. The most obvious *natural* resource of importance is water; where it is located, how accessible is it, and of what quality is it? *Biological resources* refer to the quantity and quality of grasslands/rangelands, forests, wildlife, and so forth. *Human resources* include the labor needed to develop water resources, lay pipeline, haul water and livestock feed, process citizen complaints, provide technical assistance, and direct citizens to available services.

The task force must also identify constraints to the planning process and to the activation of the various elements of the plan as drought conditions develop. These constraints may be physical, financial, legal, or political. The costs associated with plan development must be weighed against the losses that will likely result if no plan is in place. The purpose of a drought plan is to reduce risk and, therefore, economic, social, and environmental impacts. Legal constraints can include water rights, existing public trust laws, requirements for public water suppliers, liability issues, and so forth.

In drought planning, making the transition from crisis to risk management is difficult because, historically, little has been done to understand and address the risks associated with drought. To solve this problem, areas of high risk should be identified, as should actions that can be taken before a drought occurs to reduce those risks. Risk is defined by both the exposure of a location to the drought hazard and the vulnerability of that location to periods of drought-induced water shortages (Blaikie et al. 1994). Drought is a natural event; it is important to define the exposure (i.e., frequency of drought of various intensities and durations) of various parts of the region to the drought hazard. Some areas are likely to be more at risk than others. Vulnerability, on the other hand, is affected by social factors such as population growth and migration trends, urbanization, changes in land use, government policies, water use trends, diversity of economic base, cultural composition, and so forth. The drought task force should address these issues early in the planning process so they can provide more direction to the committees and working groups that will be developed under Step 5 of the planning process.

Step 5: Establish and Write Drought Plan

This step describes the process of establishing relevant committees to develop and write the drought plan. The drought plan should have three primary components: monitoring, early warning, and prediction; risk and impact assessment; and mitigation and response. It is recommended that a committee be established to focus on the first two of these needs; the drought task force can in most instances carry out the mitigation and response function. The suggested organizational structure for the plan is illustrated in Figure 2.

These committees will have their own tasks and goals, but well-established communication and information flow between committees and the task force is a necessity to ensure effective planning.

More detail on the composition of these committees and their focus is included in Wilhite et al. (2005a) and on the NDMC's website (http://drought.unl.edu/planning).

The purpose of the risk assessment process is to identify those sectors, population groups, or regions most at risk from drought, the most likely impacts, and appropriate mitigation actions that will reduce those impacts. The final outcome of this risk assessment process is the development of a vulnerability profile that establishes who and what is at risk and why. The steps in this process are

1. Identify impacts of recent and historical droughts.
2. Identify drought impact trends.
3. Prioritize impacts.
4. Identify mitigation actions that could reduce short- and long-term impacts.
5. Identify triggers to phase in and phase out actions during drought onset and termination.
6. Identify agencies and organizations to develop and implement actions.

A checklist of historical, current, and potential drought impacts is available as a guide to government entities involved in this plan development process (http://drought.unl.edu/planning).

Step 6: Identify Research Needs and Fill Institutional Gaps

As research needs and gaps in institutional responsibility become apparent during drought planning, the drought task force should compile a list of those deficiencies and recommend possible remedies to the appropriate person or government body. Step 6 should be carried out concurrently with Steps 4 and 5. For example, the Monitoring Committee may recommend establishing an automated weather station network. Another recommendation may be to initiate research on the development of a climate or water supply index to help monitor water supplies and trigger specific actions by government.

Step 7: Integrate Science and Policy

An essential aspect of the planning process is integrating the science and policy of drought management. The policy maker's understanding of the scientific issues and technical constraints involved in addressing problems associated with drought is often limited. Likewise, scientists generally have a poor understanding of existing policy constraints for responding to the impacts of drought. In many cases, communication and understanding between the science and policy communities must be enhanced if the planning process is to be successful.

Good communication is required between the two groups in order to distinguish what is feasible from what is not achievable for a broad range of science and policy issues. Integration of science and policy during the planning process will also be useful in setting research priorities and synthesizing current understanding. The drought task force should consider various alternatives to bring these groups together and maintain a strong working relationship.

Step 8: Publicize the Drought Plan, Build Public Awareness and Consensus

If there has been good communication with the public throughout the process of establishing a drought plan, citizens may already have better-than-normal awareness of drought and drought planning by the time the plan is actually written. Themes to emphasize in writing news stories during and after the drought planning process could include:

- How the drought plan is expected to relieve impacts of drought in both the short- and long-term. Stories can focus on the human dimensions of drought, such as how it affects a farm family; on its environmental consequences, such as reduced wildlife habitat; and on its economic effects, such as the costs to a particular industry or to the overall economy.

- What changes people might be asked to make in response to different degrees of drought, such as restricted lawn watering and car washing, or not irrigating certain crops at certain times.

In subsequent years, it may be useful to do "drought plan refresher" news releases at the beginning of the most drought-sensitive season, letting people know whether there is pressure on water supplies and reminding them of the plan's existence, history, and any associated success stories. It may be useful to refresh people's memories ahead of time on circumstances that would lead to water use restrictions.

During drought, the task force should work with public information professionals to keep the public well informed of the current status of water supplies, whether conditions are approaching "trigger points" that will lead to requests for voluntary or mandatory use restrictions, and how victims of drought can access assistance. All pertinent information should also be available on the drought task force's website so that the public can get information directly from the task force without having to rely on mass media.

Step 9: Develop Education Programs

A broad-based education program to raise awareness of short- and long-term water supply issues will help ensure that people know how to respond to drought when it occurs and that drought planning does not lose ground during non-drought years. It would be useful to tailor information to the needs of specific groups (e.g., elementary and secondary education, small business, industry, homeowners, and utilities). The drought task force or participating agencies should consider developing presentations and educational materials for events such as a water awareness week, community observations of Earth Day, relevant trade shows, specialized workshops, and other gatherings that focus on natural resource stewardship or management.

Step 10: Evaluate and Revise Drought Plan

The final step in the planning process is to create a detailed set of procedures to ensure adequate plan evaluation. Periodic testing, evaluation, and updating of the drought plan are essential to keep the plan responsive to the needs of the state and its citizens. To maximize the effectiveness of the system, two modes of evaluation must be in place:

Ongoing Evaluation
An ongoing or operational evaluation keeps track of how societal changes such as new technology, new research, new laws, and changes in political leadership may affect drought risk and the operational aspects of the drought plan. Drought risk may be evaluated quite frequently while the overall drought plan may be evaluated less often. An evaluation under simulated drought conditions (i.e., drought exercise) is recommended before the drought plan is implemented and periodically thereafter. Drought planning is a process, not a discrete event.

Post-drought Evaluation
A post-drought evaluation or audit documents and analyzes the assessment and response actions of government, nongovernmental organizations, and others, and provides for a mechanism to implement recommendations for improving the system. Without post-drought evaluations, it is difficult to learn from past successes and mistakes, as institutional memory fades.

Post-drought evaluations should include an analysis of the climatic and environmental aspects of the drought; its economic and social consequences; the extent to which pre-drought planning was useful in mitigating impacts, in facilitating relief or assistance to stricken areas, and in post-recovery; and any other weaknesses or problems caused by or not covered by the plan. Attention must also be directed

to situations in which drought-coping mechanisms worked and where societies exhibited resilience; evaluations should not focus only on those situations in which coping mechanisms failed. Evaluations of previous responses to severe drought are also a good planning aid.

To ensure an unbiased appraisal, governments may wish to place the responsibility for evaluating drought and societal response to it in the hands of nongovernmental organizations such as universities and/or specialized research institutes.

Drought Policy

The development and implementation of a drought policy is intended to alter a nation's approach to drought management. Over the past decade, drought policy and preparedness has received increasing attention from governments, international and regional organizations, and nongovernmental organizations. 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 policy should be consistent and equitable for all regions, population groups, and economic sectors and consistent with the goals of sustainable development. The overriding principle of drought policy should be an emphasis on risk management through the application of preparedness and mitigation measures (Wilhite et al. 2005b). The policy must reflect regional differences in drought characteristics, vulnerability, and impacts. The goal of the policy is to reduce risk by developing better awareness and understanding of the drought hazard and the underlying causes of societal vulnerability. As stated previously, 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 programs, creating a safety net of emergency response programs that ensure timely and targeted relief, and providing an organizational structure that enhances coordination within and between levels of government and with stakeholders. As vulnerability to 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. Typically, when a natural hazard event and resultant disaster has occurred, 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) that could reduce future impacts and lessen the need for government intervention in the future. Because of this emphasis on crisis management, society has generally moved from one disaster to another with little, if any, reduction in risk. In addition, in drought-prone regions, another drought event is likely to occur before the region fully recovers from the last event.

Drought Policy Objectives

The objectives associated with a national drought policy will, of course, vary from nation to nation but, in principle, will likely reflect some common themes. These objectives would likely

- Encourage vulnerable economic sectors and population groups to adopt self-reliant measures that promote risk management;
- Promote sustainable use of the agricultural and natural resource base; and
- Facilitate early recovery from drought through actions consistent with national drought policy objectives.

In the United States, there has been considerable discussion of drought policy over the past decade, beginning with passage of the National Drought Policy Act of 1998 (Public Law 105-199). This bill

was introduced in Congress as a direct result of the 1996 drought and the initiatives referred to previously. This bill created the National Drought Policy Commission (NDPC) to "provide advice and recommendations on creation of an integrated, coordinated Federal policy designed to prepare for and respond to serious drought emergencies." The NDPC's report, submitted to Congress and the president in May 2000, recommended that the United States establish a national drought policy emphasizing preparedness (NDPC, 2000).The goals of this policy would be to

1. incorporate planning, implementation of plans and proactive mitigation measures, risk management, resource stewardship, environmental considerations, and public education as key elements of an effective national drought policy;
2. improve collaboration among scientists and managers to enhance observation networks, monitoring, prediction, information delivery, and applied research and to foster public understanding of and preparedness for drought;
3. develop and incorporate comprehensive insurance and financial strategies into drought preparedness plans;
4. maintain a safety net of emergency relief that emphasizes sound stewardship of natural resources and self-help; and
5. coordinate drought programs and resources effectively, efficiently, and in a customer-oriented manner.

The NDPC further recommended creation of a long-term, continuing National Drought Council composed of federal and nonfederal members to implement the recommendations of the NDPC. The NDPC further recommended that Congress designate the secretary of agriculture as the co-chair of the Council with a nonfederal co-chair to be elected by the nonfederal Council members. An interim National Drought Council was established by the secretary of agriculture following submission of the NDPC report, pending action on a permanent council by the U.S. Congress.

In July 2003, the National Drought Preparedness Act was introduced in the U.S. Congress. The purpose of this bill was "to improve national drought preparedness, mitigation, and response efforts" (National Drought Preparedness Act of 2003 [S. 1454]). The bill authorized creation of a National Drought Council within the Office of the Secretary of Agriculture. Membership on the council was to be composed of both federal and nonfederal persons. The Council would assist in coordinating drought preparedness activities between the federal government and state, local, and tribal governments. A National Office of Drought Preparedness was proposed within the U.S. Department of Agriculture to provide assistance to the Council. The Council was to be directed by the bill to develop a "comprehensive National Drought Policy Action Plan" that:

- delineates and integrates responsibilities for activities relating to drought (including drought preparedness, mitigation, research, risk management, training, and emergency relief) among federal agencies;
- ensures that those activities are coordinated with the activities of the states, local governments, Indian tribes, and neighboring countries;
- is integrated with drought management programs of the states, Indian tribes, local governments, watershed groups, and private entities; and
- avoids duplicating federal, state, tribal, local, watershed, and private drought preparedness and monitoring programs in existence.

Another area of emphasis of this bill is to improve the national integrated drought monitoring system by enhancing monitoring and climate and water supply forecasting efforts, funding specific research activities, and developing an effective drought information delivery system to improve the flow of information to decision makers at all levels of government and to the private sector. A bill to establish a National Integrated Drought Information System (NIDIS) was passed by the U.S. Congress in 2006 (Public law 109-430),and its implementation is continuing under the leadership of the National

Oceanic and Atmospheric Administration (NOAA) in collaboration with other federal partners, national and regional organizations, and states (http://drought.gov).

Summary and Conclusion

For the most part, previous responses to drought in all parts of the world have been reactive, representing the crisis management approach. This approach has been ineffective (i.e., assistance poorly targeted to specific impacts or population groups), poorly coordinated, and untimely; more importantly, it has done little to reduce the risks associated with drought. In fact, the economic, social, and environmental impacts of drought have increased significantly in recent decades. A similar trend exists for all natural hazards.

This paper presents an overview of drought planning and policy that can provide a model for nations to use to improve their level of preparedness for drought with the ultimate goal of reducing societal vulnerability to this pervasive natural hazard. A 10-step planning process is presented that has been used at all levels of government in the United States and in other countries to guide the development of a drought mitigation plan. The goal of this planning process is to change significantly the way we prepare for and respond to drought by placing greater emphasis on risk management and the adoption of appropriate mitigation actions. The 10 steps included in this process are considered generic in order to enable governments to choose those steps and components that are most applicable to their situation. The risk assessment methodology is designed to guide governments through the process of evaluating and prioritizing impacts and identifying mitigation actions and tools that can be used to reduce impacts for future drought episodes. Drought planning must be viewed as an ongoing process, continuously evaluating our changing vulnerabilities and how governments and stakeholders can work in partnership to lessen risk.

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Drought Information Systems: Improving International and National Linkages

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Abstract

Drought information systems have multiple sub-systems which include an integrated risk assessment, communication and decision support system of which early warning is a central component and output. There are numerous drought systems warning systems being implemented at different scales of governance from the international to the community. An early warning system is much more than a forecast-it is a linked risk information (including peoples' perception of risk) and communication system that actively engages communities involved in preparedness. The successes illustrate that effective early warning depends upon a multi-sectoral and interdisciplinary collaboration among all concerned actors at each stage in the warning process from monitoring to response and evaluation. However, the links between the community-based approach and the national and global EWSs are relatively weak. The paper identifies pathways for knowledge management and action at the relevant scales for decision-making.

Introduction

Drought has long been recognized as falling into the category of incremental but long-term and cumulative environmental changes, also termed slow-onset or creeping events. Similar issues include: soil degradation and desertification processes, ecosystems change and habitat fragmentation, nitrogen overloading, and coastal erosion, among others. Such creeping changes are often left unattended in their early stages since policymakers choose or need to cope with immediate crises. Eventually, neglected creeping changes may become urgent crises that are more costly to deal with since critical thresholds for reversibility have been exceeded (Glantz 2004). Early Warning Systems (EWS) in such contexts are needed not only for the event onset at which a threshold is exceeded, but also for intensification and duration ranging temporally from a single season to decades, and spatially from a few hundred to hundreds of thousands of square kilometers.

All dimensions of food, water, and natural capital security are affected by climate extremes and variability and are likely to be affected by climate change (IPCC, 2007). While climate change is commonly presented as a gradual shift in climatic trends, its impacts will be most strongly felt by resource insecure populations through changes in the distribution, nature and magnitude of extreme events as these affect crops, disease outbreaks, and soil and water quality.

The United Nations International Strategy for Disaster Reduction (UNISDR, 2006) notes that early warning information systems must be people-and placed centered, integrating four elements - (i) knowledge of the risks faced; (ii) technical monitoring and warning service; (iii) dissemination of meaningful warnings to those at risk; and (iv) public awareness and preparedness to act. The authors of the survey go on to argue that failure in any one of these elements can mean failure of the whole early warning system. Although recent drought-related disasters have contributed to a sense of urgency, drought has not received commensurate attention within natural hazards research as have the direct impacts of hurricanes and floods. Most countries, regions, and communities, currently manage drought risk through reactive, crisis-driven approaches (Wilhite et al. 2006).

In the following discussion a drought information system represents an integrated risk assessment, communication and decision support system of which early warning is a central component and output. In turn an early warning system much more than a forecast, it is a linked risk information and communication system that informs preparedness.

Drought Monitoring, Prediction, and Indicators

Drought is among the most damaging and least understood of all such hazards. Although some droughts last a single season and affect only small areas, the instrumental and paleoclimate record shows that droughts have sometimes continued for decades and have impacted millions of square kilometres in North America, West Africa, and East Asia. In 1991-1992, parts of Africa suffered the worst dry-spell of the twentieth century when drought covered a region of 6.7 million square kilometers and affected 24 million people. So memorable were the impacts of major drought events in regions such as the U.S. Great Plains, Sub-Saharan Africa, and the Nordeste in Brazil that they are embedded in literature and cultural memory. The combination of the above factors results in warning systems for drought being more complex than those for other hydrometeorological hazards and are, consequently, relatively less developed globally.

NOAA's National Weather Service (NWS) defines a drought as "a period of abnormally dry weather sufficiently prolonged for the lack of water to cause serious hydrologic imbalance in the affected area." Although all types of droughts (meteorological, hydrological, agricultural, and socio-economic) are initiated by an extended precipitation deficiency, it is insufficient solely to monitor this parameter to assess severity and resultant impacts. Effective drought monitoring systems integrate precipitation frequency and intensity and other climatic parameters with water information such as streamflow, snow pack, groundwater levels, reservoir and lake levels, and soil moisture into a comprehensive assessment of current and future drought and water supply conditions (Svoboda et al. 2002).

There have been significant scientific advances in the last two decades in climate prediction from 1 to 6 months in advance to help decision-makers reduce risks associated with climate variability (Pulwarty 2007). General Circulation Models (GCMs) and associated statistical ensemble methods are being routinely used to provide predictions of impending climate anomalies and offer promise for increasingly useful forecasts of the onset, severity and duration of drought for large geographic regions on monthly and seasonal timescales (Dai, 2010). Global aridity has increased substantially since the 1970s due to recent drying over Africa, southern Europe, East and South Asia, and eastern Australia. Although El Niño-Southern Oscillation (ENSO), tropical Atlantic SSTs, and Asian monsoons have played a large role in the recent drying, recent warming has increased atmospheric moisture demand and likely altered atmospheric circulation patterns, both contributing to drying.

Temperature and land surface feedback on drought intensification and how these affect components of the water budgets to estimate soil moisture (for agricultural drought monitoring), snowmelt runoff and discharge and groundwater-surface water interaction (for hydrological drought monitoring), and precipitation anomalies (for meteorological drought monitoring). These indicators are used to produce composite products based on other climate indices, numerical models and input of regional and local expert judgment. The classification schemes used for each indicator, and their relative limits and strengths are available from numerous sources (Heim, 2002; Dai, 2010). A comprehensive list of such indicators, such as the Standard Precipitation and Palmer Drought Severity Indices, is available on the NOAA (www.drought.gov) and NDMC (drought.unl.edu) webpages. Additional indicators may include the Palmer Crop Moisture Index, Keetch-Byram Drought Index, Fire Danger Index, and evaporation-related indicators such as relative humidity, temperature departures from normal, reservoir and lake levels, groundwater levels, surface soil moisture observations and snowpack. Some indicators are calculated at point locations and others at regional or climate divisions, drainage/hydrological basins, or other geographical units.

Change detection is critical in natural resources management (Ludwig et al. 1993). Due to the complex nature of droughts, a comprehensive and integrated approach that would consider numerous drought indicators is required for drought monitoring and early warning. Location-specific environmental changes (i.e. ecosystems changes, loss of biodiversity and habitats, land cover/land changes, coastal erosion, urban growth, etc.) become critical. Since 1972, Landsat satellite data have

been extensively used for environmental changes providing multiple, synoptic, global coverage of high-resolution having multi-spectral imagery allowing for change detection over time. Drought monitoring thus requires a comprehensive and integrated approach to determine the drought extent and impacts. Central to detection is the characterization, monitoring, and understanding of land cover and land use change, since they have a major impact on sustainable land use, as well as land-atmosphere interactions affecting regional climate change (IGOS-P, 2004).

We now turn to a summary assessment of existing drought information systems in which the above indicators are used. The list is not meant to be comprehensive but illustrative of major ongoing activities.

International and National Drought Early Warning Systems: A Brief Survey

Over 10 years ago, an expert group meeting sponsored by the World Meteorological Organization (WMO) and others, documented the status of drought EWSs in several countries, the shortcomings and needs of drought EWSs, and recommendations on how these systems can help in achieving a greater level of drought preparedness (Wilhite et al. 2000). Risk assessment for early warning and risk management requires indicators that are internationally agreed and locally referenced. The WMO provides global meteorological information, such as precipitation levels, cloudiness, and weather forecasts. The FAO's Global Information and Early Warning System on Food and Agriculture (GIEWS) and Humanitarian Early Warning Service (HEWS) by the World Food Programme (WFP) provide information on major droughts occurring globally. The FAO-GIEWS provides information on countries facing food insecurity through monthly briefing reports on crop and food prospects, including drought information, together with an interactive map of countries in crisis. Reports are not specifically focused on drought conditions and are released monthly or less frequently. The HEWS collects drought status information from several sources including FAO-GIEWS, WFP, and Famine Early Warning System (FEWS Net), and synthesizes this information into maps and supporting notes (from FAO-GIEWS) which is then provided, on a monthly basis, through the HEWS website (UNEP, 2006). On a regional scale, the FEWS Net for Eastern Africa, Afghanistan, and Central America reports on current famine conditions including droughts, by providing monthly bulletins that are accessible on the FEWS Net webpage. Other efforts such as the Benfield Hazard Research Center of the University College London) produce global maps of monthly precipitation deficits.

Efforts in drought early warning in continue in countries such as Brazil, China, Hungary, India, Nigeria, South Africa, and the United States. Regional drought monitoring activities exist or are also being developed in eastern and southern Africa and efforts in West Asia and North Africa. The Southeast Asia Drought Monitor developed by the International Water Management Institute (IWMI), covers western India, Afghanistan and Pakistan. There is in general heavy reliance on remote sensing data and as such there are long-standing needs to improve in situ information such as meteorological and agricultural data.

The European Commission Joint Research Center (EC-JRC) provides publicly available drought-relevant information through the following real-time online maps: daily soil moisture maps of Europe; daily soil moisture anomaly maps of Europe; and daily maps of the forecasted top soil moisture development in Europe (7-day trend).

Regional Climate Outlook Fora comprising national, regional and international experts review conditions and develop climate outlooks primarily based on ENSO forecasts and teleconnections (WMO RCOFS). As an ENSO conditions develop in a particular year, the WMO coordinates the development of a global scientific consensus, involving a collaborative process to review best available evidences and predictions. The outcome is the El Niño Update, a unified global statement on the expected evolution of ENSO for months ahead, which is issued to NMHSs and to the world at large.

Many countries have developed drought early warning systems capable of integrating information from various sources and providing warnings of the imminent onset of drought. In Africa, regional centers such as the IGAD Climate Prediction and Applications Centre (ICPAC) and the Drought Monitoring Centre (DMC) in Harare, supported by WMO and regional economic commissions and the Sahara and Sahelian Observatory provide current data, develop climate outlooks and issue warnings to NMHSs.

At the national level for China, the Beijing Climate Center (BCC) of the China Meteorological Administration (CMA) monitors drought development. Based on precipitation and soil moisture monitoring from an agricultural meteorological station network and remote-sensing-based monitoring from CMA's National Satellite Meteorological Center, a drought report and a map on current drought conditions are produced daily and made available on their website. In Vietnam, drought forecasting and early warning is the responsibility of the "Short-term and Long-term Drought Forecasting Department", within the National Institute of Hydro-meteorology. At the state level in India, the drought management system follows a uniform approach throughout the country, though few exceptions exist (Prabhakar and Shaw 2007). The states have established a drought early warning system, under the Weather Watch Group. The Karnataka state has established a special Drought Monitoring Center. The center monitors rainfall, water-reservoir levels and other relevant parameters on daily basis in the rainy season improving the capacity of states in terms of analyzing the weather information (Prabhakar and Shaw 2007).

In the United States the National Integrated Drought Information System (NIDIS) and the National Drought mitigation Center (NDMC) supports or conducts impacts assessment, forecast improvements, indicators and management triggers and the development of watershed scale information portals (web-based). In partnership with other agencies, tribes and states, the NIDIS teams coordinate and develop capacity to prototype and then implement regional drought early warning information systems using the information portals and other sources of local drought knowledge. The U.S. Drought Monitor, an innovative partnership among academia and Federal agencies (Svoboda et al. 2002), provides drought current conditions at the national and state level through an interactive map available on the website accompanied with a narrative on current drought impacts and a brief description of forecasts for the following week. It has a unique approach that integrates multiple drought indicators with field information and expert input, and provides information through a single easy-to-read map of current drought conditions and notes on drought forecast conditions across the nation. The U.S. Monitor and its offspring, the North American Drought Monitor, form a basis for NIDIS and other early warning systems (Svoboda et al. 2002).

Major parts of the world which face recurring severe droughts, still do not have comprehensive information and early warning systems in place (such as in western and southern Africa, eastern China, parts of India, South America, and the Mediterranean Basin, among others).

Some innovative approaches to creating integrated indicators from available climate and socio-economic datasets are being undertaken. Global patterns and impacts of droughts through the mapping of several drought-related characteristics – either at a country level or at regular grid scales. The maps are produced by integrating a number of publicly available global datasets (Eriyagam et al. 2009). Other relevant mapping projects are carried out primarily by a few international organizations/ projects, although they are not normally focusing on droughts per se. UNEP's World Atlas of Desertification shows the global extent and severity of desertification (Middleton 1997; UNEP1992).

In some areas, farmers have identified local language radio programs as credible and accessible mechanisms to deliver forecasts if they occur with follow up meetings with extension agents or other intermediaries (Pulwarty 2007). This latter point of following-up is non-trivial. Traditional forecasting remains an important source of climate information in many rural communities. There is growing

appreciation that traditional observations and outlook methods may have scientific validity and increased interest in harmonizing traditional and modern scientific methods of climate prediction. Studies have been initiated in some countries, such as Zimbabwe and Kenya, to gain further understanding of traditional forecasting.

For most locations early warning is still treated as a linear process. There are multiple factors that limit current drought EWS capabilities and the application of data in drought preparedness, mitigation, and response globally (Wilhite et al. 2000). These include: inadequate density and data quality of meteorological and hydrological data and the lack of data networks on all major climate and water supply parameters; data sharing – inadequate data sharing between government agencies and the high cost of data limits, inadequate indices for detecting the early onset and end of drought although the Standardized Precipitation Index (SPI) has been cited as an important monitoring tool. Other issues of concern, the lack of specificity of information provided by forecasts, especially during non-ENSO years, limit the use of this information by farmers and others, and the fact that early warning system data and information products are often not user accessible and users are often not trained in the application of this information to decision making (Pulwarty 2007).

Reframing Early Warning: From Forecasts to Information Systems in Support of Adaptation

Adaptive actions are adjustments in assets, livelihoods, behaviors, technologies, and polices that address ongoing and future climates variability and change (IPCC 2011). Drought information systems are an important tool in a government's and community's portfolio to achieve adaptation as an output of sustainable practices. Drought early warning triggers multiple other warnings systems (such as for water resources, wildfire, etc) in a cascade of "early warnings" (Glantz 2004). The above examples illustrate that effective early warning depends upon a multi-sectoral and interdisciplinary collaboration among all concerned actors at each stage in the warning process from monitoring to responding (Glantz 2004; Pulwarty and Verdin 2011). However, the links between the community-based approach and the national and global EWSs are relatively weak (Birkmann et al. 2011, Pulwarty and Verdin 2011). Monnik (2000) noted, some years, ago that the main constraints on implementation include:

- Lack of a national and regional drought policy framework,
- Lack of coordination between institutions that provide different types of drought early warning, and the
- Lack of social indicators to form part of a comprehensive early warning system

Some reasons for this situation include the complexity of decision making processes; the diversity of responses across regions; monitoring gaps and uncertainty about climate changes at local scales, time lags in implementation; and economic, institutional and cultural barriers to change. The experience of NIDIS, FEWSNet and other information systems illustrate that early warning represents a proactive political process whereby networks of organizations conduct collaborative analyses. In this context, indicators help to identify when and where policy interventions are most needed and historical and institutional analyses help to identify the processes and entry points that need to be understood if vulnerability is to be reduced. Taking local knowledge and practices into account promotes mutual trust, acceptability, common understanding, and the community's sense of ownership and self-confidence (Dekens). As important as indicators are to such systems, it is the governance context in which EWSs are embedded that needs further attention, since, particularly for people-centered strategies at the so-called Last Mile, a mix of centralized and decentralized activities is required.

There is a critical need to approach early warning through an integrative approach by linking Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) (UNISDR, 2011; IPCC, 2011). This also requires an integrated risk approach, which translates climate change scenarios further, into risk,

and vulnerability profiles that can serve as a basis to inform early warning systems and their set-up. The cases above, and other efforts, have demonstrated that social protection and early warning information interventions can provide disaster risk reduction while helping to meet the goals of adaptation to changes in extreme events. From a research and monitoring perspective efforts aimed at integrating social protection and early warning within international and national drought information system should:

- Strengthen the scientific and data foundations to support early warning for drought onset, severity, persistence and frequency
- Develop risk and vulnerability profiles of drought-prone regions and locales including impact of climate change adaptation interventions on food and water availability, access, and use
- Develop Indicators and methodologies to assess the value of environmental services, value and costs of environmental degradation, and impacts of water and crop subsidies.
- Better understand whether and how best to use probabilistic information with scenarios of potential surprise and cumulative risks at each scale
- Place multiple indicators within a statistically consistent triggering framework-cross-correlation among units before a critical threshold
- Frame the goals and objectives of international and country program intervention strategy
- Inventory and map local resource capabilities (infrastructure, personnel, and government/donor/NGO-supported services) available to complement food program operations
- Map decision-making processes and identify policies and practices that impeded or enable the he flow of information among information system components

Traditional assumptions are that effective functioning of early warning systems requires, firstly, prior knowledge of risks faced by communities and other users of the early warning information; secondly, a technical monitoring and warning service for these risks; thirdly, an effective strategy for dissemination of understandable warnings to those at risk; and finally, knowledge and preparedness to act (Traore and Rogers 2006). Two additional elements are now introduced: awareness that risks are changing (and which new risks may arise) and, especially, a way to communicate new knowledge about future conditions that can be understood and trusted (IFRC 2009; Pulwarty and Verdin 2011). As Dekens observes, this requires a long-term dialogue with communities and local institutions that may not immediately trust outside information about one of the few things they consider themselves experts on- what to expect from the local weather and climate.

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The Global Drought Monitor Portal

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Abstract

Drought monitoring, assessment, response, mitigation, adaptation, and early warning systems have been created in a number of countries around the world, and some regional and continental efforts have been successful. However, the creation of a Global Drought Early Warning System (GDEWS) remains elusive. A GDEWS incorporates forecasting and research improvements, in addition to monitoring, impact, planning, mitigation and adaptation and recovery information. At a series of workshops in 2010, the U.S. National Integrated Drought Information System (NIDIS) agreed to take the first step toward a GDEWS, the formation of a Global Drought Monitoring Portal (GDMP). This effort currently covers three continents – North America, Europe, and Africa – and provides global drought indicator information through satellite products and Global Historical Climate Network locations. The GDMP has benefited from coordination with the World Meteorological Organization (WMO) and Group on Earth Observations (GEO). Other nations have expressed interest in contributing and new regional and continental information should be online shortly. This paper presents the capabilities of the GDMP to link the monitoring, forecasting, research, and impacts aspects of international drought as well as the advantages of using common architecture through GEO to facilitate transfer and interoperability of GDEWS-related information.

Introduction

Drought has had a significant impact on civilization throughout history. Every continent has semi-arid areas which are especially vulnerable to drought. In North America and Europe today, drought impacts are largely economic. But in most of the rest of the world, drought-induced crop failure and famine can create severe hardship. In a globally-warmed world, drought-affected areas will likely increase in extent and the vulnerability of semi-arid regions to drought will also likely increase. The IPCC (2007) specifically noted that annual average river runoff and water availability were projected to decrease by 10-30% over some dry regions at mid-latitudes and in semi-arid low latitudes, and increases in the frequency of droughts and floods were projected to affect local crop production negatively, especially in subsistence sectors at low latitudes, as well as reduce water availability for hydropower potential and summer tourism.

As noted by the IPCC (2007), some countries have made efforts to adapt to the recent and projected changing climate conditions, particularly through conservation of key ecosystems, early warning systems, risk management in agriculture, strategies for flood drought and coastal managements, and disease surveillance systems. Local, national, and regional collaborative drought monitoring efforts have been summarized at several venues, including World Meteorological Organization (WMO)-sponsored gatherings of experts in Lisbon, Portugal in 2000 (Wilhite et al. 2000) and Lincoln, Nebraska, USA in 2009. However, the effectiveness of these efforts is outweighed by: lack of basic information, observation and monitoring systems; lack of capacity building and appropriate political, institutional and technological frameworks; low income; and settlements in vulnerable areas, among others (IPCC 2007). These shortcomings have inhibited the development of an integrated global drought early warning system (GDEWS) (Wilhite 2005).

In 1992, an International Conference on Climate, Sustainability and Development in Semi-arid Regions (ICID-I) focused the world's attention on the plight of drylands peoples and was influential in the negotiation of the United Nations (UN) Convention to Combat Desertification (UNCCD). With 193 country Parties to the Convention, the UNCCD is a global mechanism to combat desertification and

mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements. The Second International Conference on Climate, Sustainability and Development in Semi-arid Regions (ICID 2010) seeks to build upon this work to help turn agreements into local development outcomes.

For many decades, attempts to manage drought and its impacts through a *reactive*, crisis management approach have proven to be ineffective, poorly coordinated, and untimely (Wilhite et al. 2005). In the United States, the National Integrated Drought Information System (NIDIS) was established by the NIDIS Act in 2006 as a *proactive* mechanism to:

- develop the leadership and networks to implement an integrated drought monitoring and forecasting system at federal, state, and local levels;
- foster and support a research environment focusing on risk assessment, forecasting, and management;
- create an "early warning system" for drought to provide accurate, timely, and integrated information;
- develop interactive systems, such as the Web Portal, as part of the early warning system; and
- provide a framework for public awareness and education about droughts (NPIT 2007).

The U.S. Drought Monitor is the primary drought monitoring tool utilized within the NIDIS US Drought Portal. The geographical scope of the NIDIS drought portal is being expanded with data and web services capabilities to support drought monitoring across North America, with the North American Drought Monitor (NADM) as the centerpiece.

At the Fourth Plenary Session and Ministerial Summit of the Group on Earth Observations (GEO) held in Cape Town, South Africa, in November 2007, representatives from more than 70 nations reaffirmed their commitments to working together, at both the political and technical levels, to improve the interoperability of observations, predictions and information systems as a part of the Global Earth Observation System of Systems (GEOSS). Recognizing the growing problem of drought and its impact on long-term sustainability of Earth's water resources, the event concluded with a U.S. proposal that technical representatives from participating countries were going to build upon existing programs to work toward establishing a GDEWS within the coming decade to provide: a system of infrastructures for data and information sharing, communication, and capacity building to take on the growing worldwide threat of drought; and regular drought warning assessments issued immediately with increased frequency during a crisis.

In April 2010, a Global Drought Assessment Workshop was held in Asheville, North Carolina, USA to move the coordinated global drought monitoring efforts of the WMO and GEO forward. Noting that the robust services of the NIDIS drought portal could serve as the foundation for an even broader international drought information system, the portal managers agreed to develop a prototype Global Drought Monitoring Portal (GDMP) to serve international drought information. The infrastructure has been created (http://www.drought.gov/portal/server.pt/community/global_drought), and the GDMP is currently being populated with drought information from around the world and will serve as an example of an Integrated Drought Information System at the global level and as a foundation component in a GDEWS.

The GDMP is available to all parties who have an interest and stake in drought monitoring, forecasting, impacts, mitigation, research, and education. It can provide crucial support for drought monitoring and mitigation, especially in semi-arid regions, thus enhancing climate monitoring, sustainability, and development in semi-arid regions. See section 3 for more details.

Drought Monitoring in North America

Because of the wide variety of sectors affected by drought, its diverse geographical and temporal distribution, and the demand placed on water supply by human-use systems make it difficult to develop a single definition of drought. As a result, numerous indices have been developed during the last hundred years to measure the intensity, impact, and geographic extent of drought (Heim 2002). At the end of the 20th century, a new drought monitoring tool – the Drought Monitor (USDM) – was developed for the United States. Similar national Drought Monitors were developed in Canada and Mexico during the early years of the 21st century. Collaboration between these three countries has resulted in the North American Drought Monitor (NADM), a monthly product which assesses current drought conditions on a continent-wide basis.

U.S. Drought Monitor

The USDM (http://drought.unl.edu/dm/monitor.html) was developed in 1999 in a federal/state collaborative effort to consolidate and centralize drought monitoring activities. Agencies within the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Agriculture (USDA) team with the National Drought Mitigation Center (NDMC) and NOAA Western Regional Climate Center (WRCC) to produce a weekly map (see Fig. 1) and narrative product that incorporates climatic data and professional input from all levels (Svoboda et al 2002). Since no single definition of drought works in all circumstances, the USDM authors rely on the analyses of several key indices and ancillary indicators, including impacts information, from different agencies to create the final map. Some of these ancillary indicators are available in a delayed mode or only on a local/regional basis. The key parameters are objectively scaled to five percentile-based USDM drought categories – D1 (moderate drought) to D4 (exceptional drought event, likened to a drought of record), plus a "pre-drought" or "recovering drought" category D0 (abnormally dry area) – and labels are used to indicate which sectors are being impacted by drought (A for agricultural impacts, H for hydrological impacts). The USDM maps are based on many objective inputs, but the final maps are adjusted manually to reflect real-world conditions as reported by numerous experts throughout the country. Consequently, the USDM is a consensus product reflecting the collective best judgment of many experts based on several indicators.

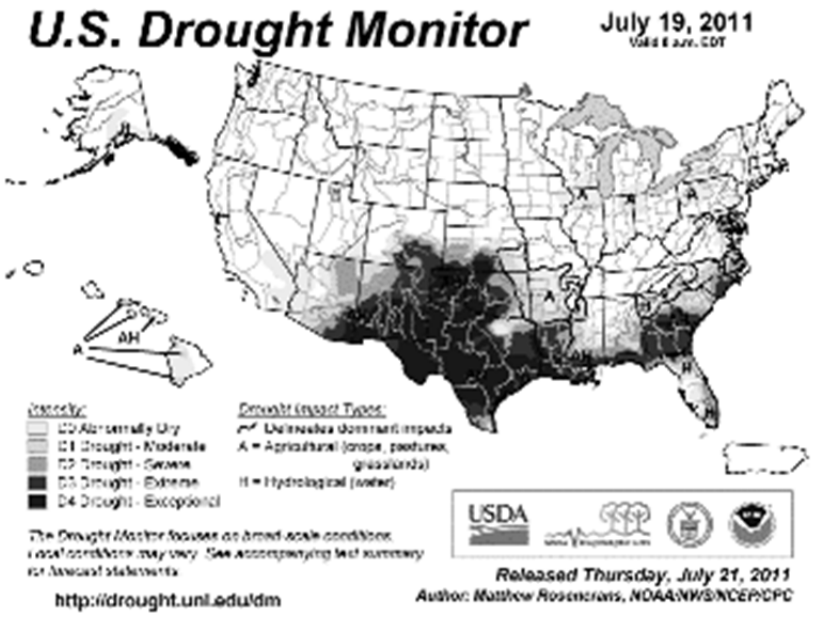

Figure 1. U.S. Drought Monitor Depiction from July 19, 2011.

North American Drought Monitor (NADM)

In a late 2001 meeting, U.S., Canadian, and Mexican representatives agreed in principle to establish a climate extremes monitoring partnership and that the first step would be to develop monthly continental drought monitoring capabilities. The result was the creation of the NADM (http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/), which is an extension of the USDM concept to the continental scale. While the USDM is a weekly product, the NADM is a monthly map and narrative product which is constructed by integrating the national drought depictions from the three countries into a continental depiction (see Fig. 2). The national depictions are each prepared by experts within the three countries independently from each other (Agriculture and Agri-Food Canada [AAFC] prepares the Canadian depiction, the National Meteorological Service [SMN] prepares the Mexican depiction, and the USDM for the week closest to the end of the month is used for the U.S.). This can result in discontinuities in drought depiction along the international borders. Drought indices covering the entire continent are needed to provide guidance for adjusting the border depictions. These continental indicators (Standardized Precipitation Index, Palmer indices, and percent of normal precipitation) are computed using the same methodologies and same analysis period for consistency. Other continental and global indicators (such as modeled soil moisture and the satellite-based Vegetation Health Index) are also used.

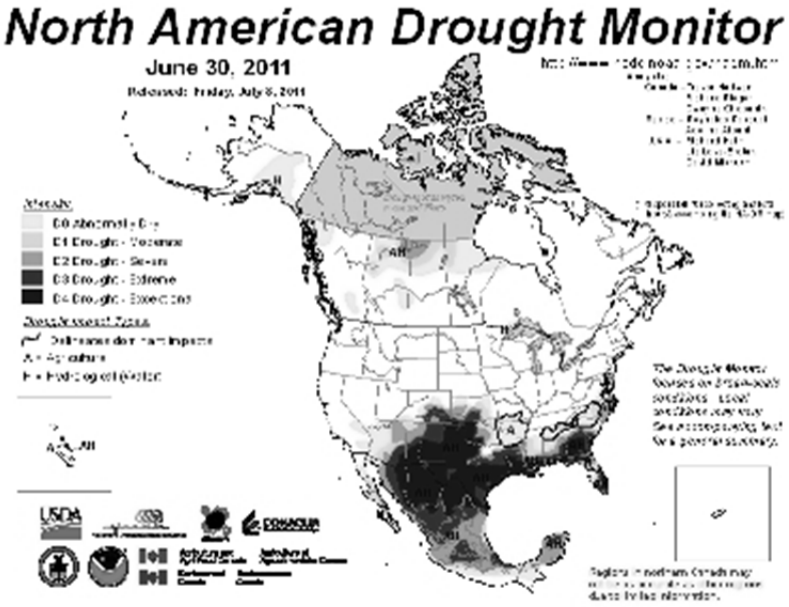

Figure 2. North American Drought Monitor Depiction from October 2010.

National Integrated Drought Information System (NIDIS) as a U.S. Drought Portal

The passage of the NIDIS Act Public Law in December 2006 resulted in the establishment of NIDIS (http://www.drought.gov/), which was created to enable the U.S. to move from a reactive to a more proactive approach to managing drought risks and impacts, resulting in better informed and more timely drought-related decisions leading to reduced impacts and costs. The five components of NIDIS include: 1) NIDIS Program Office, 2) U.S. drought portal, 3) climate/drought test beds which prototype the integration of data and forecasts, 4) integrated applications research into coping with drought, and 5) development of early warning information systems at the local level to demonstrate workable

design and prototyping approaches and methods which could be utilized in the implementation of regional then national drought early warning systems. A critical component of NIDIS is the drought portal (see Fig. 3), which serves as a web services-based internet hub for drought information related to current conditions, forecasts, impacts, planning, education, research, and recovery. The geographic scope of the NIDIS portal is being expanded with data and web services capabilities to support the NADM.

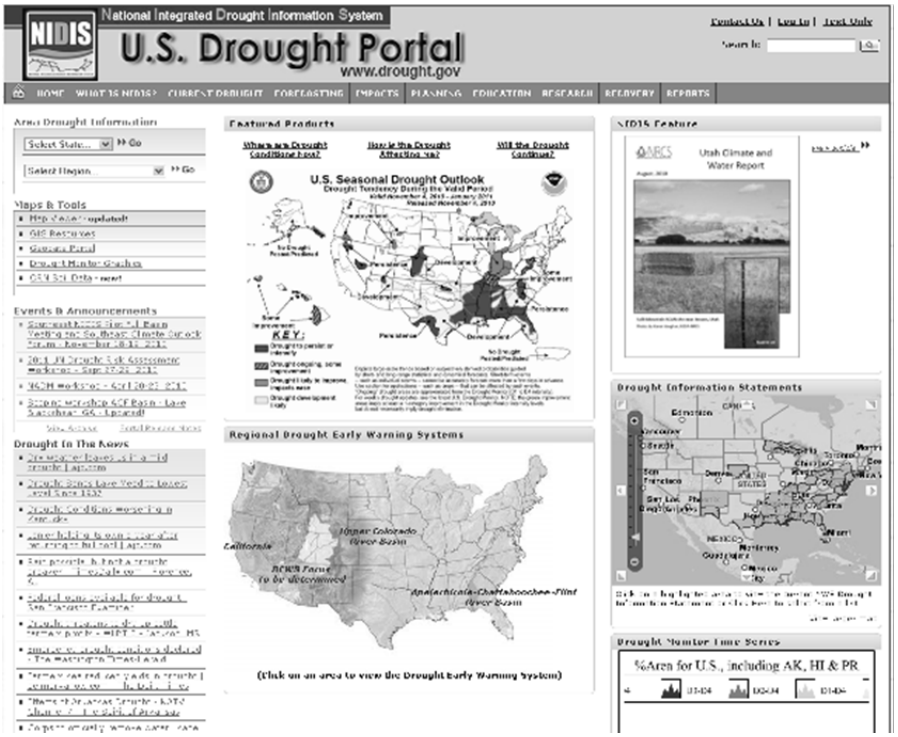

Figure 3. The NIDIS U.S. Drought Portal

Creating a Global Drought Monitoring Portal

It has long been recognized that a global-scale drought monitoring, mitigation, and response system would provide important benefits to all Nations affected by drought, especially to those people in semi-arid regions. As noted at the 2000 and 2009 drought workshops in Lisbon and Lincoln, respectively, national DEWSs have been created in many areas, including the U.S. (USDM and NIDIS), Australia, Brazil, Canada, China, Hungary, India, Mexico, Nigeria, the Philippines, Romania, and South Africa, and regional drought monitoring centers or activities have been established in North America (NADM), Europe (European Drought Observatory), southeastern Europe, eastern, western, and southern Africa, North Africa, West and Central Asia, and the Caribbean. Many of these efforts have come to fruition through work associated with the UNCCD. However, the creation and maintenance of national and regional DEWSs in other areas, as well as the creation and maintenance of a global DEWS, face many hurdles, including: inadequate data networks (station density and data quality), inadequate data sharing (both between government agencies and due to the high cost of data), data and information products that are too complex to use by decision-makers, unreliable seasonal forecasts, inadequate indices for detecting the early onset and end of drought, the lack of integrated physical and socioeconomic indicators for drought, the lack of impact assessment methodology, data and information frequently unavailable on an operational real-time basis, and inadequate comprehensive global historical data base and assessment products (Wilhite et al. 2000; Wilhite & Buchanan-Smith 2005). An additional hurdle is the lack of resources to address these issues. With these limitations in

mind, NOAA and its partners organized the Global Drought Assessment Workshop in Asheville, North Carolina, USA in April 2010 to pick up on the previous work toward GDEWS and determine next steps that are possible without new resources.

The April 2010 Global Drought Assessment Workshop

The Global Drought Assessment Workshop was part of a series of drought workshops held in Asheville during the week of 20-23 April 2010. The other workshops included the biennial NADM Forum and the U.S.-Canadian GEO Bi-lateral Technical Workshop. The NADM Forum addressed scientific, technical, administrative, and user issues associated with the NADM, while the U.S.-Canadian GEO Bi-lateral Technical Workshop's goals included reporting on the status and progress of each of the three test beds and two drought studies and developing guidelines for the test beds and studies. Many of the NADM Forum attendees were also involved in the GEO bi-lateral studies and had an interest in global drought monitoring, so the biennial NADM Forum provided an excellent opportunity for coordinated gatherings of these groups. Organizational assistance for the workshops was provided by NOAA, NIDIS, USDA, WMO, NDMC, USGEO, CGEO, the GEO Secretariat, AAFC, and SMN.

It was quickly recognized at the global workshop that no single Nation or organization can afford to tackle all of the hurdles involved in creating a GDEWS in their entirety. However, it was believed that small pieces of the problem could be solved in an incremental way. If an international drought Clearinghouse and web services infrastructure could be established – a global web portal "foundation" could be laid – then it might be easier to construct the GDEWS "building" atop it. A series of breakout groups addressed two components of this problem: *what pieces are necessary for a global Clearinghouse of drought information*, and *how should such a Clearinghouse be housed, portrayed, and distributed*.

The breakout groups concluded that the pieces of a Clearinghouse should include drought indices that can be computed on a continental to global scale and that drought impacts information should be included globally, if available. It was suggested that categories of indices be identified instead of specific indices (i.e., some evapotranspiration-based index, some soil moisture index, and modeled indices as well as satellite-based vegetation indices). Remotely-sensed data should be used in conjunction with *in situ* data, especially in parts of the world where *in situ* data are difficult to obtain. An effort at continental-scale analyses and coordination (the NADM model) should be made where feasible, but the approach should be tailored to the needs and resources of each continent (i.e., the NADM model may not be applicable to other continents). The WMO was suggested as a mechanism or a liaison with the countries/continents to determine what their alternatives are, or for integrating their alternatives into the Clearinghouse. While the initial focus of the Clearinghouse may be limited to just drought monitoring, it should expand to also include impacts, mitigation, forecasts, research, education, and planning (like NIDIS).

It was recognized that neither the WMO nor GEO has the resources to house, portray, and distribute such a Clearinghouse. The NIDIS drought portal managers noted that the NIDIS portal was developed to support drought monitoring, forecasting, research, and impacts assessment in the U.S., but new web mapping services have been developed to distribute the information that Canada, Mexico, and the U.S. integrate to aid in the production of the NADM (see Fig. 4). These new web services will be housed in the U.S. Drought Portal in a North American-specific site. These new tools will allow additional accuracy in the development of the NADM by allowing overlaying of information as well as increase the utility of the data by providing it in more accessible and useful formats. With minimal additional effort, a prototype Global Drought Monitoring Portal (GDMP) could be developed as an outgrowth of the NIDIS portal modifications (see Fig. 4). The GDMP will provide a number of different depictions of drought on the global-scale, developed using data from WMO World Data Centers. Products will include several drought indices, such as the Standardized Precipitation Index

(SPI) at various time-scales and possibly precipitation, Palmer drought indices, and satellite-based Vegetation Health depictions. The GDMP will also serve as a launching point for continental-scale drought depictions where not only an international assessment such as the NADM could reside, but also drought indicators used to develop the assessment.

Figure 4. Interoperability of Drought Web Services from the NADM, the European Drought Observatory, and Princeton Prototyped within the U.S. Drought Portal Environment.

A Vision for a Global Drought Early Warning System / Global Drought Monitor

With the creation of a GDMP "foundation" upon which to build a GDEWS or Global Drought Monitor (GDM), how would such a GDEWS/GDM look? How would it function? It is felt that to be accepted and used by nations around the world, they would have to have ownership. Therefore, the best approach would be a collaborative process whereby national or regional Drought Monitor products are prepared by the participating nations, integrated on a regional basis into regional and global products, and distributed via the GDMP. In this collaborative scenario (see Fig. 5), the national Drought Monitors (DMs) would be prepared by each nation according to processes established within the nation and using national datasets. Regional or continental DMs could be prepared following the NADM model or using a model uniquely adapted to the requirements and resources of each region or continent. The regional/continental DMs (or national DMs for regions/continents that don't have their own DM) are integrated into the GDMP for global display. The GDMP resources would be available to the Nations and regions/continents for preparation of their DMs. This process would require the establishment of certain standards for the depiction of drought on each DM (using a D0-D4 scale similar to the NADM), creation of DM shape files in a GIS environment, and smoothing of GDMP drought depictions along international borders.

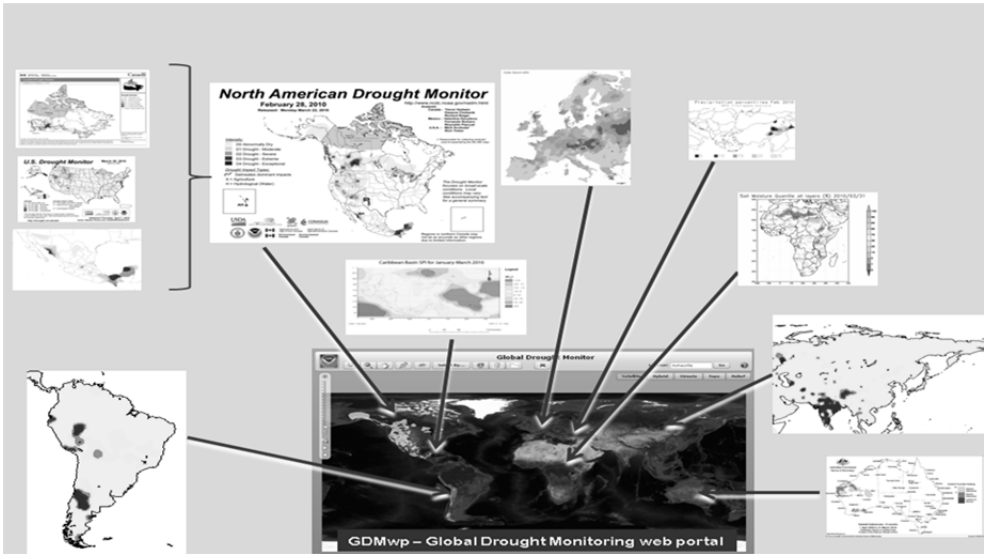

Figure 5.A Conceptual Framework for Service Integration into a Global Drought Monitoring Portal.

Implementation

The NIDIS program in the U.S. established a prototype GDMP by leveraging existing technology and lessons learned from establishing the U.S. National Integrated Drought Information System (NIDIS) architecture. In doing so, a number of questions were identified, along with simple solutions. The current GDMP includes four sections. The first is an abbreviated monthly drought assessment along with a series of global products. These high-level products represent some of the best quality drought and climate information available and provide a broad-brush look at global drought conditions and are presented as plain text and static images to encourage use in limited bandwidth areas. Because they use common base periods, they are appropriate for comparing drought status between locations around the earth but do not necessarily represent the severity of a drought at an individual location, compared to its full period of record. To do that, one must use the third tab of the GDMP Web page described below.

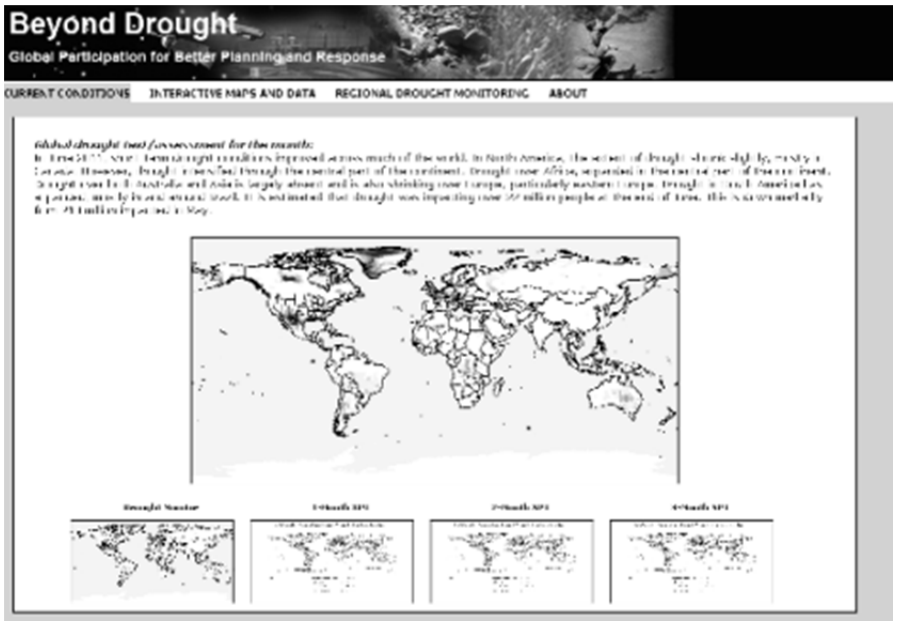

Figure 6.Section 1 of the GDMP with a Global Drought Assessment and a Limited Number of Global Products.

The second tab of the GDMP webpage includes an interactive map and data viewer (see figure 4). For locations with higher bandwidth, Open Geospatial Consortium compliant Web Mapping Services (WMS) are available and are the mechanism by which regions provide their information to the GDMP. This allows the availability of a larger suite of tools since production and maintenance is distributed, and also allows users to get more detailed local information. Through an interactive map viewer, users can zoom all the way to individual stations to get a detailed look at the drought in a specific location. Currently, North America, Europe, and Africa are providing WMS services to "paint" a global drought picture. Australia should be available soon and South America, through Argentina and Brazil, are discussing available ways to contribute. Other countries in the Middle East and Asia have expressed interest in contributing but have not yet committed to the process.

The third tab of the GDMP Web page houses a capability for users to drill down from the global to the regional scale in order to get a more robust suite of drought products and services than could be efficiently handled through a global interface. These regional sites, such as the North American Drought Monitor Website and the European Drought Observatory provide access to more tools and data than are available at the global level and further allow users to pass to individual nation drought monitoring activities, such as the U.S. Drought portal, for even more specificity, since it is recognized that drought is dominantly a local phenomenon. Further "drill-down" to states or watersheds can then be provided, should the nation decide it is beneficial. By using this nested architecture, decision makers at all levels can get access to the drought information they need seamlessly and efficiently.

The fourth tab of the GDMP Web page provides general information that includes details about those that participate and will also include help and details about contributing, when it is completed.

Opportunities for Drought Monitoring In Under-Served Areas

Limited scientific and technical resources frequently inhibit climate monitoring, sustainability, and development in semi-arid regions. Mechanisms such as the UNCCD help peoples in these areas to combat desertification and mitigate the effects of drought. The creation of a GDMP will be a new tool which could provide crucial support for drought monitoring and mitigation in semi-arid regions and other parts of the world. The GDMP will be available to provide important drought information to participating Nations, as well as serve as an infrastructure which could be populated with drought information originating from Nations in semi-arid regions. It will be available to all parties who have an interest and stake in drought monitoring, forecasting, impacts, mitigation, research, and education. The GDMP could provide crucial support for drought monitoring and mitigation, especially in semi-arid regions, thus enhancing climate monitoring, sustainability, and development in semi-arid regions.

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Managing the Planet as a Biophysical System

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With atmospheric concentrations of carbon dioxide approaching 400 ppm, the global climate is about 0.8 degrees C warmer than in pre-industrial times, and of course will continue to warm, even if the CO2 concentrations cease to rise. Beyond the physical changes in the cryosphere and sea level rise, it is already clear that the biology of the planet is responding to the current warming. Plants and animals are adjusting their annual cycles (e.g., earlier blooming and nesting times) and species are beginning to change wherever they occur. For example, Joshua Trees are moving out of Joshua Tree National Park in the American West. Some species are shifting higher in altitude in the Monteverde region of Costa Rica where the cloud forest is experiencing an increasing number of dry days every year. Changes in geographical distribution are being noted for marine plankton and fish species.

Those are relatively minor ripples in the fabric of life but we are already seeing greater changes. Tropical coral reefs respond to thermal stress by the coral animal expelling the algal partner leading to bleaching events (first observed in 1983) with consequent crashes in productivity, diversity, and human benefit. On land in western North America, longer dryer summers and milder winters have tipped the balance in favor of native bark beetles such that most of the coniferous trees are dead. These two are examples of abrupt change and can be considered a form of ecosystem failure.

In the Amazon recent modeling of the combined effects of climate change, deforestation, and fire suggest a tipping point at around 20 percent of deforestation to Amazon dieback in which savannah vegetation would replace the tropical rain forest. Ominously, the greatest recorded drought in Amazon history occurred in 2005, only to be exceeded the great drought in 2010 – essentially a preview of Amazon dieback. Fortunately the margin of safety can be built back through some proactive reforestation.

The oceans have absorbed a lot of the CO2 from emissions and elevated concentrations, but some of the CO2 has become carbonic acid. The oceans today at pH 8.1 are 0.1 more acid than in pre-industrial times (pH 8.2) – a major change since the scale is logarithmic. This has serious implications for the tens of thousands of marine species that depend on the carbonate equilibrium to build shells and skeletons. The colder and more acid the water the harder it is for marine organisms to mobilize calcium carbonate. And some of those organisms are at the base of food chains like pteropods in the northern oceans where effects are already being observed.

All of the above clearly suggest that the 450 ppm or 2.0 degree limit being discussed in international negotiations are too high for ecosystems and that in fact we need to limit climate change and bring CO2 concentrations down to something on the order of 350 ppm and an associated 1.5 degree warming over pre-industrial time. And yet it is clear that to stop at 2.0 degrees, emissions have to peak in 2016.

Clearly we need to find ways to pull CO2 out of the atmosphere and lower greenhouse gas concentrations. Biology provides one easy way to do it. Indeed, twice in the history of life on Earth very high CO2 levels have been brought down to pre-industrial levels: the first was with the appearance of plants on land, and the second was the appearance of modern flowering plants--that are much more efficient at turning CO2 into living matter.

At the moment, roughly half of the excess atmospheric carbon dioxide comes from the destruction and degradation of ecosystems over the past 3 centuries. Over the next 50 years it is possible to both meet the needs of an even larger human population and remove about 50 ppm from the atmosphere –

the difference between the 400 ppm of the moment and the safer 350 ppm target – by ecosystem restoration at a planetary scale.

This would involve sequestering about half a billion tons of carbon as CO2 per year through reforestation and better forest management, a second half billion per year through restoration of degraded grasslands and pasture lands, and a third half billion by managing agro-ecosystems so they sequester carbon rather than release it from the soil. The potential of soil carbon may be even greater than that. There is also the possibility of sequestering carbon in coastal and marine habitats. Given continuing emissions, that is not enough, of course, so non-biological means to sequester carbon from the atmosphere by transformation into something relatively inert is extremely important. Nonetheless the potential through ecosystem restoration at a planetary scale is quite significant. Further, it is something that can be done almost immediately and often has attendant benefits such as better grazing or increased soil fertility. It essentially recognizes the planet as the biophysical system that it is and using the living planet to make the planet more habitable.

PROPOSED ELEMENTS IN

THE COMPENDIUM ON

NATIONAL DROUGHT POLICY

Proposed Elements in the Compendium on National Drought Policy

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Abstract

Crisis management has typically characterized governmental response to drought. This approach has been ineffective, leading to untimely and poorly coordinated responses. The growing frequency and magnitude of droughts in many parts of the world call for the development of a pro-active, risk-based approach, the tenets of which are outlined in a national drought policy. Improved management of drought requires completion of a vulnerability assessment at the outset to determine those sectors, regions, and population groups most at risk to severe drought. Each country is unique in its vulnerability and institutional capacity to prepare for and respond to drought. Since the national drought policy for any given country will depend very much on the local circumstances and priorities, it is imperative that the guidance provided on the development of a national drought policy not be prescriptive to any government. Instead, we propose to develop a compendium of the desirable elements in a national drought policy from which countries could adopt those elements that will be appropriate to their local circumstances and national priorities. This paper describes some of those elements that could be included in the compendium on national drought policy under three main categories: Drought Monitoring and Early Warning Systems; Vulnerability Assessment and Impacts and Emergency Relief and Response.

Introduction

Drought is recognized universally as the major natural hazard that carries multiple impacts on a wide range of economic, social, and environmental sectors, especially agriculture. Subsistence farmers in many developing countries are most vulnerable to the impacts of droughts. An efficient and effective policy approach to drought risk management is critical to the livelihoods of millions of people vulnerable to droughts. Improving drought management will require a more proactive approach that addresses the unique risks associated with drought in each country.

Despite the repeated occurrences of droughts throughout human history and the significant impacts on different socio-economic sectors, no concerted efforts have ever been made to initiate a dialogue on the formulation and adoption of national drought policies. The time is ripe for nations to move forward with the development of a pro-active, risk-based national drought policy.

There is no optimum set of drought risk management strategies that fit all countries. There are different layers of risks which require differentiated responses. Since a national drought policy for any given country will depend on local capacity and priorities, it is important that the guidance on national drought policy to any government should not be prescriptive. Instead, as explained by Sivakumar (2011), a compendium of desirable elements in a national drought policy (*hereinafter referred to as compendium*) should be compiled and countries around the world could be encouraged to adopt the elements that will be appropriate to their local circumstances and national priorities and design their national drought policies.

Hence, an Expert Meeting on the Preparation of a Compendium on National Drought Policy was held at the George Mason University in Fairfax, Virginia (USA), from 14 to 15 July 2011, the issue of the

desirable elements in the Compendium was discussed and three break-out groups were established to begin the process of defining the key elements of national drought policy under the three areas:

1) Drought Monitoring and Early Warning Systems
2) Vulnerability Assessment and Impacts
3) Emergency Relief and Response

Proposed elements for inclusion in the Compendium by the three break-out groups are described below.

Drought Monitoring and Early Warning Systems

1) Evaluate the availability of comprehensive, integrated drought monitoring systems which couple multiple climate, water and soil parameters and socio-economic indicators to fully characterize the magnitude, spatial extent and potential impacts of droughts.

    a) Establish and support a comprehensive integrated drought monitoring system at the national level;
    b) Ensure that relevant parameters for climate, water, and soil and the indicators for socio-economic parameters are collected and made available through the system;
    c) Place more emphasis on supporting research to characterize the magnitude, spatial extent, persistence length and potential impact of droughts;
    d) Use an appropriate classification system on different types of droughts, i.e., meteorological, agricultural and hydrological droughts, while communicating information on droughts on a routine basis.

2) Assess the adequacy of meteorological and hydrological networks and data quality.

    a) Ensure that an adequate network of meteorological and hydrological stations is established in the country to provide good spatial characterization of droughts and other climatic features;
    b) Take full advantage of the advances in instrumentation technology such as Data Collection Platforms (DCPs), automatic weather stations, telemetry, hydroprobes in automating the data collection;
    c) Encourage the wider availability and use of remote sensing data and products and provide training on the proper interpretation of these products for natural resource managers and policy makers;
    d) Implement an effective data quality control system consistent with WMO quality control procedures;
    e) Ensure the long-term sustainability of meteorological and hydrological networks in order to provide the user community relevant information on a regular basis.

3) Examine the current procedures for coordinating the collection and analysis of meteorological and hydrological data and eliminate fragmentation between many agencies and ministries at the different administrative levels.

    a) Encourage close collaboration among meteorological, hydrological and other relevant agencies in the collection of comprehensive drought data;
    b) Establish a centralized authority for the analysis of meteorological and hydrological data to generate integrated products related to droughts;

4) Evaluate existing procedures for data sharing and their applications of drought monitoring, preparedness, mitigation and response.

   a) Encourage regular interaction between all relevant agencies and institutions at the national, regional, and local levels in developing appropriate drought products for application in all sectors affected by droughts.
   b) Adopt agreed upon standards for sharing of data and products with all sectors concerned with the impacts of droughts;
   c) Promote a policy of free and open exchange of data and products with all interested agencies and institutions in the public and private sectors;
   d) Establish a rigorous monitoring system to ensure that data and products are shared freely between institutions and agencies in a timely manner.

5) Assess the availability of early warning and decision-support tools and methodologies in support of drought preparedness planning and policy development.

   a) Undertake a comprehensive assessment of drought risks; identify potential threats and establish the degree of vulnerability of local populations and economic sectors to droughts and how these vulnerabilities vary by region within a country;
   b) Evaluate the existing capabilities in the country for early warning of droughts, identify the gaps and take appropriate steps to develop and strengthen the national capabilities to provide effective drought early warnings;
   c) Collaborate with the Global Producing Centres for Long-range Forecasts (GPCs) and the Regional Climate Centres (RCCs) to augment the ability in the country to provide seasonal and inter-annual forecasts for the drought outlook and decision making;
   d) Strengthen research capacity at the national, regional and local levels into the causes and effects of climate variations and long-term climate prediction to provide drought early warnings;
   e) Evaluate existing decision-support tools in close collaboration with the user community in different sectors which are impacted by droughts and improve these tools by taking advantage of current advances to provide better and more timely information for decision making;
   f) Promote multidisciplinary collaboration among meteorologists, hydrologists, soil scientists, ecologists, agronomists, the social/behavioral sciences, and others in the collection of data and generation of drought products for the user community.

6) Evaluate the four phases in early warning systems, i.e., mitigation or prevention, preparedness, response and recovery.

   a) Establish an evaluation procedure for each of the four phases of the early warning systems in the country i.e., mitigation or prevention, preparedness, response and recovery;
   b) Implement a feedback process in the drought cycle to learn from past practices in the mitigation or prevention, preparedness, response and recovery strategies;
   c) Ensure that the early warnings are delivered to the decision makers in a timely fashion and in appropriate formats and that preparedness, response and recovery plans are in place.

7) Examine the need for the development of useful end products or decision-support tools for delivery to the end users.

   a) Ensure that the user community in different sectors impacted by droughts is involved right from the beginning in the development of useful end products or decision-support tools in order to ensure that the products meet their needs and expectations;
   b) Develop appropriate decision support tools and products to assist the users in their decision making in drought risk management.

8) Assess the delivery systems for disseminating data to users in a timely manner to enhance their usefulness for decision support.

   a) Establish a procedure/survey to ensure that the needs of the decision makers are being adequately met by the delivery system and modify the system as required;
   b) Design the presentation of data and products to meet the specific needs for different decision makers (do not make users search through all data but provide access to different products for different groups, e.g., agriculture, education, policy makers);
   c) Use the most cost effective and modern methods for information delivery including Internet, social media (Facebook, Twitter, etc.), mobile phones, radio, TV, etc., which are appropriate to the local conditions;
   d) Place emphasis on training of the user communities in the use of decision support tools and products.

Vulnerability Assessment and Impacts

9) Understand the natural processes and human activities that contribute to vulnerability and community resilience and how these will be integrated to inform risk reduction and management.

   a) Address the gaps in knowledge, methodologies and types of information that are preventing the effective application of these methodologies. A key goal is the enablement of affected populations.
   b) Assist communities facing hazards to manage their own environments more responsibly and equitably over the long term by joining in a global structure that supports informed, responsible, systematic actions to improve local conditions in vulnerable regions.
   c) Encourage governments and institutions to support, provide incentives, coordinate data and decision support, and legitimize successful approaches to increasing capacity and action

10) Characterize and integrate drought-related impacts, vulnerability and risk information.

11) Define spatial scale of assessment using biophysical and socio-economic boundaries (watershed, city, agricultural community, ecosystem, etc.).

12) Elicit key stakeholder problem framing and needs (for seasonal and longer climate-sensitive information).

13) Describe socio-economic and management characteristics, capacity-mapping and trends in the countries/communities of concern, and include standards for data collection.

14) Develop risk assessments and profiles showing physical, social, economic and environmental pressures on a community from global, regional, and local scales.

15) Understand effective decision-making in the context of drought risk management – what it is and how it can be improved- research on decision making and risk perceptions, and applied research on implementation of risk management and mitigation programs.

   a) Include critical actors at each jurisdictional level; the actors' risk assumptions; their needs for different types of information; and the design of an information infrastructure that would support their decisions at critical entry points

16) Develop, test and improve methodologies and measure progress in reducing vulnerability and enhancing community capacity—e.g., drought risk management, cost-effectiveness of methodologies and analyses, and societal impacts of catastrophic events.

17) Strengthen cross-sectorial coordination of impacts assessments and partnerships among state, academia and the private sector for conducting impacts assessments.

    a) Assess impediments and opportunities to the flow of information including issues of credibility, legitimacy, compatibility (appropriate scale, content, and match with existing practice) and acceptability.
    b) Develop and test common drought risk reduction practices, coordinating information flow from different organizations into easily understandable language for all affected communities in countries and communities at risk.

18) Develop and mainstream effectiveness of Early Warning Information Systems that include warning of potential impacts on livelihoods.

19) Enable affected populations through support from governments and institutions, provision of incentives, and legitimization of successful approaches to increasing capacity and action at the local level.

20) Conduct risk profiles prior to the onset of droughts, and capture drought impacts on vulnerable populations. Risk profiles should consider vulnerable groups, including but not limited to:

    a) women;
    b) children;
    c) the elderly;
    d) the landless;
    e) farmers;
    f) pastoralists;
    g) marginalized communities; and
    h) indigenous communities and populations

21) Record drought impacts on and conduct risk assessments for vulnerable economic sectors, including but not limited to:

    a) Rain-fed agricultural production
        i. *Impact(s):* Reduced yields
        ii. *Potential mitigations:* Imports (short term); choosing to sow different crops or do not sow at all (short term)

    b) Irrigated agricultural production
        i. *Impact(s):* Reduced yields
        ii. *Potential mitigations:* Water rationing; water allocation review; sowing dryland crops.

    c) Livestock production
        i. *Impacts:* Weight loss; mortality; destocking; increase in incidence of diseases; lower fertility and reproduction rates
        ii. *Potential mitigations:* Destocking; feed distribution; cattle parking/relocation of herds; nomadic migration; use of special reserved areas (stock routes and stock reserves)

    d) Water
        i. *Impacts:* degraded water quality (salinity, BOD/COD); surface water shortages; overdrawing and depletion of groundwater; increased competition and conflict over water

ii. *Potential mitigations: Ex ante* identification of supplemental and alternative sources of water; use of reserve sources of groundwater; technical optimization of water resources; water laws and rules for special circumstances dry-year options (sale, expropriation, restrictions) using critical drought thresholds; development of critical thresholds; prediction of future water use to determine zoning.

e) Environment
   i. *Impacts:* Ecosystem degradation; loss of biodiversity; species migration and extension; landscape change and wind erosion; increased risk of wildfires; fisheries impacts
   ii. *Potential mitigations:* maintenance of environmental flows

f) Transportation
   i. *Impacts:* Reduced transportation and navigation

g) Health
   i. *Impacts:* Morbidity; incidence of wind-, dust- and vector-borne diseases and respiratory illnesses; degradation of sanitation; levels of nutrition, happiness, depression, trauma and suicide; increased use and dependence on drugs and alcohol
   ii. *Potential mitigations:* Food supplements; stockpiling food; more robust social safety nets; improved access to mental and physical health care

h) Tourism and recreation
   i. *Impact(s):* Loss of recreation areas

i) Energy
   i. *Impacts:* Decreased hydropower production; brownouts; increased demand; destruction of transmission lines
   ii. *Potential mitigations:* Energy restrictions; improvements in efficiency; alternative energy supplies; diversification of energy sources

j) Society
   i. *Impacts:* Migration and loss of community; decreased marriage rates; increased divorce rates; increased conflicts; loss of assets and reduced property values; increased theft and crime; impacts on cultural practices
   ii. *Potential mitigations:* Social protection and cash-transfer programs; diversification of rural livelihoods

k) Education
   i. *Impacts*: School dropout rates (short-term); lower school enrollment (longer term)
   ii. *Potential mitigations:* Targeted social protection (e.g., Bolsa Familiar)

l) Dues/costs of responding
   i. *Impacts:* Amount spent on relief and response

m) Secondary and tertiary impacts on economic productivity:
   i. *Impacts:* Loss of income and productivity*; o*pportunity costs*;* higher personal debt levels

22) Identify and assess vulnerable people and communities, and factors to consider such as:

a) Gender
b) Age
c) Political status
d) Dependency on agriculture

e) Level of wealth/poverty and human development
f) Status of education
g) Access to natural assets
h) Access to alternative supplies of water and fodder
i) Access to markets
j) Baseline health
k) Livelihood and employment options, and access to alternative or supplemental employment
l) Social networks and level of isolation
m) Access to infrastructure
n) Underlying climate variability
o) Exposure to previous droughts, floods and other hazards

23) Develop criteria to weigh the importance drought impacts and vulnerability factors, and to identify high-leverage mitigation actions.

24) Develop mitigation options at multiple time scales.

a) Use drought impact records to develop probabilistic drought-risk assessments and facilitate proactive planning and drought risk management.

25) Systematically monitor and record local drought impacts in real time.

a) Measure and control data quality; and
b) Ensure that drought EWS information systems are designed to reach (and can be used by) local communities.

26) Develop common methodologies and terminology to assess drought vulnerability to facilitate the assessment of drought risk at multiple spatial scales and across political borders.

27) Link drought vulnerability assessments with assessments associated with other hazards.

a) Use climate models and to integrate drought vulnerability assessments into climate change adaptation plans.

Emergency Relief / Response

28) Develop drought response measures that reinforce the concept of risk management as a key element of a national drought policy while promoting environmental stewardship.

a) Emphasize fundamental need for integrated monitoring/observational and analysis system.
b) Establish drought criteria or thresholds for taking action.
c) Differentiate between seasonal dry situations and prolonged drought situation in the context of implementing emergency relief and response measures.
d) Continue assessment of socio-economic consequences/impacts of the specific drought event.
e) Identify emergency measures that will reduce the impact of current drought while reducing vulnerability of future occurrences (at least has to be neutral).
f) Establish an effective communications and awareness building strategy for public education.
g) Policy should be developed to ensure that the relief reaches affected farmers in a timely fashion
h) Governments should provide a drought fund for relief and response as part of a National Drought Policy.

29) Promote training opportunities to enhance understanding of how seasonal forecasts and other decision support tools can be applied by vulnerable groups and within vulnerable sectors to improve resilience/coping capacity and preparedness.

a) Develop business (management) plan training by sectors
b) Emphasize training of trainers to better communicate the policy instruments to user communities
c) Stress the application of climate risk information for management and policy
d) Understand user needs and involvement of users in decision support tools from the beginning
e) Employ the media to engage the public and policy makers and receive feedback on the effectiveness of emergency relief measures

30) Identify incentives that could be provided to vulnerable sectors/groups to enhance the adoption of risk-based management measures in support of a national drought policy.

a) Consider financial incentives (implementation of a government approved program to provide loans on a tax-free basis to address drought)
b) Link drought relief to establishment/implementation of drought plans at any level (local, state)
c) Apportion a portion of funds provided for emergency relief payments to mitigation to reduce the impacts of future droughts
d) Evaluate existing drought insurance plans or schemes in terms of how effective the plans promote rewarding wise stewardship of natural resources and sustainable development
e) Use rewards for drought preparedness and effective response. Use matching funds to finance good / expand plans.

31) Conduct research that evaluates the effect of drought relief measures on societal vulnerability.

a) Identify case studies at the local level how risk management can reduce vulnerability/risk (positive/negative)
b) Examine how drought drills or exercises could be effectively used to promote more effective preparedness and response
c) Develop virtual drought scenarios/exercises for policy and decision makers
d) Diversify activities and portfolio of assets as a drought mitigation strategy (i.e. crop production)
e) Assess the effectiveness of drought policies and look for areas of improvement and refinement
f) Use risk mapping to identify vulnerabilities in support of drought policies

32) Identify successful examples of how interagency coordination has enhanced drought monitoring, mitigation, response, and planning.

a) Virtual drought scenarios/exercises for policy and decision makers
b) River basin agreements / compacts / working arrangements
c) Multidisciplinary working groups (AGRHYMET - West Africa)
d) U.S. Drought Monitor
e) Australia NAMS
f) Chinese example
g) Drought Monitoring/Management Centers (ICPAC, DMC-SADC, DMCSEE)
h) State of Ceara, Brazil

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