IMPROVED DROUGHT EARLY WARNING AND FORECASTING TO STRENGTHEN PREPAREDNESS AND ADAPTATION TO DROUGHTS IN AFRICA (DEWFORA)

A 7th Framework Programme Collaborative Research Project

Work Package 2

Assessing existing drought monitoring and forecasting capacities, mitigation and adaptation practices in Africa

DELIVERABLE 2.5 – GAP ANALYSIS REPORT ON DROUGHT MITIGATION AND ADAPTATION PRACTICES AND ORGANIZATIONAL STRUCTURES FOR DROUGHT MANAGEMENT IN AFRICA

Final

30 November 2012

DOCUMENT INFORMATION

Title	Gap Analysis Report on Drought Mitigation and Adaptation Practices and Organizational Structures for Drought Management in Africa	
Lead Author	W R Nyabeze and Associates, South Africa	
Contributors	C van Kempen	Deltares
	S Vermooten	Deltares
	T. Ferreira	University of Porto, Faculty of Engineering
	R. Maia	University of Porto, Faculty of Engineering
	J.P. Pêgo	University of Porto, Faculty of Engineering
	E. Vivas	University of Porto, Faculty of Engineering
	O Lahlou	Institut Agronomique et Vétérinaire Hassan II
	S. B. Alaoui	Institut Agronomique et Vétérinaire Hassan II
	Y Imani	Institut Agronomique et Vétérinaire Hassan II
	C Ndayisaba	Institute of Scientific and Technological Research (Rwanda)
	K Mahmoud Attia	Nile Research Institute, Egypt
	H Farag	Environment and Climate Research Institute, NWRC, Egypt
	D Mulungu	University of Dar es Salam, Tanzania
	M Mohamed Elhag	University of Gezira, Sudan
	S O Dulo	University of Nairobi, Kenya
	B Chisadza	WR Nyabeze and Associates
	L Dlamini	WR Nyabeze and Associates
	A Muhate	WR Nyabeze and Associates
	P Manguambe	WR Nyabeze and Associates
	W Nyabeze	WR Nyabeze and Associates
	M Tumbare	WR Nyabeze and Associates
Distribution	PP: Restricted to other programme participants (including the Commission Services)	
Reference	Inventory of institutional frameworks and drought mitigation and adaptation practices in Africa	

DOCUMENT HISTORY

Date	Revision	Prepared by	Organisation	Approved by	Notes
07/12/2012		W R Nyabeze	WRNA	W Nyabeze	

ACKNOWLEDGEMENT

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement N°265454

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
Ac-ft/yr	Acre-feet per year
ACT	Australian Capital Territory
ACTEW	Australian Capital Territory Electricity and Water Corporation, Ltd.
BOM	Bureau of Meteorology
CC	Climate Change
CMI	Crop Moisture Index
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Federal Department of Agriculture Fisheries and Forestry
DCP	Drought Preparedness Council
DSHS	Department of State Health and Human Services
EC	Exceptional circumstances
FEMA	Federal Emergency Management Agency
FSA	Farm Service Agency
GRDC	Grains Research and Development Corporation
HUD	Housing and Urban Development
IBWC	International Boundary and Water Commission
IED	Income Equalisation Deposits
KBDI	Keetch-Byram Drought Index
MDB	Murray Darling Basin
MDBA	Murray Darling Basin Authority
mgd	Million gallons per day
MLDRIN	Murray Lower Darling Rivers Indigenous Nations
NAMS	National Agricultural Monitoring System
NARC	National Rural Advisory Council
NBAN	Northern Murray–Darling Basin Aboriginal Nations
NFF	National Farmers' Federation
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NSW	New South Wales
NWI	National Water Initiative

NWS	National Weather Service
ORCA	Office of Rural Community Affairs
OSC	Office of the State Climatologist Office
PC	Productivity Commission
PDSI	Palmer Drought Severity Index
PIMC	Primary Industries Ministerial council
RAS	Rural Adjustment Scheme
RD	Rural Development
SCoPI	Standing Council on primary industries
SDL	Sustainable Diversion Limits
SITREP	Texas Drought Situation Report
SPI	Standardized Precipitation Index
SRA	Sabine River Basin Authority
TAC	Texas Administrative Code
TAEX	Texas Agricultural Extension Service
TAGD	Texas Alliance of Groundwater Districts
TCEQ	Texas Commission on Environment Quality
TDA	Texas Department of Agriculture
TDED	Texas Department of Economic Development
TDHCA	Texas Department of Housing and Community Affairs
TFS	Texas Forest Service
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TxD	Texas Department
TxDOT	Texas Department of Transportation
US	United States
USACE	US Army Corps of Engineers
USBR	US Bureau of Reclamation
USFS	US Forest Service
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
USPHS	US Public Health Service
WIRADA	Water Information Research and Development Alliance
WS&D	Water Scarcity and Droughts

EXECUTIVE SUMMARY

*This document (Deliverable D2.5) presents an assessment of the gaps between "**state of the art**" and **current practices in Africa** for local, regional and continental drought **mitigation** and **adaptation** and **organizational structures** for drought management. This is informed by an evaluation of the gap between (i) **user requirements in Africa** and **current practices** and (ii) user **requirements in Africa** and "**state of the art**" practices.*

In the Unites States of America (USA) and Australia drought may affect societies in several sectors and may extend over varying jurisdictional and political scales. In concordance, drought management often requires mitigation and adaptation practices in several sectors and regulation from varying political scales. Mapping of institutions and their interactions is important. Institutional changes (through social, political, cultural or other changes) can increase or reduce vulnerability of communities to drought, limit and/or facilitate mitigation and adaptation. The review of adaptation and mitigation practices in the USA and Australia considers agricultural, industrial, domestic and environmental sectors and for the following scales (if relevant):

- *national level*
- *state level*
- *river basin level*
- *indigenous or tribal level*
- *cities and utilities*

Mitigation and adaptive practices may apply to several sectors at once. The environmental sector for example is closely related to range management and forestry, both of which are also affected by wildfire and the density of grazing animals. Similarly, the industrial and domestic sectors are closely related as industry is often located in urban environments, obtaining its water from the same sources as the urban dwellers.

In this report, whenever a mitigation or adaptive measure could fall in several sectors, they are assigned to the most logical and most relevant sector. In some cases duplication may occur, because slightly different phrasing of a similar measure could make it more relevant for another sector. The same holds for adaptive versus mitigation practices: some practices are relevant both to drought adaptation and mitigation.

***Drought mitigation** as defined in this document considers – "the reduction in the classification of a drought in terms of frequency and magnitude of risks and resulting from*

reduction of the potential impact of a drought", therefore mitigation practices can be considered as all the actions that somehow contribute to the reduction of drought effects on the environment, human wellbeing and economic activities. In this document examples from Europe, Australia and the USA are analyzed using historical drought situations and drought plans to provide best practice or "state of the art" on elaboration of drought management plans and measures adopted according to specific regional conditions and drought severity level.

The definition of ***drought adaptation*** *provided in this document considers "a process of being able to survive in a drought condition. It refers to changes in processes, practices, and structures to moderate potential impacts of future drought" therefore adaptation practices can be considered as the measures/actions/strategies capable of reducing regional vulnerability to future droughts. In this document, examples from Europe, Australia and the USA are analyzed using historical drought situations to provide best practice or "state of the art" on elaboration of specific strategies for adaptation to climate-change (medium to long term window of time) and reduction of water scarcity levels in order to reduce future droughts effects.*

From the European experience, the "state of the art" institutional framework for drought management corresponds to the existence of a specific drought committees (at local and national level where they exist in member states), with both political and technical responsibilities in drought management and that coordinates actions with regional and local bodies responsible for water resources management and/or civil protection. It can be a permanent body or a body just constituted when a drought situation is declared. The organisational arrangements at different levels from local to regional are elaborated. For the U.S., the "state of the art" institutional framework is closely related to the existence of drought plans at all scales of society, from the farmer's ranch through city boards and state governments. These state plans define the institutional framework relevant for that particular locality by defining the roles and responsibilities of all stakeholders in the onset or event of a drought. In some cases, this might include a drought committee, but that is not always the case. In Australia, in the past decade, a lot has happened with respect to drought policy at the national, state, basin and city level. Additionally, farmers have a large role to play in adapting to drought and have an increasing responsibility for managing the risks arising from climatic variability. At the national level, for example, in the framework of a review of the national drought policy, the Primary Industries Ministerial council agreed in 2008 that current approaches to drought and Exceptional Circumstances (EC) were no longer the most appropriate 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. As a follow-up to the review, the Australian government (DAFF), in partnership with the western Australian government, implemented a pilot of drought reform measures in part of Western Australia.

The requirements of users to mitigate drought impacts in the four "regions" in Africa considered on this study can be summarised as follows:

Oum er Rbia Basin	***Nile Basin***			***Limpopo Basin***	
Morocco	***Ethiopian Plateau***	***Downstream Countries***	***Equatorial Lakes Region***	***South Africa***	***Zimbabwe***
• *Public awareness programs for saving potable water as water is generally taken for granted by the public.* • *Legislation to prevent wasting of water* • *Adoption of restrictions* • *Improved maintenance of urban water supply networks* • *Improved access to potable water in rural areas* • *Regulated water consumption in public facilities* • *Encouraging Water conservation measures* • *Improving water use efficiency* • *Treatment and reuse of water* • *Alternative land use systems* • *Use of crop varieties that tolerate drought* • *Adoption and diffusion of agriculture good practices* • *Adoption of soil conservation measures* • *Development of deficit irrigation*	• *Providing access to credit to enable pastoral farmers to cultivate crops, plant trees, and dig wells;* • *Promotion of grower associations to grow crops;* • *Facilities to process produce* • *Markets for outputs and assisting farmers to market their produce;* • *Developing or strengthening cooperatives*	• *Data for mitigation studies* • *Climate change impacts mitigation strategy* • *Estimation of impacts of droughts on agricultural productivity* • *Mitigation of impacts of extreme events* • *Irrigation infrastructure development and improving water supply* • *Sustainable and appropriate mitigation strategies* • *Crop yield estimates* • *Guidelines to achieve stable or increased crop yields* • *Guidelines on optimal planting dates* • *Guidelines to select suitable crops varieties* • *Guidelines on mitigating impacts of desertification*	• *Information on climate change impacts mitigation strategies* • *Impacts of future droughts on agriculture and levels of uncertainty* • *Mitigation of impacts of extreme events* • *Poverty reduction strategies* • *Irrigation infrastructure development* • *Improved water supply* • *Stronger local institutions on drought management* • *Sustainable and appropriate mitigation strategies* • *Estimates of crop yields* • *Estimates of food availability per capita* • *Mitigation of electricity power-peaking* • *Guidelines for mitigating cultivation practices to achieve stable or increased yields* • *Guidelines for optimal planting dates for each agricultural year* • *Crops varieties selection guidelines* • *Guidelines on food storage and processing to reduce post-harvest losses and optimize usage of harvest*	• *Public awareness campaigns* • *Giving higher priority to drinking water* • *Sinking of wells and boreholes* • *Irrigation infrastructure* • *Livestock vaccination* • *Livestock feeding* • *Improved livestock husbandry* • *Water use efficiency* • *Farmers cropping strategies* • *Irrigation management* • *Small dams* • *Saving livestock* • *Controlled forest grazing* • *Food aid* • *Drought relief* • *Harvesting of rainfall water*	• *Classification of a drought in terms of being hydrological, agricultural and meteorological and severity* • *Drought and water management awareness campaigns* • *Coordination of mitigation programmes and relief and communication.* • *Water rationing schedule, recycling water, and water conservation awareness campaigns* • *Promotion of soil and water conservation* • *Review of the Drought Plan to cater more for long term mitigation and a more proactive plan.* • *Local scale weather forecasting and advance warning of extreme events* • *Provision of inputs and rehabilitation of irrigation schemes and dams* • *More research on climate change and drought related issues*

*The following **gaps between mitigation actions and requirements of users** were identified:*

- *lack of effective early warning and information systems*
- *limited accuracy of forecast information, forecasts only provide indicative outlooks.*
- *poor access to drought contingency funds especially at local level*
- *blending indigenous interventions is very limited*
- *public awareness is constrained by inappropriate dissemination methods*
- *inaccessible products*
- *reliability of the indicators/output information cannot be established and*
- *spatial scale of the output information limits application by users to make practical decision.*

The mitigation actions address some of the user requirements but they are most often reactive and are taken in emergency situations. As a result they suffer from by the following:

- *very high cost*
- *increasing dependency on government assistance*
- *limited impacts on the long term*
- *primarily benefit the wealth, who have additional financial resources and are better integrated into the commercial economy and*
- *negative side effects on the environment from short-term unsustainable practices.*

*The following "**state of the art" drought mitigation practices** were identified from available literature:*

Mitigation Actions	
Public awareness campaigns	*Livestock vaccination campaign*
Giving priority to drinking water	*Importing and distributing stock-feed*
Water use efficiency	*Setting of preserved pastures*
Diversification of income sources	*Food storage and crop varieties*
Restructuring bank debt	*Harvesting of rainfall water*
Rescheduling of farmers' credits	*New drought tolerant crops*
Debt forgiveness	*Natural forest plantations*
Better and easier access credit	*Agroforestry*
Importing and subsidizing drilling	*Drought relief programs*
Restricting summer crops	*Food aid*
Wells digging and irrigation	*Agro-pastoral fares*

Mitigation Actions	
Farmers cropping strategies	*Horticulture*
Livestock vaccination campaign	*Local seed production*
Livestock husbandry practices	*Fruit production*
Saving livestock	*Irrigation systems*
Livestock watering points	*Use of lowlands*
Opening of preserved pastures	*Irrigation management*
Controlled forest grazing	*Boreholes, wells and small dams*
Livestock feeding program	*Cloud seeding*

Most of the "state of the art" mitigation actions are also implemented in Africa however ***current practice on drought mitigation*** *shows the following as the main* ***weaknesses****:*

- *very slow response to disasters*
- *inadequate capacity to implement timely drought response measures*
- *lack of high caliber professional staff including hydrologists, for example in the Equatorial lakes region, ICPAC has only four metrological and two water resource experts, resources for engaging institutions for dissemination remains a challenge*
- *limited progress in mobilizing stakeholder participation and investment*
- *inadequate effort on dissemination of data information and products*
- *poor promotion of local efforts such as traditional lending of stock to relatives/friends*
- *limited institutional outreach at local level*
- *fuzzy attention to delivery of interventions*
- *inadequate capacity to provide support on recovery interventions*
- *reliance of networks and institutions on high level staff limits engagement at the local level*
- *The early warning systems/networks have significant challenges on the following:*
    - *coverage and maintenance of hydro-meteorological observation networks*
    - *consistency of meteorological and hydrological data*
    - *willingness to share data freely*
    - *management of data*
    - *suitability and adequacy of input data for application on the available methods/techniques/models*
    - *understanding of local and regional processes*
    - *modelling and downscaling of climate data*
    - *information exchange and dissemination strategies*
    - *provision of usable information on climate change*

A shift towards a risk based drought management approach presents ***opportunities*** *for Africa to move away from expensive relief actions. To achieve this, the following improvements were identified:*

- ***Seasonal weather forecasts*** *to assess the likelihood, spatial extent, magnitude and duration of drought. Tthere is a need to improve early warning systems available. Current practice provides regional forecasts which have very limited use at local scale.The interface between the scientific and the traditional systems requires more negotiation. Indigenous knowledge systems on seasonal rainfall predictions have been applied for many years and are part of local practice. There is a striking similarity between some of the indigenous and contemporary climate indicators especially those related to wind direction, temperature and clouds. Observations of plant and animal behaviour dominate indigenous climate forecast systems in many parts of the country. Inter-annual fluctuations in fruit production in certain tree species have been used as an advance seasonal rainfall indicator. Animal behaviour is also used to predict weather conditions. integrating scientific and traditional monitoring to improve applicability and accuracy of drought early warnings. Improved reliability of forecasts can win back trust from users*
- ***The definition and development of accurate and suitable drought indicators*** *to provide information on the impact of drought and vulnerability assessments*
- ***Agro-meteorological monitoring*** *especially for areas of significant agronomic importance*
- ***Assessment of the drought vulnerability*** *at system level to evaluate the system's resistance and resilience to drought*
- *Providing* ***usable, user friendly early warning products*** *in a timely manner Improvement type ana quality of information for improved crop production, water resources management and livestock management*
- ***training and public awareness*** *campaigns using media which they are familiar with or trust*
- *improving* ***data sharing*** *between government agencies and research institutions and*
- ***reducing cost of data*** *as it limits application.*

The requirements of users to adapt to drought conditions in the four "regions" in Africa considered on this study can be summarised as follows:

Oum er Rbia Basin	***Nile Basin***		***Limpopo Basin***	
Morocco	***Ethiopian Plateau***	***Equatorial Lakes Region***	***South Africa***	***Zimbabwe***
• *Educational programs on restructuring water consumption patterns.* • *A shared "sacred" vision of water.* • *The development of household water saving and water harvesting devices.* • *Use of landscape water conservation devices that target outdoor water use.* • *Recycling and reuse of domestic wastewater* • *Implementation of vigilance committees, individual counters, and review of tariffs* • *Visible effort to fight against water losses in distribution networks* • *Implementation of water saving measures in building standards*	• *Reducing number and size of meals per day* • *Eating less water intensive food, for example wild fruits* • *Reduce or avoid cultural ceremonies that are said to be extravagant* • *Minimizing cultural ceremonies* • *Temporary movement of some of family members to better areas* • *Work as daily laborers in nearby towns* • *Food aid* • *Food and cash for work* • *Feeding livestock cactus, sisal and aloe leaves* • *Selling livestock* • *Introduction and scaling out of cactus as source of feed* • *Growing eucalyptus in homesteads for construction and fuel wood and for sale* • *use of early maturing seed varieties* • *Transport for livestock or livestock products* • *Low livestock mortality rate* • *Higher livestock reproduction rate and improved products*	• *Climate change impacts mitigation strategy* • *Estimation of impacts of future droughts and the associated levels of uncertainty* • *Estimation of impacts of droughts on agricultural productivity* • *Poverty reduction strategy* • *Irrigation infrastructure development and improving water supply* • *Stronger local institutions on drought management* • *Sustainable and appropriate mitigation strategies* • *Estimates of crop yields* • *Estimates of food availability per capita* • *Mitigation of hydropeaking arising from power generation* • *Farming guidelines for mitigating cultivation to achieve stable or increased yields*	• *Drought early warning systems* • *Water rationing* • *Management of ground water* • *Expansion of protected areas* • *Tree planting at homesteads* • *Control of deforestation* • *Importation of water* • *Desalination/demineralization of water* • *Inter-basin water transfers* • *Construct small and large dams* • *Water infrastructure management and development* • *Management of water networks* • *Water harvesting* • *Water recycling* • *Promotion of local/cultural practices* • *Water conservation technologies* • *Soil and water conservation* • *Drought resistant crop varieties* • *Food-for-work programmes* • *Planting short maturing crops* • *Livestock health programmes*	• *Drought awareness campaigns* • *Classification of a drought in terms of being hydrological, agricultural and meteorological and severity* • *Coordinated mitigation programmes and relief efforts* • *Coordinated communication.* • *Water rationing schedule, recycling water, and water conservation awareness campaigns* • *Promotion of soil and water conservation* • *Review of drought plans to cater more for long term impacts* • *Proactive interventions.* • *Local scale weather forecasting and advance warning of extreme events* • *Agricultural inputs* • *Rehabilitation of irrigation schemes and dams* • *More research on climate change and drought related issues*

*A **comparison of drought adaptation practices in Africa with user requirements** in North Africa shows that in this region countries must develop more non-conventional water and water harvesting. In Morocco, large, medium and small dams are needed to address the adaptation requirements. In addition the practice of flood-irrigation is still dominant should be phased out as it results in huge water losses. Improved or more effective irrigation systems require a modern system of information for irrigation scheduling in real time should be developed. This can be addressed through technology transfer arrangements. Some of the traditional extension services are becoming obsolete and farmers need to combine their traditional knowledge with scientific information to improve impact of adaptation actions*

In the Eastern Nile region there is a lack of implementation of adaptation actions as demonstrated by the following:

- *increasing humanitarian needs of pastoralists*
- *poor coordination in recent interventions*
- *insufficient regional mechanisms to address the regional root causes and impacts.*
- *failure to link relief to recovery. This has resulted in duplication and cost-inefficient responses*
- *exclusion of pastoralists in policy making and the design of response strategies*
- *insufficient understanding of pastoralism (and inadequate research into pastoralist needs to inform response) have also fuelled poor design and implementation of interventions and projects in pastoral areas*
- *no scaling up successful pilot based community adaptation projects and*
- *absence of new partners and new ways of working with pastoralists.*

The comparison of user requirements with currently adopted drought adaptation practices reveals gaps mainly in terms of the level of dissemination and uptake. There is a need for implementation on a larger scale in order to fulfill user requirements. In addition some research programs have identified appropriate interventions. To transfer efficiently these techniques and strategies on the field, financial support, awareness and communication can provide a development of better and more complete adaptation packages by combining traditional and scientific knowledge.

*The following **globally available "state of the art" drought adaptation practices** were identified from available literature.*

Adaptation Actions	
Planting short maturing crops	*Cultural practices*
Reducing biomass fuel use	*Water harvesting*
Food-for-work programmes	*Water conservation technologies*
Multi-activity agriculture	*Soil and water conservation*
Cereal sole and fruit-trees	*Water infrastructure management and development*
Market gardening	*Management of water networks*
Local bovine	*Construct small and large dams*
Herd splitting and distribution	*Capacitation of farmers*
Strategic destocking	*Management of water resources*
Managing wildlife	*Inter-basin water transfers*
Control of animals & grazing	*Desalination/demineralization of water*
Livestock health programmes	*Importation of water*
Extra-agricultural incomes	*Control of deforestation*
Dry land farming practices	*Tree planting at homesteads*
Drought resistant crop varieties	*Rangeland management*
Diversification of breeds/species	*Drought early warning system.*
Crop monitoring	*Expansion of protected areas*
Crop diversification	*Resource management*
Integrated Water Management	*Water rationing*
Improve lake water environment	*Management of ground water*
Drought early warning systems	*Conservation farming*

*The following gaps were identified between **current practice on drought adaptation and "state of the art";***

- *Weak water management institutions*
- *Inadequate human and financial capacity*
- *Inadequate monitoring and documentation of drought events*
- *Lack of international cooperation*
- *ineffective knowledge sharing especially on water and agriculture*
- *Low technical and design standards*
- *Inadequate/ineffective regulations*
- *Interventions not included in investment priorities*

- *Inadequate infrastructure to reduce impact of extreme events*

The following opportunities were identified for ***improving adaptation practices in Africa****:*

- *development and implementation of a multiple water development strategy of collecting, producing, recycling and conserving water which is taken up in national regional and local plans*
- *socio-economic and policy decision-making processes that integrate adaptation strategies and actions on an on-gong basis*
- *involvement of resource users in all aspects of the planning, designing, implementation, and monitoring of water management and drought adaptations strategies. Local practices can be incorporated into drought mitigation*
- *water resources management, including the best agricultural practices has to be more developed and disseminated at a larger scale and outreaching directly the users*
- *opportunities of accessing to new technologies by users have to be improved, with training on their use and demonstration for their benefits*
- *access to collected meteorological, agronomical, hydrological, remote-sensing data have to be facilitate to institutions, users and public*
- *best practices and stakeholders trainings have to be permanently implemented and the knowledge updated*
- *development of a drought adaptation program to be used by users as related drought national institutions does not have a specific program*
- *increased knowledge of improved techniques of adaptation among the rural population through small training sessions*
- *public trusts the media more than the specialists, improve information available to media so that the media can inform more correctly*
- *develop guidelines on how to communicate with media and conduct workshops to train the media on technical aspects*
- *explain to the media the concept of uncertainty in forecasts*
- *integration of different projects on drought*
- *coordination between institutions to build cooperation across institutional boundaries and between different interests at and across multiple scales*
- *feedback from end users and the recognition of public values, concerns and priorities in shaping policies are necessary to create linkages between diverse levels, and to build collaboration and sustainability*

- *use indigenous knowledge to improve forecasts*
- *educating communities to change culture and reduce vulnerability*
- *increase awareness*
- *improve communication with local community in order to avoid disasters and involve local leader/religious leaders*
- *promote involvement of government and link scientists to the community and the media*
- *satellite data can be used to fill gaps of measurements*
- *exchange of data/experience between countries and institutions is important*
- *drought tolerant crops offer opportunity to produce even in drought years*
- *strengthening resilience against climate variability*
  - *improve water use efficiency*
  - *promote soil and water conservation*
  - *manage evapo-transpiration so as to achieve water saving*
  - *Improve human and financial capacity*
- *Improve drought events monitoring and documentation*
- *International cooperation*
- *Practice effective knowledge sharing especially for the highly vulnerable sectors such as water and agriculture and the sub-Saharan region*
- *Adjustment to technical and design standards, and regulations*
- *Establish investment priorities*
- *Introduce/Improve new crop varieties to changes in cropping seasons*
- *Build infrastructure to reduce the damage from extreme events and increase water storage capacities.*
- *increase the number of qualified personnel and*
- *create a department to deal specifically with drought.*

*A **comparison of organizational structures for drought mitigation in Africa with experiences in Europe, USA and Australia** shows that in European "state of the art" institutional framework for drought management correspond to specific drought committees (at local and national level where they exist in member states), with both political and technical responsibilities in drought management and that coordinates actions with regional and local bodies responsible for water resources management and/or civil protection. In the USA the "state of the art" institutional framework is closely related to the existence of drought*

plans at all scales of society, from the farmer's ranch through city boards and state government. The framework does not separate mitigation and adaptation.

The organizational structure for drought management in the USA and Australia shows the following:

- *a strong, efficient and permanent collaboration between institutions involved in DM and a clear definition of the scope of activity and duties of each one*
- *an effective proactive action based on a efficient drought monitoring system and thus a good information flow between monitoring and mitigating activities*
- *the development of drought management plans at national or even lower levels*
- *strong research and application science and*
- *development of a national drought policy.*

In Africa most institutions involved in drought management are in fact only involved in mitigation activities. Very few institutions work specifically on planning for drought. Drought and/ or water management is scattered among several institutions including those responsible for the following:

- *water and environment*
- *agriculture including irrigation*
- *forestry*
- *energy and mines*
- *industry and transport and*
- *Interior/local government.*

The organizational structures in Africa are characterized by:

- *lack of a department that deals specifically with drought related issues*
- *lack of structures for managing drought at the local level*
- *division of responsibilities among many governmental jurisdictions*
- *lack of coordination and integration between the large number and variety of institutions involved in drought management; duplication and conflicts of interests that emerge among them*
- *inadequate infrastructure including drought forecast systems, advanced models and software*
- *lack of equipment and technology to increase the credibility of information*

- *no clear drought management policies and drought mitigation plans*
- *inadequate financial resources*
- *Lack of involvement of the private sector*
- *lack of technical capacity, insufficient human resources and inadequate training and*
- *weak science-policy interface.*

A further analysis of the ***organizational structures for drought management in Africa*** *shows that in most countries government ministries/agencies and international NGOs are involved especially on mitigation activities. The involvement of government ministries/agencies is intended to provide for the following* ***strengths****:*

- *legal authority to manage drought and responsibility for water resources irrigation planning and implementation*
- *part of government machinery and are able to guide policy*
- *can initiate large construction of water storage infrastructure*
- *coordinate basin development policy, monitors and evaluates basin mitigation*
- *provide prompt health services*
- *regulates and set standards and policy for health service delivery*
- *collect/monitor and assemble long term historical data from observation network*
- *some capacity to analyse, assess and predict drought situations*
- *regular drought prediction and monitoring products*
- *human resources well trained in the field of risk assessment and management*
- *capacity to intervene during the natural disasters and*
- *coordination of disaster management efforts.*

International NGOs which include ISDR, UNOCH, World Vision, Action Aid, Practical Action, Plan International, Care International, Kenya Red Cross, FEWSNet and World Food Program are involved in drought mitigation. *These NGOs have the following* ***strengths:***

- *drive and influence drought risk reduction strategies*
- *provide policy guidance*
- *can convene ad hoc meetings of experts*
- *empower communities*
- *participate in rehabilitating and constructing shallow wells and boreholes*
- *carry out humanitarian work*
- *promote pilot intervention on resilience*

- *coordinate formulation and implementation of policies and institutional framework for drought mitigation*
- *coordinate the mobilization of resources for drought mitigation*
- *coordinate all stakeholders on drought risk reduction and mitigation*
- *monitoring and evaluation of the drought mitigation programmes*
- *provide information for drought mitigation*
- *UN agencies have a forum within the United Nations system*
- *Involvement of NGOs opens access to substantial international human and institutional resources*
- *UN agencies and NGOs command good will and*
- *technical assistance and financial/material support help communities in rebuilding their livelihoods.*

*The main **weaknesses of the approaches** by the NGOs on drought mitigation are as follows:*

- *limited in personnel for extended programs*
- *activities are project area is specific and funds rely on good will donations*
- *sustainability of interventions not guaranteed.*
- *cover a very wide range of activities*
- *do not have distribution network and rely on government and other NGOs to implement programs*
- *inadequate spatial resolution of drought impact assessment*
- *sampling/selection methodologies are generally weak and*
- *engendered a culture of dependency from relief efforts.*

*The existing **institutional arrangements for drought mitigation in Africa** offer following **opportunities**:*

- *the framework for mobilization of government agencies exists*
- *substantial resources can be brought together*
- *institutional structures for water management and development as well as health and sanitation exist*
- *the need for strategies to manage and mitigate drought is generally appreciated*
- *the need for drought early warning systems is appreciated*

Possible improvements in the existing institutional structures for drought management in include the following:

- ***continuous and efficient collaboration of ministerial departments and services*** *involved in drought management, not only limited to drought periods*
- ***reinforcement (and/ or creation) of institutions or at least ministerial services or cells*** *specially dedicated to drought monitoring, awareness-raising and disseminating information*
- ***development of Public Private Partnerships (PPP****): Collaboration between private and public sectors is essential*
- ***promotion of a participatory approach to drought management****: Community participation is essential for increasing community ownership and ability to replicate and sustain activities. The emphasis on the roles of community organization such as water users associations.* ***Empower the hierarchy of rural structures*** *from clan, division, and county structures to inform the national policy and intervention planning*
- ***effective development and use of drought plans****: A risk analysis must be carried out to assess its probability of occurrence and measures to be applied, must be planned ahead*
- ***mainstreaming of drought management into an integrated management framework*** *for coping with drought impacts on different sectors*
- ***promotion of regional collaboration and share of experiences****: Strengthen existing networks to share experiences and lessons learned (successes and failures) on drought mitigation and adaptation*
- ***development of the science-policy interface (SPI)****: Improve understanding of policy makers regarding scientific issues and technical constraints, as well as the understanding of scientists on the existing policy constraints*
- ***enhancement of research on drought management****: Cluster drought-related research themes along the drought management cycle and*
- *incorporating* ***concepts of Integrated Water Resources Management (IWRM)*** *in drought mitigation and adaptation practices, and in drought management*

1 INTRODUCTION

This deliverable provides an inventory of institutional frameworks for *drought mitigation and adaptation in* Australia, America and Europe. The experiences in Australia, America and Europe are used to define "state of the art drought mitigation and adaptation practices". A gap analysis is then conducted by comparing these with the drought mitigation and adaptation practices in Africa as captured in deliverable D2.2. The comparison is done for the Oum-er-Rbia River Basin, (Morocco), Eastern Nile Basin (Burundi, Egypt, Ethiopia, Kenya, Rwanda, Sudan and Tanzania), Limpopo Basin (Botswana, Mozambique, South Africa and Zimbabwe) and Niger Basin (Algeria, Benin, Burkina-Faso, Guinea, Ivory Coast, Mali, Niger and Nigeria). These river basins are shown in Figure 1. This deliverable also uses the historical drought experiences described in Deliverable D2.3 to assess information requirements to further inform the gap analysis.

This document addresses two objectives of Work Package 2 as follows:

a) to assess European and globally available drought mitigation and adaptation practices and institutional frameworks
b) to identify gaps/opportunities in drought mitigation and adaptation practices and institutional frameworks in Africa compared with globally available state-of-the-art.

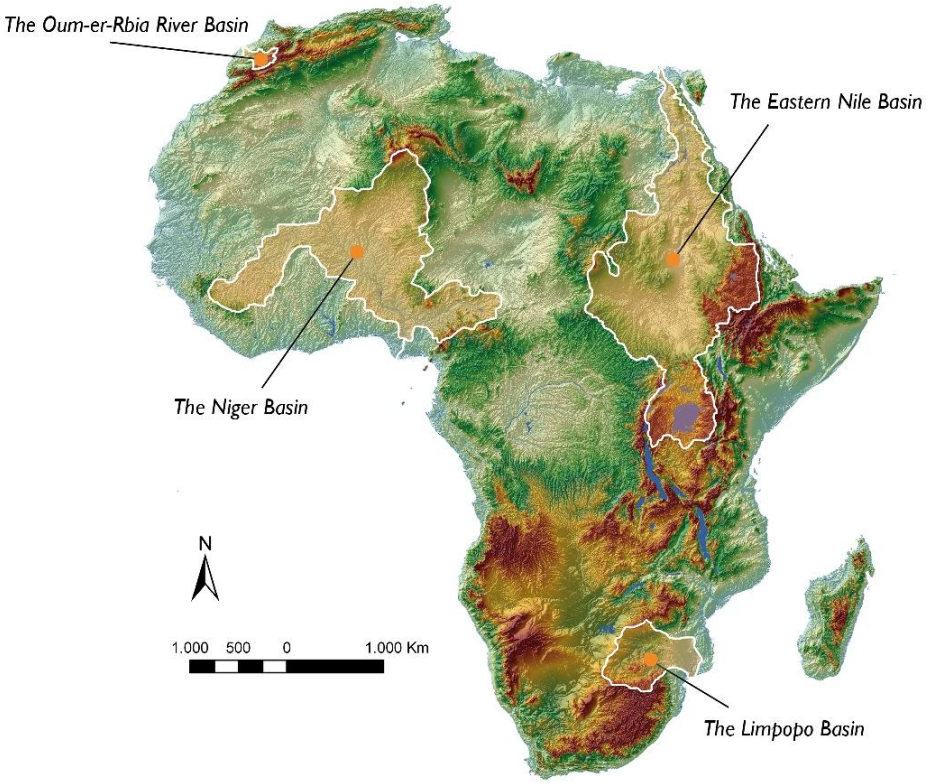


Figure 1: Location of case study basins

2 IMPORTANT DEFINITIONS

The following definitions apply to this document:

- **Drought** – a condition that originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector
- **Meteorological drought** – occurs when annual precipitation is between 70% and 85% of the long-term annual mean precipitation.
- **Hydrological drought** - a deficit in runoff in rivers, surface reservoirs and ground water
- **Agricultural drought** - a situation of inadequate soil moisture for rain-fed crops
- **Socio-economical** - a drought which results in social stress and economic hardships
- **Drought mitigation** – the reduction in the classification of a drought in terms of frequency and magnitude of risks and resulting from reduction of the potential impact of a drought
- **Drought adaptation** – a process of being able to survive in a drought condition. It refers to changes in processes, practices, and structures to moderate potential impacts of future drought.
- **Desertification** - a process of land degradation in arid, semi-arid and dry sub-humid areas, resulting from various factors, including climatic variation and human activities. Land degradation manifests itself through soil erosion, water scarcity, reduced agricultural productivity, loss of vegetation cover and biodiversity, drought and poverty.

3 INVENTORY OF AVAILABLE STATE OF THE ART DROUGHT MITIGATION AND ADPTATION PRACTICES IN THE EUROPEAN UNION

Based on DG ENV (2007a) data provided by several Member States, severe drought events, have affected, on an annual basis, more than 800.000 km² of the European Union's territory (37%) and at least 100 million inhabitants (20%) with different degrees of intensity. Figure 2 shows the main drought events occurred in Europe during the last decade, being the Iberian Peninsula the region with higher number of occurrences (3): 2003, 2005 and 2007-2008.

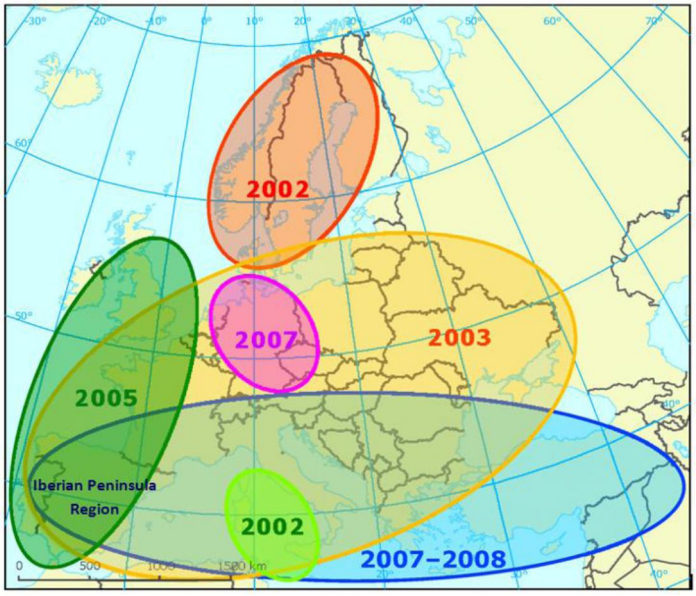


Figure 2: Main drought events in Europe of the last decade (EEA, 2010; Maia, 2011)

Moreover, water scarcity's impacts have affected at least 19% of the European Union's inhabitants and 33 river basins (12%) within the European Union's territory. In fact, water scarcity and drought issues are of main relevance in the European context, since most Member States have suffered drought episodes in recent decades and many situations of water scarcity and aquifer overexploitation have been reported. According to the DG ENV EC (2007a), several Member States, including Spain, are using up 20% or more of their long-term supplies every year.

On the other hand, Climate Change (CC) is expected to influence the baseline of present water scarcity and droughts (WS&D) difficulties, with a direct bearing on water availability and quality, affecting in particular the temporal and spatial variability of water availability and extreme hydrological events. In this way a link should be established between the two issues of WS&D and CC and their specific strategies (MAOTDR, 2007). The adopted EC Green

Paper on adaptation already focuses on these aspects, regarding that drought situations could become more frequent across the entire EU and water quality will deteriorate (CEC, 2007b).

Nonetheless, the main overall objective of EU water policy centred on Water Framework Directive (WFD) is to ensure access to good quality water in sufficient quantity for all Europeans, and to ensure the good status of all water bodies across Europe. The full implementation of the WFD is a major priority for the Member States, since:

(i) it expands water protection to all waters, groundwater and surface waters;
(ii) it aims within a set deadline to achieve and keep "good" ecological and chemical status and to promote "no-deterioration" state after its implementation;
(iii) it envisages the development of a single management system for all European waters, the river basin;
(iv) it supports the establishment of appropriate water pricing policies and
(v) it aims to introduce public participation within water management.

The River Basin Management Plans, as established under the WFD, will need to take into due account both demand and supply side measures, including within-year and over-year behaviour analyses, and to consider new water supply infrastructures when necessary, subject to the scrutiny of EU legislation enforcement.

A common approach to drought risk assessment and drought management plans should be adopted, bearing in mind that droughts, with their specific regional characteristics, are a common concern of all Member States. In fact, in November 2003, the informal meeting of the EU Water Directors reached the agreement to develop an initiative on WS&D issues. This decision came after one of the most widespread droughts, in 2003, when over 100 million people and a third of the EU territory were affected. The Communication of the Commission towards the European Parliament and the Council addressing the challenge of water scarcity and droughts at the European Union (CEC, 2007a), issued in the 18th of July 2007, identified a first set of policy options with a view to opening up a wide-ranging debate on how to adapt to WS&D. The proposed policy options are the following:

- Putting the right price tag on water;
- Allocating water and water-related funding more efficiently:
    - Improving land-use planning;
    - Financing water efficiency.

- Improving drought risk management:
    - Developing drought risk management plans;
    - Developing an observatory and an early warning system on droughts;
    - Further optimising the use of the EU Solidarity Fund and European Mechanism for Civil Protection.
- Considering additional water supply infrastructures;
- Fostering water efficient technologies and practices;
- Fostering the emergence of a water-saving culture in Europe;
- Improve knowledge and data collection:
    - A water scarcity and drought information system throughout Europe;
    - Research and technological development opportunities.

In general the Commission's Communication focused on the full implementation of the Water Framework Directive and identified additional policy options that could be implemented within the WFD in order to address WS&D in specific. In 2012, the WS&D Policy review will be integrated in a revised European water strategy – called a "Blueprint to safeguard European Waters". This Blueprint will be based on a report on the implementation of the WFD, a review of vulnerability of environmental resources (water, biodiversity, soil etc.), to climate impacts and man man-made pressures.

In this context, although there is no specific Drought policy in Europe many approaches and activities are currently on-going in Europe to monitor and manage drought, water scarcity and desertification risk, with the priority to move towards a water-efficient and water-saving economy. In fact, several countries are already monitoring drought or developing regional or national Drought Management Plans [DMP], while others are considering drought management in the context of the River Basin Management Plans (EEA, 2009; CEC, 2010). Also, at EU level, various initiatives related to droughts are being implemented by different agents, centres and networks (e.g. Joint Research Centre – Institute for Environment and Sustainability [JRC-IES], Drought Management Centre for South-Eastern Europe [DMCSEE], European Drought Centre [EDC], Euro-Mediterranean Information System on know-how in the Water sector [SEMIDE/EMWIS], European Environment Agency [EEA], etc.). The supported activities deal with different aspects like drought observation and forecasting, indicators' based information collection and dissemination, impact and risk assessments, development of mitigation measures like DMPs, development of a drought policy framework

etc., nevertheless the inter-linkages are significant; hence a good framework for cooperation, clear definition of roles and efficient joint use of information is vital (EEA, 2009).

Therefore, the following topics are focused in shortly describing: (i) the experience of the different EU member states on drought mitigation and adaptation, (ii) the best practices identified by European R&D projects, like MEDROPLAN and XEROCHORE projects in that subject and, finally, (iii) a compilation of the more important examples of drought mitigation and adaptation practices normally adopted in Europe, for different water uses, regarding the information available for the southern region of EU, more severely affected by drought situations.

3.1 EXPERIENCE OF DROUGHT MITIGATION AND ADAPTATION PRACTICES IN EU MEMBER STATES

This section presents a description of the drought mitigation and adaptation experiences in Europe, based on a brief overall characterization of the situation of the European member states in terms of drought management, and also on a more detailed description of the mitigation and adaptation experience presented for four EU member states that can be considered representative of different realities in Europe, in that subject. For the southern region, more arid and severely affected by drought situations, it is described the situation of Spain (considered a water stressed country) and Portugal (considered a non-water stressed country). On the other hand, for the North/Centre region of Europe, with less arid climate conditions England (as representative of water stressed country) and the Netherlands (as representative of non-water stressed country) were considered.

3.1.1 Overall characterization of drought management capabilities of EU states

The characterization of drought management capabilities in Europe is made regarding (EEA, 2009): (i) the classification as water stressed or non-water stress country, (ii) the existence (or not) of drought management plans and, (iii) even if there are no drought plans, the existence of any programmes of measures/ early warning systems/ monitoring systems created to support the management of drought situations and (iv) finally, if there is specific drought management system, the main actions already applied. The resume of the information available based on these topics is briefly systematized in Table 1 and Figure 3. Although the Czech Republic, Malta and Poland are classified as water stressed no information is available on drought management plans and actions implemented. Nine other countries namely Ireland, Estonia, Finland, Latvia, Lithuania, Luxembourg, Romania, Slovakia and Slovenia are not water stressed.

Table 1: Characterization of the European member states situation in terms of drought management (based on European Environment Agency (EEA), 2009, and European Centre for Climate Adaptation - ECCA, 2012)

Countries	Classification (EEA, 2009)	Drought Management Plans (DMP)	Main actions already applied
Austria	Non-water-stressed		Water saving campaigns, use of new water sources (springs) and establishment of provisional associations.
Belgium	Water-stressed		Educational measures to mitigate water scarcity and drought; thematic centre to provide information on sustainable water use; awareness rising campaigns through printed (newspapers and magazines) and audio-visual media (TV and radio).
Bulgaria	Severely water-stressed	YES	Measures for control, monitoring and assessment of drought; insurance of minimum permissible rivers run off; measures to prevent from groundwater overexploitation; selection of drought resistant crops.
Cyprus	Severely water-stressed		Restrictions in the supply of water for irrigation purposes; multiple water development strategy of collecting, producing, recycling and conserving water (construction of dams and desalinization plants, wastewater recycling for irrigation, conservation campaigns, incentives for households water recycling)
Denmark	Non-water-stressed		Local community-based programmes to sustainable enhance the productivity of land and the efficient use of water resources.
France	Water-stressed	YES	Water scarcity management plan to reduce France's exposure to drought (additional safety margins to the drinking water supply, reconciling the various uses while preserving the quality of aquatic environments); Drought Early Warning System (DEWS) as well as Drought Mitigation and Response Plans.
Germany	Water-stressed		Water saving measures (water consumption control); price policies; Adaptation Strategy

Countries	Classification (EEA, 2009)	Drought Management Plans (DMP)	Main actions already applied
			to Climate Changes.
Greece	Non-water-stressed		*Proactive measures:* construction of water reservoirs; groundwater recharge; measures for the protection and recharge of water tables and to reduce irrigation; canal rectification to reduce water losses; modernization and improvements of irrigation networks. *Reactive measures:* constraints in water consumption, intensification of the use of groundwater resources, reallocation of water resources, use of saline and brackish waters and water transfer.
Hungary	Non-water-stressed		National Drought Strategy promoting water-saving farming methods, as tillage systems, plant protection and weed control; amelioration and irrigation; etc; forestation programmes that support the planting of drought-resistant; storage of excess surface waters; increase of the water storage capacity of the soil; alternative development of irrigation regionally; reconstruction of water-flow regulation facilities.
Italy	Water-stressed	YES	Priority allocation of available resources to perennial crops and water rationing for annual crops; maintenance of canal networks for reducing water losses; transformation of the irrigation canal networks in pipelines; public ponds to improve the operation of irrigation systems; introduction of more efficient irrigation techniques; construction of farm ponds, or reduction of irrigated areas for annual crops; deepening of existing wells or construction of new ones; water transfer by water tanks in extreme cases.
Portugal	Non-water-stressed		Details provided in section 4.1.2
Spain	Water-stressed	YES	Details provided in section 4.1.3
Sweden	Non-water-stressed		Policy reports and textbooks or even techniques to manage demand in dry periods ranging from temporary restrictions on water use to public education campaigns, have been identified.
The Netherlands	Non-water-stressed		Details provided in section 4.1.4
England	Water-stressed	YES	Details provided in section 4.1.5

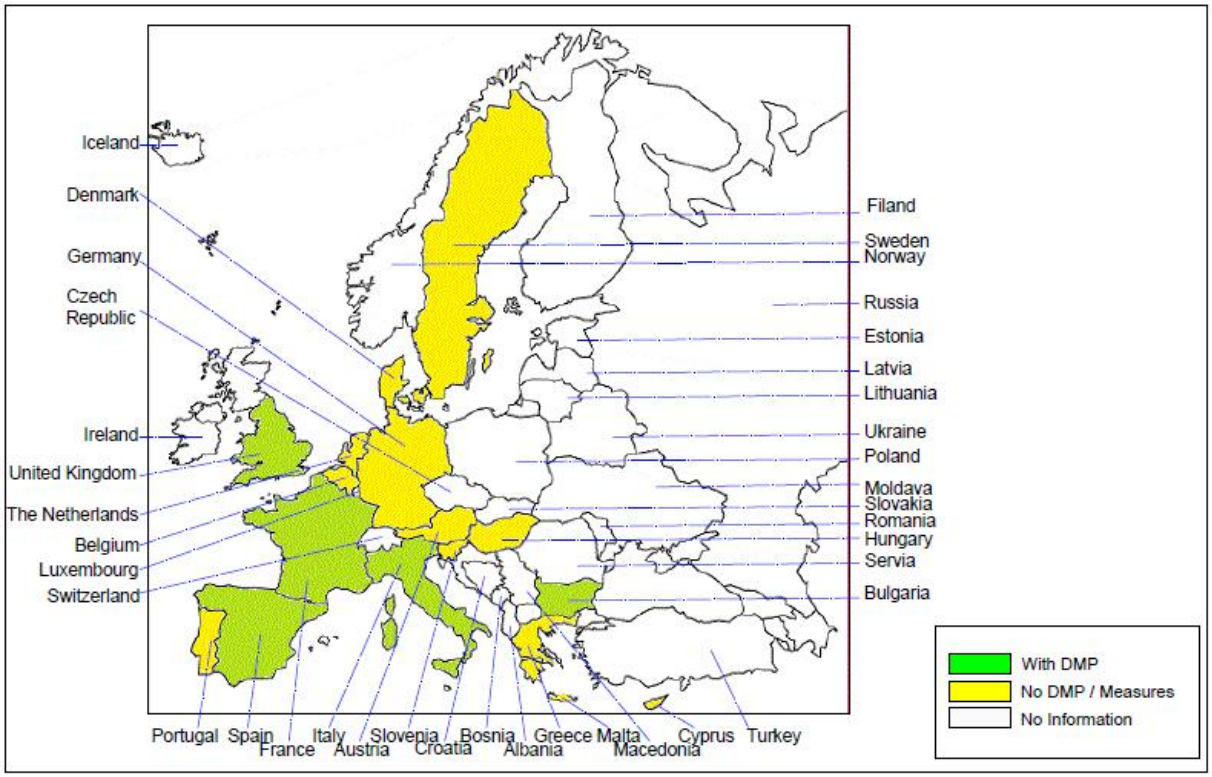


Figure 3: Characterization of the European member states situation in terms of drought management (based on EEA, 2009, and ECCA, 2012)

3.1.2 Drought management experience in Portugal (Southern Europe)

Portugal is classified as a non-water-stressed country (EEA, 2009). On the other hand, droughts occur regularly with more of less intensity, depending also on the duration and timing of occurrence (winter or summer). The drought situations can result in widespread impacts in different activities such as in agriculture, forest fires, water distribution to population and energy generation.

As detailed in DG ENV (2007b), the practice in Portugal is that before the occurrence of a drought, in normal climate situation, there is a permanent monitoring by the Meteorological Institute (IM) of the main climate variables, namely precipitation and temperature, and also by the Water Authority (APA, former INAG) more specifically regarding river water flows, reservoirs water levels, groundwater levels and river water quality. However, when a drought situation is detected and declared, a drought commission is constituted, by the Government, in order to ensure drought management at two different action levels:

(vi) for the political and strategic issues;

(vii) for the technical and operational issues.

The operation of the drought commission is especially focused on the permanent availability of information to all authorities, economic agents and the public in general, using a page on the internet created for this specific purpose, and to exchange documents for decision-making.

As an example, the evolution of both the 2005 and 2012 drought situations was evaluated on real time, in terms of water availability in rivers, reservoirs and groundwater and the water requested by the different water users, in order to define different levels of priority and restrictions. Public and institutional awareness campaigns were applied, as well as exceptional measures, including the construction of emergency infrastructures and new wells that were implemented according to the local needs (especially in the 2005 drought situation).

Also, regarding the 2005 situation, the Drought Commission elaborated, at the end of the drought, the Drought Balance Report, with the main results and lessons obtained. From that report it is possible to conclude that the lessons from the 2005 drought situation include among other issues (CPS, 2005), the review of the existing drought monitoring and management procedure, in order to foster the development of a Drought Alert and Management System - SPGS "*Sistema de Previsão e Gestão de Secas"*. The SPGS (still in prototype phase) is further described in Appendix B of Deliverable D2.4. Its purpose is to provide managers and users of water resources with an instrument that allows the anticipation of the potential impacts of drought situations, in order to promote the implementation of mitigation measures.

In terms of drought monitoring and assessment features, the SPGS enables the following:

(viii) the evaluation of drought severity taking into account the socio-economic impacts;

(ix) the (monthly) evaluation of current situation and outlook of future evolution trends, till the end of the present hydrological year (based on appropriate scenarios and simulation of hydrological conditions);

(x) the elaboration of maps, expressing, at the spatial level, the distribution of drought severity.

In terms of drought management features, the SPGS enables the identification and selection of measures according to the current and potential impacts (till the end of the hydrological

year) on different water uses, in accordance with the socioeconomic classification of drought severity.

Presently droughts' risk assessment is also an important topic already integrated in the new generation of River Basin Management Plans (developed in the frame of WFD implementation), though they generally indicate the necessity to elaborate specific drought management plans for each river basin in the near future.

On the other hand, regarding the adaptation to future drought situations in Portugal, it should be noted that the National Program for Efficient Water Use (PNUEA – "*Programa Nacional de Uso Eficiente da Água*") is a national wide program that was created to attend to unsustainable economic and environmental costs, the consequence of considerable water losses on water systems and non-rational use of this resource in domestic, agricultural and industrial sectors. This program proposed the application of specific conservation measures for each water user. It was approved in July 2005 and the initially foreseen period for total program implementation is of ten years.

3.1.3 Drought management experience in Spain (Southern Europe)

Located in the Iberian Peninsula, as Portugal, Spain is also regularly affected by drought situations. However, the situation is even more critical, since Spain is a water-stressed country as classified by EEA (2009).

In fact, the National Hydrological Plan Act (Law10/2001 of 5th July) already established, in 2001, that to decrease drought vulnerability, should be developed (i) drought management plans (DMPs) for each River Basin district, (ii) a drought monitoring system and (iii) emergency plans, specific for urban water supply for settlements with more than 20.000 inhabitants.

The DMP were approved by Ministerial Order in March 2007 and are considered, according to the Hydrological Planning Royal Decree (RD 907/2007), as specific plans associated to the respective River Basin Management Plans: (Estrela, 2006), namely for the specific river basin districts: Cantabrico; Douro; Ebro; Guadiana; Jucar; Miño-Sil; Segura; and Tejo. Moreover, presently, some of these drought plans were already revised for the first time in the new generation of River Basin Management Plans (developed in the frame of WFD).

These DMPs identify the most adequate mitigation measures, adapted to the different established drought thresholds and phases. They have provided the basis for a more planned drought management in Spain, establishing drought phases and describing the measures that should be progressively applied and the needed monitoring and follow-up processes for each river basin. The basin's drought policy can be summarized in the following list of possible actions to be taken in case of drought:

- **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.
- **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.
- **Water resources**. Drought measures focus on conservation and protection of stored resources, activation of additional resources or monitoring of indicators of water quality.
- **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.
- **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.

The DMP are also supported by a core set of indicators, defined by the Spanish Ministry of Environment and other Public Bodies such as the Hydrological Studies Centre (CEDEX) that facilitate a better understanding of the water resources status and identify the main pressures and uses of the water in Spain. In fact, these indicators are the support of drought management and prevention in Spain, since they constitute the basis not only for the application of the mitigation and adaptation practices, defined in the regional drought management plans, but also for the National Drought Indicator System (for each river basin district, further described in Annex B of D 2.4) that ensures the drought monitoring and follow up.

This monitoring system is formed by basic variables selected in different points throughout the river basins (reservoir storages, groundwater piezometric levels, stream flows, reservoir inflows and precipitation) that are weighted in order to obtain an integrated indicator representative of the hydrological status in each river basin. This indicator is compared to

historical series and the standardized values of the indicators (ranging from 0 to 1) define the basin drought status: normal, pre-alert, alert and emergency, useful to launch the different measures detailed in the drought management plans to mitigate the effects of droughts. The link between the drought status results and the adoption of the necessary mitigation measures is generally defined in Table 2, being possible that slight differences occur for each river basin.

Table 2: Schematic definition of the link between the indicators results and the mitigation measures defined in DMP (Vargas, 2008)

TYPES OF MITIGATION MEASURES							
Indicator	1-0.5	0.5-0.4	0.4-0.3	0.3-0.2	0.2-0.15	0.15-0.1	0.1-0
Status	Normal	Pre-alert		Alert		Emergency	
Objective	Planning	Information-control		Conservation		Restrictions	
Type of measure	Strategic			Tactics		Emergency	

Estrela and Vargas (2012) also highlighted that once drought management plans came into force, a Royal Decree-Law was passed in 2008, which contained emergency measures regarding mainly fees' payment exemptions and extraordinary measures of land occupation. In addition, in this decree-law, the water use rights management was approved and the declaration of drought situation in the river basins affected was established, taking as a general reference the basin status of the National Drought Indicator System. These definitions were very useful to put the necessary measures into practice when needed in accordance with the criteria established in the DMPs.

The Drought Management Plans have contributed to alleviate the negative effects of the last drought occurred in Spain, resulting in water savings, avoiding public water supply restrictions and improving aquatic ecosystem protection. These plans are considered as supplementary plans to the River Basin Management Plans and have proven to be valuable management tools. In the development and application of the DMPs, public participation and the involvement of all interested parties (users, NGOs, administration, private sector, universities, etc.) as well as the consideration of environmental requirements have been essential to minimize social conflicts caused by the lack of sufficient water resources.

Finally, it should be referred that the emergency plans for urban water supply enables the water utilities to count with several emergency measures to manage the impact of drought including measures to reduce demand as well as resource options and cover a range of

scenarios from high demand during short summer dry spells to more prolonged drought events.

3.1.4 Drought management experience in the Netherlands (Northern/central Europe)

The Netherlands is classified as non-water-stressed country (EEA, 2009). Also, being located in the north/centre region of Europe, the climate is more humid than in the southern countries (namely, for example, Portugal and Spain). However, since in the Netherlands there is an increase of water abstraction, it is considered that some cases of water deficit can occur (EEA, 2009).

In fact, in a lowland country like the Netherlands water can be readily distributed through a network of canals and ditches. During dry periods river water is transferred into the network, and used for agriculture. Locally the surface water network is also needed to set up water levels preventing intrusion of saline groundwater. In areas where no surface water is available, groundwater is used for irrigating. However under normal conditions (no drought) the main water source for agriculture is precipitation, either directly or through the replenishment of the groundwater (DG ENV; 2007b).

Moreover, warm summers, as the one recorded in 2003 resulted in deficit of cooling water, causing problems in power stations affecting the energy supply. Extreme dry spells led in the past to extensive forest fires, as well. As far as agriculture is concerned, it forms the larger single water consumer for the Netherlands and water deficit for irrigation can cause damages to crops. Also, the Dutch government is concerned about the impacts of drought on environment (aquatic habitats and terrestrial nature) and also on social activities like cruising, recreational angling and swimming.

Recently (2005-2006) a policy study on drought risk management developed a scheme for qualifying drought severity on the basis of the (adverse) consequences of the drought, taking into account a detailed list of economical, environmental and social factors. However, since consequences will only be known after a drought event, the scheme cannot be used for operational management.

The most important drought mitigation actions adopted in the Netherlands are, then, as follows:

- A time-dependent (monthly) lower limit is assumed for Rhine discharge levels, and the LCW (National Coordination Committee for Water Distribution) is expected to meet when the limits are exceeded and the situation is expected to last longer than 3 successive days. Also, discharge and water temperature can be specific reasons for a LCW meeting.
- During water deficit, water drainage is avoided as much as possible.
- Abstraction of drinking water is avoided where and/or when possible.
- Weirs and discharge sluices are kept closed with full chambers.
- Flushing used to combat salinization is restricted.
- Anti-drought measures, such as letting in fresh water and changing the management of sluices, can exacerbate the salinization of surface water and groundwater in those parts of the country at or below sea level.
- In general, every user is expected to use water as efficiently as possible.

3.1.5 Drought management experience in England (Northern /central European)

Although located in the central region of Europe, and being more humid than the southern region (as the Netherlands), also due to the strong influence of the Atlantic Ocean (as an island), England is classified as a water-stressed country (EEA, 2009).

In this context, in England, the drought plans are voluntary and not required under statutory legislation, or under regulatory or administrative provision (except in what regards emergency plans for water utilities). Even though, there are specific drought plans for England, developed by the Environment Agency (EA – national entity responsible for drought management) at two different spatial scales:

- National Drought Plan
- Regional Drought Plans

The National Drought Plan is an overall plan that sets the main guidelines, at national level, of the drought management process in England, coordinated, at regional level, with the referred Regional Drought Plans.

There are seven Regional Drought Plans; one for Wales and other six plans, one for each of the six Environment Agency dependencies in England, namely:

- Anglian Region
- Midlands Region

- North West Region
- South East Region
- South West Region
- Yorkshire and North East Region

Figure 4: England territory division in seven regionals authorities

In all of these drought management plans, a range of drought triggers was defined to identify whether there is a need to take drought actions and when, although the surpassing of a drought trigger does not necessarily mean that a specific action must be taken. The decisions on whether action is needed is based on a range of factors, including present and forecast conditions and assessment of how effective the action would be, with local judgment an important part of drought management (see also the institutional framework on section 7.1.4).

The EA also publishes Early Drought Prospects reports whenever a drought situation is imminent and also throughout the drought situation. They identify the hydrological situation,

the area likely to be affected by drought, and recommended actions for water companies, farmers and people.

The droughts actions and respective triggers, for each region, are organized in accordance with the drought stage:

i. normal situation,
ii. potential drought,
iii. during a drought and
iv. post drought.

In normal conditions, there are no particular drought actions other than monitoring hydrological and environmental conditions. At this stage organizations start to get ready to deal with drought. It is considered as drought the stage where the impact can be measured, either on the environment or on water availability, being certain that some droughts can have a very minor impact, while others are extremely serious.

In terms of mitigation measures in England and Wales spray irrigation can be limited by the Environment Agency as needed. In addition many abstraction licences have conditions that limit/stop abstraction at times of low flows or water levels. In Northern Ireland water use restrictions and interruptions are determined by assessment of the extent of water scarcity.

Only after a drought is over (post-drought situation) the duration and extent of the drought is identified. Rainfall deficit is an important part of measuring drought duration and intensity, but comparison between droughts (at hydrological year scale) and assessment of the impacts caused are also crucial. It is important to notice that, as described in DG ENV (2007b), England does not attempt to define different drought severity, since droughts are complex events and it is considered that no benefit results from debating the exact stage of a drought. England, therefore considers more important to make sure that appropriate actions are taken, proportionate to the potential impact and specific to the drought experienced.

Also, regarding drought management, the Environmental Agency's website provides information on droughts, and assures the execution of Habitats Regulations Assessment if actions foreseen in drought plans could have an impact on European designated sites. The revision of the regional drought plans is made each spring to make sure all experiences from drought situations are captured.

On the other hand, all water supply companies must have emergency drought plans by law. Similarly to the situation in Spain, these drought plans explain the measures that water companies will take to identify and manage the impact of drought. These include also an assessment of the environmental impact of different drought management options and are subject to public consultation and submitted to Government Ministers, being reviewed in a three-year cycle.

3.2 DROUGHT MITIGATION AND ADAPTATION PRACTICES FROM RESEARCH AND DEVELOPMENT PROJECTS.

Several research projects funded by the European Union such as ARIDE, SEDEMED, WAMME, PRODIM, MEDROPLAN, WATCH, MIRAGE, XEROCHORE and others show significant and useful results on how to better manage water scarcity and droughts (Estrela and Vargas, 2012). These projects increased the knowledge on droughts in different research areas and regions providing additional tools and experiences for policy makers and water managers. The MEDROPLAN (2007) and the XEROCHORE (2010a; 2010b; 2010c) projects are two of the more important projects in this subject, having contributed to a systematization of best practices on drought adaptation and mitigation practices for Europe and the Mediterranean region. These two projects are further described in the following topics.

3.2.1 Experiences from the MEDROPLAN

Using the experience from different countries/case studies (Cyprus, Greece, Italy, Morocco, Spain and Tunisia) and the current legislation, management, technology and methods for evaluating drought risk, the **MEDROPLAN** project (Mediterranean Drought Preparedness and Mitigation Planning) developed Drought Management Guidelines for Mediterranean countries which provide an effective and systematic approach to develop drought management plans linking science and policy. These Guidelines (MEDROPLAN, 2007) were developed starting from the premises of moving from a reactive to a proactive approach to fighting drought, placing emphasis on the institutional and legal framework and on stakeholder participation, and establishing a wide range of methodologies to cope with drought. The MEDROPLAN defines drought adaptation and mitigation process as the operational component of drought management, which includes six fundamental aspects:

- Preparedness, early warning, monitoring systems;
- Establishing priorities of water use;
- Defining the conditions and the thresholds to declare drought levels;

- Establishing the management objectives in each drought level;
- Defining the actions;
- Implementing actions.

In fact, preparedness and early warning are considered the key to determine the success of the overall drought management plan since they help to:

(xi) establish the drought plan:

(xii) reduce social vulnerability,

(xiii) identify alert mechanisms;

(xiv) establish the links between drought, water and development policies.

The effective response to drought events is considered to rely on having a monitoring system able to provide adequate and timely information for an objective drought declaration and for avoiding severe water shortages through effective water resource management. The main objective of a monitoring system is to help decision-makers identify the drought warning conditions and to provide useful information for identifying the best drought mitigation measures on the basis of a continuous monitoring of drought's evolution in terms of meteorological and hydrological variables and water resource availability. The slow initiation and undefined end of a drought makes it difficult to select the opportunity to take defensive or remedial action. Thus MEDROPLAN suggests that drought measures should be organized according to two different levels of priority:

a) Ensure that adequate supplies of domestic water are available for public health, safety and welfare.
b) Minimize adverse drought effects on the economy, environment, and social well-being.

On the formal declaration of drought the approach by most public institutions is cautious, and is only issued when a water shortage situation is of extreme magnitude, which, in many cases, means that only emergency actions are possible. MEDROPLAN Guidelines address this key issue by linking technical indicators to manage actions:

- The pre-alert scenario shall be declared when monitoring shows the initial stage of drought development, which corresponds to moderate risk (e.g. greater than 10%) of consuming all water stored in the system and not being able to meet water demands.
- The alert scenario shall be 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 (e.g. greater than 30%) of water deficits in the time horizon.

- The emergency scenario shall be declared when drought indices show that impacts have occurred and supply is not guaranteed if drought persists.

The measures to be taken in each drought alert level are specific according to drought management objectives. In the **pre-alert** scenario the main goal is to prepare for the possibility of a drought, i.e., to ensure public acceptance of measures to be taken if drought intensity increases by raising awareness of the possibility of societal impacts due to drought.

The pre-alert measures are generally of indirect nature, implemented voluntarily by stakeholders and usually low-cost. In the **alert** situation the objective is to overcome drought by avoiding the emergency situation through the application of water conservation policies and mobilization of additional water supplies. The kinds of measures that are taken in the alert situation are generally of a direct nature, coercive to stakeholders and generally of low to medium implementation cost, although they may have significant impacts on stakeholders' economies. During the **emergency** situation the objective is to mitigate impacts and minimize damage. The priority is satisfying the minimum requirements for drinking water. Other uses of water are a second priority in this level of drought. Measures adopted in emergency are of high economic and social cost, and they should be direct and restrictive.

Finally, drought actions are defined in two steps, description and ranking. The description, drought of measures shall have precise and quantitative actions, a definite organizational unit responsible for the action and also of the timeframe of implementation. On ranking, the general objective is to allow for a certain level of prioritization depending on the evaluation of aspects like: effectiveness, costs, feasibility, assistance required for adoption and adequacy for non-drought situation.

Public review must also play an important role throughout the plan development process since the social and environmental conditions may change and aspects of risk analysis and management improve and evolve. Once the plan is developed, it may be necessary to revise periodically certain aspects or the totality of the plan. In European countries, the information and public participation in the development and the revision of drought management plans should be achieved according to article 14 of the European WFD (2000/60 Directive).

3.2.2 Experiences from the XEROCHORE

The XEROCHORE (2010a; 2010b; 2010c) is another research project that provides an overview of existing drought policies, drought management efforts and drought-related research projects. It is possible to conclude from several countries experience that rather than focusing only on drought mitigation and recovery, equal (or more) emphasis needs to be placed on drought preparedness and enhanced water security. Since drought has significant impact on the temporal and spatial availability of water resources, thus affecting the wellbeing of society and the environment, drought policies need to be mainstreamed with existing water management and climate change adaptation policies, rather than being developed aside from these. Therefore drought-related aspects should be integrated into water management policies on two levels (XEROCHORE, 2010a):

- the development of drought management plans, specifying a concerted course of action, to be implemented once a drought event occurs;
- the development of a permanent strategy for enhancing resilience to drought events, thus helping to achieve water security.

A process for the development of Drought Management Plans (DMPs) is proposed, to include (XEROCHORE, 2010a): a) preparatory actions, such as the development of the organizational structure to support the drought definition and risk assessment activities, and the integration of science and policy aspects, b) publication of the draft DMP and stakeholder consultation processes, c) DMP implementation, and d) development of public awareness programmes and post-drought evaluation processes. On the other hand, besides political commitment to developing drought resilient societies and water systems, a drought mitigation strategy requires the involvement and contribution from various levels of governance. XEROCHORE presented also some policy recommendations at different levels of governance (XEROCHORE, 2010a) as follows:

(b) EU policy framework:

- Overall framework for drought management & planning (under the WFD framework & objectives);
- Synergies with other EU policies;
- Technical guidance to Member States for drought management;
- Encouragement for the enhanced application of instruments that internalize costs and risks (self-reliance);
- Better orientation of the EU Solidarity Fund and of the Mechanism for Civil Protection.

(c) National policies:

- Formalization of monitoring requirements & drought declaration processes;
- Coordination/Harmonization of river basin drought management plans;
- National drought management plan, if required;
- Enabling environment for drought management;
- Foreseeing assistance programmes for the most affected/vulnerable sectors;
- Reporting mechanisms.

(d) Regional/ river basin planning:

- Drought characterization & vulnerability assessment;
- Drought triggers – Monitoring of relevant indicators;
- Drought mitigation options;
- Establishment of strategic reserves for use in drought;
- Development of the drought management plans;
- Raising awareness on drought risk among local stakeholders and actors.

3.3 DROUGHT MITIGATION AND ADAPTATION ACTIONS IN EUROPE

The southern European countries are more affected by regular drought situations and experiences from these countries are used to identify and compile some of the more common mitigation and adaptation practices for drought situations. Sources of information on these experiences include the Spanish drought management plan (of the Guadiana river basin) (CHG, 2007), the MEDROPLAN guidelines (MEDROPLAN, 2007), and the balance report of the 2005 drought situation in Portugal (CPS, 2005).

3.3.1 Examples of drought mitigation measures

Drought mitigation practices considered short term actions applied to minimize drought effects, according to the current drought alert/ severity level (Table 3). The measures were identified according to the water use sector envisaged, being the general measures, where more than one specific water use sector was involved there were, classified as transversal measures.

Table 3: Compilation of the more important examples of drought mitigation measures in Europe – Short term actions

Drought level	Sector	Description
Normal situation	Transversal measures	Continuous drought monitoring
		Drought forecasting studies
		Analysis of available resources and possible optimization of water uses (wastewater reuse, management of surface and groundwater)
		Definition of strategic water reserves for priority uses (environmental needs, household supply)

Drought level	Sector	Description
Pre-Alert situation	Transversal measures	Realization of public awareness campaigns
		Analysis of existing infrastructures (abstractions, small reservoirs, etc.) capable of being used in case of drought situation
		Intensification of pollution discharges control
		Intensification of environmental flows control
		Constitution of the technical drought committee to follow up drought evolution.
		Control of drought measures' implementation
	Agriculture	Water conservation recommendations for farmers
		Control of water allocation in irrigation areas
	Urban water supply	Activation of emergency plans in water supply systems
Alert situation	Transversal measures	Voluntary use restrictions
		Reinforcement of water treatment
		Use of non-conventional resources (wastewater reuse, water transfers, etc.)
		Adaptation of reservoir exploitation rules
		Increase of water quantity and quality monitoring
		Reinforcement of water discharges control and increase of penalties for irregular discharges
		Constitution of the "Permanent Drought Committee"
		Extraordinary meetings of the reservoirs discharge committee
	Agriculture	Water use restrictions in irrigation areas
	Urban water supply	Activation of water systems interconnections
		Reduction of pressure head during night periods.
		Verification of emergency plan activation for urban supply
Emergency situation	Transversal measures	Weekly report of drought evolution
		Intensification of non-conventional resources use for green areas irrigation.
		Intensification of water resources transfer within the river basin
		Reallocation of water resources
		Obligatory water use restrictions
		Restriction in flows to satisfy environmental needs, till the minimum values defined for the area.
		Intensification of water quality control in reservoirs in risk of eutrophication, avoiding the use of the minimum stored volumes.
		Intensification of pollution discharges control.
		Increase of penalties for irregular discharges, within legal limits.
	Agriculture	Restrictions of some crops cultivation.
		Control of water use restrictions in irrigation areas
	Urban water supply	Restriction of water use for certain purposes (car wash, streets washing, etc.)
		Water tanks supply.
		Intensification of water treatment processes to compensate water quality decrease.
		Temporary change of water tariffs for urban supply.
		Use of the minimum or strategic water reserves to cover environmental needs and household supply.

3.3.2 Examples of drought adaptation measures

The identification of drought adaptation measures was based on their period of influence (long term) and on the effect on drought vulnerability of a certain region/ water use sector

(increasing sustainability of water use and reducing the potential effect of a drought situation). Table 4 presents a short description of the main drought adaptation measures aggregated by water use sector, and types of measures (scope). It shall be noticed that the transversal measures are referred to those with wider application and influence than just one specific water use sector.

Table 4: Compilation of the more important examples of drought adaptation measures in Europe – Long terms actions

Sector	Type of measures	Description
Transversal measures	Legislation and regulations	Regulations to improve water savings
	Information and education	Public awareness campaigns (increase awareness of the value of the water and of the importance of water savings)
	Water recycling	Wastewater reuse for specific purposes
	Impact management	Contingency planning and definition of emergency actions for drought impacts mitigation
		Development of Early warning system
		Hydrological forecasting and drought monitoring systems
		Application of optimization tools for water allocation and to schedule deliveries
	Reinforcing the use of nonconventional water sources	Reinforcing the use of rainfall harvesting, water cisterns, fog collection, etc.
	Groundwater use and recharge	Groundwater recharge
		Application of optimization, risk, and decision models
	Information systems	Remote sensing, GIS, and models that provide to the balance between water availability (water storage) and the estimated water demand for different uses.
Agriculture	Demand management	Demand delivery scheduling in pressurized systems
		Selection of crop varieties according to their tolerance to the water stress conditions and their water use efficiency
		Tillage and land-forming practices (soil management)
		Improving surface irrigation measures (use of sprinkler and micro-irrigation systems)
		Adopting water prices that induce farmers to save water and to irrigate during night
		Farmers involvement in decisions to change delivery schedules dictated by limited supply
	Supply management	Terracing (maximization of soil infiltration)
		Use of small dams (farm ponds), also to increase aquifer recharge
	Insurance development	Based on the probability of a reduction in crop yield below a pre-established threshold
Urban water supply	Water saving practices and management	Water pricing (establish rate policies that emphasize greater user involvement in water conservation and saving)
	Water conservation, systems maintenance and management	Adopting low-pressure pipe distributors (to reduce spills and leaks, to achieve higher flexibility and service performance, and to easily adopt water metering)
		Intermediate storage, to increase the flexibility of the system to

Sector	Type of measures	Description
		respond to variations in demand, and also to reduce operation losses during periods of reduced water use,
		Information systems, to identify the state variables of the system, inclusive in real time, thus providing for better matching deliveries to demand.

4 INVENTORY OF AVAILABLE STATE OF THE ART DROUGHT MITIGATION AND ADAPTATION PRACTICES IN THE UNITED STATES OF AMERICA

Drought is in a normal, recurrent feature of climate in the US, but is often mistaken to be a rare and random event because climate has chaotic aspects which may cause droughts in an unpredictable manner. However, there are also cyclical natural processes that influence climate and that cause the chance of a drought to return regularly. The El Nino/La Nina cycle is one of the most important cycles, causing precipitation variability in a 2-6 year cycle across much of the globe and the US. Unsurprisingly, droughts may last for a few years, and particularly devastating droughts will last for 4 to 5 years in the US. The Pacific Decadal Oscillation (PDO) and the Atlantic Multi-decadal Oscillation (AMO) among other drive long-term droughts such as the 1930's Dust Bowl over the western Great Plains (Dirmeyer, 2012). Droughts have affected humans from prehistoric times to present and the same is true for the American continent. Native American tribes in pre-Columbian times already responded to droughts by adapting their life-styles and increasing managing their environment and the natural resources they used. Nonetheless, civilization collapse and population movements as a response to droughts have also been recorded (Schwarzenegger *et* al., 2008; Orlove, 2005; Benson *et al.*) and form a warning for what droughts may cause for present civilizations in the face of natural drought and exacerbated drought by climate change.

It is estimated that presently on average 15% of the United States is affected by drought in any given year. Figure 5 shows the extent of extreme droughts, which can vary from 0% of the states up to 65% in the devastating Dust Bowl years of the 1930's. This exceptional drought affected Oklahoma and portions of Kansas, Texas, Colorado and New Mexico (Orlove, 2005). Although droughts occur everywhere in the United States, also in relatively wet areas, these are still the states that are often affected if a drought is particularly extensive, intensive and/or of long duration, as shown in Table 5. The arrows in Figure 5 refer to the same drought events as listed in Table 5.

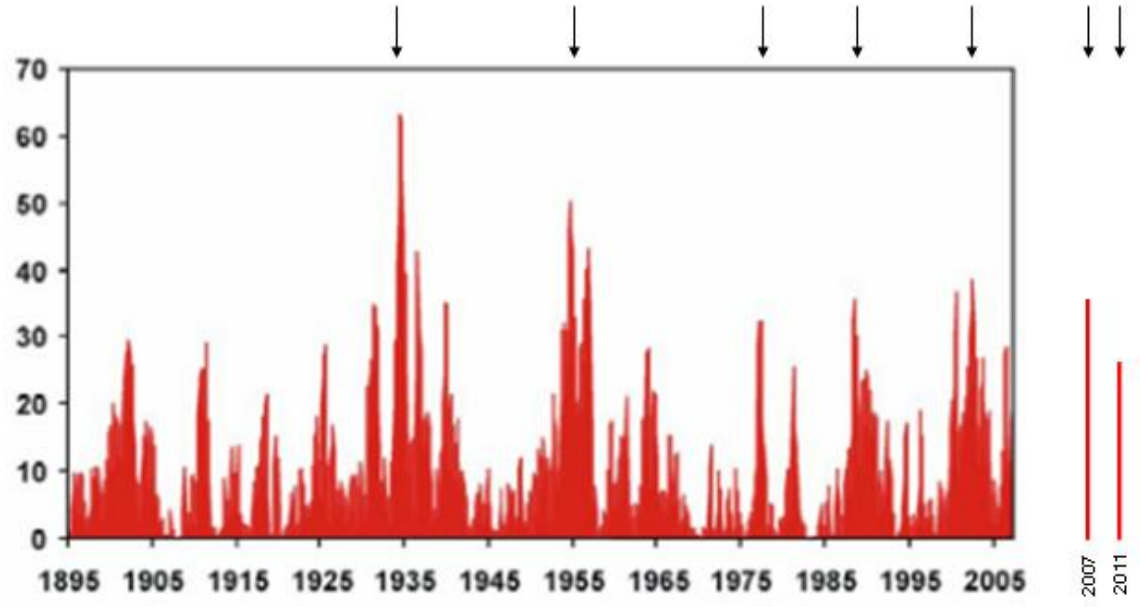


Figure 5: Percentage of the US in severe to extreme drought, 1895 to present. NDMC analysis of NCDC/NOAA data and adjusted by Deltares

The average annual drought cost to the United States range from US$6 to $8 billion, but catastrophic droughts may cause a tenfold damage. M. Hayes (2012) made a small table of billion Dollar Disasters that occurred in the period of 1980-2011. Based on that it can be concluded that of all natural disasters only hurricanes have a similar financial impact as drought on a per-event basis and as if that is not enough, they occur twice more often than droughts. Tornadoes also occur twice more often, but their financial impact is at least four times smaller, around $ 2.5 billion. Other disasters, like tornadoes, floods, fires and winter-related disasters also cause damages of 2 to 5 billion dollar per event and occur a little less often than droughts (Murphy, 2012). Despite the high damages that droughts cause, **there is still no national policy in relation to droughts**, while national policy does exist in relation to hurricanes (Nielsen-Gammon and McRoberts, 2012). The lack of national policy for drought can be ascribed to the gradual nature of the onset of drought and the eventual return of a wet season, reducing the need for policy. This will be further explained in the following chapter which deals with the evolution of a drought risk management frameworks in the US.

Table 5: Costs and extents of some catastrophic droughts in the 20th and 21st centuries

Period	Government spending	Agricultural loss	Total impact	Area
1930			65% of the US[2]	Oklahoma, Kansas, Texas, Colorado and New Mexico
1953 – 1956	$ 3.3 billion (1998 value)[1]			South-western United States, New Mexico and Texas
1976-1977	$ 6.5 billion[1]			particular spots of the United States
1988-1989	$ 6 billion[1]	$ 20 billion[1]	$ 80 - 120 billion (2008 USD) 45% of the US	the Mid-Atlantic, Southeast, Midwest, Northern Great Plains and Western United States
1996 – 1998		$ 6 billion in Texas	$ 11 billion[1] 50% of the country[2]	Arizona, Kansas, New Mexico, Oklahoma, and Texas
2007			43% of the country	California
2011		$ 10 billion[3]		Texas, New Mexico
The arrows in Figure 5 are refer to these years. (Source 1: NDPC (2000); Source 2: Wilhite et al. (2006); Source 3 : Svoboda (2012))				

The Drought extent does not fully characterize the catastrophic nature of a drought event. The drought of 2011 for example had a smaller extent than previous years, but where it hit, it was of a record breaking intensity. (See Figure 6)

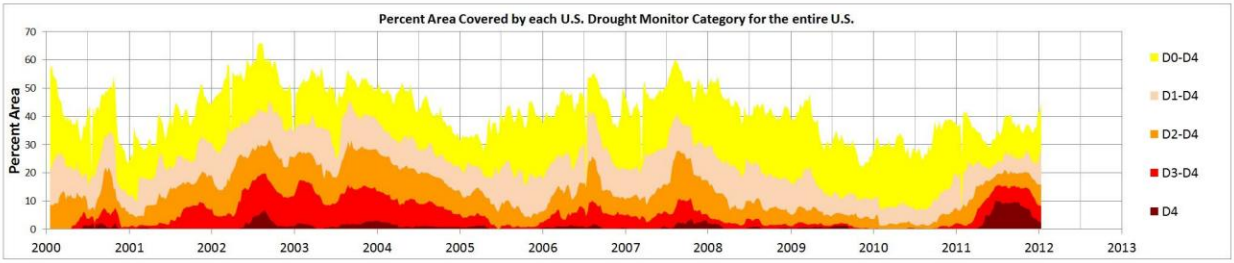


Figure 6: from the NDMC newsletter Droughtscape, winter 2011/2012

Figure 7 shows the impact of the 2011 drought on different states and sectors. Clearly, this year Texas was hit most gravely and the agricultural sector in particular. As could be seen earlier in this document, mitigation and adaptation actions are often related to agriculture, because of its large water consumption for irrigation. Business and industry are further reported to more often be able to afford to buy water even when prices increase due to scarcity. Also water supplies to sustain nature and wildlife are sometimes deemed so

important that they are put before agricultural users and the same thing is true for domestic water use. All in all, agriculture is often the most vulnerable sector to droughts, because they are easily and heavily impacted while they can ill afford to keep buying water rights in the light of increasing demand and prices. At the same time there are a lot of different adaptive an mitigating measures that farmers and ranchers may take, which cost relatively small investments both in time and money as the examples in the following paragraphs will show.

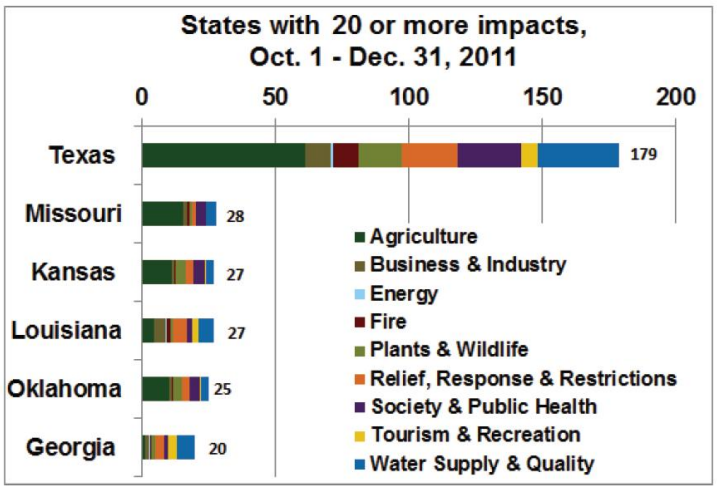


Figure 7: Impacts per sector and state-Drought impact reporter for Oct. 1 to Dec. 31, 2011.

In the United States there is no national policy on drought management or emergency management but there are a lot of institutions which have a clear mandates on drought. Most states now have drought plans. It is generally expected in the US that drought plans exist for states, river basins, cities, tribes, farmers and utilities. In many cases, organizations (agencies, authorities, research centers etc) were set in place to aid water managers at all scales. Drought plans contain clear indications on which mitigation and adaptive measures should be taken in the face of drought. The mitigation actions presented here were primarily taken from drought plans in the state of Texas, however not all states have the same laws, so that the same situation may not exist in all states.

4.1 MITIGATION PRACTICES IN THE AGRICULTURAL SECTOR

The US Department of Agriculture (USDA) is one of the most important organizations to aid farmers in the face of drought. They actively take into account Climate Change in their policy and it is expected that climate change will bring about more and more severe droughts. The USDA lists the following measures to aid farmers and civilians in the case of drought:

a) Crop Assistance for Farmers

The Noninsured Crop Disaster Assistance Program (NAP) provides financial assistance to producers of non-insurable crops when low yields, loss of inventory or prevented planting occur due to natural disasters. The Supplemental Revenue Assistance Payments (SURE) Program provides financial assistance for crop production and or quality losses due to a natural disaster.

b) Crop Insurance

Crop insurance is a risk management tool available to agricultural producers providing protection against low yields and/or lost revenue due to natural disasters including drought, excessive moisture, disease and other perils.

c) Assistance for Livestock Losses

The Livestock Forage Disaster Program (LFP) provides financial assistance to producers who suffered grazing losses due to drought or fire. Conservation Reserve Program (CRP) Emergency Haying and Grazing Haying and grazing of CRP acreage is authorized under certain conditions to improve the quality and performance of the CRP cover or to provide emergency relief to livestock producers due to certain natural disasters.

d) Post-Disaster assistance

Emergency Farm Loans allow producers to borrow up to 100 percent of actual production or physical losses, to a maximum amount of $500,000.

e) Other programs and offices:

- Hay Net – an internet-based service allowing farmers and ranchers to share 'Need Hay' ads and 'Have Hay' ads online.
- Farm Service Agency disaster programs
- Risk Management Agency programs
- State Farm Service Agency offices
- Tree Assistance Program (TAP) which provides financial assistance to qualifying orchardists to replace eligible trees, bushes, and vines damaged by natural disasters.

Table 6 lists organizations involved in drought management and the mitigation actions that they implement.

Table 6: Organisations in the agriculture sector and the mitigation actions they implement

Organisation	Mitigation actions
TAEX	Education of agricultural producers, irrigators, youth, urban dwellers
TAEX	Research, education and demonstrations in tillage, soil fertility, fertilizer use, crop insurance and risk management
TAEX	Research and development/breeding of new drought resistant species
TDA	Coordinate and communicate drought information with USDA, TASS, FSA.
TDA	coordinate hay intra-state exchange
TDA	Education, amongst others through 'DRIP' database and on drought and agriculture
TDA	Provide assistance help with economic rural development and infrastructure
TDED	Maintains EDC database
TDED	Rural Communities with Office of rural Community Affairs
TSSWCB	Conservation and mitigation for landowners, farmers and ranchers on topics like irrigation and brush management
Cheyene tribe	- Educate producers, implement, and enforce the tribal grazing ordinance. - Assist individual operators in grazing management practices - Inventory stock water sources and monitor yields - Encourage water conservation practices. - Complete the noxious weed control plan for the Reservation. - Develop a grasshopper control program. - Working with elected officials, consider water projects that would utilize water for agricultural and other purposes.
Hualapai tribe	Agriculture Program - Purchase/build storage facilities - Where possible, reduce undesirable species. Develop plans for reducing exotic vegetation. - Remove feral animals where possible. - Maintain and monitor catchments. - Construct new catchments. - Purchase pumps. - Implement grazing plans. - Begin cleaning tanks as they dry out. - Begin stocking feed under Warning condition. - Begin stock reduction under Warning condition.

Organisation	Mitigation actions
Hualapai tribe	Range Water Program - Assist in installation of new water distribution facilities. - Work with GIS Coordinator to establish GIS/GPS database of distribution and storage systems. - Assist in planning for expansion of distribution systems.
Navajo tribe	Irrigators and Dryland Farmers - Create water conservation and management plans - Improve reservoir operations - Improve use of drought monitor forecasts in dry-land farming Ranchers - Establish a Navajo Nation (NN) Grazing Policy - Improve Range management o Reduce overgrazing by reducing the number of animals o Remove feral animals - Provide assistance to farmers o Distribute climate and market information for ranchers o Encourage livestock sale barns or cattle auctions o Construct storage for USDA grain o Increase the number of range managers - Improve the reliability of livestock supplies o Develop the livestock water plan o Repair and overhaul livestock wells.
Zuni tribe	Farming - Use existing wells or drill new wells, as listed in Appendix C, to augment limited crops - Measure irrigation diversions - Replace irrigation ditches with pipelines and appropriate valves - Reuse irrigation tail water (return flow) - Use treated wastewater from constructed wetlands for Tekapo Unit, if quality acceptable - Evaluate/repair/maintain existing dams and irrigation works - Develop reservoir operation rules to optimize irrigation releases - Increase capacity of reservoirs through dredging or modification - Implement soil moisture monitoring program - Use traditional Zuni crop varieties and other drought-resistant varieties - Use traditional runoff fields and techniques - Conduct training for farmers (irrigation and planting methods, soil and water conservation, etc.) - Use field conservation measures (eg. level fields, line ditches, efficient irrigation/tillage, mulch)
Zuni tribe	Ranching - Evaluate/repair/maintain existing springs/wells and watering facilities (tanks, pipelines, drinkers) - Develop new springs/wells with watering facilities - Evaluate/repair/maintain existing stock ponds (earthen and other water harvesting catchments) - Construct new stock ponds - Address water development ownership issues (i.e. costs/fees, technical assistance, maintenance) - Conduct training for ranchers (range and herd management, well/pump maintenance, etc.)

Organisation	Mitigation actions
	- Revise, implement, and enforce Zuni Range Code - Develop range management plans for each range unit - Improve range survey and monitoring methods

4.2 MITIGATION PRACTICES IN THE INDUSTRIAL SECTOR

Table 7 lists organizations in the industrial sector involved in drought management and the mitigation actions that they implement.

Table 7: Organisations in the industrial sector and the mitigation actions they implement

Organisation	Mitigation actions
TxDOT	research and funding for the transport system: themes are Environmental Impact Assessments (EIA), erosion and landscaping
TDED	grants for public infrastructure with relation to water and wastewater facilities
ORCA	information on grants and funds (a.o. for water sewage and drainage)
Navajo tribe	- Reuse of treated effluent
Cheyene tribe	Avoid adding demand for water that cannot be met - Require all developers (commercial, industrial, mining and residential) to provide projections of water needs and identify water sources to meet the projected need - Evaluate all development proposals for potential impacts to surface and groundwater - Issue permits - Study aquifer yield potential and use this information when permitting new uses.
Zuni tribe	All Sectors - Promote water conservation and drought education, including demonstration projects - Develop well permitting and assistance program - Develop a Tribal Water Plan and Code - Secure water rights - Develop drought contingency plans for each water use sector - Improve administration and enforcement of relevant Tribal codes and policies - Enhance/maintain/protect Nutria/Pescado/Ojo Caliente/Black Rock/other spring developments

4.3 MITIGATION PRACTICES IN THE DOMESTIC SECTOR

Table 8 lists organizations in the domestic sector involved in drought management and the mitigation actions that they implement.

Table 8: Organisations in the domestic sector and the mitigation actions they implement

Organisation	Mitigation actions
USDA	Disaster Resilience for Rural Communities The goal of the National Institute of Food and Agriculture's Disaster Resilience for Rural Communities grant program is to advance basic research in engineering and in the social, behavioral, and economic sciences to enhance disaster resilience in rural communities.
GDEM	training and education of emergency management coordinators
GDEM	maintains a database, reference documents and state plan

Organisation	Mitigation actions
GDEM	Form a state hazard mitigation team
DSHS	Educate, plan, monitor, inspect and take measures with respect to health, vector control, stray animals, livestock and effects of drought
TCEQ	Communication and information on water use and water rights through databases, websites, outreach and a drought reference manual
TCEQ	Monitor water use, register water rights permits, help with contingency and conservation plans for users and utilities
TWDB	State water plan and its relation to other water plans
TWDB	Water planning and finances through grants and loans
TWDB	Monitor and forecast future water demand and need,
TWDB	Communication through website
Navajo tribe	Drought Monitoring - Reliable Internet Access and a Navajo Nation (NN) drought information website - Improve the NN climate network
Navajo tribe	Domestic water haulers and Public Drinking Water Systems - Establish “pay per fill” watering stations - Address storage deficiencies in public water systems - Assist water haulers with cisterns - Small household filters and other treatment systems
OSC	Research drought and give climate information through a Climate Database and weekly and monthly reports
Cheyene tribe	Domestic drinking water - identify emergency/back-up water supply for each drinking water system and clinic - Develop and maintain a list of individuals/companies able to haul water. - Develop additional storage capacity for public water supplies - Establish a fund for assisting individuals in replacing wells that go dry - Develop wellhead protection plans for public water supplies. - Work with tribal extension to encourage the practice of water conservation through education. - Develop program in conjunction with tribal housing to identify and repair easily-fixed plumbing leaks. - Develop public drinking water sources where they do not exist
Cheyene tribe	Establish a tribal drought Advisory Committee (to review the drought indices, determine drought severity and address drought issues). Monitor water quantity and quality on the reservation - Map and monitor major springs - Monitor static water levels in monitoring wells - Monitor water quality - Install more monitoring wells - Inventory and prioritize abandoned wells that need to be sealed. Apply for funding and seal the highest priority wells.
Zuni tribe	Municipal - Provide adequate resources for system operation, maintenance, repair, and replacement - Implement a rate structure or surcharge program to discourage wasteful water practices - Maintain old wells and pumping facilities for emergency backup

Organisation	Mitigation actions
	- Meter all system connections - Improve record keeping to report water use - Evaluate feasibility for water reuse - Provide incentives for installation of water-saving devices and replacement of defective fixtures - Promote xeriscaping if/when lawn watering allowed - Implement Source Water Assessment for old wells and perform/implement one for new wells
Zuni tribe	Domestic - Encourage connection to municipal system - Rehabilitate small systems at Nutria and Ojo Caliente and develop ones at other farming villages

4.4 MITIGATION PRACTICES IN THE ENVIRONMENT SECTOR

Table 9 lists organizations in the environment sector involved in drought management and the mitigation actions that they implement.

Table 9: Organisations in the environment sector and the mitigation actions they implement

Organisation	Mitigation actions
TAGD	Conservation districts
ORCA	Educate in floodplain management
TFS	Educate and research in land management, forestry and pest management
TFS	Texas Wildfire Protection Plan and Communication of fire emergencies
TFS	Evaluate weather forecasts: KBDI index
TCEQ	Texas Water Availability Model
TPWD	Research, monitor, forecast, educate on the impacts on wildlife
TWDB	Monitor and forecast hydrologic and climatic factors and the TNRIS (Natural Resources Information System)
Navajo tribe	Recreation, wildlife and Forestry - Apply for water use permits from the Water Code Administration - Create wells where runoff was insufficient - Forests and fires: Fire prevention, detection, suppression and forest restoration
Cheyene tribe	fish and wildlife - enforce existing fish and game regulations. - Review and adjust regulations during drought to reduce pressure on stressed species. - Evaluate proposed irrigation uses to determine impacts to fishery. - Remove diversion dams to accommodate fish passage. - Develop springs for wildlife use. Forest and Fire. - Develop a list of fire hydrants across the Reservation that need to be replaced. Make a bulk purchase and install new hydrants. - Identify best locations and develop additional water storage for fire fighting. - Identify best locations and develop water sources for wild land fire fighting in remote areas. - Relocate unused water tanks for structural fire fighting water storage - Continue to utilize burning permits to reduce the number of escaped fires. - Continue fire prevention education. - Continue with fuel reduction and prescribed burning
Hualapai tribe	BIA Forestry - Continue prescribed burning and mechanical fuels treatments where conditions permit. - Begin to implement dead tree removal plan under Warning condition. - Begin to implement exotic vegetation control plan under Warning condition. - Reduce visitor volumes in vulnerable areas under Warning

Organisation	Mitigation actions
	conditions. - Restrict access to vulnerable areas
Hualapai tribe	Water Resources Program - Develop water conservation plans - Seek funding for new well development and restoration. - Evaluate wells and springs for potential development; prioritize potential developments; begin development.
Hualapai tribe	Wildfire, fisheries and parks program - Install new catchments, troughs and drinkers. - Seek funding for feral livestock removal and remove livestock where possible. - Implement disease education program
Hualapai tribe	Seek funding for the Natural Resources Department
Zuni tribe	Fish and Wildlife/ Recreation - Dredge Reservoirs and channels - Construct drinkers - Implement beaver management plan - Restore and protect riparian and wetland areas - Construction Maintain old municipal wells - Develop other accessible sources - Improve Water Permit system by evaluating policies and financial system and accountability - Develop permit revenue set-aside for water development/management - Include adequate funding for water in construction project budgets
Zuni tribe	Wildfire - Suppression - Implement fuels reduction program - Maintain old municipal Wells

4.5 ADAPTATION PRACTICES IN THE AGRICULTURAL SECTOR

Table 10 lists identified adaption actions in the agriculture sector.

Table 10: Adaptation actions in the agriculture sector

Responsibility/Source	Mitigation Action
Stakeholders	Crops and varieties to plant, the correct mixture of crops to plant, irrigation planning and fertilizer planning irrigation systems planning, crop and seed types; planting acreage; insurance coverage; timing of fertilizer, herbicide and pesticide application; and disease control
Stakeholders	Decisions about crops transportation to market by truck, train or barge
Reilly et al. (2000), Wlodarz, 2011	- change sowing dates, plant two crops instead of one, fall crop with a short fallow period - new crop varieties - improve irrigation efficiency and reduce soil degradation problems; with economic incentives if necessary.
Wlodarz (2011)	- Better fertilization techniques - Adjustment in land use
Pandey et al.(2003)	- Rainwater Harvesting (with small dams)

Responsibility/Source	Mitigation Action
	- Well-digging
TWDB	- Water conservation in Agriculture - Providing grants to political subdivisions to implement conservation programs, and by utilizing either local districts or local lending institutions to provide loans for individual farmers to install more efficient irrigation equipment.

4.6 ADAPTATION PRACTICES IN THE INDUSTRIAL SECTOR

Table 11 lists identified adaption actions in the industrial sector.

Table 11: Adaptation actions in the industrial sector

Responsibility/Source	Mitigation Action
Stakeholders	Electricity - construction of new plants, number of water intakes, wholesale purchase of fuel, and wholesale marketing of electricity, stringent regulations about temperature of cooling water
Stakeholders	Reservoir operations - planning for water level, and water release times and amounts in spring
TWDB	- assists water utilities with development of required municipal water conservation plans and water loss audits; collects data for the required conservation plans and annual reports and for water loss audits; and also provides resources for industrial, commercial, institutional water conservation programs.

4.7 ADAPTATION PRACTICES IN THE DOMESTIC SECTOR

Table 12 lists identified adaption actions in the domestic sector.

Table 12: Adaptation actions in the domestic sector

Responsibility/Source	Mitigation Action
Stakeholders	municipal water supply and drainage systems - decision-making about sources, prices, water use restrictions construction of new wells or reservoirs, establishing new pipelines
Marchildon (2007)	Relocate population
TWDB	Some of the techniques they work on and which can be considered adaptation techniques: - Aquifer Storage and Recovery - underground storage of appropriated surface water for subsequent retrieval and beneficial use - Desalination – through Texas' first seawater desalination plant and BRACS – Brackish Resources Aquifer Characterization System; - Rainwater Harvesting – from rooftops - Water Reuse
TWDB	participating in research needed to advance technology demonstration projects; developing publications and educational materials; making presentations to the public; and, actively participating in key water organizations.

4.8 ADAPTATION PRACTICES IN THE ENVIRONMENT SECTOR

Table 13 lists identified adaption actions in the environment sector.

Table 13: Adaptation actions in the environment sector

Responsibility/Source	Mitigation Action
Stakeholders	fisheries and wildlife hatcheries - holding or selling livestock, range or lot feeding, purchasing water to maintain cattle on range or in lots, environmental stress, and estimate feed-to-production ratios
Stakeholders	fire-fighting - of equipment for fighting wildfires, required number of fire-fighters, and timing of controlled burns; timing of environmental habitat restorations
Stakeholders	groundwater - quality and protection, more accurate surface water outlooks

5 INVENTORY OF AVAILABLE STATE OF THE ART DROUGHT MITIGATION AND ADPTATION PRACTICES IN AUSTRALIA

Australia is a country regularly experiencing severe droughts. Table 14 (BOM, 2011) presents the historic droughts from mid19th century to now. The impact of these droughts was important especially when drought are lasting for a couple of years in a row, as year after year water buffers dry up and the vulnerability to droughts increases. In the past decade a lot has happened in Australia with respect to drought policy at the national, state, basin and city level as a reaction to the severe drought of 2002-2007 or 'big dry'.

.

Table 14: Historic droughts in Australia (BOM 2011)

Period	Description
1864–1866	All states affected except Tasmania.
1880–1886	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 per cent of cattle were lost. This was Australia's most devastating drought in terms of stock losses.
1911–1916	Loss of 19 million sheep and 2 million cattle.
1918–1920	Most parts of Australia in drought.
1939–1945	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.
1963–1968	Widespread drought, the last two years of which saw a 40 per cent drop in wheat harvest, a loss of 20 million sheep and a decrease in farm income of $300–600 million.
1972–1973	Mainly in eastern Australia.
1982–1983	One of the most intense and widespread droughts on record. Total loss was estimated to have been in excess of $3 billion.
1991–1995	Particularly dry in parts of Queensland, northern New South Wales and parts of central Australia. Average production by rural industries fell by about 10 per cent, 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.
2002–2007 *	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.

5.1 MITIGATION PRACTICES IN THE AGRICULTURE SECTOR

Australian farmers manage drought in a number of ways, including diversifying their production risks, building reserves for when conditions are unfavorable and increasing or decreasing their production based on climatic conditions. However, there are times when severe drought is considered by government to be outside of the scope of 'normal' risk management. In these 'exceptional circumstances', government intervention may be warranted in order to keep viable farmers on the land. Defining what is exceptional and what is normal climate variation is itself a challenge, particularly in the context of a changing global

climate (ABARES, 2012). The formal drought declarations are handled by the State or Federal Government.

As a follow-up to the review of the national drought policy (see chapter 8.3), the Australian government (DAFF), in partnership with the western Australian government implemented a pilot of drought reform measures in part of Western Australia (annual report DAFF 2010/2011). Drought mitigation measures implemented in 2010–11 included the following:

- Farm planning—demand for these courses exceeded expectations. A total of 374 farm businesses completed the course. Under the program, participants developed a strategic plan for their farm business. Most did not have a written strategic farm business plan before attending the course and found the assistance valuable.
- Building farm businesses—there was strong interest in these grants, which assisted 119 farm businesses to manage and prepare for the impacts of drought, reduced water availability and a changing climate. A total of $510 000 was paid of the $7.5 million jointly committed by the Commonwealth and the Western Australian Government over the four-year funding profile. The Commonwealth's total commitment under this program is $6.7 million, of which $453 900 was paid in 2010–11.
- Stronger rural communities—interest in this measure was also strong. It is designed to build community resilience and assist communities to manage significant hardship caused by agricultural downturns. Eight grants, totaling $0.9 million, were awarded for projects in seven local government areas.
- Farm social support—this program was jointly funded by the Department of Human Services (Centrelink), the Department of Health and Ageing, and the Department of Families, Housing, Community Services and Indigenous Affairs. DAFF assists in coordinating the program and chairs a Farm Social Support Committee of all agencies. The program aimed to build stronger social support networks to meet the mental health, counseling and other social needs of farming families and rural communities in the pilot region. All three elements of the program—family relationship counseling, professional assistance and online counseling for young people—were in strong demand. During 2010–11, rural services officers and social workers visited 1160 farms and stations to assist farm families. The Australian Government Mobile Office made 38 visits to towns and assisted more than 2000 rural people within the pilot region. A total of 2159 people received free professional family relationship

assistance and 37 young people in the pilot region received confidential and free professional online counseling.

- Farm family support—this program was jointly delivered by DAFF, the Department of Human Services (Centrelink), the Department of Health and Ageing, and the Department of Education, Employment and Workplace Relations. The program provided income support totaling $4.8 million to 450 recipients.
- Farm exit support—exit grants valued at up to $150 000 were available to eligible farm families in significant financial difficulty, to re-establish out of farming. Five grants were paid, totaling $0.7 million. The support also included a $10 000 advice and retraining grant and a $10 000 relocation grant.
- Beyond farming—the Western Australian Council of Social Services delivered this program on behalf of DAFF. Twenty former farmers were engaged and trained as mentors. Demand for the program by current farmers was lower than projected. Mentors were matched with 14 farmers to talk about opportunities available beyond farming.

5.2 MITIGATION PRACTICES IN THE DOMESTIC SECTOR

Water rationing is a mitigation measure used in all states of Australia. Restrictions are applied according to the stage the drought is in at the state or even at a more local level like municipalities. Types of measures are as followed:

- Sprinklers and irrigation (alternate days or no irrigation)
- Hand watering gardens and lawns (time restricted, day alternation, grey water only)
- Swimming pools (no emptying, filling or topping up)
- Car washing (from weekly to not allowed)
- Window washing (from only bucket to no window cleaning)
- Hard surfaces (No hosing hard surfaces (paths, driveways, cars, floors and buildings).

In New South Wales for example, in particular in Sydney, 3 stages for water restriction were used by Sydney Water. From 2009, Water Wise Rules are applied in Sydney instead of water restriction. The following rules were followed:

- All hoses with trigger nozzles, hand held hoses, sprinklers and watering systems and used only before 10 am and after 4 pm on any day
- No hosing of hard surfaces such as paths and driveways;
- Washing vehicles is allowed;

- Fire hoses may be used for fire-fighting activities only.

Water Wise Rules started in 2010 and were introduced when dam storage levels had been around 60% for 12 months. (http://www.sydneywater.com.au/Water4Life/WaterWise/)

The Australian Capital Territory (ACT) and ACTEW for example, currently apply permanent Water Conservation Measures these are mandatory and enforceable. Anyone found in breach of the restrictions may be liable for fines starting at $200 for an individual or $1,000 for a corporation. These ACT's Permanent Water Conservation Measures apply to ACTEW's potable water ('drinking' or 'tap' water). Non-potable sources are not restricted. The utilities Water Conservation Measures Approval 2010 of ACT contains the following measures and limitations on use applied to water drawn from ACTEW Corporation Limited's potable water supply system (Australian Capital Territory, 2010).

- Private gardens and lawns (use of hand-held hose with trigger nozzle or bucket, time restrictions on sprinkler and irrigation systems, watering without causing pooling or runoff)
- Public sports amenities, Public parks and gardens, public open spaces (use of hand-held hose with trigger nozzle or bucket, time restrictions on sprinkler and irrigation systems)
- Commercial nursery, commercial market garden and commercial turf-growing businesses (use of non-potable water if possible, use of a hand-held hose fitted with a trigger nozzle, a bucket or a watering can, time restrictions on sprinkler and irrigation systems, watering without causing pooling or runoff)
- Vehicles (washing on a lawn or porous surface, us of bucket, watering can etc…,
- Paved areas (no water used to clean paved areas unless cleaning is necessary as a result of accident, fire, health hazard or other emergency)
- Windows, buildings and building gutters (gutters may be cleaned at any time by any means, windows and other external parts of buildings may be washed at any time, but only by using a bucket and mop/brush, squeegee or a high-pressure low-volume cleaner)
- Private or public ponds and fountains (may only be filled or topped up using a bucket, a watering can or a handheld hose fitted with a trigger. There is no restriction on the operation of fountains that recirculate water from the pond or reservoir in which they are installed. Other fountains may not be operated).
- Private or public swimming pools and spas (Pools and spas with a capacity less than 3,000 litres may only be refilled, or filled for the first time, using a hand-held hose fitted with a trigger nozzle, a bucket or a watering can. Public swimming pools and

spas may not be filled or topped up unless there is an agreed management plan with ACTEW)

- Water storage tanks, dams and lakes (filling and topping up only if agreed with ACTEW)
- Construction and related activities (Wherever practicable non-potable water should be used. In greenfields sites, water can be used for dust or pollutant suppression or earth compaction only if agreed with ACTEW)

5.3 MITIGATION PRACTICES IN THE INDUSTRIAL SECTOR

In Australia most of the industry affected by drought is the primary industry, which is directly linked to the agricultural sector. This is dealt with in the chapter on the agricultural sector 6.1. Beside the primary industry, the mining industry, the manufacturing industry and the electricity, gas, water and waste services can also be affected by droughts. According to the water account 2010-2011 (Australian Bureau of Statistics) the mining and the manufacturing industry both use less then 10% of the total water used in the agricultural sectors. To the mining industry, the availability of water for their operations is essential (Mining and quarrying developments). This sector has a lot of experience in the reuse of water, mine water use efficiency and securing of water supplies in remote, difficult-to-serve areas.

With respect to drought mitigation practices by the mining and manufacturing sectors, no information has been encountered showing that these sectors are carrying out mitigation actions in times of drought.

5.4 ADAPTATION PRACTICES IN THE AGRICULTURAL SECTOR

In 2008, the Primary Industries Ministerial council (PIMC) agreed that current approaches to drought and EC were no longer the most appropriate 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**.

Emphasis is put on adapting farm practices. The **Grains Research and Development Corporation (GRDC)** for example helps Australian farmers to manage climate risk on-farm, providing practical tools to incorporate weather and climate information into farm business decisions. The GRDC is a statutory corporation, operating as a research investment body in partnership with growers and Government. Funding is provided through a levy on grain growers and is determined each year by the grains industry's peak body. The Australian Government matches this funding, up to an agreed ceiling. **Climate Kelpie** was also set up

by GRDC and is a 'one-stop shop' for climate risk management information and tools. It is designed for Australian farmers and farm advisors. It connects farmers to the best available tools and information about climate to help them make decisions about their farm business. To manage the increasing variability, farmers need to adapt their practices. See http://www.climatekelpie.com.au/ to find out which services they provide.

The Australian government additionally funds a lot of research and development. Topics are among others:

- Developing drought tolerant plants and new cropping practices. CSIRO for example is looking at a range of drought adaptive traits and associated genes to develop tools to help breeders breed more drought adaptive wheat varieties (CSIRO Plant Industry, 2008).
- Geographic shift of current varieties
- Near real time estimation of pasture biomass using daily satellite information.

5.5 ADAPTATION PRACTICES IN THE DOMESTIC SECTOR

In the previous section, it was clear that regarding domestic use of water, Australia has many restrictions measures to mitigate drought. The main adaption measures which are seeking solutions for the longer term, are mostly related to the **reuse of water, dam management and desalination**. Seawater desalination plants have been reported as being an adaptation measure to drought in Australia. Since 2005, desalination plants have been constructed in Perth, Sydney, and the Gold Coast and are planned for Melbourne and Adelaide. It seems that for now, cities have focuses on supply-side measures (i.e. desalination), rather than rethinking how water is used and managing demand (Lawhon Isler et al., 2010).

Australian cities have an important role to play when it comes to adaptation. The practical experience of the **city of Melbourne** shows that actions were taken to improve customers' water efficiency through education and demand management programmes; to augment the centralised reservoir network with a desalination plant and to create new recycled water and stormwater reuse schemes to substitute potable demands. As a result, water consumption has fallen and supply capacity has both risen and diversified (Ewert, Melbourne Water). Other interventions include the following:

- Developing new water sources for the city that include a rainfall-independent desalination plant and localised alternative water sources such as sewage recycling, stormwater harvesting, aquifers and rainwater tanks that can be used as substitutes for potable water when drinking water quality is not essential. Although not 'least cost'

according to traditional assessments, these options diversify the system and thereby add a level of redundancy to cope with a broad range of conditions. They also provide a range of other community benefits such as guaranteeing greener open spaces during water restrictions and reducing run-off impacts to urban streams.

- Actively managing the forested water supply catchments to reduce wild fire risk by increasing fuel-reduction burning and improving firebreaks,
- Incorporating climate change effects into the design considerations for major infrastructure,
- Improving the city's water use efficiency through programs that promote water conservation and improve water use efficiency across Melbourne,
- Assessing the scope of sewage spills from more intense storms and moving to real time monitoring of emergency relief structures.
- Improving our understanding of the nature of extreme storms and future sea level rise and using this information to update guidelines for urban development in floodprone areas,
- Identifying vulnerable aquatic species, as well as their survival thresholds under reduced stream flow, and using this to build refuge habitat in rivers and wetlands.

(http://www.iwahq.org/contentsuite/upload/iwa/all/Case%20study_Melbourne_preview.pdf)

6 INSTITUTIONAL FRAMEWORK FOR DROUGHT MANAGEMENT IN THE EUROPEAN UNION

Understanding the national institutional regime is a key factor for establishing effective and integrated drought management plans that incorporate monitoring, public participation, and contingency planning. In this context, effective policies requires coordinated regional, national and international action due to the extension reached by droughts, not dependent on administrative borders, therefore requiring effort coordination among the affected stakeholders.

A common methodology is to provide information that will contribute to compare among and across countries and to promote the cooperation between the existing institutions, organizations, networks, and other stakeholders in different countries/states. In this point, the first step included the identification of the main stakeholders, authorities, agents, etc. who manage and/or deal with drought at Regional, National and/or European level, and the collection of relative data on their objectives, priorities, activities (monitoring, management, mitigation, etc.). Nevertheless, according to the available information (EEA, 2009), in the majority of the EU member states, the management and follow up of drought situations is ensured by the Ministries of Environment, or water authorities under their responsibility, being drought management and response considered part of the usual water resources management. In fact, only in Italy, Portugal and England there is the creation of a specific institutional body/ committee specially dedicated to drought management and alleviation of impacts.

Moreover, the institutional frameworks for drought management of the EU countries considered representative, namely Portugal, Spain, The Netherlands and England, similarly to what was justified in topic 3.1, are further described regarding their experience in drought management and also the different characteristics in terms of Institutional framework for drought management. Moreover, the main recommendations, regarding Europe experience are briefly described, as best practices, by two of the more important Research and Development European projects on this subject, the MEDROPLAN and the XEROCHORE, also similarly to what was considered in section 3.2.

6.1 INSTITUTIONAL FRAMEWORKS FOR DROUGHT MANAGEMENT IN PORTUGAL

The bodies and structures responsible for water resources management in Portugal are the Environment Agency - *Agência Portuguesa do Ambiente* (APA) (that cummulated the responsibilities of National Water Authority – former INAG, as well as River Basin Districts

Administrations – former ARHs) under the Ministry of Agriculture, Sea, Environment and Spatial Planning (*Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território*).

However, as referred in section 4.1.1, during normal situation, the Meteorological Institute (IM) and APA are responsible for permanent assessment of meteorological and hydrological data, respectively. Nevertheless, whenever a drought situation is declared it is created a specific Drought Committee for drought management and follow-up at national level, constituted by representatives of several Ministries (at political level), as well as representatives of several public institutions (at technical level, to assessor the political level), regarding not only the participation of the entities responsible for water resources management, like APA, and entities somehow related to drought effects evaluation, like the entity responsible for agricultural European funding management– PRODER, or the National Statistics Institute - INE, but also of representatives of sectors potentially affected by drought impacts like: agriculture, water supply, energy production, tourism, forestry, public health, etc.

In Figure 8, it is shown an example of the constitution of the Commission for Prevention, Monitoring and Follow-Up of Drought and Climate Change effects, created specifically to manage the drought situation of the present year (2012).

Commission for Prevention, Monitoring and Follow-Up of Drought and Climate Change Effects

At Political level:

Representatives from Ministries of:

- Agriculture, Sea, Environment and Spatial Planning, that coordinates
- Finances
- European Subjects
- Internal Administration
- Local Administration
- Economy
- Health
- Solidarity and Social Security

Representatives of the National Association of Portuguese Municipalities (ANMP)

At Technical level (assessor of the political level):

Representatives from the following public institutions:

- Bureau of Planning and Politics (GPP- Agriculture), that coordinates
- Portuguese Environment Agency (APA – Environment and Water Resources)
- Portuguese Institute of Sea and Atmosphere (IPMA – Meteorology and Sea resources)
- Directorate of Agriculture and Rural Development – (DGADR)
- Institute for Nature Conservation and Forests (ICNF)
- Directorate of Food and Veterinary (DGAV)
- Directorate of Territory (DGT – Spatial Planning)
- Institute for Agriculture and Fisheries Financing (IFAP)
- Regional Directorate for Agriculture and Fisheries (DRAP)
- PRODER Management Authority (AGPRODER, Agriculture European Funding)
- Directorate of Budget (DGO, Finance)
- Authority for Taxing and Customs (ATA – Finance)
- Directorate for European Subjects (DGAE)
- National Statistics Institute (INE)
- National Authority for Civil Protection (ANPC)
- Directorate for Local Authorities (DGAL)
- Directorate for Geology and Energy (DGE)
- Directorate for Economic Activities (DGAE)
- Public Health Directorate (DGS)
- Institute for Finance Management of Social Security (IGFSS)

Figure 8: Constitution of the Portuguese Drought Committee for Drought Management in 2012.

Moreover, regarding the future implementation of the Drought Alert and Management System – SPGS, referred in section 3.1.2, it is foreseen that the institutional arrangements shall be

coordinated with the system and also with drought mitigation plans developed in accordance, as suggested in the 2005 Drought Balance Report (CPS, 2005), including different levels of action: National, River Basin and Local or for specific sector and different levels of drought severity. The corresponding drought management and response process is presented in Figure 9, being based in a specific Drought Task Force (correspondent to the Drought Committee previously referred), that follows the drought responses foreseen in the specific drought plans (to be developed) and integrates information from different sources, namely: the monitoring system (the SPGS), the risk analysis and management group (to be defined) and the responsible for the response and mitigation programmes (also still to be settled) (CPS, 2005).

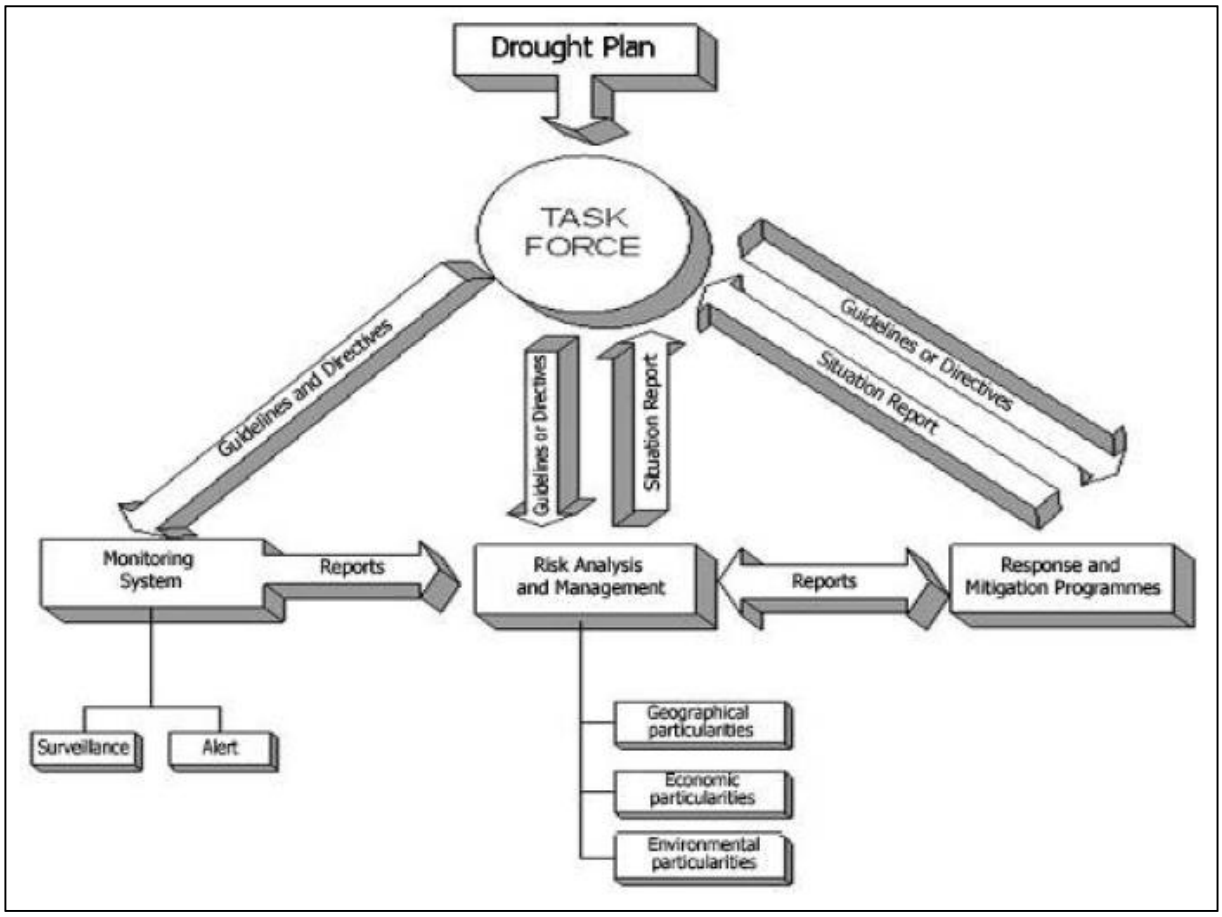


Figure 9: Schematic representation of the possible future drought management process in Portugal (CPS, 2005)

6.2 INSTITUTIONAL FRAMEWORKS FOR DROUGHT MANAGEMENT IN SPAIN

The Spanish Ministry of Agriculture, Food and Environment, is the main governmental body involved in the definition and implementation of strategies, monitoring systems and data

acquisition for drought management in Spain, providing updated general information at national level, through the National Drought Observatory (hosted by the Ministry).

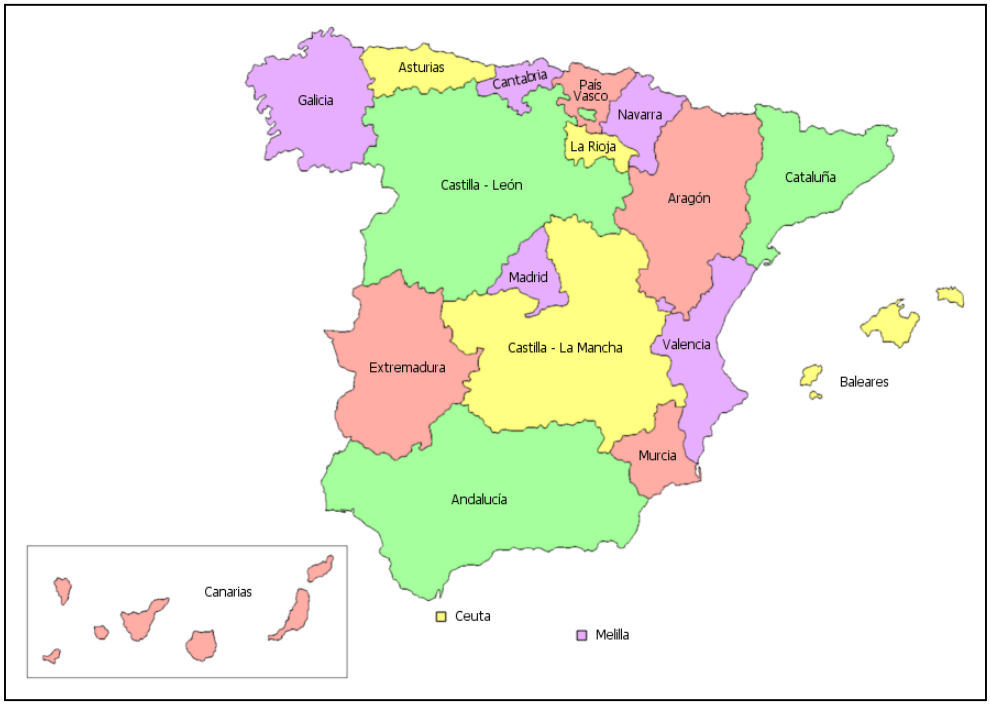
Nonetheless, even though under responsibility of the Ministry of Agriculture, Food and Environment, the Basin Authorities are autonomous public organizations that are responsible for the drought management in their territory. In fact these organizations were involved, together with the Directorate General for Water, in the elaboration and approval process of Drought Plans, launched on March 2007 after completing their Strategic Environmental Assessment processes (as referred in section 3.1.3).

Therefore, it is curious to notice that, although corresponding to one of the EU countries with a more advanced and developed drought policy, being a reference to several other EU member states as an example to follow in what regards drought management process, especially in the Mediterranean region (Southern Europe), Spain does not have a specific management body/ committee to ensure and coordinate the drought response process.

In fact, among other factors, it can be enhanced that due to: (i) the division of Spain into Autonomous regions, in which territories the Regional Governments have more extended competences than the National Government in the whole country, (ii) the inclusion, in the organizational Basin Authorities' structures of representatives of different regional and central administrations, water users and other stakeholders and (iii) the long term experience in dealing with drought situations of the Basin Authorities, the drought management process in Spain is usually undertaken with considerable success by these last institutions, in a close cooperation with SHs.

Nonetheless, as it can easily be understood, these regional subdivisions imply also some difficulties in the coordination and implementation of national drought plans due to the different regional interests. In fact, some River Basins are even belonging exclusively to the regions (as for example the Andalusian Water Agency and the Catalan Water Agency, specifically for the management of the streams basins not included in the communitarian river basin districts). In Figure 10 it is possible to understand the main differences in terms of areas of influence of the Autonomous Communities (a) and the Basin Authorities (b), being, in this last figure, also represented (in grey) the river basins under exclusive responsibility of the respective regional governments.

a)


Asturias
Cantabria
País Vasco
Navarra
La Rioja
Galicia
Castilla - León
Aragón
Cataluña
Madrid
Castilla - La Mancha
Valencia
Extremadura
Baleares
Murcia
Andalucía
Canarias
Ceuta
Melilla

b)


GALICIA-COSTA
CANTABRICO
C.I. PAIS VASCO
MIÑO-SIL
DUERO
EBRO
CUENCAS INTERNAS DE CATALUÑA
TAJO
JUCAR
ISLAS BALEARES
GUADIANA
SEGURA
GUADALQUIVIR
CUENCA ATLANTICA ANDALUZA
CUENCA MEDITERRANEA ANDALUZA
CEUTA
MELILLA
LA PALMA
TENERIFE
LANZAROTE
FUERTEVENTURA
LA GOMERA
GRAN CANARIA
EL HIERRO

Figure 10: Spanish territory division in a) Autonomous Communities and b) river basin authorities

6.3 INSTITUTIONAL FRAMEWORKS FOR DROUGHT MANAGEMENT IN THE NETHERLANDS

The main Dutch bodies and structures responsible for WS & D management are the Ministry of Transport, Public Works and Water Management and the Royal Netherlands Meteorological Institute (KNMI).

The National Water Monitoring Network (*Landelijk Meetnet Water*) derives measurement data about water quantity from the water system, the water quality is measured by monitoring stations and laboratories. All measurement data ends up at the Water Management Centre, where the data are interpreted and enhanced with weather forecasts from the KNMI and Deltares models. Based on these data, the Water Management Centre provides water information to users and water reports to the water authorities based on which they can intervene in the water system.

Under special circumstances, activities are also coordinated with the Departmental Coordination centre for Crisis control (DCC) of the Ministry of Infrastructure and the Environment and the SVC and VCNL. Advice is provided to the safety regions via the regional water authorities (WMCN, 2011).

Nonetheless, the National Coordination Committee on Water Allocation (LCW), in case of water shortages, allocates available national water to the sectors that depend on it. LCW consists of representatives of the Ministry of Infrastructure and Environment (including all regional offices of *Rijkswaterstaat*), the Union of Water Boards and the Association of Provincial Authorities. LCW has no formal decision-making role, but advises the Director General of Public Works. The Director-General decides whether to follow and implement the advise or not. If the situation is more critical decision-making can be deposited with the Secretary of State.

6.4 INSTITUTIONAL FRAMEWORKS FOR DROUGHT MANAGEMENT IN ENGLAND

The bodies and structures responsible for water resources management in England are the Environment Agency, DEFRA (Department for Environment, Food and Rural Affairs), the Scottish Environment Protection Agency, the Centre for Ecology and Hydrology and others.

The Environment Agency publishes an Early Drought Prospects report when drought threatens and throughout the drought. They identify the hydrological situation, the area likely to be affected by drought, and recommended actions for water companies, farmers and people. Also, regional and national offices have identified drought teams who operate the day to day management of drought incident response, in the different regions of England.

At National level there is a Strategic Management Team (SMT) during drought to provide strategic governance and direction. On the other hand, drought planning is principally led at a national level by water resources teams in Environment & Business and Operations Technical Services (OTS) in partnership with the National Incidents and Contingency Planning (ICP) team. In regions, it is led by Environment and Performance teams.

Once SMT is convened, the Single Point of Contact (SPoC) arrangements are put in place. Each region and the National Incident Room (NIR) nominate an individual to be the SPoC for drought, which is normally the regional drought coordinator. The main role of the SPoC is to ensure effective communication flow between SMT/NIR and the region for briefings, information requests and drought related actions.

On the other hand, at regional level, there are specific strategic and drought management teams that coordinate with the Strategic Management Team (SMT) and the Head Office Drought Team, at National level and also with the Area Drought Management team (ADC), at local level (EA, 2012), according to the schematic representation presented in Figure 11.

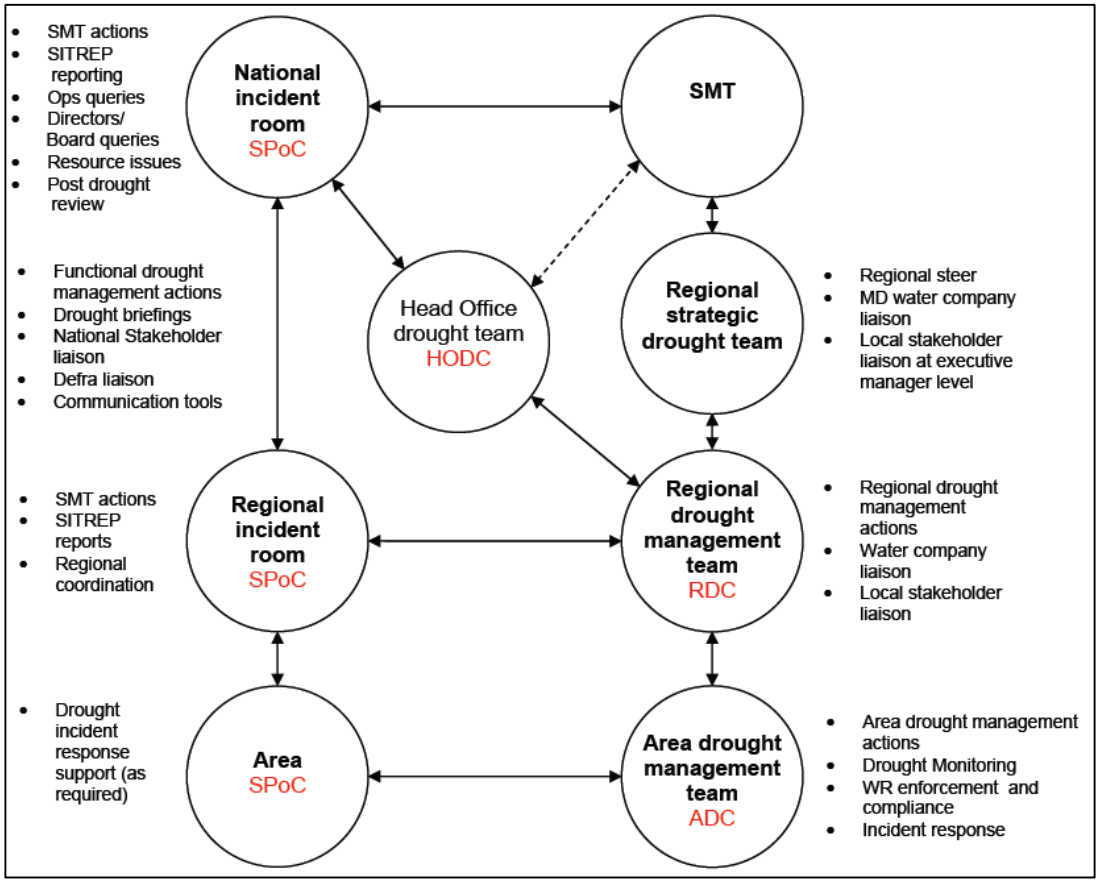


Figure 11: Schematic representation of the institutional framework for drought management in England, at different scales (National, regional and local level) (EA, 2012).

6.5 RECOMMENDATIONS ON INSTITUTIONAL FRAMEWORK FROM RESEARCH AND DEVELOPMENT PROJECTS

Attending to European member states and Mediterranean countries experience, like the above referred, the MEDROPLAN (MEDROPLAN, 2007) and XEROCHORE (XEROCHORE, 2010a) provide important recommendations on institutional frameworks for drought management.

6.5.1 MEDROPLAN

MEDROPLAN points out that designing effective risk-based strategies that mitigate the effects of drought in agriculture and water supply systems ultimately depends on the role of organizations, institutions, and civil stakeholders involved in drought in each case. Therefore, for countries that are establishing a strategy for droughts adaptation and mitigation, an institutional analysis should be ensured in order to clearly identify, analyse, and promote

cooperation among and between international, national, and local organizations and institutions that work on (i) the collection, processing, storing of meteorological, hydrological, biological, and socio-economic data and (ii) the Water resources planning and operation of water supply systems.

Moreover, the main objectives of the analysis are: (i) that the drought plan fits or matches as far as possible to the legal and institutional framework of the region where it will be implemented, to avoid contradictions and duplication of tasks and to be as operative as possible; (ii) to identify strengths and weaknesses of the framework and (if possible) propose improvements.

According to the results of the analysis, it may be necessary to propose the design of a drought management committee, indicating its composition, competences and mode of operation, both during drought and non-drought periods. This committee would have a very relevant role both in the drought management plans and in their revision and updating when the climatic and socio-economic circumstances so advise. Also, the drought committee may have competences at different levels of implementation of policy and expert analysis.

The components of a possible policy committee may include representatives of the Organizations and Institutions relevant to drought management previously defined and relevant to the geographic unit of the study. The competences and mode of operation, both during drought and non-drought periods should be clearly defined. As the diagnostic risk analysis of drought is complex, an expert committee may assist in the evaluations of the Drought Committee. An important aspect of these evaluations is to provide timely and accurate information on drought conditions to both governmental organizations and civil society, so that decisions can be made before a crisis situation develops.

6.5.2 XEROCHORE

Regarding drought planning and management at regional level the XEROCHORE reflected also the importance of appointing a Drought Managing Body. This Body is aimed at supervising and coordinating the development of the drought plan and related activities, mitigation options and response programs, as well as making policy recommendations on how to improve Drought Management Planning.

The Drought Managing Body is also encouraged to oversee the development of the plan with respect to the changing conditions due to climate change and the impacts of anthropogenic factors. The Structure of this Body should reflect the multidisciplinary nature of drought and its impacts, and, therefore, it should include representatives of the state, research community, and the private sector. Also, since social, economic, and environmental values often compete in water use, especially when the problem of scarce water resources intensifies, representative groups should be engaged in the early stages of the Drought planning process so as to express their concerns and ideas on mitigation options and collaborative solutions.

Although the level of stakeholder involvement may vary notably among regions, the power of public interest groups in policy making is considerable, as they are those who are mainly affected by the impacts of drought and are the arbiters of success and failure of the Drought Management Plans.

7 INSTITUTIONAL FRAMEWORK FOR DROUGHT MANAGEMENT IN THE UNITED STATES OF AMERICA

As with policy for other natural disasters, frameworks for drought risk management have emerged in the US as a result of the occurrence of catastrophic drought events. The higher state of awareness that lingers for some time following a drought offers a window of opportunity to further the development of drought policy. Hurricane events have lead to the development of national policy in the period of 1900 to 1969 (Simpson, 1998). No such national policy exists yet for drought, but this may change in the future, as managers keep calling for a national policy (Jimenez and Jimenez, 2011).

Droughts differ from other catastrophic events like hurricanes, floods, fires and other natural disasters in that their onset is very gradual while their duration, extent and intensity are hard to foresee and can persist for months or even years. This 'creeping' nature of drought is often blamed as explanation why national policy is still lacking. Other natural disasters tend to hit quite suddenly and are of short duration, after which reconstruction and relief can be undertaken if necessary. Only 'climate change', which is not really a disaster, has comparable characteristics to drought and Australian economist Daniel Connell therefore thinks that climate change will be managed in the same way as drought is presently managed, without meaning that in a positive sense (Svoboda, 2012).

Because of the slow onset of drought and rains eventually always return, public and private sectors alike tend to fall in what has been called the **"hydro-illogical" cycle**. This cycle can also be recognized in Figure 4, which shows how drought is presently often reacted on (Iglesias et al., 2007). An alert is given only after the onset of the drought, followed by the escalation into an emergency situation after which a natural disaster is declared and drought contingency plans are finally activated. In other words, the cycle is characterized by panic and ad hoc, reactive approaches in the event of a serious drought while upon the return of more favorable conditions, managers and water users return to past practices and apathy (Adler, 2011).

The lower image in Figure 4 (adapted from Iglesias et al., 2007) shows a much better way to respond to drought, where a warning is issued well in advance of a drought, followed by direct implementation of drought mitigation plans even before the drought has set in. During the drought an alert is given, but the emergency situation is never reached. A post-drought recovery plan is foreseen to help with recovery. Despite that there is no national drought

policy in the US, **there is broad-based understanding of the value and benefits of drought preparedness**, which has grown as experience in dealing with major droughts accumulated over the years. Consistent with that, **drought mitigation and planning are increasingly taking place at the level of states, tribes, river basins, counties, cities and even at the level of ranches, farms and utilities.** Federal drought policy however is still lacking and drought assistance to states, local governments, tribes, and individuals is primarily relief oriented as opposed to providing drought preparedness assistance (NDPC, 2000). Furthermore, there is considerable criticism on the Federal Government's inability to address catastrophic regional droughts, which is also directly ascribed to the lack of a national drought policy. Further, the federal government is also said to fail at coordinating and utilizing existing interagency emergency management statutory authorities, mechanisms, and the National Response Framework in the light of this type of serious natural disaster (Jimenez and Jimenez, 2011).

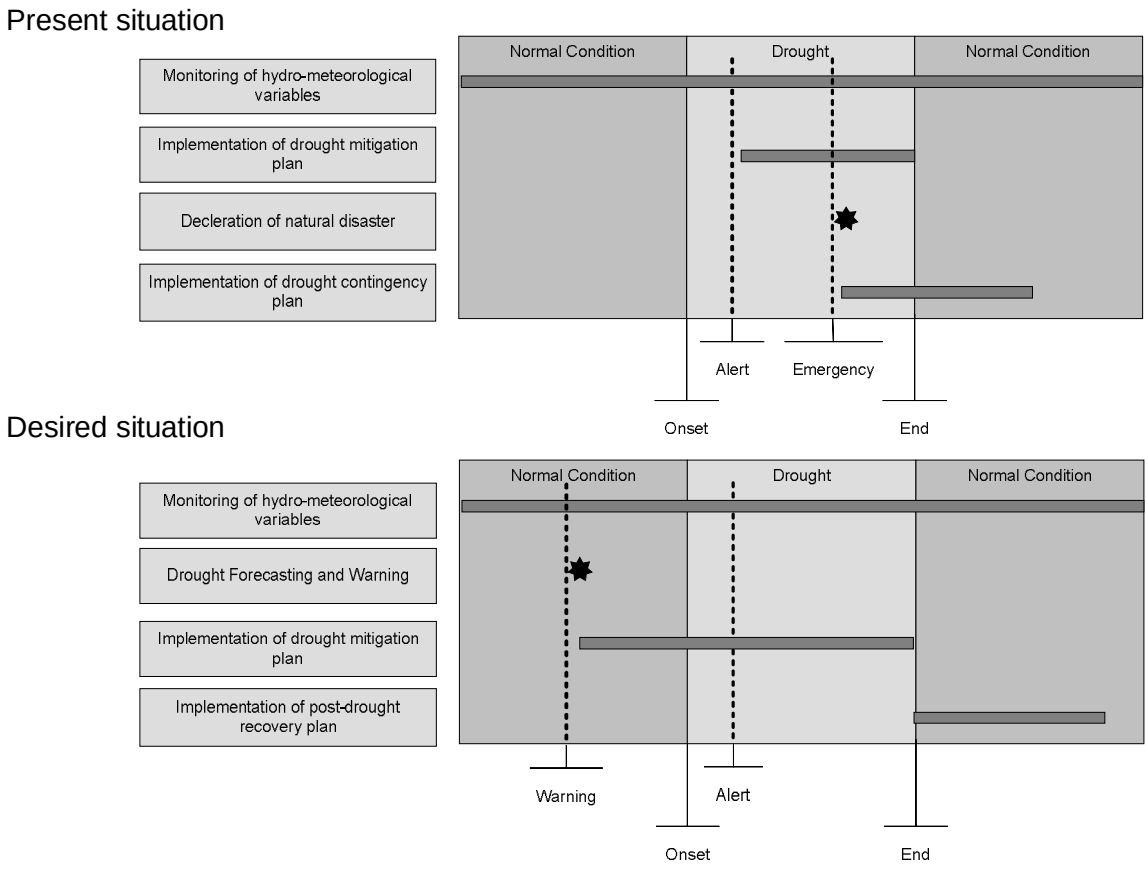


Figure 12: Sequential steps for implementing operational drought management actions (Iglesias et al. 2007). Present situation and desired situation, where warning and implementation of a mitigation plan are instantiated before the onset of the drought.

In fact, to declare a drought as a national disaster, a request must be made at the Federal Emergency Management Agency (FEMA), but they explicitly excluded drought from the

declarable emergencies. Often, a limited disaster declaration is presently requested from the US Department of Agriculture Secretary, but this limits US Federal support to the States (Jimenez and Jimenez, 2011).

In the following paragraph a chronological account is given of the most import reports and institutes that have created the present state-of-the-art in drought management, mitigation and adaptation in the US.

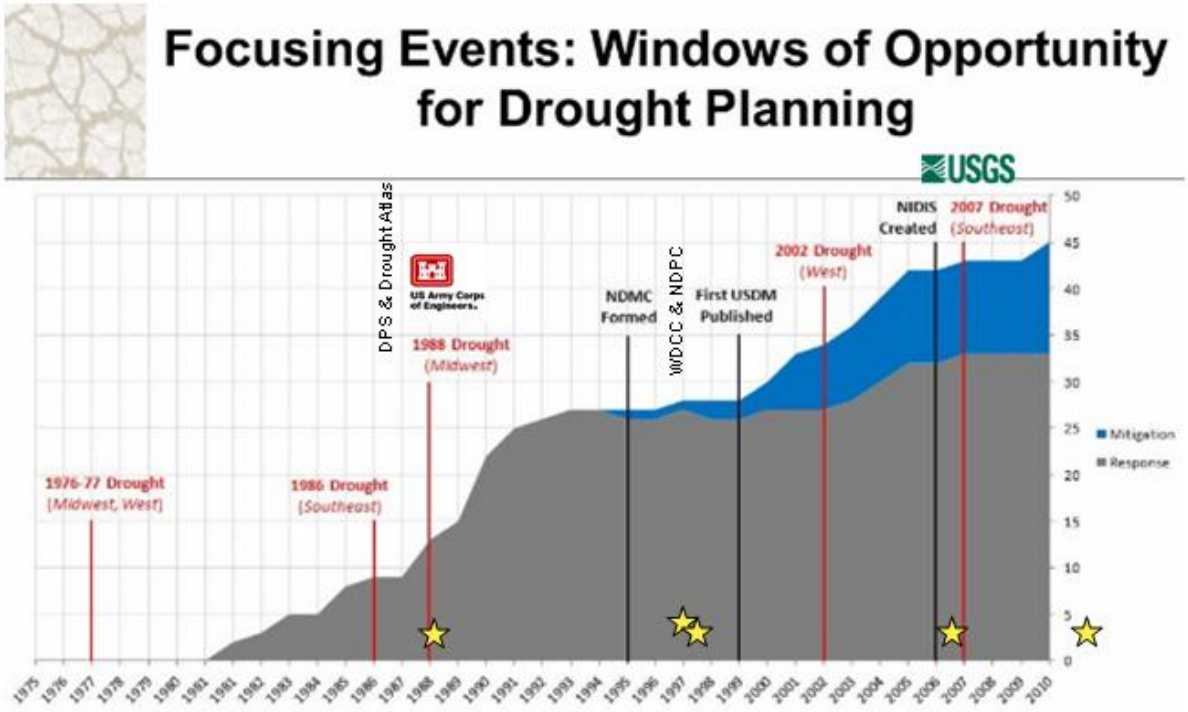


Figure 13: image adjusted from a slide by NMDC and the ~~university~~University of Nebraska Lincoln (Svoboda, 2012). Shown are some major drought event, the number of drought plans and their nature (mitigation or responsive) and the dates of publications of major reports, institutes and tools with respect to drought management (stars, black texts and logos)

Figure 13~~Figure 5~~ shows the relation between the development of State drought management plans, the publication of important reports and the establishment of institutes versus the occurrence of major drought events. The number of states with a drought plan clearly rapidly increased in the 80's, especially after the droughts of 1986 and 1988.

In fact, in response to the droughts of 1988, Congress authorized the Army Corps of Engineers (Corps) to make a nationwide survey with the goal of finding a better way to manage water during drought. The resulting effort was titled the National Study of Water Management d~~D~~uring Drought (referred to simply as the National Drought Study, 1988-1994) (Werick and Whipple, 1994). This national study proposes a DPS, a 7-step Drought Preparedness method. The first 5 steps are performed iteratively.

At the same time, a National Drought Atlas was published in Willeke (1994), providing statistical information, designed to help water managers and planners answer questions about the expected frequency, duration and severity of droughts. It forms a national reference for precipitation and streamflow statistics (Werick and Whipple, 1994). In 1995 the Senate Task Force on Funding Disaster relief –already concluded that it was necessary to deal with drought in a proactive mitigating fashion. Through preparedness as opposed to relief (NDPC, 2000) and the NDMC was formed. In 1997 the Western Governors' Association closed a memorandum of understanding with representatives of federal, tribal and local governments, leading to the initiation of the Western Drought Coordination Council (WDCC) which was operational from 1997 to 1999. It then went on a hiatus year, which lasted until present. Depending on drought in the West and on the work of the National Drought Policy Commission, which was being formed at that time, this commission could become operational again. The WDCC produced a number of documents that may serve as handles or checklists for drought (risk) managers.

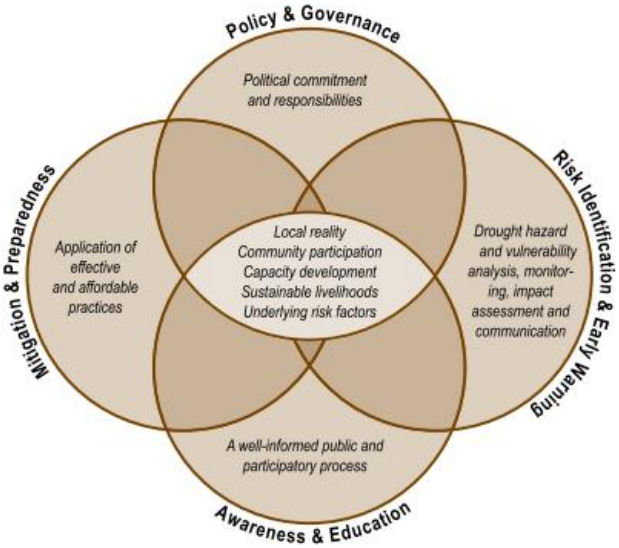
In 1998, the U.S. Congress enacted the National Drought Policy Act that established an advisory commission to provide advice and recommendations on the creation of a national drought policy. The resulting National Drought Policy Commission published a report that represents the basis for a national drought policy and called for commitment and resolve in providing sufficient resources to achieve the policy goals (UNISDR, 2009). The report called for drought mitigation planning at the local, state, federal and regional (hydrologic basins') level (Wilhite *et al., 2006*). In 2006 the Geological Society of America (GSA) organized a participatory conference, the results of which were presented in a conference report: " Managing drought: a roadmap for change in the United States" (Wilhite *et al., 2006*). A congressional meeting of the same name followed in 2007. Conference attendees collaborated in identifying promising science and water policy solutions to managing and mitigating the impacts of drought. Physical scientists, life scientists, social scientists, Native Americans, policy-makers, water managers, water users, and students found that enhanced data and analyses are needed to improve: the fundamental understanding of the causes of droughts; the prediction of droughts; and drought mitigation and management. To be useful to decision-makers, drought analysis reports must be timely and at appropriate spatial scales. Including measures of confidence or uncertainty helps decision makers assess the credibility and usefulness of the information (Wilhite *et al., 2006*). The NIDIS portal was launched in 2007 (drought.gov) after having been approved by law in 2006. NIDIS represents

a coordinated federal effort to provide in drought monitoring and research for stakeholders at different levels in the country.

In 2011, S. Jimenez and A. Jimenez (2011) publish a report calling on presidential action with respect to observed weaknesses in the US System of emergency management for when it comes to drought emergencies. They make the following 10 recommendations:

- Appointment of a national drought and food-security czar;
- Creation of a national emergency livestock hay/feed program;
- Development of a national drought policy;
- Designation of a lead federal agency for drought, preferably DHS and/or FEMA;
- Initiation of emergency management catastrophic drought planning;
- Development of a clear disaster declaration policy for catastrophic droughts;
- Development of a strategic national food stockpile;
- Conducting a bottom-up review of USDA and FEMA emergency assistance programs; and
- Improving public drought outreach efforts.

During the Annual Conference by the American Meteorological Society, in January 2012, Mark Svoboda points out that there is still no national policy in place that deals with drought. Also in 2012, the NDMC and partners (NIDIS, NOAA, universities of Illinois and Oklahoma) publish a Guide to Community Drought Preparedness, a web-based educational resource for forage and rangeland producers (ranchplan), and a mitigation database project. Many groups are working together via NIDIS and NDMC to create a comprehensive national drought early warning system (DEWS) that focuses on a proactive risk management approach. Collaboration takes place between tribes, states, and federal agencies, regional and state climate offices, river basin authorities and various communities across the United States (USDA-FSA, 2009). Drought Policy and management, Institutes and roles at different levels.



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

In 2009, the UNISDR publish the Drought Risk Reduction Framework and Practices, which identifies 5 important elements that should be part of any drought risk reduction framework:

1. **Policy and governance** are essential for drought risk management. Without political commitment and availability of resources, little can be achieved.
2. **Drought risk identification, impact assessment, and early warning** including hazard monitoring and analysis, vulnerability and capability analysis, assessments of possible impacts, and the development of early warning and communication systems.
3. **Drought awareness and knowledge management** is necessary to create resilient communities where drought risk reduction is part of culture and natural behavior.
4. **Reducing underlying factors of drought risk** such as changing social, economic and environmental conditions, land use, weather, water, climate variability and climate change.
5. **Strengthening preparedness for drought** to move from policies to practices in order to reduce the potential negative effects of drought.

At the interface of all these spheres lies an area where the “local reality of community participation, capacity development, sustainable livelihoods and the underlying risk factors” are mentioned. This to emphasize that although droughts may impact very extensive areas and policy and governance are necessary at higher levels (i.e. at national or state-levels), impacts are felt locally and local participation and response are necessary to manage, mitigate and adapt to drought.

Drought management in the US is increasingly being institutionalized and is increasingly becoming part of good citizenship, good governance and good entrepreneurship. In other words, it is taking its place in daily life of people, organizations and local to state governments who gradually steer their subjects towards the establishment of sustainable communities. Despite the lack of a national drought policy, individual states, state leaders and governing persons at lower levels have played important roles in the development of the present state of the art in drought planning and mitigation. The conference of Governors and later the conference of Mayors have played important roles in the growing number of states and cities with a drought plan. They also keep pushing for a national drought policy and increased inter-state collaboration on drought research and awareness.

The national institutes that have emerged as a result of the state-level efforts, work together with research institutes at and below the state level and all increasingly work towards activating people, organizations, utilities, farmers etc. at lower levels. Providing them with information and handles for drought management, effectively building awareness and capacity. The result is that presently the levels at which drought plans are being developed are at the tribal, state, basin, county, city, utility and ranch or farm levels.

Drought management is necessary at all these levels, because in the end it is the water users who have to be curtailed and brought to change their water-consuming processes and habits. Citizens, farmers and water consuming utilities are therefore the primary target for drought mitigating efforts. On the other hand, they are also the first to experience the negative consequences of droughts and therefore greatly benefit from building resilience and reducing their own vulnerability.

In fact, drought is sometimes primarily considered a problem to agriculture, which of course is most severely hit by drought. This is also said to be the reason why national policy for drought emergencies still has not been established: declaration of an emergency situation is now often done via the USDA, resulting in a state-declaration and not a national emergency declaration.

Because drought must be managed at so many different levels, there are also a lot of stake holders and different water users that will be affected by drought. Also, there may be different types of laws that might apply as river basins may cross national and state borders.

7.1 INSTITUTIONS AT THE NATIONAL LEVEL

Figure 14 shows the roles different institutes take in the drought risk reduction framework as published by UNISDR. The figure has been adjusted by including arrows to represent flow of information and the order in which action is taken by different actors.

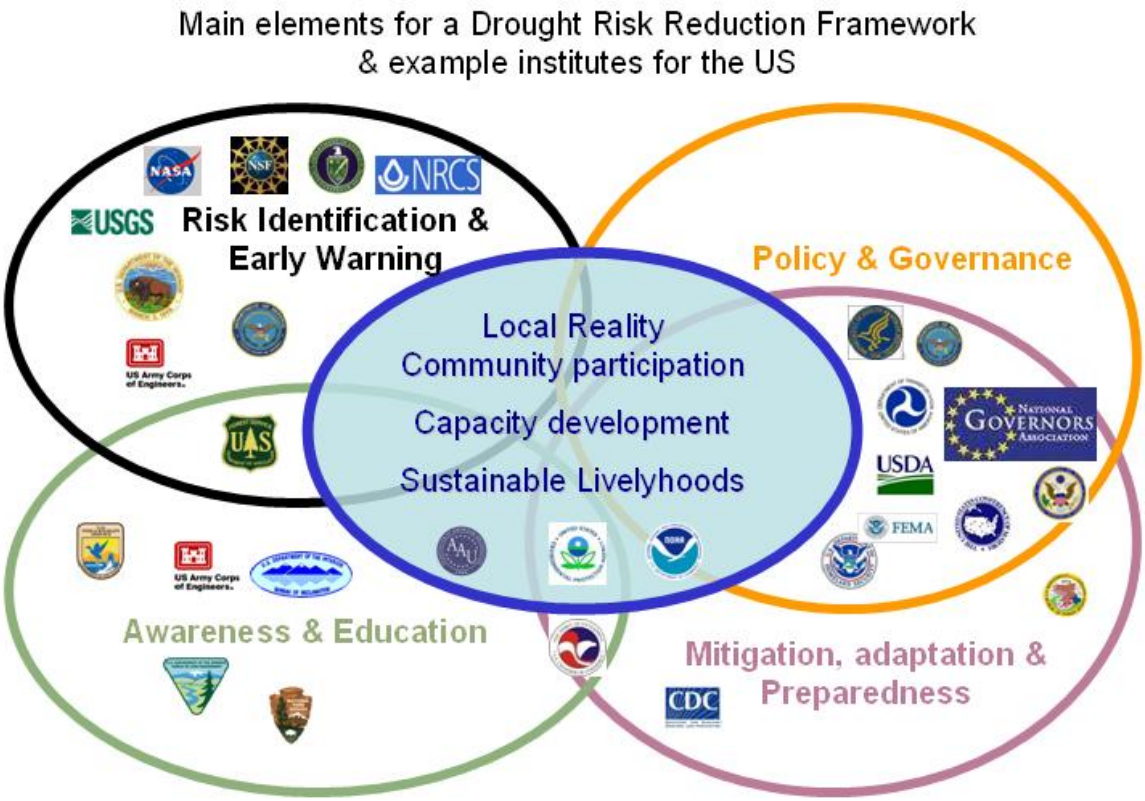


Figure 14: American institutes and their position in the Drought Risk Reduction Framework as published by UNISDR. Organisations in the central circle are active in all categories.

One can go through the figure through different pathways, representing different scenarios. To see how the institutes would interact in the case of the onset of a drought event, it is logical to start in the upper left corner. There, risk identification and early warning is performed by a score of research institutes, like NASA, USGS and NRCS by monitoring and forecasting weather patterns. These institutes will give warnings to governing bodies, at state, river basin, city and tribes' levels. These will ask for an emergency declaration by FEMA or, more likely, USDA and will activate or make policy to give governance in how to deal with the foreseen drought. As a result, mitigation, adaptation and preparedness actions will be initiated as well as efforts for awareness and education. These are all directed to the citizens, farms, utilities, river basin managers etc. In other words the people who are actually curtailed in their water use in the face of drought are at the intersection of the 4 spheres. Apart of these, there are also water managing institutes like the Army Corps of Engineers. In

the circle of Policy and Governance, the different national offices and departments reside, as well as governor and mayor associations. USDA and FEMA are special organizations as drought emergencies are declared by them, allowing for relief to be organized for victims of droughts.

As can be seen in the figure, the biggest circle is that of mitigation, adaptation and preparedness. The reason for this is that many different actors are necessary for this and it cannot be achieved without knowledge of present and future climate dynamics, awareness & education or policy and governance.

The NDMC lists a couple of the major players in drought risk management in the US, which can also be found back in Figure 14. Some of them are described more extensively in other DEWFORA documents:

- The **National Oceanic and Atmospheric Administration** is the lead federal agency in monitoring and attempting to predict drought. They have very extensive and sophisticated monitoring networks for that purpose.
- The **Federal Emergency Management Agency** (FEMA) has at times explicitly excluded drought from its responsibilities, and generally focuses more on faster-moving disasters. This has caused the undesirable situation where drought is barely ever declared an Emergency at the highest (presidential major) level, also inhibiting relief which is available to other types of disasters (Jimenez and Jimenez, 2011; USDA-FSA, 2009).
- The **U.S. Department of Agriculture** (USDA) is involved in many aspects of preventing drought impacts and providing relief to affected agricultural producers (See earlier in this document). The USDA can also declare a disaster designation, but this is for disasters of a lower level than the presidential. Consequently, the relief and support programs in such situations are different than those with a presidential designation. (USDA-FSA, 2009).
- **The U.S. Geological Survey** (USGS) plays a key role in monitoring hydrologic aspects of drought, including snowpack, streamflow, and groundwater.
- The **U.S. Army Corps of Engineers** and the **Bureau of Reclamation** both manage river systems through dams, levies and reclamation.
- The **U.S. Environmental Protection Agency** (EPA) monitors water quality, which suffers during drought.
- The **Centers for Disease Control** is in charge of public health which can be impacted through drougts

- The **NDMC (DM G 04)** works to reduce societal vulnerability to drought by helping decision makers at all levels to: implement mitigation planning and DEWS, understand and prevent drought impacts and increase long-term resilience to drought through proactive planning. The NDMC is a national center that was founded in 1995 at the University of Nebraska-Lincoln. The NDMC conducts basic and applied research along with the maintaining of a number of operational drought-related activities, including the U.S. Drought Monitor (USDM), Drought Impact Reporter (DIR) and the Vegetation Drought Response Index (VegDRI).

7.2 INSTITUTIONS AT STATE LEVEL

State drought plans are the highest level of drought plans that exist in the US. They were often written after a particularly severe drought affected a certain state. During the widespread U.S. drought of 1976-77, no state had a formal drought plan, and in 1982, only three states had drought plans. But as of October 2006, thirty-seven states had drought plans, and presently that number has grown to 45. In addition to that, one state is presently developing a plan (Louisiana); one has delegated drought management to local authorities (Mississippi) and three states simply don't have a plan (Alaska, Arkansas and Wisconsin).

The drought plans of 36 states can be downloaded from the UNL website (http://drought.unl.edu/planstateplans.htm). Some states do not seem to have updated their drought plans since they were drawn up (see Figure 15), over 20 years ago, despite that considerable developments have taken place since then and much better tools for both drought forecasting, and drought management are now available. Also, insights in monitoring drought severity might have changed, not to mention population pressures and water demands from different sectors. Five drought plans date from the 80's, eight from the 90's and 32 were written or updated between 2000 and 2011. With respect to the institutes or commissions who published the documents, six have the word "emergency" in their title, eight contain "water". Three documents were published by a state department, five by a committee or team. The documents themselves generally bear the state's name, the words "drought" and "plan". In four cases the documents focus on the management of water instead of "drought" and in three cases the document consists of a plan to manage multiple hazards as opposed to just drought. Five documents have the word "emergency" in their title, while 13 document titles contain the word "response". Three documents have "mitigation" in their names and two mention "preparedness". Four documents use the word "contingency". Seven documents bear a title related to "drought Management" and another seven simply use "drought plan" as title. The titles used, but especially their contents supports the notion that

most state drought plans are still of a responsive nature, while a growing number of them are now focusing on drought mitigation.

Each of the states has a State Climatologist who works at the State Climate Office or an institute of approximately the same name. Their names and e-mail addresses are available from the UNL website. Further, an additional contact is provided for 24 states, generally working for a state department.

Twenty states have a state website dedicated to drought. Drought warnings, information on drought mitigation and drought relief can often be obtained from these websites (see Table 15).

The state drought plan of Texas mentions that it was created after numerous drought plans from various states had been reviewed. From that review and interviews with drought experts it was concluded that many drought plans provided 'triggering' mechanisms or thresholds intended to initiate specific actions by various agencies, but when these thresholds were reached or exceeded, the prescribed response was rarely implemented in a timely or effective manner (State of Texas, 2005).

Table 15. State websites dedicated to drought.

State Website	Website Link
Virginia Department of Environmental Quality: Drought Information	http://www.deq.virginia.gov/waterresources/drought.php
Pennsylvania Department of Environmental Protection: Drought Information	http://www.portal.state.pa.us/portal/server.pt/community/drought_information/10606
New Jersey Dept. of Environmental Protection: Drought Information	http://www.njdrought.org/
New Hampshire Dept. of Environmental Services: Drought Management Program	http://des.nh.gov/organization/divisions/water/dam/drought/index.htm
Montana Natural Resource Information System: Drought Information	http://nris.state.mt.us/Drought/
Massachusetts Office of the State Climatologist: Drought Status	http://www.mass.gov/dcr/waterSupply/rainfall/drought.htm
Maryland Drought Status and Information	http://www.mde.state.md.us/Water/Drought/index.asp
Kentucky Division of Water: Drought page	http://water.ky.gov/wa/Pages/Drought.aspx
Indiana Drought Information	http://drinet.hubzero.org/INDrought

State Website	Website Link
Hawaii Drought Monitor	http://hawaii.gov/dlnr/drought/
Georgia Environmental Protection Division	http://www.gaepd.org/
Florida Drought Conditions	http://www.dep.state.fl.us/drought/default.htm
Drought Update from the Kansas Water Office	http://www.kwo.org/reports_publications/Drought.htm
Drought Information Resources Minnesota	http://climate.umn.edu/doc/journal/drought_information_resources.htm
Drought Central	http://www.droughtcentral.nebraska.gov/
Division of Water Supply - Drought Planning	http://www.tn.gov/environment/dws/droughtplanning/
Connecticut - Water Status	http://www.ct.gov/waterstatus/site/default.asp
California Department of Water Resources: Drought Page	http://www.water.ca.gov/drought/
Arizona Drought Program	http://www.azwater.gov/AzDWR/StatewidePlanning/Drought/
Texas Agricultural Drought Task Force	http://www.twdb.state.tx.us/

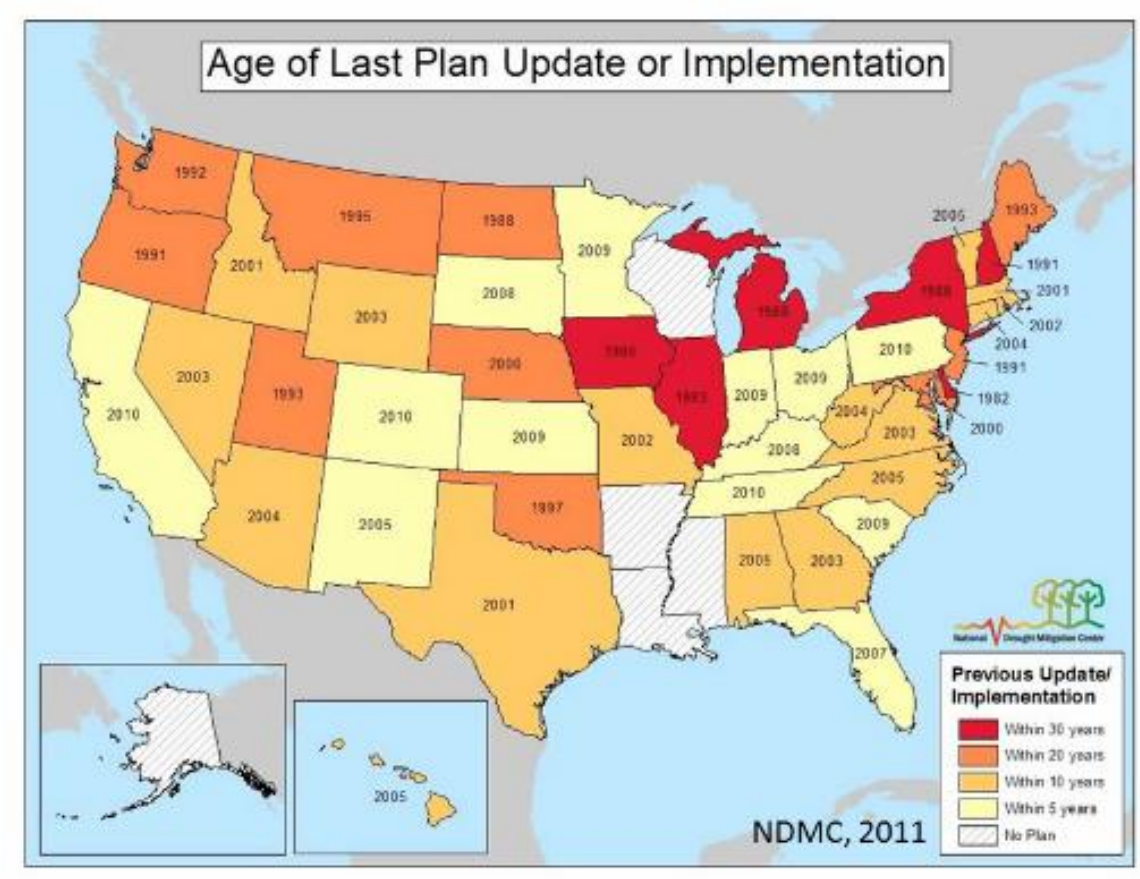


Figure 15 : Years in which the state drought plans were drawn up or last updated.

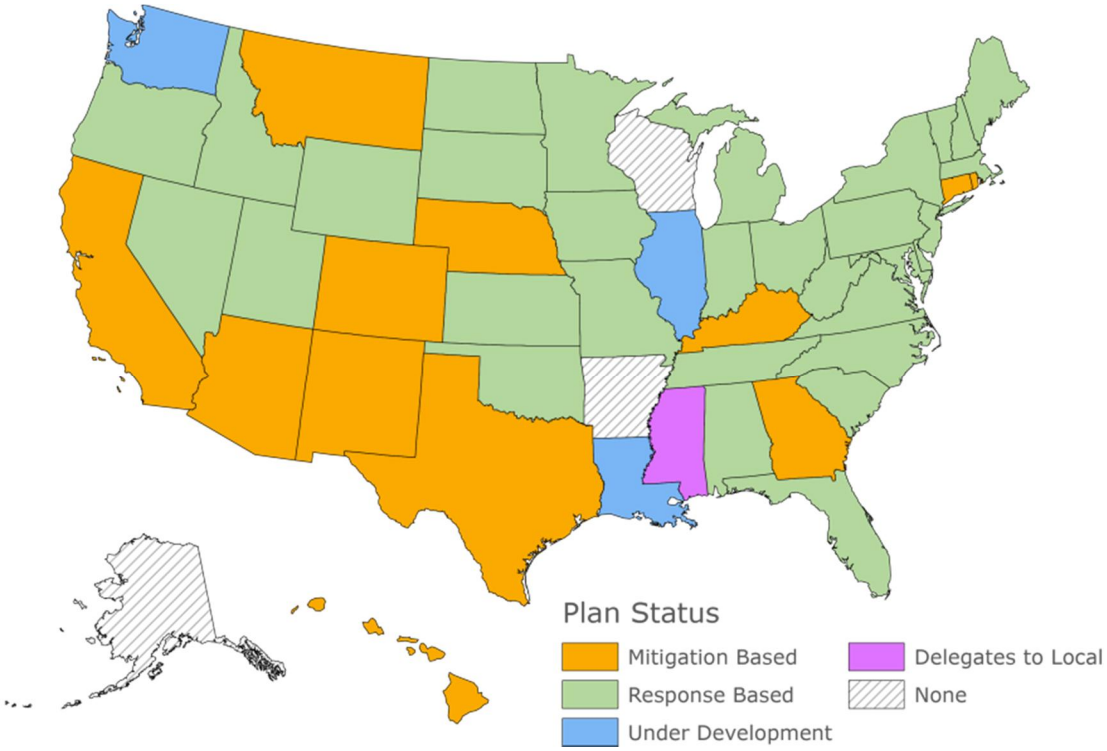


Figure 16: Nature of the state drought plans: mitigation, or response based; under development, delegated to local institutes or non-existent.

7.2.1 Texas: Example of drought management and mitigation at the state level

Drought is a recurring event in Texas: the state was affected by drought in many of the drought periods as listed earlier in this document. In 1990 governor G.W. Bush signed legislation (HB 2660) that formed the Drought Preparedness Council (DPC) which was required to develop a comprehensive State Drought Preparedness Plan. The plan:

1. Identifies the local, state, federal and private sector entities that are involved with state drought management and defines their responsibilities.
2. Defines a process to be followed in addressing drought-related activities, including monitoring, impact assessment, and response.
3. Identifies long and short-term activities that can be implemented to prevent and mitigate drought impacts.
4. Acts as a catalyst for creation and implementation of local drought planning and response efforts.

The State Drought Preparedness Plan is intended to complement the State Water Plan and takes into account on-going water resource planning through local and regional Water Conservation Plans and Drought Contingency Plans. Also the Texas Water Code and State

Water Plan are important in relation to this plan. Finally, existing partnerships, lines of communication and local stakeholders were included in the design process of the plan.

Because timely dissemination of drought-related information is considered vital in an effective use of the plan, an information dissemination systems was developed using target customer lists for e-mail and fax communication systems. Further, informational brochures and internet web sites are used to communicate drought information. Finally, the drought preparedness plan itself is available online and is printed as 'loose leaves', allowing for quick updates. The Drought Preparedness Council exists of the following agencies and participants, which are active in multiple commissions and roles:

Table 16: Drought Preparedness Council; Agencies and participants

Drought Planning and Coordination		Drought Monitoring and Water Supply		Drought Technical Assistance and Technology		Drought Impact Assessment	
*GDEM	TPWD	*TWDB	TDA	*TWDB	TAEX	*TCEQ	TAEX
TWDB	TDED	TCEQ	TAEX	TCEQ	TxDOT	DSHS	TFS
TCEQ	DSHS	TPWD	TFS	TSSWCB	TDA	TDA	TDED
TSSWCB	TDA	GDEM	NWS	TPWD	ORCA	TPWD	TWDB
TDHCA	TFS	USFS	USGS	GDEM	USACE	GDEM	USFS
TAEX	TxDOT	USPHS	USACE	USBR	USFS	USPHS	NWS
FEMA	USFS	IBWC	TAGD	USPHS	HUD	USACE	USGS
HUD	USACE	RD	OSC	NRCS	FSA	TAGD	USFWS
USGS	USBR					NRCS	
NRCS	TAGD						
ORCA	OSC						

NOAA has defined a climatic regional delineation, dividing Texas into 10 separate regions within which climate can be considered approximately uniform. Because this approximation is still considered too course, a sub-delineation is under development. For each region, a number of indices with multiple sub-indices are monitored, resulting in the assignment of a 'level of concern' to each region main index. The results are included in the monthly Drought Situation Report (SITREP) and are discussed by the DCP, who decide whether further action is needed. The 'levels of concern' are:

1. advisory

2. watch
3. warning
4. emergency
5. disaster

The indices and the organizations responsible for monitoring and acting upon them are shown in Table 17:

Table 17: Indices and organizations responsible for monitoring and acting

Index	Index short	Organization
Climatological Assessment Index		TWDB
Standard Precipitation Index	SPI	TWDB
Keetch-Byram Drought Index	KBDI	TFS
Vegetation and Temperature Condition index	VT	TWDB
Crop Moisture Index	CMI	TWDB
Palmer Drought Severity Index	PDSI	TWDB
Agriculture Assessment Index		TAEX
Soil Moisture Index		TAEX
Crop Condition Index		TAEX
Pasture and Range Condition Index		TAEX
Livestock Sales Index		TAEX
USDA Drought Declarations		TDA
Water Availability Assessment Index		TWDB
Reservoir Levels		TWDB
Streamflow Data		TWDB

Actions that the DCP can undertake as a result of the 'levels of concern' are:

- increase the frequency of DCP meetings
- further assess and disseminate information about needs, emergencies and drought effects
- initiate, coordinate and communicate
    - drought awareness and conservation campaigns,
    - concerns to Regional Water Planning Groups, state leaders, federal representatives
    - agency, interagency and legislative responsibility and action
    - support a declaration for a drought emergency in particular county(s) or climatic region

The Texas Drought Plan finally lists 4 phases for which emergency management can be undertaken and describes all actions and responsibilities per agent in each phase. It is also

mentioned that drought assessment and response in Texas is designed to be proactive and to assist existing state, federal and local agencies in carrying out their designated missions for assisting drought-affected customer groups. The phases for emergency management do not only apply to drought, but to all emergencies and consist of:

1. Mitigation
2. Preparedness
3. Response
4. Recovery

7.3 RIVER BASIN LEVEL

The US has river basin authorities, which were created by legislature as official state agencies. They have as task conservation, reclamation and to control, store, preserve and distribute water of a particular river basin. Water is supplied to municipal, agricultural and recreational users, who are all stakeholders. Because river basins may cross state boundaries and international boundaries, compacts between basin authorities are sometimes necessary, as is the case for the Sabine River Basin

7.3.1 Sabine River basin (state of Texas)

In Sabine River Basin, all holders of water rights of 1,000 acre-feet per year (ac-ft/yr) or more for municipal, industrial and other uses and 10,000 ac-ft/yr for irrigation are required to submit a water conservation plan according to the Texas Administrative Code (TAC). Apart of that, wholesale water providers are also required to prepare a drought management plan.

With conservation are meant all practices, techniques and technologies that will reduce the consumption of water, reduce the loss of water, improve the efficiency in the use of water, or increase the recycling and reuse of water. The TCEQ is responsible for oversight of these plans. There are precise prescriptions as to what the plan should include.

Apart of that, the TCEQ provides guidance on additional conservation strategies that may be selected by water wholesalers if they are necessary to achieve the plan's stated water conservation goals. These optional conservation strategies can include:

- Conservation-oriented water rates and water rate structures.
- A program to assist customers in the development of conservation plans.
- A program for reuse/recycling of wastewater/gray water.

The drought management plan should include an education and information program about the plan, notification procedures to identify the initiation and termination of the drought and the corresponding implementation and termination of the drought measures, trigger conditions signaling the start of any identified drought period, and drought water-use measures corresponding to each trigger condition.

Table 18: Content of Sabine River basin Authority's (SRA) drought management plan.

Item	Description
Introduction	Presents background information on SRA, the purpose and goals for water conservation, and a description of the sections in this report.
Service area and system evaluation	Evaluates SRA service area and supply system, including data on the Basin and out-of-Basin service area population and customers, water use, existing supply system, and historical and projected use.
Conservation practices for a regional wholesale supplier	Describes SRA's compliance with the requirements of TAC: - Specific, quantified 5-year and 10-year targets for water savings. - Practices and devices used to measure and account for the amount of water diverted - SRA's monitoring and record management program for determining water deliveries, sales, and losses - Leak detection and repair program - universal metering, meter repair and replacement - Description of conservation and drought contingency planning section in all new and renewed water sales contracts - Description of reservoir systems operations plans that include optimization of water supplies as one of the significant goals. - Means of implementation and enforcement - Documentation of coordination with Regional Water Planning Groups in SRA's service area - Other measures o Water conservation education and information programs o Technical assistance in development of conservation plans o Recycling and reuse o Best management practices o Community Assistance Program o Review and update schedule.

Sabine River's contingency plan is based on the percent reservoir storage, divided into five stages. For each stage the requirements to initiate and terminate the stage are defined, as well as goals to achieve and measures to take. The goals consist of reductions in the water diversions from four to 10%, or 'as necessary' in the worst drought cases. The triggers for initiating or terminating a drought stage are based on a drought condition or the absence thereof for fourteen consecutive days. Measures indicate where water reductions should take place during each drought stage.

7.3.2 The Potomac River

C.J. Bergman highlighted some interesting manners of managing drought in the US at the River basin levels in a presentation given in January 2012. The Potomac River is one of the largest unregulated rivers in the US and is the only river basin that holds an annual basin drought exercise. During such an exercise they all the stakeholders are brought together for a week. The reason why they do this annually is because of high staff turnover rates. During the exercise, a hydrologic model is used to simulate flow of drought conditions and possible future conditions. In the late 70's a low-flow allocation agreement was made for the Potomac river, but droughts were never so severe that this drought contingency plan had to be made effective (Bergman, 2012).

7.3.3 Red River basin (State of North Dakota, Minnesota, and Manitoba)

The Red River basin is shared with Canada, resulting in a situation where different water laws apply to the different river parts as they lay in different states and provinces. In this case it was therefore very important to take into account the differences in laws and law-approaches and convincing stakeholders to use a basin-wide perspective. They use a flow model to aid with drought forecasting. Communication among stakeholders is reported to be key (Bergman, 2012).

7.3.4 Lower Colorado River Basin (State of Arizona, and parts of California, Nevada, Utah, New Mexico and Mexico)

Bob Rose tells in his presentation about the challenges the 2011 drought poses to the Lower Colorado River Authority. If the drought of 2011 continues in 2012, then projections are that there will be no water available at all for agriculture. In the lower Colorado a lot of rice growing takes place, producing two crops per year. The farmers however, usually take a cheap water supply contract, which has a potential curtailing of water supplies to 100% of supplies. This is a risk farmers chose for when they took the contracts, as different, more expensive contracts were available. However, the consequences may be very large (Rose, 2012). Another consequence is that the low outflows of freshwater, the lagoon/bay at the coast is becoming very saline, even more saline than the gulf of Mexico.

7.4 NATIVE AMERICANS

Several Native American Tribes have lands that experience arid or semi-arid climatic conditions. Drought plans are part of their land management programs. The NDMC has links to drought plans for four tribes: the Hualapai, the Navajo Nation and the Northern Cheyenne and the Zuni tribe. The Cheyenne tribe mentions to have developed the plan after reviewing

drought plans of other tribes, specifically the Ft. Peck, Navajo, and Hopi plans (Beck Consulting, 2007).

The Hualapai, Navajo and Zuni drought plans were all funded by the US Bureau of Reclamation. In at least two cases this was under the authority of the Reclamation States Emergency Drought Relief Act of 1991, Title II, Drought Contingency Planning.

Each of the drought plans under review here uses a general drought indicator as developed by other institutes to base their decision-making on (Table 19). The Navajo Nation however mentions that the SPI as made available by the WRCC is too coarse to highlight regional differences within the Navajo Nation. They therefore propose to calculate their own NNSPI, based on more local data and use this next to the SPI and information from the NDMC.

All reports begin with an overview of the available water resources and the water demand by sector. Further, the reports define how monitoring and reporting should take place, the roles of different stakeholders and institutes, and how should be responded to drought. In two reports all relevant contact details are included in appendixes, as well as information on where relief and financial assistance can be obtained.

The Zuni and Cheyenne have defined clear actions that need to be undertaken, like the reparation of water tanks, and assigned priorities to them. In the case of the Zuni cost estimates were added.

Table 19: Drought plans of several tribes and indicators used.

Tribe	Document Title	Indicators used
Hualapai	Cooperative Drought Contingency Plan (Christensen, 2003)	SPI, PDSI
Navajo Nation	Navajo Nation Drought Contingency Plan (NNDWR, 2003)	SPI, NNSPI
Northern Cheyenne	Northern Cheyenne Tribe Drought Mitigation Plan (Beck Consulting, 2007)	SPI, PDSI
Zuni	Zuni Drought Contingency Plan (Zuni, 2001)	PDSI, ZPI, SFI
Indicators		**Indicative for**
SPI	Standardized Precipitation Index	all sectors
NNSPI	Navajo Nation SPI	all sectors
PDSI	Palmer Drought Severity Index	all sectors
ZPI	Z-Score Precipitation Index	Groundwater Supply
SFI	Stream Flow Index	Surface Water Supply

The Zuni Drought plan also indicates how to handle conflicts if different water use sectors use the same source. In the case of a drought, prioritizing water uses may be necessary. To determining the relative importance of uses, it must be considered whether a certain use is essential, socioeconomically valued, or nonessential will be required. For Zuni, essential uses include drinking, maintaining public health, and wildfire suppression. Socioeconomically valued uses include farming, ranching, construction, and fish and wildlife. Nonessential uses include recreation and unnecessary domestic uses, such as lawn watering, car washing, etc.

7.5 CITIES AND UTILITIES

7.5.1 City of Austin (State of Texas)

Cities in Texas too need to have drought management and contingency plans according to TAC. To be precise, their plan was designed to meet Section 11.1272 of the Texas Water Code and Chapter 288 of Title 30 of the Texas Administrative Code. These regulations require all Texas wholesale public water suppliers and all retail public water suppliers providing water service to 3,300 or more connections to update Drought Contingency Plans by May 1, 2009 and every five years thereafter. Additionally, as part of its water agreements with the Lower Colorado River Authority (LCRA), the City is required to have a Drought Contingency Plan that reflects consideration of the targets and goals set forth in the LCRA Drought Contingency Plan (Austin Water Utility, 2012).

The Plan specifies **how the City will respond to and manage the water system during demand and infrastructure constraints as well as during drought**, including a repetition of the critical drought of record. The City will coordinate with LCRA and the policies set forth in its Water Management Plan, if and when a drought or other shortage of water supply should occur.

Although the city of Austin is high on the priority list for the provision of water from river run-off, during droughts, this water supply is not always guaranteed. Therefore the city of Austin closed a contract with LCRA to use stored water in the Highland Lakes and other sources as back up in 1999.

The City of Austin has established year-round water conservation measures that apply to its retail water customers. Residential and commercial facilities may use spray irrigation either before 10:00 a.m. or after 7:00 p.m. only on a designated outdoor water use day.

Commercial patio misters may operate only between 4:00 p.m. and midnight. All customers are limited to no more than two designated outdoor water use days per week. The City Manager or his/her designee monitors water supply, water system capacity and demand conditions to determine when to consider implementing additional conservation actions for the City's retail water customers as outlined in the demand, supply, and emergency triggers.

Demand triggers are based on 2 water demand values: 260 million gallons/day (mgd) for 3 consecutive days or 270 mgd for one day. In that case, water restrictions will be imposed with as goal to reduce water use by 15% of the water demand. Supply triggers are based on combined lake storage, which may not fall between 1.4 million acre-feet, 900,000 acre-feet or 600,000 acre-feet, or a drought worse than the drought of record is declared. In each case water restrictions are imposed with as goal a 5 to 20% reduction in water use. The situation may be ended when the lake storage conditions have improved and endured for 4 months.

The city manager finally can also determine that an emergency like a system outage, equipment failure or contamination of water may cause reason for an emergency trigger. In that case water reduction may be imposed as deemed necessary. The condition may be ended based on daily water demand or the end of supply constraints.

7.5.2 City of Willow-park (State of Texas)

In the city of Willow-park, Texas 5 drought stages are defined with indicator of when to increase to the next stage or return to the previous stage. Increases are based on the failure to restore levels to a certain depth in storage tanks for a number of consecutive days and returns are based on similar measures with an additional time-restriction on the number of days elapsed since that state of emergency was entered (Willow Park, 2001).

Willow Park asks its customers to voluntarily conserve water and adhere to prescribed restrictions for certain water uses every year during part of the year, namely from may first to the end of September. To reduce water use, a system is in place where houses with even numbers may use water for certain uses during one day and the houses with odd numbers during the next.

7.5.3 City of Boulder (State of Colorado)

The revised Drought Planning and Response Plan of the city of Boulder, Colorado, updates the information in the 2003 document and incorporates the use of water budgets as a tool in drought response actions. A five (5) block, water budget rate structure was approved by City

Council in 2004 and was implemented in January 2007. Included in this implementation are water budget options for the commercial, industrial and institutional (CII) customer that are based on historical or average monthly use (City of Boulder, 2010).

7.5.4 City of Louisville (State of Colorado)

The Drought plan of Louisville is based on the ability to provide water even during droughts that occur only once in 300 years. The Water Supply Index (WSI) is based on the supply to demand ratio, which are determined by several water reservoirs and customers. Further, carryover is taken into account, which is the amount of water carried over from the previous year and direct flow rights (Louisville, 2004).

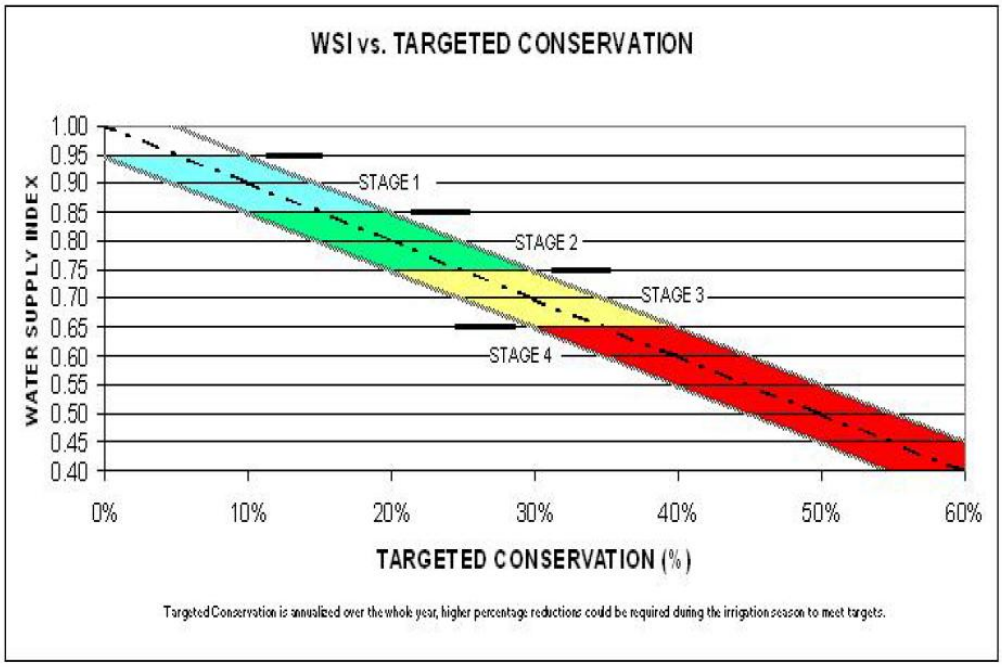


Figure 17: Targeted water conservation in the city of Louisville, Colorado, in relation to the water supply index and four declarable drought stages.

8 INSTITUTIONAL FRAMEWORK FOR DROUGHT MANAGEMENT IN AUSTRALIA

In the past decade a lot has happened in Australia with respect to drought policy at the national, state, basin and city level. Farmers have a large role to play in adapting to drought and have an increasing responsibility for managing the risks arising from climatic variability. In this section, the current development with respects to the institutional framework are described by presenting developments with respect to the national drought policy, the actors involved and by zooming in at the state, basin and city level.

The three elements of the Australian water legislation are the following:

1) the water act 2007
2) the water amendment act 2008
3) water regulations

Additionally there is a **national drought policy** based on principles of sustainable development, risk management, productivity growth and structural adjustment in the farm sector. Recently reviews of the policy showed that the practical implementation is sometimes difficult also because of the changing climate. Drought policy reform is currently a major priority for the government.

8.1 NATIONAL DROUGHT POLICY (1992)

The national drought policy had the following objectives:

1) Encourage primary producers and other sections of rural Australia to adopt self-reliant approaches to managing for climatic variability;
2) Maintain and protect Australia's agricultural and environmental resource base during periods of extreme climate stress;
3) Ensure early recovery of agricultural and rural industries, consistent with long-term sustainable levels.

Farmers and national and state governments have an important role in this policy. **Farmers** have a responsibility for managing the risks arising from climatic variability. The policy states that the government will help by creating an overall environment which will encourage producers to adopt improved property management practices through a system of incentives, information transfer, education and training, landscape care group projects and research and development.

The **commonwealth government** (or national government) will act in times of severe downturns to preserve the social and physical resources base and provides adjustment assistance in the recovery phase **The State governments** may provide drought-assistance measures (transaction-based subsidies for example) in addition to those offered by the commonwealth, but these should not compromise the overall direction of the national policy.

Policy measures described are the following:

1) New Rural Adjustment Scheme (RAS)
   a) Ongoing measures (incentives through interest subsidies on commercial finance or grants to enhance the profitability of their businesses through farm improvement and development for example)
   b) Banks and other financial institutions will continue to play a major role in financing the farm sector (introduction of flexible interest and capital repayment terms)
   c) Exceptional downturn (interest subsidies above the level; of 50%of the interest rate on commercial loans and/or existing debt may be provided by the states and the commonwealth for example)
   d) Farm household support (for farmers in extreme financial hardship)

2) Increasing self reliance
   a) Building financial reserves (mechanisms such as tax averaging Income Equalisation Deposits IED's for example)
   b) Whole farm planning
   c) Educational training

3) Research and Development (development of a national drought R&D program aimed at enhancing the capacity of farmers to manage drought)

4) Rural communities (programs to meet economic and social needs of rural communities, including non-farm business

5) Resource management (property management planning for example)

Implementation of the national drought policy was done through awareness campaigns and on-going education and training on risk management and whole farm business practices.

In relation to drought, the Australian government did not have an explicit drought policy. Assistance to affected producers was provided through a natural disaster relief program. (Nicholson et al., 2011).

According to Nicholson et al. (2011), “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.'' Self-reliance was considered an important part of the new drought policy although the policy also described that ''exceptional circumstance'' can happen.

8.2 EXCEPTIONAL CIRCUMSTANCES (EC)

Exceptional circumstances (EC) events (Exceptional circumstances information handbook, 2010) are rare and severe events that are outside those that a farmer could normally be expected to manage using responsible farm management strategies. Specifically, they are events that occur on average once every 20 to 25 years and have an impact on income for a prolonged period (e.g. greater than 12 months). To be classified as an EC event, the event:

- must be rare and severe, that is it must not have occurred more than once on average in every 20 to 25 years and must be a significant scale;
- must result in a rare and severe downturn in farm income over a prolonged period of time (e.g. greater than 12 months);
- must not be predictable or part of a process of structural adjustment.

The assessment was done using data on meteorological conditions, agronomic and stock conditions, water supplies, environmental impacts, farm income levels and the scale of the event.

How does the EC declaration process work? State and territory governments are responsible for compiling and submitting EC applications to the Australian Government. Once an application is received, the Australian Government Minister for Agriculture, Fisheries and Forestry may refer it to the **National Rural Advisory Council (NRAC)** for assessment. NRAC is a skills-based independent advisory council to the Minister, and conducts a comprehensive assessment of the application against the agreed EC criteria, which may

include an on-ground inspection. The information used by NRAC in assessing applications is gathered from a number of sources including:

- state and territory agriculture and primary industries departments
- industry bodies
- individual farmers
- the Bureau of Meteorology
- the Australian Bureau of Agricultural and Resource Economics – Bureau of
- Rural Sciences (ABARE–BRS).

On completion of its assessment, NRAC presents its recommendations to the Minister, who has responsibility, after consulting with the Australian Government, for declaring whether or not a particular area is experiencing EC. If a full EC declaration is announced, EC assistance is available to eligible farmers for up to two years. The drought and exceptional circumstances policy was enacted through legislation, including the rural adjustment act 1992 and the farm household support act 1992. (Nicholson et al, 2011).

8.3 REVIEW OF THE NATIONAL DROUGHT POLICY BY THE AUSTRALIAN GOVERNMENT

In 2008, the PIMC agreed that current approaches to drought and EC were no longer the most appropriate 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 (Nicholson et al, 2011). A review of the national drought policy (DAFF 2011) was carried out consisting of and economic, social and climatic assessment:

- 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 Organisation (CSIRO) of likely future climate patterns and the current EC criteria of a 1 in 20 to 25 year event. (Hennessy et al., 2008)

An important conclusion was that the EC's declarations and related drought assistance programs did not help farmers to improve their self-reliance, preparedness and climate change management. The economic assessment for example showed that the application of the EC criteria did not distinguish between droughts defined as those expected to be managed and those beyond the ability of the most prudent farmer to manage (PC 2009). Additionally, because of the diversity of the climatic conditions, landuse, production systems,

flexibility in the chosen criteria should be present. Rainfall is used in different ways and at different times (White and Walcott, 2009) and requirements and timing of government assistance can be different depending on the industry.

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 (Nicholson, 2011).

As a follow-up to the review, the Australian government (DAFF), in partnership with the western Australian government implement a **pilot of drought reform measures in part of Western Australia** (see chapter 5.1). The pilot is testing a package of new measures developed in response to the national review of drought policy. The measures are designed to move from a crisis management approach to risk management. The aim is to better support farmers, their families and rural communities in preparing for future challenges, rather than waiting until they are in crisis to offer assistance. The pilot was rolled out on the 1 July 2010 for a trial period of 12 months. On 10 May 2011 the government announced that the trial period was to be extended for a further 12 months until the 30 June 2012. From 1 July 2011 the pilot was expanded in area, including all of the south west region of Western Australia. The initiatives under the WA Pilot of drought reform measures are scheduled to close on 30 June 2012. http://www.daff.gov.au/agriculture-food/drought/drought-pilot

The development of a national drought policy, in **April 2012**, the following was stated in a communiqué of the SCoPI (Standing Council on primary industries): *''Council tasked the Primary Industries Standing Committee with* ***developing proposals for a future drought policy package that moves from crisis management to a greater emphasis on risk management and preparedness by farmers****. These proposals will be considered at the council's meeting in October 2012, with the new package being implemented from 1 July 2014. Council reaffirmed that the Exceptional Circumstances Interest Rate Subsidy and EC Exit Grants do not assist the farming community to prepare for future challenges or improve risk management, and noted that these will not be included in any future drought policy package. Consistent with past resolutions, council agreed that a future drought policy package should equip farmers to manage an increasingly variable climate''.*

8.4 DROUGHT TRIGGER (INDICATOR FOR DROUGHT ENTRY) AND INDICATOR FOR DROUGHT EXIT

What indicators is the decision to declare a drought and to implement any drought mitigation plan or other government interventions based on? Additionally, what indicators is the decision to end the declaration of drought based on?

The National Drought policy states that the entry threshold for a drought is 5th percentile rainfall, rainfall in the lowest 5 % of the historic record, combined with a scientific and economic assessment of the production conditions within the region (Nicholson, 2011). The current EC guidelines use an exit threshold based on whether or not producers have begun to carry out typical farm practices. Under the current EC process, it is difficult to determine the end of an EC. Some regions have been EC declared for 14 out of 17 years (PC 2009).

The principal implication of the findings of the third assessment (climatic assessment by CSIRO and BoM) of the national drought policy review is that the existing drought trigger is not appropriate under a changing climate (Hennessy et al., 2008).

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).** This proved to be difficult as the 2002-2007 drought had cumulative effects. After years of drought and failed production, producers in some regions had become more risk averse and found it difficult to take opportunity to carry out typical risk management practices, despite favorable conditions (Nicholson, 2011).

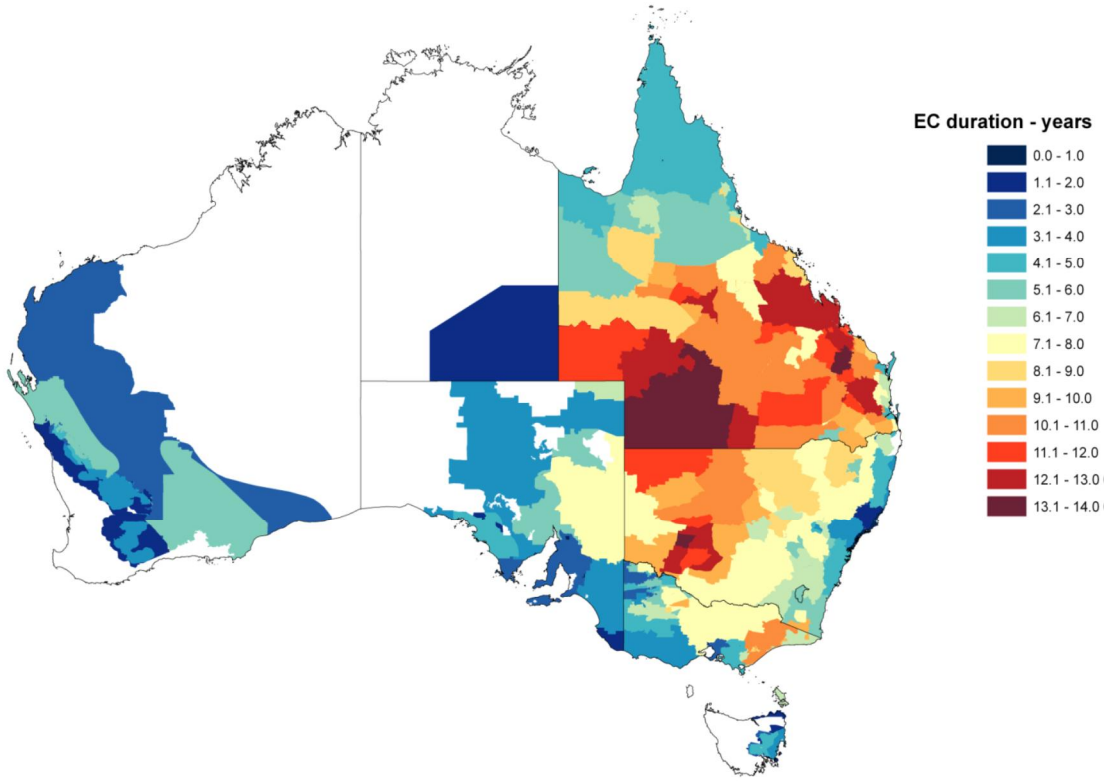


Figure 18: Duration of EC declarations, 1992–2010 (PC 2009)

8.5 ACTORS IN DROUGHT MITIGATION AND ADAPTATION

8.5.1 The Bureau of Meteorology (BOM)

Its role is to:

- collect, hold, manage, interpret and disseminate Australia‘s water information;
- provide regular reports on the status of Australia‘s water resources and patterns of usage of those resources;
- provide regular forecasts on the future availability of Australia‘s water resources;
- compile and maintaining water accounts for Australia, including a set of water accounts to be known as the National Water Account;
- issue National Water Information Standards;
- give advice on matters relating to water information;
- undertake and commission investigations to enhance understanding of Australia‘s water resources.

Additionally the Director of Meteorology must annually publish the National Water Account in a form readily accessible by the public publish other water accounts from time to time. Water information that is not in the public interest or water information that expressly identifies an individual‘s water use does not have to be published. (Water Act 2007)

The National Climate Centre at BOM for example issues Drought Statements or Special Climate Statements through their website http://www.bom.gov.au/climate/drought/. Below is an example of a drought statement issued on the 6th of June 2012 (Box 1).

Box 1. Dry conditions return to southwest WA

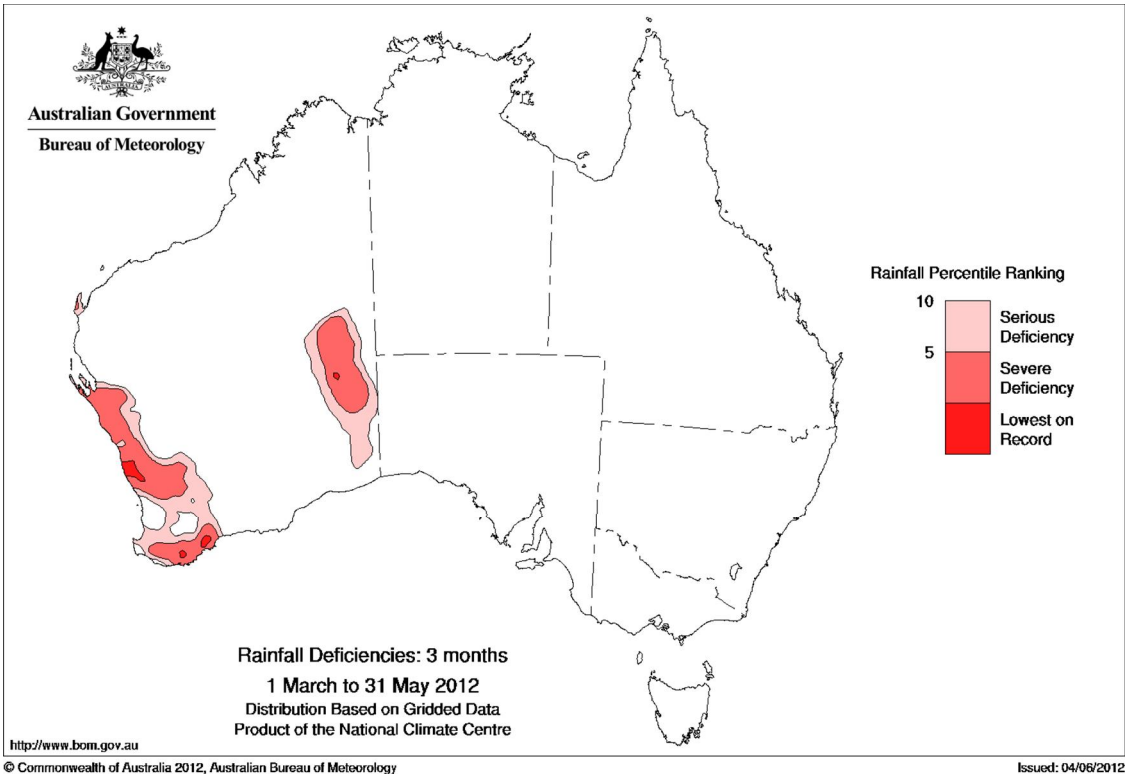
Conditions were drier than average across most of southern Australia in April and May 2012.Drier than normal late autumn-early winters have been experienced across southwest and southeast Australia for more than a decade. As a result of recent dry conditions and a very dry March:

Severe rainfall deficiencies have emerged across south-western and southern and central interior districts of Western Australia for the 3-month autumn period (March to May 2012). Southwest Western Australia recorded its 7th driest autumn on record, while May was the 5th driest on record for Western Australia as a whole.

Heavy rain in parts of southern coastal WA at the start of June only had a minor impact on the areas of severe deficiencies.

Long-term rainfall deficiencies are also evident in southwest Western Australia. The southwest region had its driest year on record in 2010, and the two-year period of 2010 to 2011 was the driest on record in some parts of southwest Western Australia.

For more information on dry periods and extreme rain events over Australia see the Special Climate Statements issued by the Bureau of Meteorology.



The special climatic statements are provided by BOM and give a detailed summary of significant weather and climate events. They are produced an occasional basis for weather/climate events, which are unusual in the context of the climatology of the affected region. By publishing these statements, major events are documented and presented to the public and the media. (See http://www.bom.gov.au/climate/current/special-statements.shtml)

BOM works together with CSIRO in the water information Rand Alliance (**WIRADA**, www.csiro.au/partnerships/WIRADA.html). **CSIRO** is Commonwealth Scientific and Industrial Research Organisation, is Australia's national science agency. In this alliance, they are developing the science and technology to support the water information role of BOM and underpin the following services:

- conduction of regular national water resources assessments
- publishing of an annual National Water Account
- providing regular water availability forecasts
- enhancing understanding of Australia's water resources.

8.5.2 Federal Department of Agriculture Fisheries and Forestry (DAFF)

The Australian Department of Agriculture, Fisheries and Forestry's role is to develop and implement policies and programs that ensure Australia's agricultural, fisheries, food and forestry industries remain competitive, profitable and sustainable. Part of their policy and programme is to encourage and support sustainable natural resource use and management.

The drought program of DAFF consists of supporting eligible farmers and small businesses with targeted assistance during exceptional circumstances events, including drought. The Formal drought declarations handled by the Federal Government are administered by DAFF. DAFF is involved in the Western Australian pilot of drought reform measures. They implemented a pilot of reform measures designed to move farmers from crisis management to risk management. The pilot covered some 96 per cent of farmers in the south-west of the state. According to their annual report (2010-2011), their objective in 2012 is to continue with the National drought policy reform. ''Helping farmers better adapt and adjust to the impacts of drought, increased climate variability and reduced water availability will continue to be a significant priority. Review of the Western Australian pilot of drought reform measures will assist the government's consideration of national drought policy reform. We will support the government in working with the states and territories to develop new national drought preparedness policies and programs.''

8.5.3 Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

ABARES is a research bureau within the Department of Agriculture, Fisheries and Forestry. They provide professionally independent research, analysis and advice for government and

private sector decision-makers on significant issues affecting Australia's agriculture, fisheries and forestry industries.

Their role in drought management is to provide assessments and analysis of the meteorological events and their impact on specific production systems. ABARES economic information is used to assess the impact on farm production and income for example. For that purpose, they use data, models and information systems working in cooperation with BOM, ABS (Australian Bureau of Statistics) and State Agricultural departments.

These tools are NAMS (withdrawn from public access, see below), the Monitor (currently internal system), the Rainfall Reliability Wizard and GrowEst (ABARES 2011). They provide decision-makers with ready access to information on climate variability, water availability, economic indicators and the impacts on agricultural production systems.

8.5.4 The National Agricultural monitoring system (NAMS)

During the 2002-2007 drought, several actions were carried out to improve the efficiency of drought measures and response. Among those, the national Agricultural monitoring system was set up following an advice of the Australian Agricultural ministers through the Primary Industries Ministerial council (PIMC) to develop a national monitoring system to assist in the development of EC applications and facilitate decision-making for government intervention and policies.

The NAMS evolved out of a need to streamline the Australian Governments' drought assistance program but is developing into a broader tool (Bruce et al. 2006). It has been designed to deliver a number of set products, including EC reports, but also has the capacity to deliver a wide range of climatic- and production-based analyses for any selected region within Australia. The development of NAMS has involved extensive collaboration with major stakeholder groups, including representatives from the Australian and State and Territory Governments, producer groups and scientific research organisations.

Reports can be downloaded on Climate Risk, Crop and Pasture Production, Production Statistics, Livestock Numbers, Water Availability, Water Storage, Economic Performance for a User Defined Period for different scales (national, state, River Basins, NRM Regions, Cropping Regions, Rural Lands Protection Board, Local Government Areas and Exceptional Circumstances Areas).

NAMS opens up the possibility of providing proactive support to producers before the full impact of a major drought is experienced (Leedman et al, 2008). This type of assistance could help avert significant environmental damage by helping producers prepare for, and manage, the inevitable impact of droughts. The information provided by NAMS could also help producers better manage climate variability as a business risk.

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.** (Nicholson, 2011)

8.5.5 The Monitor (2012)

The Monitor is an online tool that delivers a broad range of climatic, production, biophysical and economic information, for various regions throughout Australia. It provides the ability to explore and report on spatial, temporal and point-based data and information at various regional scales. The Monitor also provides access to a mapping interface to view spatial data against several different region types. The Monitor can be used to assess climate risks to production systems and assist with land management decisions. The Monitor includes:

- information on geography, climate and water availability;
- economic information;
- information at several different regional boundaries;
- a mapping interface;
- user-specified reporting;
- both point and spatial analysis capability;
- more than 130 maps, graphs and analyses.

This information can be viewed online from a regional to a national scale, providing insight and support to evidence-based decision-making in the rural sector.
http://www.daff.gov.au/abares/monitor/home

8.5.6 National Rural Advisory Council (NRAC)

The National Rural Advisory Council (NRAC) is a skills-based independent advisory council to the Australian Government Minister for Agriculture, Fisheries and Forestry. NRAC was

established in December 1999 as a statutory consultative body following legislative changes to the Rural Adjustment Act 1992. NRAC provides advice to the minister on rural, regional and industry issues affecting agriculture in Australia, including advice on ‘’Exceptional Circumstances’’ declarations.

NRAC consists of up to eight members including:

- a Chairperson
- a representative of the National Farmers’ Federation
- others appointed as expert members in the areas of economics, financial
- administration, banking, sustainable agriculture, farm management or training
- one Australian Government representative
- one state or territory government representative.

8.5.7 Primary Industries Ministerial council (PIMC) or Standing Council on Primary Industries (SCoPI)

The council consists of the Australian Federal, State/Territory and New Zealand Ministers responsible for the development of sustainable, innovative and profitable agriculture, fisheries/aquaculture, food and forestry industries. It has been replaced by the Standing Council on Primary Industries (SCoPI) in 2011.

All Australian/state/territory and New Zealand ministers with responsibility for primary industries matters are members of SCoPI. The secretariat is provided by the Australian Government Department of Agriculture, Fisheries and Forestry. With respect to the national drought policy reform, resolution 1.3 was presented in April 2012 (See Box 2).

Box 2. Resolution of SCoPI with respect to the national drought policy reform (April 2012)

The council :
(a) Reaffirmed its commitment to a new drought policy that enables farmers to move from crisis management to risk management and preparedness;

(b) Noted consultations with industry stakeholders and the issues raised in relation to drought policy reform and that there is a consistent message from the range of industry stakeholders on the need to progress reform **while seasonal conditions are good**, including general acknowledgment that Exceptional Circumstances Interest Rate Subsidies do not build farmer resilience or improve risk management;

(c) Agreed to the Primary Industries Standing Committee developing proposals, without prejudice, for a **new drought policy package to replace existing arrangements** for consideration by the Standing Council on Primary Industries at its meeting in October 2012, with full implementation of the package from 1 July 2014;

(d) Agreed that the package of measures will be developed in line with the Primary Industries Ministerial Council’s guidance of October 2011 and the **outcomes of the review of the pilot of drought reform measures in Western Australia**.

8.5.8 National Water Commission

The National Water Commission is responsible for driving progress towards the sustainable management and use of Australia's water resources under our blueprint for water reform - the National Water Initiative. Established under the National Water Commission Act 2004 , the Commission advises Council of Australian Governments (COAG) and the Australian Government on national water issues and the progress of the National Water Initiative.

Under the Water Act 2007, the Commission has a new, ongoing function to audit the effectiveness of implementation of the Murray-Darling Basin Plan and associated water resource plans.

Seven commissioners make up the National Water Commission, all of whom are appointed by the Australian Government for terms of up to three years. Commissioners are appointed in recognition of their expertise in water resource policies, natural resource program management, relevant scientific disciplines, and public sector governance. Four are nominated by the Australian Government, and three by the states and territories.

8.5.9 Farmers

Under the national drought policy (2004), farmers have a responsibility form managing the risks arising from climatic variability. The policy states that the government will help by creating an overall environment which will encourage producers to adopt improved property management practices through a system of incentives, information transfer, education and training, landscape care group projects and research and development.

8.5.10 National Farmers Federation and drought working group

The National Farmers' Federation (NFF) is the peak national body representing farmers and, more broadly, agriculture across Australia.

The NFF Board has developed the Drought Pilot Working Group to engage with the Federal Government’s proposed changes to drought policy, particularly the drought reform measures pilot. This working group will provide an alternative mechanism for the development of drought policy.

8.5.11 Traditional owners in Australia

Traditional owners are the Australian Aborigines. There are up to 300 aboriginal nation-states in Australia. The Murray-Darling Basin Authority (MDBA), for example, works closely with self-determining independent Indigenous organisations like the Murray Lower Darling Rivers Indigenous Nations (MLDRIN) and the Northern Murray–Darling Basin Aboriginal Nations (NBAN.) MLDRIN and NBAN contribute to the development of the Basin Plan and more broadly provide an Aboriginal perspective on natural resource management and cultural issues in the Murray–Darling Basin. NBAN and MLDRIN share a common aim to seek greater recognition and respect for Aboriginal knowledge and values regarding land and water management. MLDRIN (www.mldrin.org.au) is a confederation of 21 Indigenous Nations in the southern part of the Murray Darling Basin. The chair of MLDRIN and the Deputy Chair of NBAN sit on the MDBA Basin Community Committee and its Indigenous Water Sub-Committee which provides advice to the Basin Community Committee and the Authority.

8.5.12 State level and the mainland capital city

In time of drought, according to the national drought policy (2004), may provide drought-assistance measures (transaction-based subsidies for example) in addition to those offered by the commonwealth, but these should not compromise the overall direction of the national policy. At the state level, the Formal drought declarations are handled by the following departments (Table 20).

Table 20: States and departments handling formal drought declarations.

States	Departments handling formal drought declarations
Australian Capital Territory (ACT)	Department of the Environment, Climate Change, Energy and Water
Queensland (QLD)	Department of Natural Resources and Mines
New South Wales (NSW)	Department of Agriculture
South Australia (SA)	Department of Primary Industries and Resources
Tasmania (TAS)	Through Farm Point
Victoria (VIC)	Department of Primary Industries
Western Australia (WA)	Department of Agriculture and Food

8.5.13 Utilities

In Australia, the utility companies that supply water have an important role in water conservation. Because of the droughts, the way water is valued has changed. In the ACT, for example, ACTEW (owned by ACT government) owns and operates the water and sewerage assets and business in the ACT. ACTEW's Water Conservation Office is

responsible for **managing, monitoring and enforcing water restrictions and water conservation measures** in the ACT. The websites reports the daily use of water and the combined dam levels to create awareness among the water users.

In the New South Wales State, Sydney Water (Australia's largest water utility) provides drinking water, recycled water, wastewater services and some stormwater services to Sydney, the Illawarra and the Blue Mountains. It is a statutory State owned corporation, wholly owned by the New South Wales Government.

Sydney water first developed a Water Conservation Strategy in 1995. At that time there was little information to help customers save water and no regulation to promote water efficiency. Sydney Water provided information and education, and developed an extensive suite of programs, rebates and incentives to help customers to reduce water use.

Sydney Water's 2010-15 Water Conservation Strategy (Sydney water, 2010) complements the NSW Government's 2010 Metropolitan Water Plan to ensure that greater Sydney has enough water now and in the future. They are one of many agencies responsible for implementing the 2010 Metropolitan Water Plan.

8.5.14 River basin level: example of the Murray-Darling Basin

In Australia, 12 drainage divisions were defined by both the major topographic features of the continent and the main climatic zones to give broadly homogeneous hydrologic regions. Within the drainage divisions the 245 river basins are defined by the major watershed lines (Australian Natural Resources Atlas, 2008).
The Murray Darling Basin is taken as an example to present the institutional framework at the drainage division scale.

Box 3. Murray Darling Basin – facts and figures

- Named after the two major rivers; Darling and Murray rivers
- Drains 1/7th of Australian land => about 1 million Km2
- More then 2 million people
- Producing more the none third of Australia's food
- Home to about 30 aboriginal nations
- Covers 5 states or territory governments
- More than 25.000 wetlands
- 6 jurisdictions
- Cross border interactions
- Different levels of development; Wild to highly developed

The Water act 2007, the water amendment act 2008 and the water regulations are the three elements of the Australian water legislation. In these acts, provisions are also made for the **management of the water resources of the Murray-Darling Basin** and for other matters of national interest in relation to water and water information, and for related purposes. (Source Water Act 2007).

The Act provides for the **creation of a Murray Darling Basin Authority** (from the Murray Darling Basin Commission), a **Basin Plan** that set limits on the amount of water (both surface and groundwater) that can be taken from Basin, and a **Commonwealth Environmental Water Holder** that will manage the Commonwealth's environmental water.
Key elements of the Basin Plan will include sustainable limits for surface water and groundwater, basin-wide environmental objectives including water quality and salinity targets, rules for a Basin-wide water trading regime, requirements for each of the four state sub-plans that will implement the Basin plan objectives and measures that will improve security for water entitlement holders (Cork et al, 2010).

In relation to drought the revised Basin Plan (MDBA, 2012) states that the objectives and outcomes in relation to long-term average sustainable diversion limits (SDL's) should 'provide greater certainty for all water users, including in times of drought and low water availability'. It also want to ensure that water-dependent ecosystems and the flora and fauna are resilient to climate change and other risks and threats. 'An objective is that water-dependent ecosystems are resilient to climate change, climate variability and disturbances (for example, drought and fire)'. The Sustainable Diversion Limits (SDL's) are the

environmentally sustainable limits on the amount of water that can be taken from the Basin's water resources.

8.5.15 Murray–Darling Basin Authority

The Murray–Darling Basin Authority's principal aim is to manage the Basin's water resources in the national interest. The establishment of the MDBA means that, for the first time, a single agency is now responsible for planning integrated management of the water resources of the Murray–Darling Basin. In December 2008, MDBA assumed responsibility for all of the functions of the former Murray–Darling Basin Commission. The Authority is made up of six members who are supported by an office of around 300 staff. The Ministerial Council and the Basin Officials Committee play important roles in providing advice and making high level decisions relating to the functions of the MDBA. (www.mdba.gov.au)

Figure 19 presents the governance structure of the Murray–Darling Basin. From the start of the 20th century to now, governance structures have evolved as did the availability and demand for water. Until the 1980's, agreements between commonwealth and some Basin states were made. In the 1980's and 1990's, there was a first period of reform characterised by an MDB agreement (dependent on cooperation of jurisdictions), the explicit allocation of water to the environment and use of markets to address water allocation and sharing. The droughts of the 2000's forced even more reforms with a pressure for a more integrated water governance system, a national Water Initiative (NWI) - markets, regulatory and planning/ economic, social and environmental outcomes and the Water Act 2007 consolidating powers to manage the Basin's water resources under Australian Government control.

The key points about the governance of the Murray–Darling Basin is that:

- Governments play a key role
- Jurisdictions (states) have mechanisms to work together
- Decisions about water allocations are made centrally according to rules and discretionary decisions but increasingly markets are being used.

(Source; presentation on Governance and Drought in the Murray Darling Basin by Connell and Cork)

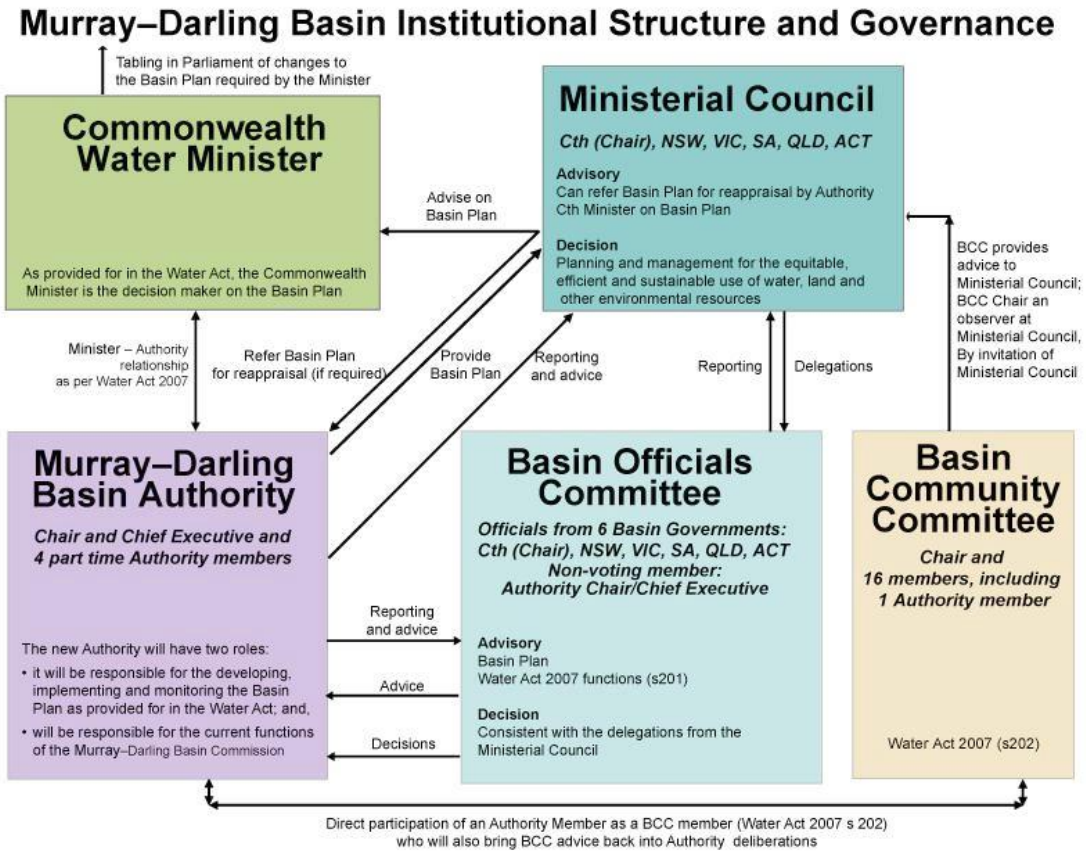


Figure 19: Governance of the Murray–Darling Basin

(http://www.mdba.gov.au/about/governance)

8.5.16 The role of the Commonwealth Environmental Water Holder

As part of Murray-Darling Basin reforms, the Australian Government is acquiring water entitlements with the objective of **returning more water to the environment**. These entitlements become part of the Commonwealth environmental water holdings and are managed so that increased flows are provided to rivers and wetlands. The water is acquired through direct buybacks of water entitlements from irrigators as well as savings from infrastructure upgrades. The Commonwealth Environmental Water Holder is required to use its holdings to **protect or restore environmental assets** of the Murray-Darling Basin, and other areas outside the Basin where the Commonwealth holds water, so as to give effect to relevant international agreements. Water that is held in the Murray-Darling Basin is required to be managed in accordance with the environmental watering plan, part of the **Basin Plan** being developed by the Murray-Darling Basin Authority in consultation with state governments and stakeholders. (http://www.environment.gov.au/ewater/about/index.html)

Box 4. The 2002–2007 drought (ABARES, 2011)

Australia has recently experienced one of its most severe droughts on record. This occurred during 2002–2007 (ABARES, 2011). 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 (5th 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 per cent of capacity in 2003, and remained below pre-drought levels until late 2010 (Figure 20).

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 on-going 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.

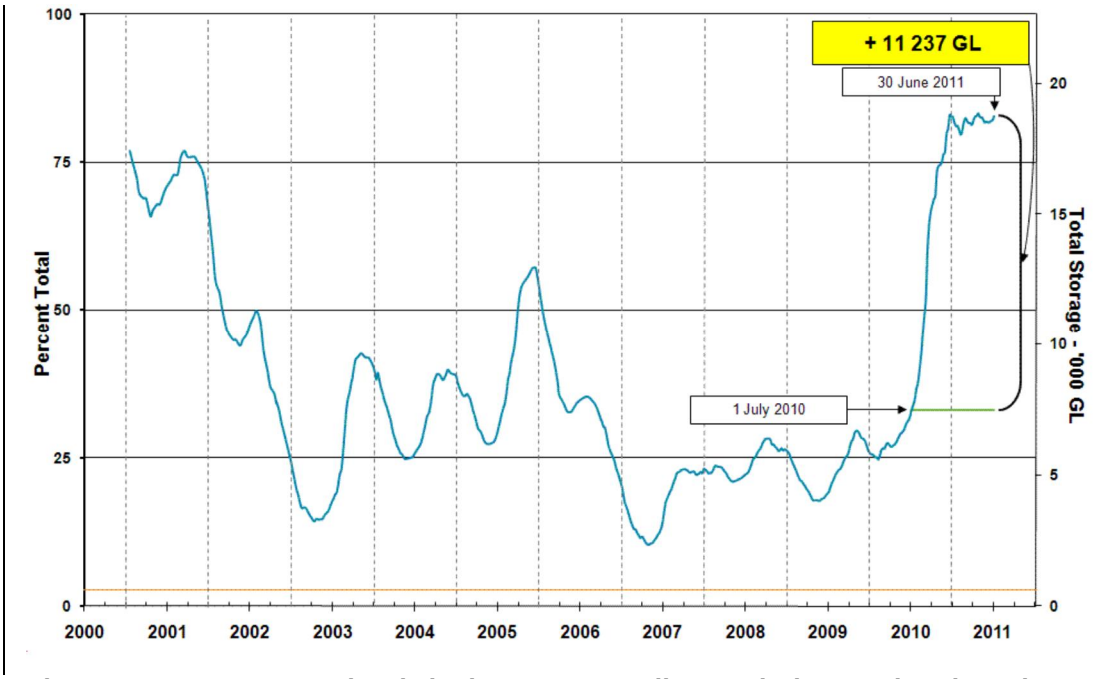


Figure 20: Water storage levels in the Murray–Darling Basin (NSW, Victoria and Queensland).

9 ASSESSMENT OF DROUGHT MITIGATION PRACTICES IN AFRICA

9.1 USER REQUIREMENTS FOR DROUGHT MITIGATION IN AFRICA

9.1.1 North Africa

This section of the report will address user's requirements in North-Africa in terms of drought mitigation practices. Droughts represent a recurrent characteristic of North-African climate but the increase of the frequency, severity and extent of dry episodes during the three last decades led to an urgent need to move on from a reactive drought management strategy to a more proactive and integrated drought management coupling efficient Drought Monitoring Systems with mitigation and adaptation actions.

In the past, mitigation often meant actions that were taken during or after drought to rehabilitate or remedy the damage made. In the context of this paper, the term is used to refer to the actions taken prior to, during and after drought to minimize its effects and the cost incurred. In this dimension, mitigation includes both proactive elements of drought preparedness and retroactive remedy actions. As the primary concern of drought is water shortage, most mitigation practices aim at reducing the effect of such shortage but they also include other measures to reduce societal vulnerability that are not necessary linked to water resources.(Bazza, 2001)

Drought is a creepy phenomenon that may have numerous impacts varying markedly across sectors, timescales and location. Given this context, a diverse set of user needs exists when it comes to adopt efficient strategies necessary to mitigate drought impacts. The provision of relevant practices to mitigate drought impacts relies first on the identification of the main users and the definition of their requirements in terms of mitigation practices. When it comes to drought mitigation strategies, 3 main categories of users can be defined:

9.1.1.1 Domestic sector

In North-Africa, although the domestic water use is much less compared to the irrigation water use (In Morocco, nearly 90% of water resources go to agriculture), there is an urgent need for the development of mitigation practices that may achieve substantial water savings. Among them figure:

- The implementation of public awareness programs for saving potable water. Indeed, Public awareness is very important, as water is generally taken for granted by the public. The ignorance of the water scarcity problem leads to misuse of water.
- The needs for legislations to prevent potable water waste

- The adoption of restrictions on water use during dry events or the generalization of restrictions on water use on a systemic manner. That may apply to watering loans, filling pools, washing cars….
- Improvement of the maintenance of urban water supply networks
- Improvement of the access to potable water in rural areas
- Regulation of water consumption in public showers and bath houses which are still very wide spread in North-Africa

9.1.1.2 Industrial and commercial sector

In North-Africa, although water use by the industrial and commercial sectors represents less than 10 % of the total water use, with agricultural water being the predominant water use sector, there is a growing concern for a better management of the available water resources. This can be represented by the following needs:

- Encouraging Water conservation measures
- Improving water use efficiency
- Treatment and reuse of water

9.1.1.3 Agricultural sector

In North-Africa, Tunisian and Moroccan economies rely heavily on the Agricultural sector which may be deeply affected by droughts. Indeed, it remains mainly traditional, conducted under rainfed conditions. For example, in Morocco, irrigated areas represent only 15% of the total arable lands.

Agriculture is also by far the largest user of water in the region. On a consumptive use basis, 80 to 90 percent of all the available water resources are consumed by agriculture. Unfortunately, the water use efficiency in this sector is very poor not exceeding the 45% with more than 50% water losses, and thereby, enormous water saving could be achieved in the agricultural sector comparable with the other sectorial water use.

In order to cope with drought episodes and mitigate their impacts, a wide range of agricultural practices including finding additional water supplies and conserving water should be developed. The needs have to be centered on improvements in production and management of crops, land and water resources:

- Alternative land use systems (less consuming species or short duration crops, perennial grasses for livestock farming..)
- Use of crop varieties that tolerate drought

- Adoption and diffusion of agriculture good practices such as reduced planting densities, integrated weed and fertilizers management, surface mulching,…
- Adoption of soil conservation measures such as no-till or minimum tillage systems
- Development of deficit or supplemental irrigation whenever possible
- Identification of supplemental and alternative sources of water
- Development and generalization of crop insurance
- Development of livestock insurance and Extension of the micro-credit strategy to the pastoral and agro-pastoral sectors
- Deepening wells and implementations of rainwater harvesting techniques and rainwater storage facilities in farms.
- Better management of livestock through the improvement of livestock supplies (livestock water plans, wells); destocking of feral animal, feed subsidies…

The previous points represent the main needs in terms of drought mitigation practices in rainfed areas. In the irrigated sector, user's requirements for drought mitigation may involve additional needs:

- Water reallocation: Priority allocation of available water resources to perennial crops
- Water rationing: Modification of the irrigation calendar: from reducing irrigation frequencies to irrigation prohibition.
- Irrigation Water management

Besides the technical aspects, user's and particularly decision makers requirements for implementing effective drought mitigation plans in North-Africa include in addition and on a trans-sectoral approach several needs related to:

- Implementation of an effective drought early warning system that will allow the development of appropriate mitigation measures in time and place.
- Improvement and generalization of medium and long range weather forecasts
- Development of appropriate policies to effectively manage groundwater development and use
- Needs for revision and enforcement of water laws
- The development and enforcement of the national capabilities to provide effective drought early warnings and adequate linkages between early warning and relief and mitigation strategies.
- The assessment of drought hazards: Drought hazard assessment refers to determining the degree of hazard related to the occurrence of drought. More specifically, its goal is to quantify the magnitude/duration/frequency relationship of

drought episodes in a particular region, expressed in terms of probability. (Vincente-Serrano et al., 2012)

- The development of drought impacts assessments products. Indeed, lack of impact assessment methodologies hinders impact estimates and the activation of appropriate and timely effective mitigation and response programs. A careful consideration of drought risk which is a proportional combination of the likelihood of occurrence of a drought event (hazard) and the expected impacts is a central and key component of drought mitigation strategies.
-
- The assessment of drought vulnerability to 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 each country. Drought vulnerability is an index of the inability of a society or an ecosystem to cope with drought, and is the sum of the impacts on the various elements of the system (e.g. water resources, crops, etc). Drought vulnerability is thus related to the degree of natural and social adaptation to drought, in terms of both resistance and resilience. (Vincente-Serrano et al., 2012).
- Needs for the preparation of drought plans: Drought plans should be ready to be implemented upon notification from monitoring systems or early warning systems. They have the advantage of targeting feasible and coast effective actions. Drought plans need to be developed in close concert with the key stakeholders such as associations of water users, government agencies, local communities and other interest groups. The plans are to be formulated and coordinated first at the national level, then on that of river basins or hydrological regions, then local level. The plans normally highlight the different drought mitigation measures to be implemented, by each level of the hierarchy. (Bazza, 2001)
- Needs for capacity building: development of effective extension services and training sessions to transfer drought mitigation practices to farmers in the agricultural sector and training and education of educators in the domestic and industrial sectors

9.1.2 Equatorial Lakes Region

9.1.2.1 Tanzania

The main user requirement for mitigation actions in the case study areas of droughts are shown in **Table 21**

Table 21: User requirement as policies, strategies and guidelines for drought mitigation actions in Tanzania

Mitigate drought impacts	Requirement of users	To whom and when action is required
Policies	• Established mitigation methods that are most promising for specific areas • Availability of data for mitigation studies • Assessment of effectiveness of various methods of increasing agricultural productivity	• Central government • Environmental matters line ministries • Disaster Management Department (DMD) • Tanzania Meteorological Agency (TMA)
Strategies	• Climate change impacts mitigation strategy • Estimation of impacts which droughts can have on agriculture and the uncertainty involved in the estimates • Estimation of impacts of droughts on agricultural productivity • Mitigation of impacts of extreme events • Poverty reduction strategy • Irrigation infrastructure development and improving water supply for irrigation • Strengthen the local institutions on drought management • Sustainability and appropriateness of mitigation strategies • Estimation of crop yields for each agricultural year • Estimation of food availability per capita • Mitigation of hydropeaking arising from power generation	• Ministry of Agriculture and Cooperatives • Ministry of Water • Disaster Management Office (DMO) • Tanzania Meteorological Agency (TMA) • Vice President's Office – Environmental Affairs • Ministry of Energy and Minerals • Ministry of Water
Guidelines	• Farming guidelines for mitigating cultivation practices to drought occurrences so as to achieve stable or increased yields • Guidelines on optimal planting dates for each agricultural year • Crops varieties selection guidelines • Guidelines on food storage and processing to reduce post-harvest losses and optimize usage of harvest • Guidelines on methods of increasing agricultural production • Guidelines on mitigating the adverse effects of droughts and of a changing climate	• Smallholders farmers • Rural and urban communities • Practitioners

9.1.2.2 Kenya

The hierarchy of implementation of drought mitigation is effective when they have immediate impact at the grassroots. This requires the following key components;

Table 22: User requirement as policies, strategies and guidelines for drought mitigation actions in Kenya

User	Requirements	When action is required
Farmers, pastoralists and general citizenry	An efficient and environmentally-sound demand side management of the available water resources within the country needs to deal with the following issues: • safeguarding water to meet basic needs for various uses; • minimizing water losses; • allocating scarce water for socioeconomic development; and protecting the environment from degradation and loss of productive capacity. • Self reliance and drought resilience.	Continuous with respect to seasonal demands for sustainability.
Policy, planning and management	• Water demand management is not just as a technology to apply or a programme to deliver, but is a form of governance. • Training programmes in special techniques such as soil and water observation, water harvesting, small-scale irrigation and agro-forestry can play a major role in the process of drought disaster mitigation. • Drought monitoring, risk assessment, and the identification of appropriate risk reduction measures are principal components of a drought policy and plan.	Priority planned before the disaster, with during disaster measures all clearly outlined.

9.1.3 Eastern Nile Region (Ethiopian Plateau)

Many of the inhabitants of the arid and semi-arid rangelands of sub-Saharan Africa gain their livelihood from pastoral activities, using common property rangeland and water resources to raise their livestock. They live under highly variable climatic conditions, with their herds subject to large variations in feed and water availability. Managing these strong fluctuations in pastoral livelihoods is the main development challenge facing agencies seeking to support pastoral development. Drought mitigation needs to be part of government policy and planning but should not create unsustainable welfare mechanisms. Cash-for-work may be more appropriate than food-for-work as it stimulates the local economy.

The extent to which there is potential to increase the offtake from pastoral herds is dependent upon existing patterns of stock marketing, pastoralists' strategies to cope with drought, their needs for cash and the availability of alternative forms of investment. In general, in Kenya and Ethiopia the market requires male cattle, goats and sheep for meat, and these are the animals that pastoralists are willing to sell. Herders only dispose of females when they are suffering severe economic and social stress (usually during drought). Male animals in the herd are sold or exchanged according to the need for cash. To some extent, most households are integrated into the market.

Pastoralists are more likely to value livestock as a source of income in kind (milk, reproduction and blood) rather than of cash. Under these circumstances these income generating assets will be held until income generating value falls below salvage value (during drought) particularly where there are limited alternative investments. This may partly explain the limited supply response of pastoralists to favourable market conditions (high prices).

Declining per capita milk and meat production increasingly requires households to purchase grain and is leading towards greater integration of pastoral households into the market economy. Another factor drawing pastoral households into the market economy is the availability of education for children and recognition of its value by their parents. Many households therefore need to find cash at regular intervals throughout the year to pay for school fees. At the same time there may be increasing demand for, and availability of, consumer goods. It is clear, in Southern Ethiopia at least, that access to grazing resources and production (per household) are in decline, grain consumption is increasing, milk sales are of greater importance than formerly and that the need for cash is evident. In addition the development of the pastoral banking concept is needed to engender self-reliance in pastoral communities (Coppock 1994).

A shortage of land, absence of fallowing, limited use of appropriate technologies, high cost of fertilizer and seeds, as well as a shortage of labor and improved breed livestock were also identified as common constraints. Respondents also cited a range of market related constraints including a lack of timely information, price fluctuation and the inability to acquire fertilizer for irrigated crop production on credit. It was also mentioned that the lack of a consistent and clean water supply and silt deposition in micro-dams are also constraints which frequently reduce household productivity.

Boom and Bust: Another characteristics of pastoral livelihood, particularly that of Somali pastoralists, is a phenomenon some have referred to as “boom and bust” (Ellis and Swift, 1988). Numerous shocks have struck livestock owners in Somali Region in the last few years, exposing them to the ‘boom and bust’ cycles of accumulation, collapse and rebuilding of herds and flocks that characterize pastoralist economies. As noted in the Afar section above, the pastoralist livestock population has been depleted to the point that recovery to the “old days” is no longer an option. The “boom and bust” theory may no longer be applicable.

Crop Production as a Diversification Strategy: Crop production represents a diversification option, given the pressure on pastoralism. It has been shown that Afar pastoralists are prepared to try farming provided local rivers are diverted for small scale irrigation. IIRR (2004:52) has identified various techniques that might allow traditional pastoral communities to pursue crop production:

- Irrigation, ranging from small plots watered by hand or by pump irrigation to large, river-fed schemes.
- Flood recession agriculture using water that soaks into the soil during the seasonal flooding of rivers.
- Water harvesting rainfall using bunds and ditches to divert rainwater into plots or shallow basins allowing seepage into the soil
- Dryland cropping of drought-resistant crops.

Pastoralists, however, must confront several issues before considering a diversification strategy that includes farming or any other alternative livelihoods:

- Access to land: Although land is legally jointly owned by the government and the people, in practice the clan decides on land use rights, although individual households have the right to pursue crop production on land. One recent survey (Devereux, 2006) found that almost half of the surveyed Somali households own rights to land primarily for farming. Along riverbanks, arable land is usually allocated for land is inherited. The average farm size – 1.4 hectares – is larger than in highland Ethiopia but not large enough to promote extensive farming.
- Access to water: Currently farming is restricted to households living in close proximity to rivers.
- Research and extension services: The government is moving quite slowly to establish agricultural research centers in pastoral areas.

Access to credit, markets and cooperatives: IIRR (2004:59) suggests:

- Providing access to credit to enable pastoral farmers to cultivate crops, plant trees, and dig wells;
- Promoting organisations to form plant out grower associations to grow crops such as cotton, sugarcane, and horticultural crops;
- Establishing facilities to process produce and developing markets for outputs;
- Assisting farmers to market their produce; and
- Developing or strengthening cooperatives to promote market opportunities for corps and livestock.

The pastoralists in a Focus Group Discussion argued that cereal price stabilisation through cereal banks, even on a commercial basis, would have been a more cost-efficient intervention, and would have helped households protect their assets. Cereal banks were not in place during the 2005/2006 drought, apart from limited support by AFD to banks in Borena.

Pastoralist communities in Moyale, Mega and Areroworedas expressed appreciation for a number of livelihoods-based interventions, namely commercial destocking and supplementary feeding. Supplementary feeding of breeding small stock was ranked second after cereal banks for its potential to save livestock. Pastoralists in Walensit (Arero) expressed willingness to purchase concentrate feeds at full cost if these were available. They also suggested that support could be provided to entrepreneurs to manufacture feed closer to pastoral areas, to reduce transaction costs. Pastoralists in Arero and Mega ranked commercial destocking as their third preferred intervention at the onset of a drought, though they stressed that it would only be valuable as long as remote areas were also reached, local traders participated and the intervention was correctly timed, with early and clear information and communication provided to pastoralist households.

They also stressed the need for investment in access feeder roads. Interventions such as slaughter destocking, water trucking and the excavation of contingency boreholes in dry season grazing areas were also favourably received, though pastoralists were aware of the high costs associated with the latter two. Cash transfers were seen as less costly, but questions were raised about the sustainability, security and usefulness of cash in remote areas, where goods and services may not be readily available. There was little enthusiasm for livestock vaccination as most pastoralists believed that vaccinating animals during drought undermined their resilience.

9.1.4 Eastern Nile Region (Down Stream)

9.1.4.1 Sudan

The most common actions implemented in Sudan during the drought events include:

1. Actions from decision makers pre-event; in sort of the following:
   a. Building community resilience towards drought mitigation based on their indigenous knowledge. During the event;
   b. Transparency of declaration of drought situations (based on national drought monitoring system);
   c. Implement the interventions plans to prevent the spread of loss of lives and livestock, land and infrastructure.
2. Actions from community leaders/members; they have to adhere to the government drought plans/regulations.

9.1.4.2 Egypt

For drought mitigation issue in Egypt as mention in previous reports suffers from what is called agriculture drought, a lot of agricultural mitigation strategies have implemented to mitigate that that agriculture drought. The users are mainly farmers, fishermen, and tourism sector

A lot of research studies have been carried out to change verities of some crops to be less water requirements than the other verities used. The irrigation system is also developed to save the water losses and the applied the subsurface drainage to reduce the waster salinity which causing deterioration of agriculture land productivity.

The co-operation and integration plans between the two ministries, Ministry of Water Resources and Irrigation (Nile Forecast Center-Planning Sector) and Ministry of Agriculture and Land Reclamation to mitigate the impact of climate change and environmental changes on land degradation. Table 23 shows the requirements of users to mitigate drought impacts considering policies, strategies and guidelines.

Table 23: Requirements of users to mitigate drought impacts

Mitigate drought impacts	Requirement of users	To whom and when action is required
Policies	• Availability of data for mitigation	• Egyptian Environment

Mitigate drought impacts	Requirement of users	To whom and when action is required
	studies • Assessment of effectiveness of various methods of increasing agricultural productivity	Affairs Agency EEAA • Ministry of Water Resources and Irrigation MWRI • Ministry of Land Reclamation and Agriculture •
Strategies	• Climate change impacts mitigation strategy • Estimation of impacts of droughts on agricultural productivity • Mitigation of impacts of extreme events • Irrigation infrastructure development and improving water supply for irrigation • Sustainability and appropriateness of mitigation strategies • Estimation of crop yields for each agricultural year	• Ministry of Water Resources and Irrigation • The Ministry of Housing and Utilities • Ministry of Land Reclamation and Agriculture •
Guidelines	• Farming guidelines for mitigating cultivation practices to desertification to achieve stable or increased yields • Guidelines on optimal planting dates for each agricultural year • Crops varieties selection guidelines • Guidelines on methods of increasing agricultural production • Guidelines on mitigating the adverse effects of desertification and of a changing climate	• • farmers • Rural and urban communities •

9.1.5 Southern Africa

9.1.5.1 Botswana

The main user requirement for mitigation actions for each of the identified droughts are listed in Table 24.

Table 24: List of user requirement drought mitigation actions in Botswana

Mitigation requirement/ Action required
• Public awareness campaigns • Giving priority to drinking water • Wells digging and irrigation • Livestock vaccination campaign • Livestock feeding program

- Importing and subsidizing drilling
- Livestock husbandry practices
- Water use efficiency
- Farmers cropping strategies
- Irrigation management
- Boreholes, wells and small dams
- Saving livestock
- Controlled forest grazing
- Food aid
- Drought relief program
- Harvesting of rainfall water
- Irrigation systems
- Food security information
- Local seed production
- Livestock vaccination campaign
- New drought tolerant crops
- Food storage and crop varieties

The mitigation actions implemented in Botswana on past droughts are as follows:

- Labour intensive public works programme
- Livestock drought related programme
- Drought relief programme

a) Labour intensive public works programme

Drought Relief Programme in Botswana was able to achieve zero deaths attributable to drought-related malnutrition by coping with the 1982–86 droughts (Valentine, 1993). The main reasons cited for the success in Botswana were:

- targeting – the drought relief was targeted at the rural poor and other vulnerable groups to minimize income disparities during and after the drought;
- use of established infrastructure – established local and district-level supplementary feeding facilities and lines of communication and distribution were used;
- funds were available – there were surplus national funds available generated by the diamond resources of the country;
- willingness to learn from past experience;
- political will – good governance and drought relief seen as a high priority issue.

Following an evaluation of drought relief programmes carried out during the 1980s, the recommendations of the Government of Botswana created an Inter-Ministerial Drought Committee (IMDC) in the early 1980s to help develop and coordinate various aspects of the drought response programmes. A major inter-sectorial programme was the Labour Intensive Public Works Project (LIPWP), developed to relieve drought-affected people and to provide sustainable and viable projects to create employment. From 1992 to 1996, some 50 000 people were employed annually under the programme (of whom 70 per cent were women).

Completed projects included houses, feeder roads (see bridge in **Error! Reference source not found.**), classrooms, day care centres, health posts, clinics, offices, community halls and other community-based projects. The approximate annual employment of people under this drought relief employment programme is equivalent to 21 per cent of Botswana's current formal economic sector employment and, therefore, provides significant employment benefit to the country.

However, the LIPWP has not been without its problems, and the Government of Botswana has acknowledged deficiencies in the programme. The "working age" group (15–64 years) was projected to increase by 42 per cent between 1991 and 2001 (compared with a far lower increase of 12.4 per cent in total population over the same time period). Saddled with this increasing "working" population, it will be difficult for the authorities in Botswana to withdraw completely from this public works employment programme.

Figure 21: Weir construction in Botswana-labour intensive

Source: www.flicker.com

b) Livestock drought-related programmes

Through the IMDC, which was set up to monitor and evaluate drought situations, the government has developed short-term programmes or subsidies for livestock owners. These short-term programmes, generally referred to as drought relief livestock projects, are assessed on an annual basis and instituted as necessary. They include:

- maintenance of breeding stock, where farmers are encouraged to sell during drought to maintain breeding and young animals
- feed supplements for energy, protein and minerals are sold at 50 percent of the cost price during drought
- disease prevention (e.g. botulism vaccines and vitamin A) is provided free in drought years.
- accelerating the implementation of water projects; where feasible, utilizing labour-intensive construction techniques to generate local employment, thereby enhancing local purchasing power
- channelling financing to the district level, so that emergency measures reflect local decisions
- targeting projects that serve the greatest population and exhibit low per-capita costs; maintaining subsidies where necessary to expedite implementation
- continuing the provision of safe drinking water in areas with existing schemes, without concern for cost recovery
- if capacity allows, providing one extra borehole per village as a safety margin.

c) Drought relief programmes

Drought relief programmes in Botswana have been essentially short-term operations and programmes, with action taken immediately after a drought. Major objectives of the drought relief programmes have been to:

- prevent human mortality through:
    - averting deterioration in nutritional status of particularly vulnerable groups,
    - setting up emergency water supplies for human survival,
    - using labour-based work programmes to compensate households for income lost;
- protect endangered rural household productive assets required to generate household and self-sustenance (e.g. cattle breeding stock and cattle for draught power);
- facilitate rural recovery and post-drought rehabilitation.

Three practical main components related to these overall objectives are:

- human relief, which means that in addition to existing and ongoing institutional programmes, human feeding strategies are geared up to include specific targeted populations;

- livestock relief, which includes the provision of free vaccinations in certain drought-related conditions, an expanded livestock water development programme (see pump in **Error! Reference source not found.**), the facilitation of supplies of livestock feeds and requisites, and, where feasible, incentives for an increased livestock offtake;
- arable assistance packages, which include the provision of free seeds, ploughing services, and row-planting grants.

Figure 22: Animal driven pump in Manyana 1984

Source: www.flicker.com

d) Actions by other governments

- ITALY - In 1984: 19 tons pharmaceutical and veterinary equipment value 300,000 pula, for refugee programme: 4 trucks and 2 ambulances value lira 600 million,
- SWEDEN - Emergency water supply programme rural areas: s.kr. 8 million, through lutheran world federation for emergency water supply programme s.kr. 1.9 million
- USA - In 1984: additional 2,000 tons veg. oil (total 5,000 mt). total cost including freight (for 5,000 mt), in 1985: 3,000 tons veg. oil and 8,000 tons maize, total value (maize for commercial sales, local currency generated to be used for warehouse construction), food aid through WFP

e) Actions by international agencies

Twelve drought-related projects totalling USD1.8 million funded by UNDP, UNCDF, FAO, WFP, CIDA and Australia have been formulated. UNDRO provided additional cash grant for stock-feed covers. The WFP programme provided assistance as follows: in 1984: 1,440 tons maize and 144 tons edible oil including total cost including freight and superintendence, in 1985: 1,440 tons maize and 224 tons pulses including total cost including freight and superintendence. This was enough for 20,000 remote area dwellers for 180 days

9.1.5.2 Mozambique

The users of information for drought mitigation are the Farmers, Local Government, ARA-SUL, INAM, MICOA, FEWSNet, SETSAN and INGC.

To improve drought mitigation there is a need to:

- Increase dams capacities and maintenance;
- Build new irrigation schemes for the small-scale farmers around the dams to expand not only the cultivated areas but also to guarantee food security; and
- Identify and train staff for managing mitigation systems and provide technical assistance to address management issues related to the operation of these systems.

The following are the existing policies and mitigation strategies on Mozambique (SETSAN, 2005):

(i) Policies

- Establishing of a District Action Plan disaggregated at the level of the locality, based on local identified and prioritized interventions;
- Introduction of modern technologies for a regular and systematic data collection, transmission and processing including the information exchange with neighbouring countries; and
- Establishing agreements on watercourses of shared river basins in most critical situation.

(ii) Strategies

- Intensify activities directly related to agriculture that include planting material, vegetable production, local seed production, utilization of lower areas, improved granaries, school gardens, pest and diseases control, and fruitculture;

- Intensify activities directly related to livestock that include veterinary cares, promotion of animal traction, livestock development, management of pasture and milk production;
- Development of input fairs, agricultural fairs, irrigation systems and water storage, irrigation management, fish farming, nutrition education, hunger alert and agricultural shops; and
- Development of national seed industry, with the ability to produce enough seeds in quality and quantity to cover the needs of the various sectors of social production in the long term.

(iii) Local Strategies

- Cultivation of drought resistant crops and opening new sources of water (traditional wells).
- Participate in "food-for-work" programs and planting of vegetable crops for domestic consumption.
- Work closely with the associations as a mitigation strategy.

9.1.5.3 South Africa

The main user requirement for mitigation actions for each of the identified droughts are listed in Table 25

Table 25: List of user requirement drought mitigation actions in South Africa

Mitigation requirement/ Action required
• Public awareness campaigns • Giving priority to drinking water • Wells digging and irrigation • Livestock vaccination campaign • Livestock feeding program • Importing and subsidizing drilling • Livestock husbandry practices • Water use efficiency • Farmers cropping strategies • Irrigation management • Boreholes, wells and small dams • Saving livestock • Controlled forest grazing • Food aid • Drought relief program • Harvesting of rainfall water • Irrigation systems • Food security information • Local seed production • New drought tolerant crops • Food storage and crop varieties

The mitigation actions implemented in South Africa are as follows:

- Public works programme and relief efforts
- Emergency water supply
- Nutrition security and supplemental feeding
- Drought relief schemes
- Water harvesting
- Drought recovery/rehabilitation schemes

a) Public works programme and relief efforts

Before 1994, the commercial farming districts came under the jurisdiction of national drought relief schemes. Farmers in the communal areas of the old homeland regions were assisted by special drought relief schemes implemented by the respective governments. Such schemes usually centred on: human relief (food parcels, water drilling for distressed villagers and labour-intensive public works programmes); debt relief to farmer borrowers (mainly the write-off of short-term crop production loans); and a plethora of different livestock schemes over the years. The Nutritional Task Force coordinated transport and distribution of food, while public works programmes facilitated job creation to stabilize household income. Various state structures were involved at local and regional level in drought relief.

b) Emergency water supply

During the 1991/92 drought, the Water Supply Task Force provided emergency water supply by means of water tankers to 950 communities, repaired existing water infrastructure, installed some 800 emergency pipelines, drilled more than 5 000 new boreholes, protected springs, and installed packaged water treatment plants.

Boreholes and wells are drilled as a drought mitigation measure in 1991.

Figure 23: Manually operated borehole in the Limpopo

(Source: http://www.grasdk.com/News/2011/02/26/AGISToolForMappingGroundwaterDroughtVulnerabilityInTheSADCRegion.aspx **)**

c) Nutrition security and supplemental feeding programmes

The Department of Health implemented three nutrition security programmes in all of South Africa's nine provinces (R. Ochse, personal communication, 1999). These are targeted at the rural poor and those living in poor crop production areas. The programmes focus on high-risk areas such as those prone to disasters. The first was known as the National Nutrition Development Programme (1991–92), subsequently renamed the National Nutrition and Social Development Programme (1994) and now called the Nutrition Development Projects. Between 1992 and 1996, the programme's objectives were to help people to become self-reliant by assisting them to establish nutrition-security-related projects. However, because of the drought, the programme became one of social relief, with different NGOs in the provinces being contracted to deliver food parcels to the needy. After 1996, it was realized that food parcels created a spirit of dependency among beneficiaries, and hence it was decided to encourage people to start up their own nutrition development projects. Money is channelled through NGOs and community-based organizations to communities and individuals that submit business proposals for projects such as nutrition gardens, small farms, bakeries, and fish projects. The current focus by the Department of Health promotes nutrition and food security in the region, and will enable resource-poor families to better withstand the impacts of drought

d) Drought relief schemes
   - general food aid to most affected households;
   - supplementary feeding programmes for:
     - children, especially under five years old,
     - pregnant and lactating mothers,
     - the elderly and disabled;
   - emergency water supplies for people and animals;
   - assistance in destocking livestock.

e) Water harvesting
   - dam construction;
   - water harvesting;
   - small irrigation schemes;

f) Drought recovery/rehabilitation schemes
   - seed-pack and fertilizer distribution;
   - livestock restocking programmes;
   - nutritional garden projects;
   - subsidies and loans.

9.1.5.4 Zimbabwe

The main user requirement for mitigation actions for each of the identified droughts are listed Table 26

Table 26 List of user requirement drought mitigation actions in Zimbabwe

From who the action is required	Required action	When the action is required
Government (EMA, Ministry of Agriculture, Research councils and Universities)	More research on climate change and drought related issues	Constantly
Meteorological Services Department (MSD).	Local scale weather forecasting and advance warning of extreme events.	Weather forecasts(daily, monthly and seasonal) Warnings: at least a month in advance.
Government	Provision of inputs and rehabilitation of irrigation schemes and dams	Off rainy season At least a month before the onset of the rain season.

Government	Declaration of disaster; Assessment of droughts.	Well before the onset of the disaster
Government	Policies that promote more involvement of local institutions	Constantly
Government	Policies that promote of local or indigenous strategies in drought mitigation.	
Local institutions, NGOs and government	awareness campaigns; and educational on drought and climate change related issues	Constantly
Government	Review of the Drought Plan to cater more for long term mitigation and a more proactive plan.	constantly
NGOs ,Government and local institutions	Promotion of soil and water conservation	All year round
Local council	Water rationing schedule, recycling water, and water conservation awareness campaigns	
All drought mitigation organisations related	Coordination of mitigation programmes and relief and communication.	
Relevant sector ministries: Ministry of water;Agriculture,an ZINWA	Drought and water management awareness campaigns	Constantly
Meteorological Services department	Classification of a drought in terms of being hydrological, agricultural and meteorological and severity	Well before drought onset

9.2 COMPARISON OF DROUGHT MITIGATION PRACTICES IN AFRICA FROM D2.2 WITH THE USER REQUIREMENTS

9.2.1 North Africa

Morocco, Tunisia and Algeria are located in the central part of North-Africa, in an arid to semi-arid region characterized by a Saharan climate in the south, an oceanic climate in the west and a Mediterranean climate in the North. Due to this common geographic position, they share many common geophysical and social features:

- The inter and intra-annual variability of rainfall that makes them drought prone areas,
- The increasing frequencies, durations and severity of drought episodes over the last decades
- Their classification among the most water scarce region of the world and the common concern about the increasing water scarcity. Indeed, The three countries are considered water-stressed (less than 1,000 m3/inhabitant/year), with Algeria and Tunisia being closer to a shortage (less than 500 m3/inhabitant/year);.

- The common Berber, Arabic and Islamic cultures

The socio-economic development of these north-African countries was based on different economic choices and production sectors. In Algeria, the industrial sector is the largest. In Tunisia, the service sector predominates although the agricultural sector has also a big importance. In Morocco, the largest sector is the agricultural and fishing sector. In addition, the importance of the agricultural sector in the economy and the predominance of rainfed traditional farming makes the life of the population and in particular of rural population very much linked to the climate and its fluctuation. This is particularly striking in Morocco and Tunisia whereas Algeria is essentially a desert country where arable lands represent only a small percentage of the total area and where pastoral activities are dominant.

Due to these common features, the drought mitigation practices developed in this countries share to some extent many similarities, although some particularities can be distinguished. This section of the report will make a comparison between the practices presented in detail for each country in D 2.2 and the users requirements developed in the last point. Although we put the emphasis on the agricultural sector in D 2.2 because it is by far the major consuming water sector, we will also review here drought mitigation actions in the other sectors. Indeed, in Algeria, according to Benblida (2011), the water consumption of the domestic sector increased greatly during the last decades moving from 16 % of the total consumption in 1975 to 35% nowadays. In the same time, the part of the agricultural sector declined from 80 to 60%; the industrial consumption remaining the same. The trend observed in Algeria may be prefigurative of what may happen in the future in all north-African countries as a consequence to the running demography, the development of other sectors and the simultaneous increase of water scarcity. Indeed, in North-Africa, the irrigation water will be cut because of increasing competition with other sectors, especially the tourism sector, which has enormous profits, and can pay much more for one cubic meter than farmers. Thus, drought mitigation practices in the domestic sector tend to get more importance although they are still scarce.

9.2.1.1 Agricultural sector

In the agricultural sector, drought mitigation practices currently observed can be divided into reactive and proactive measures. In addition, they can be both analyzed according to the branch of activity towards which they are oriented:

a) Crop related practices

In the agricultural sector and especially under rainfed conditions there is not much to do as a relief action in case of prolonged and severe drought besides the look for complementary irrigation (see point c)) and as a last resort, the use of sowed fields as grazing lands. In irrigated areas, actions are more concrete and include the adjustment of irrigation frequencies and doses according to the available water resources, the reallocation of water resources in order to give priority to perennial crops, the suppression of summer crops.

Thus, in terms of relief actions, there is no real gap in comparison with user's requirements. However, the major shortcoming comes from the lack of an effective early warning and drought forecasting. Indeed, in Morocco, the agricultural campaign of 2011-2012 faced a severe drought in many regions of the country and although the premises of a dry year appeared in early winter, the official declaration of drought by the Ministry of Agriculture and Maritime Fisheries occurred only in March. An earlier drought declaration or even the fear of a dry year would have open the opportunities to take more adapted mitigation strategies such as taking or not the decision to sow, decisions about planting crops (date of planting, seeding rate, initial fertilizer treatment, etc), shifting to less consuming water crops.

Reliable drought forecasts that predict rainfall outcomes before they even begin could also enable governments and relief agencies to position themselves each year for more effective and cost efficient drought interventions.

b) Livestock relief strategies

During all drought episodes and across all these three north-African countries, livestock relief is a predominant component of drought management programs. However, these actions are mainly relief practices mainly oriented towards livestock preservation through water provision, feed supplementation and subsidies, Control of livestock health (subsidized vaccination, provision of exonerated veterinary medicaments, etc.). Bank credit support and/or Debt forgiveness have also been parts of these programs. Thus, these actions do meet a part of the user's requirements but they also, like all the reactive actions taken in emergency, present the side effects of:

- being very expensive,
- increasing the dependency of herders on government assistance
- having a limited impact on the long term.
- Being not equally shared among beneficiaries and especially between big owners and smaller herders. Although some feed subsidies in North Africa were targeted at poorer herders, the literature suggests that subsidies in fact tended primarily to benefit the

wealthy herders, who had additional financial resources and were better integrated into the commercial economy.

- Having negative side effects on the environment due to the promotion of unsustainable practices like overgrazing

Thus, in order to fully fulfill user's requirements, the gap needed to be filled concerns proactive mitigations practices. In this context, some emerging approaches can avoid these problems by providing farmers and herders with the means to better manage drought risks themselves with a minimum of government intervention. Like the previous point related to crops management, they include reliable early warning systems and medium range and seasonal drought forecasts. In addition, the development of livestock insurance on the model of the crop insurance may be an instrument of choice for helping herders to manage climate risks like drought. The de-stocking of animals to adjust the number of animals to forage availability, the alternation of grazing areas to avoid overgrazing, the promotion of drought resistant breeds and the plantation of resistant forage shrubs such as *atriplex* and *Opuntia* that play already an important role in the fight against desertification represent other user's needs for more effective drought preparedness compared to the predominant reactive practices currently adopted. Nevertheless, in Algeria, where pastoral activities have a prevalent economic importance, such proactive drought mitigation strategies are already well developed.

c) Access to drinking water for rural populations, Water saving, preservation of water resources and look for complementary water resources practices

In North-Africa, since water scarcity and its increasing represent a major concern, the integrated management of water resources accounts more for adaptation "to a future with less water" and will be developed later in the section related to drought adaptation.
Nevertheless, several actions are undertaken on the short term to cope with drought. They are mainly oriented towards providing drinking water to rural population, water saving and the look for additional water resources. They include the development of deficit or supplemental irrigation whenever possible, the deepening of wells and the conjunctive use of surface and groundwater resources, the reallocation of water resources and the adjustment of irrigation doses and calendar in irrigated perimeters. In Morocco, in the Tadla region (Oum er-rbia basin), researchers from the National Institute for Agronomic Research have developed a deficit irrigation technique: Using only 70 percent of the conventional quantity suffices for most crops. They introduced it to farmers in the region that can now save in average 1,000-

1,200 cubic meters of water a year without reducing grain yield. Yet, these practices still need to be disseminated on a larger scale in order to fulfill user's requirements.

In north-Africa, the intensive and excessive recourse to groundwater during some particular dry years and even in normal years in some particularly water stressed regions of these countries relying mainly on ground water resources led to an alarming decrease of the water table. Indeed, in North Africa, the renewable groundwater resource mobilization rate (withdrawal-to-recharge ratio) is high (Bzioui, 2005). The average groundwater exploitation rate in Northern Algeria is 80%. The estimated number of aquifers in Tunisia is 273, 71 of which are overexploited at an average rate of 146% (TICET, 2009). Overexploitation has also been noted for most of the large aquifers in North Africa, such as the Souss, Tadla, Berrechid and Saïss aquifers in Morocco, those of Bas-Cheliff, on the Mascara Plain and Mostaganem Plateau in Algeria, and the Sisseb el Alem aquifer in Tunisia (Bahir and Mennani, 2002; Boudjadja et al., 2003; Loucif, 2003). In Morocco, the water table of the Saïss deep aquifer has fallen by an annual average of 3 metres over the past 20 years. The water volume stored within the Berrchid aquifer fell from 1500 million m3 in 1980 to 800 million m3 in 2009, according to the Bouregreg-Chaouia Basin Agency which predicts that the aquifer could be completely dewatered by 2025. Moreover, when the aquifer is located in a coastal area, overexploitation may lead to saline infiltration as in the case of the Chaouia coast in Morocco where, due to a sharp rise in salinity, farmers have had to return to rain fed agriculture.

This led to a closer control of wells and boreholes exploitation by focus on control of new drillings and the depth of the existing withdrawal points. In Algeria, borehole control policies have been implemented since the late 1980s, with in particular, a ban on new boreholes in Collective Farms (EAC) which had been established after the break-up of self-managed domains (large-scale public farms). In Tunisia, boreholes are banned both in the protection and irrigated areas. In Morocco, the ban on borehole drilling is determined by the agencies for aquifers considered as being overexploited. hese borehole drilling bans are unevenly implemented. In Chaouia, although boreholes are officially banned, there is no control in practice.In the other cases studied in Morocco, there has been growing interestin borehole control. In Souss, Saïss and the Berrchid Region, the administrations are beginning to control borehole drilling, in particular by impounding drilling machines. The Souss agency is also trying to organize the drilling machine sector, especially through the establishment of a professional association, which could become a management interlocutor. In Algeria, some farmers have served prison sentences for illegal drilling. In Tunisia, controls have been less stringent. Moreover, since the events of January 2011, the public administrations have a

much weaker presence and fewer activities in rural areas. In the Nadhour region, a local official estimated that, in the spring of 2011, 70 of the existing 210 illegal boreholes had been drilled since January 2011 (Ordu *et al*., 2011).

In the three countries, various policies are under discussion to ensure sustainable aquifer management. In Tunisia and in Morocco, a specific groundwater management strategy is being designed. The main focus of these strategies is on local contractual mechanisms, which would lead to integration of the different policies, in particular those relating to supply and demand management. Thus, in Morocco, the River basin agencies implemented a new policy: the so called “Contrat de nappes”. It aims to set up aquifer management contracts for the main overused aquifers, which should bring together broad coalitions of actors around coordinated supply and demand policies. In Tunisia, since the 1990s, the Ministry of Agriculture’s general policy has been to support the formation of groups of farmers, known as GDAs which aims groundwater management in their areas of operation and in particular, borehole control.

The proposed contractual approaches in Morocco and in Tunisia are different. The Moroccan approach has from the outset focused on large aquifers, whereas the Tunisian approach will, a priori, apply more easily to smaller-scale aquifers. Yet, these actions still need to be generalized since in Morocco in 2011, the only groundwater contract signed has been the Souss-Massa Aquifer Framework Agreement while in Tunisia there is currently only one case where such an approach has been initiated in practice (the Bsissi GDA in the Gabès Governorate).

d) Socio-economic relief strategies

When talking about drought mitigation, the socio-economic dimension is an important component of any global strategy. In North-African countries, socio-economic drought mitigation takes usually the form of relief actions and concerns mainly the agricultural sector since it is the most deeply impacted one. Thus, all the identified relief practices described in D 2.2 include actions such as:

- The rescheduling of farmers’ credits,
- The debts forgiveness,
- The creation of non-farming jobs for the diversification of households incomes,
- A better and easier access to the credit

However, all these practices remain reactive and there is a need for more proactive measures. Among the measures typically oriented towards the agricultural sector figure the development and implementation of drought insurance. In Morocco, a pilot project to provide drought insurance in cereal production was implemented starting with the 1995-96 crop season. The program was managed by *Mutuelle Agricole Marocaine d'Assurances* (MAMDA, the agricultural mutual insurance company). Very recently, in august 2011, a new multi-risk insurance against all extreme weather conditions (droughts, floods, hurricanes…) was implemented for cereal and legume crops all over the country with an objective of covering 300 000 ha in 2011-2012 and a provisional objective of 1 000 000 ha by 2015. Yet, these programs still need to be extended to other regions and crops.

Besides these actions, socio-economic drought mitigation should be evaluated on a more trans-sectoral approach considering drought vulnerability and impact assessments and will be treated later in point 11.2.4.

9.2.1.2 Domestic sector (urban areas)

With agriculture being the only sector where households really suffer from droughts and their various impacts, North-African countries and especially Tunisia and Morocco (Algeria being a special case regarding tap water availability and consumption) developed since decades a wasting water behavior in urban areas and cities. People took water for granted and used to over consume it although in a near past houses did not have current water and people were used to save water. In 1956, right after the independence, only 28% of the Moroccan urban households had direct access to water. In these countries, even in drought periods there are usually no water restrictions. The case is quite different for Algeria where the increasing demography in big cities associated to the increase of water scarcity led to rotating water cuts and the allowance of a specific water quota per day and habitant. In Morocco, drought mitigation measures are a component of a more global strategy of coping with the increasing water scarcity. They include:

- Institutional and legal aspects through the application of the new water law (10-95)
- Tariff adjustments aspects through the adoption of a progressive water pricing that gives all a first tranche of water with a reduce price and over taxes high consumptions as a deterrent measure against over-consumption.
- Technical aspects through the improvement of distribution networks and the promotion of the marketing of water saving devices, the development of wastewater reuse.

- Communication aspects through the development of awareness and educational campaigns to promote water saving. In Morocco, the ONEP (Office national de l'Eau potable) developed two kinds of programs. The first one (from 1984 to 1990) was a "Grand Public" action though all the media (TV, radios, newspapers….) while the second one (from 1991) had a more targeted action through the development of "Direct action on sites" with young people being the main targets. Figure 24 presents examples of the awareness and sensitisation communication supports developed by ONEP. In rural areas, the ONEP promotes the encouragement of local management for drinking water supply through the implementation of fountain terminals with system manager guardians, the creation of user's associations for drinking water, the mobilization of local expertise for networks management (micro-enterprises).
  Other institutions, as the basin agencies (ABH), or ministries water department (SEEE) can develop punctually communication and sensitisation actions in some targeted regions (Figure 2).

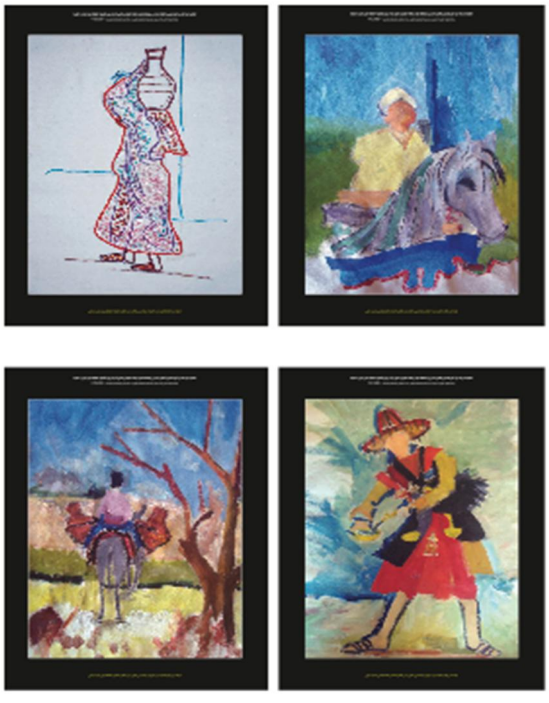
In the context of the sector requirements, these actions allowed:

- To reduce the annual growing rate of water demand from 8% in the 80's to less than 3 % in 2009. (Belmamoun B Communication sociale et approche participative au service de la gestion intégrée des ressources hydriques et des projets d'alimentation en eau potable.) Conférence sur la gouvernance de l'eau Tunis 8-9 juillet 2009)
- The recruitment of 45 000 guardians that manage more than 5000 fountains for a population of 2 million people and the implementation of more than 6000 drinking water users associations that manage water devices for more than 2 million people.

Figure 24: Examples of communication and sensitisation tools (in urban (left) and rural (right) areas) developed by the ONEP in Morocco

1.Communication on the Declaration of Water Withdrawals (SEEE/ GIZ (2011))

2. Awareness campaign on the dangers of swimming in the dam (ABH souss Massa (2009))



3. Restrictions on water use dams (ABH Sebou, 2011)

4. Painting competition for schoolchildren (ABH Oum er-biâ, 2009)

Figure 25: Examples of communication and sensibilisation tools for saving agricultural water in Morocco

Nevertheless, although these awareness and sensitization campaigns allowed some water savings, they need to be completed by other actions, especially during drought events. Indeed, there are currently no policies rationing drinking water consumption in case of severe droughts.

9.2.1.3 Industrial and commercial sectors

Like in the domestic sector, there is actually a growing interest and concern in the industrial and commercial sectors for the promotion of sustainable water use in factories. It is in fact essential since a study conducted in Morocco in 2006 by the CMPP (Centre Marocain des Etudes Propres) revealed that some industries that do not recycle at all their water use can lose 90% of it!

Thus in Morocco several leading enterprises of the industrial sector started to develop and implement their own solutions for a better and more sustainable water management. It is for example the case of:

- “la centrale laitière” which is the main Moroccan dairy products industry and which developed in its unit of Fquih Ben saleh (Oum er-Rbia basin) a water management program through the optimization of water consumptions in the different services, the implementation of water consumption measure equipments in all the critical points, the renewing of water consuming devices, the sensibilisation of employees to the necessity of water saving, the recycling of waste water.
- “L’Office Chérifien des Phosphates” which is a Moroccan global leader in phosphates extraction and transformation that consumes important volumes of water, made of water management a condition to its sustainable development through the optimization of water use along all the production chain, the abandonment of groundwater use and the recourse to nonconventional water resources (industrial reuse of treated domestic waste water, desalination)

Such examples are a part of a national sustainable and integrated water management strategy. However, like in the domestic sector, there are currently no concrete water rationing actions and drought mitigation actions undertaken by the relevant authorities during drought episodes and more policies should be developed in that direction in order to fulfill user’s requirements.

As a conclusion, the analysis of drought mitigation practices undertaken in three countries of the North-African region (Morocco, Tunisia and Algeria) revealed that they are mainly relief actions implemented in the agricultural and pastoral sectors. These measures are very necessary but are of limited effect in the long term; they hardly contribute to reducing the vulnerability of the affected populations to drought.

In the domestic, industrial and commercial sectors, although there is a growing concern about water saving, the implemented programs are rather a part of a global strategy designed for the necessity of coping with the increase of water scarcity than specific drought mitigation. More can be done at the policy and institutional levels (see point ….) but also and in particular in terms of decision support tools.

9.2.1.4 Decision support tools

When analyzing drought mitigation practices in the Maghreb region and comparing them with user's requirements, one common characteristic and major shortcoming emerge: the lack or the relatively weak development and implementation of decision support tools and overall of drought plans that represent a guideline to drought management, although they do represent an important components of user's requirements. Indeed, according to Wilhite (2002), there are two fundamental requisites for reinforcing drought mitigation and preparedness in the long term:

- An accurate drought risk assessment quantifying the degree of hazard and the vulnerability of the different regions
- Real-time information concerning the development of drought conditions and providing forecasts of the occurrence of the likely evolution of drought

a) Drought early warning systems

In an expert meeting on drought early warning systems in the Mediterranean jointly prepared by World Meteorological Organization (WMO) and US National Drought Mitigation Center, held in 2000 in Lisbon, it was considered that effective information delivery and early warning systems are the foundation for effective drought policies. (Hamdy, 2004, Options Méditerranéennes)

Drought early warning systems can help decision makers and users taking early the right decisions for mitigating drought impacts. In the Maghreb region, the only example of implementation of a drought early warning system was the regional SMAS project. However, the system is not longer operational since the end of the project in 2009 and currently there is no effective national or regional drought early warning system.

b) Medium range and Seasonal forecasts

Medium range and seasonal weather forecasts may provide valuable information regarding whether conditions that are likely to improve or deteriorate in the coming months and thus help developing subsequent mitigation strategies in the case of a forthcoming period of drought before its onset. Studies on seasonal weather forecasts started in Morocco following the long and severe drought periods that occurred in the 80's. They were based on the fact that North Atlantic Oscillation (NAO) is the major driver of rainfall variability in ~~orth~~north-Africa. The DMN (Direction de la Météorologie Nationale) has implemented since 1994 a program aiming to develop the seasonal long-term forecast of the precipitation using large scale climate patterns such as the SST, NAO and ENSO2. The main objective of the program was to help the decision-makers to foresee the periods of drought in order to mobilize the necessary means to face it. The project is supported by international cooperation and has two main components: ALMOUBARAK3 mounted in association with the University of Oklahoma (USA) and co-financed by the USAID, and ALMASIFA3 implemented in association with the research centres of the met services of France, Algeria and Tunisia 4 and co-financed by the European Commission. According to the DMN, the key sectors and decision makers that could benefit from seasonal forecasts in their management processes are high ministerial authorities, hydrological services and agriculture services. As a result, it has been decided from discussions between DMN and Moroccan Hydrological and agricultural Services to provide predicted regional rainfall indices in drought forecasting Bulletins are now issued to end users and sent mainly by mail at the beginning of each month (Bellow *et al*., 2007). However, we could not find any relevant information about the current use of these bulletins for drought mitigation purposes.

The European Centre for Medium-Range Weather Forecasts (ECMWF), an independent organization supported by 31 states across Europe, maintains a seasonal forecast up to four months lead in time for the entire Africa. The prediction is based on an ensemble of GCMs, which provides a reasonable skill (Palmer et al., 2005). Thus, an ensemble mean and associated probabilities are publicly available for temperature, precipitation and other climatic variables which make computing drought indicators possible. (http://www.ecmwf.int/products/forecasts/d/charts/seasonal/forecast/) (Vincente-Serrano *et al.*, 2012).

c) Drought risk, hazard and vulnerability assessments

A careful consideration and assessment of drought hazard, impacts and vulnerability are key components of any drought mitigation plan. Indeed, carrying these processes is fundamental

to decide on the specific mitigation actions that can be taken to reduce short and long-terms drought risks. Such actions will differ from one place to other and have to be tailored to cope with the prevailing conditions.

The review of drought mitigation practices and strategies developed in North-Africa show that besides very few studies conducted in the frame of punctual projects (cf, Agricultural Drought vulnerability assessment of the rainfed cereal production in the Oum er –Rbia basin, Drought Hazard assessment in the Shoul area) there is currently no drought risk and vulnerability assessments on a trans-sectorial approach. That represents a major gap that need to be filled.

9.2.2 Equatorial Lakes Region

9.2.2.1 Tanzania

The identified droughts mitigation practices and user requirements from historical drought events in Tanzania are shown in Table 27.

Table 27: Experiences from historical drought events and the user requirements for drought mitigation in Tanzania

Drought	Drought mitigation practices	User requirements
Meteorological drought during 2000/2001	Emergency Assistance Fund for Drought and Famine: • Ensure food Security through increased farm Production • Mitigate against drought through Irrigation • Facilitate rehabilitation of irrigation canals • Purchase and distribution of seeds for the 2000/2001 farming season • Production of improved seeds	• Information on when droughts are expected • Information on what can be done to mitigate drought impacts
Prolonged dry spells during the 2005/2006 season: Seven regions of Tanga, Mbeya, Lindi, Kagera, Morogoro, Iringa and Manyara had surpluses of varying magnitudes but had also several pockets of food shortages. Other food self-sufficient regions that had several pockets of food shortages include Coast, Kilimanjaro, Tabora and Arusha. The other five regions of Shinyanga,	• In order to mitigate against future food shortages amongst livestock keepers, they were advised to consider adopting better husbandry practices and keep small herds economically rather than large herds, which do not provide them with economic gains • Food Security Information Team (FSIT) recommended the Local Government Authorities (LGAs) enact and continue to enforce existing by-laws that require households that had good harvest to store adequate amounts of food to meet their requirements through the next harvest. Moreover, the	• Support from the government during drought impacts • Early warning on the coming droughts • Clear knowledge of the local institutions dealing with drought management • Strengthened local institutions dealing with drought management •

Dodoma, Singida, Mwanza and Dar es Salaam had food deficits of varying degrees at regional level and in nearly all its districts (PMO, 2006)	LGAs should enforce by-laws requiring farmers to plant crops according to their agro-ecological suitability to reduce food shortages attributed to failure to observe crop production requirements. This was observed as one of the factors that can be remedied for improving household food security and avert the food and seed assistance dependency syndrome, which is growing among the rural communities • FSIT recommended the LGAs be mandated, and provided with capacity, to carry out the vulnerability assessments locally but maintaining strong links with the Prime Minister's Office (PMO) and Ministry of agriculture, food security and Cooperatives (MAFC) so as to have cost effective and timely in the production and dissemination of the food security information thereby handling even the small and localized food insecurity concerns, and avert delays in responses	
Agricultural drought during 2003-2004 (Amani and Standen, 2004)	• FSIT carried a Rapid Vulnerability Assessment (RVA) and indicated that a total of 2 million people in 47 districts would need food assistance of 77,490 MT • Food security update in February 2004 indicated the area and number of vulnerable had increased since June 2003, recommended additional food assistance for severely food insecure households in uni-modal areas and bimodal areas with a poor vuli (short rains) harvest, until the end of April 2004 • The Government conducted an RVA in February 2004 and established that about 3.5 million people would require food assistance in March 2004 • Government drought response (sect. 4.2; Fig. 3) programmes were: • Distribution of subsidized maize (sold at Tshs 50 per kg while market prices were above Tshs 250 per kg in some regional markets at that time) by market traders and coordinated by PMO-Disaster Management Department	• Support from the government during drought impacts • Be informed on support from the government or development partners during drought impacts • Roles of leaders and Village Relief Committee (VRC) members or roles of stakeholders in the intervention • The community be educated regarding the type of food available for distribution • All stakeholders to be facilitated to attend the (Community Managed Targeting and Distribution) CMTD training • Early warning on the coming droughts • Clear knowledge of the local institutions dealing with drought management • Strengthened local institutions dealing with drought management • Ensure that some emergency funds are

	(DMD) • Government managed distribution subsidized food, implemented by PMO-DMD in collaboration with LGAs • Food for farming operation, consisting of World Food Programme (WFP) Emergence Operation (EMOP) relief assistance • Distribution of seeds, implemented by FAO, MAFS (transport matters), PMO-DMD (guidelines), LGAs and NGOs (distribution matters) • Due to the reduced quantities of food available, some of the previously targeted geographical areas were not covered, the programme finally covering 30 of the originally planned 47 districts • For the drought response, the RIA done in May 2004 indicated that food assistance programmes were generally more desirable / successful than the accompanying seed distributions; with relief assistance considered more desirable / successful that the subsidized food programme • The food for farming/WFP EMOP programme was well received at all levels (district & villages) • PMO-DMD chose CMTD as the targeting method to use during drought operations although it was not always adopted	allocated every financial year for unanticipated food shortages, and replenished each time they are used • The Food Security Information Team (FSIT) should conduct a Rapid Vulnerability Assessment (RVA) in August every year, in order to establish a most accurate vulnerability situation • DALDO (District crop officer), MAFS (Seeds unit) and PMO-DMD should identify vulnerable areas, allocate and deliver seeds early - before the planting season • Relevant stakeholders need to be involved in selection of seed types and varieties suitable for the ecological and cultural conditions of the specific target area/population • MAFS crop development dept should develop an agro-ecological zonation map that shows compatibility of different crops with the different zones • DALDO (Crop section), MAF (Crop dev. dept), PMO – DMD and Food and Agricultural Organization (FAO) should make sure that enough resources and personnel are allocated for supervision, monitoring and evaluation at all stages of the intervention • MAFS (Crop dev. dept), PMO-DMD should provide comprehensive guidelines for targeting to personnel involved in supervision, monitoring and evaluation for seed distribution at all levels • Find ways to substantially lift small farm productivity in terms of returns to farm labour and increase the profitability of farming, so as to realize the potential contribution of agriculture to

		reducing poverty and ensuring food security in rural areas • Minimize risks to low productivity • Research services to be responsive to farmers' needs • Effort to promote improved farm implements • Irrigation holds the key to stabilizing agricultural production but it requires political commitment to allocate the necessary resources and create an enabling environment for private sector investment

9.2.2.2 Kenya

The most common actions implemented in Africa in the past include food aid, drought relief programs, growing of drought tolerate crops, saving livestock, water efficiency and construction or rehabilitation of boreholes, wells and small dams.

9.2.3 Eastern Nile Region (Ethiopian Plateau)

The following is a list of the main mitigation actions implemented during different droughts:

1. 1973/4 for twenty years, the focus was on disaster response and the distribution of relief supplies
2. In 1993 a link between the relief and development was established
3. In 2004, acute cases of emergency response were activated. The responsibility to coordinate employment generation, was one of the major strategies that link relief with development.
4. Food Security Coordination Bureau (FSCB)was responsible to respond to fast-on set disasters or unpredictable events through safety nets program, other food security-related projects that attempted to enhance assets and livelihoods, and a voluntary resettlement program.
5. Significant shift in policy direction 2008-2009, through the Disaster Management and Food Security Sector (DMFSS) to shift toward proactive ex-ante disaster risk management.

The concept of Drought Cycle Management (DCM) was developed in Kenya by Jeremy Swift in the mid-1980s under the EU-funded Turkana Rehabilitation Project. It was adapted by IIRR, Cordaid and Acacia Consultants in 2004, and is becoming increasingly accepted as the

dominant drought management model in East Africa and the Horn. DCM was designed to identify appropriate activities for each of the four phases of the drought cycle: normal, alert, emergency and recovery. In Ethiopia, SC/US and other PLI partners have made the DCM model central to their work. In order to implement the model successfully, agencies need to better integrate development and emergency responses. Ideally, the system should include the following (adapted from Behnke et al., ibid.):

- strong institutional, management and coordination structures at all levels;
- effective early warning and information systems;
- drought contingency planning at all levels;
- easily accessible drought contingency funds at central, zonal and/or woreda level; and
- the capacity to implement timely drought response measures and to provide support to
- drought recovery interventions.

9.2.4 Eastern Nile Region (Down Stream)

9.2.4.1 Sudan

The mitigation practices that provides be the governmental bodies and research institutes, NGOS and private sector in most cases not meet the user's requirement. For example the Sorghum farmers in rainfed areas in Sudan have no access to get the mitigation practices because there is no active body that work to transfer these practices to the end users. Some NGOS work hard to be able to transfer and help in applying the mitigation practices (e.g. planting trees, water harvesting techniques, supporting establish trees nurseries)

Mitigation practices may be summarized in the following points:

1. Strengthening the community capacity towards drought episodes.
2. Make use of indigenous knowledge

9.2.4.2 Egypt

The main mitigation actions have implemented to combat the desertification and extreme events

- Irrigation improvement that achieved by integrated irrigation management project (IIMP), Land improvement and Water and land pollution control
- Preparing and adoption the preliminary outlines of the strategy and action

plan of the National Capacity Needs Self Assessment.

- Production of awareness raising materials.
- Program for rehabilitation, conservation and sustainable use of soil and water
- Program for rainfed agriculture
- Program for sand dunes stabilization

Each of the previous programs for mitigating the impact of desertification

9.2.5 Southern Africa

9.2.5.1 Botswana and South Africa

The main mitigation actions implemented for each of the identified droughts are listed in: Table 28

Table 28: List of drought mitigation actions per the user requirement

Mitigating Action	Botswana	South Africa
Giving priority to drinking water	X	X
Public awareness campaigns	X	X
Rescheduling of farmers' credits		X
Restricting summer crops		X
Wells digging and irrigation	X	X
Farmers cropping strategies		
Water use efficiency		X
Drought relief program		X
Saving livestock	X	X
Livestock watering points		X
Controlled forest grazing		X
Livestock feeding program	X	X
Livestock vaccination campaign		X
Boreholes, wells and small dams	X	X
Diversification of income sources		X
Harvesting of rainfall water	X	X
New drought tolerant crops	X	
Natural forest plantations		
Agroforestry		X
Food aid	X	X
Horticulture		X
Local seed production		X

Mitigating Action	Botswana	South Africa
Fruit production		X
Irrigation systems		X
Irrigation management		X

9.2.5.2 Mozambique

The main mitigation Practices for each user requirement are listed in Table 29.

Table 29: List of drought mitigation practices per user requirement

Institution	Mitigation Practices	Users' requirements

Institution	Mitigation Practices	Users' requirements
National Institute of Disaster Management (INGC)	Education; civic training activities about disaster threats; preventive measures with active participation of the media using local languages.	Dissemination and publication of information in disaster situations; Organize and coordinate the collection, analysis, and dissemination of weather information, trends and consequent impacts on the population; Provide regular information to managers and their respective donors; Promote mutual assistance and exchange of information among international organizations.
National Institute of Meteorology (INAM)	Regular collection, processing and dissemination of weather information, drought forecasting; Improve the management and inspection	Weather monitoring across the country
Ministry for Coordination of Environmental Action (MICOA) - (DNGA - National Directorate of Environmental Management)	Coordinating all the actions across the country regarding drought and flood management, particularly those causing direct impact to the environment,	Preparation of National Action Plan for Adaptation (NAPA) which includes different projects and activities: Assessment of the need for national capacity Project; Self-assessment of overall environment management; Action Plan to combat drought and desertification.

Institution	Mitigation Practices	Users' requirements
Ministry of Agriculture (MOA)	Development of seed fairs; Intensive use of water resources through the construction and rehabilitation of irrigation systems; dams and water sources, as well as the purchase and installation of irrigation equipment (ex: pumps) to ensure sustainable interventions.	Weather forecasting for the different growing seasons. Development of adaptation strategies such as the use of crop resistance to drought. Build and rehabilitate damaged irrigation systems and water courses
FEWSNet	Promote the strengthening of local capacity to manage risk.	Improve early warning system; Improve access to and use of integrated information for reducing disaster risk; Identification and correction of gaps in information about the vulnerability and disasters

9.2.5.3 Zimbabwe

The main mitigation Practices for each user requirement are listed in Table 30.

Table 30 Drought mitigation practices in Zimbabwe

Mitigation actions/Practices
Cloud seeding
Weather monitoring
Government and NGO input programmes.
Research and programmes for genetic improvement on crops and livestock
Research on climate change.
Providing drought relief hand-outs.
Drought monitoring surveys and early warning.
Legislation /policy changes.
Public awareness and educational programmes.
Drought emergency preparedness.(disaster preparedness)

Development of new water supplies (e.g. drilling of boreholes).

Figure 11 shows some of the drought mitigation practices in Zimbabwe. The mitigation practices and user requirements tally in some areas and diverge on other areas. In most cases user requirements differ with the mitigation practices in the ways the latter are implemented. For instance the user requirements demand more and effective channels of communication flow for successful drought management, which is currently difficult because of the hierarchical nature of the national drought taskforce team. (See figure 10) .User requirements call for a proactive approach to drought management, yet in practice there is more of a reactive approach. Furthermore user requirements call for a participatory approach and use of some local indigenous interventions.

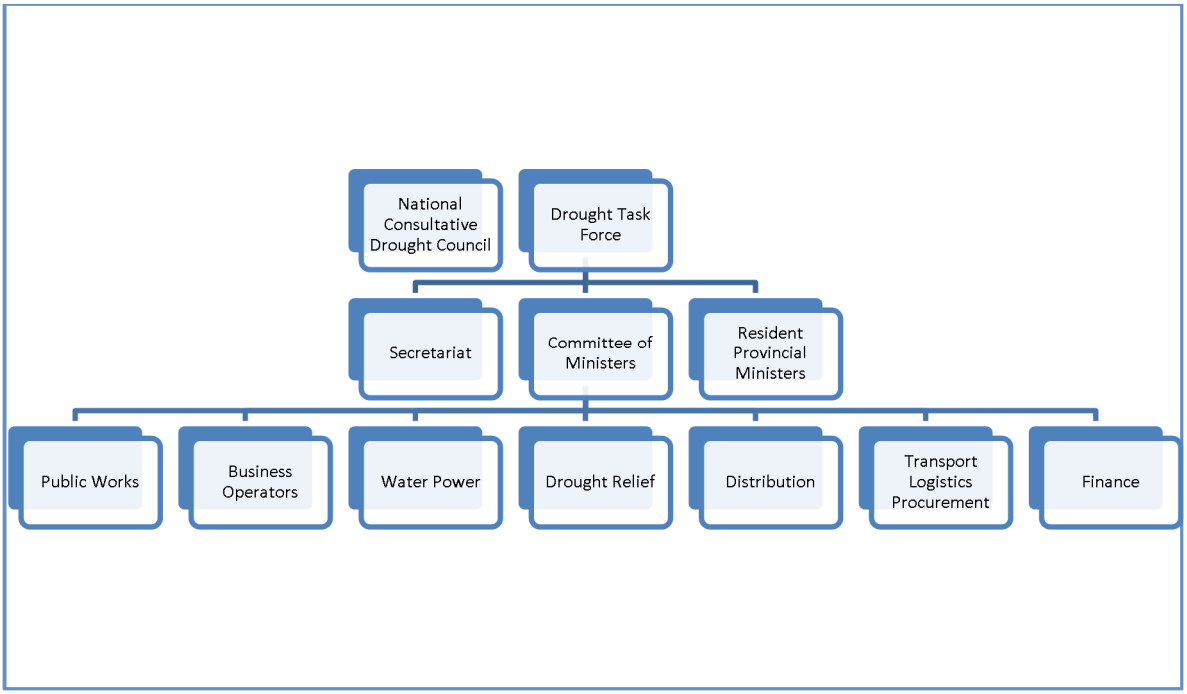


Figure 26 Zimbabwe National Action Group. Source Thompson (1993:86)

9.3 COMPARISON OF GLOBALLY AVAILABLE STATE-OF-THE-ART DROUGHT MITIGATION PRACTICES WITH REQUIREMENTS OF USERS IN AFRICA

9.3.1 North Africa

This section of the report will compare available state-of-the art drought mitigation practices with requirements of users in Africa. Like the previous points it will make the difference between the three main user's sectors, namely the agricultural, domestic and industrial and commercial sectors. The state-of-the art drought mitigation practices used as a basis of

comparison are mainly from countries of the Mediterranean basin (Experiences from Spain, Italy, Portugal, France, Cyprus, and Greece) that share through this common geographical feature some climate similarities with North-Africa, and from Australia and United-States which have developed very efficient drought management strategies.

9.3.1.1 Agricultural sector

In the agricultural sector, the main available state of the art technical drought mitigation practices are related to:

- The rescheduling of irrigation calendar: from the decrease of irrigation frequencies to irrigation prohibition in case of very severe droughts.
- The priority allocation of available resources to perennial crops and water rationing for annual crops
- The recourse to groundwater resources through the deepening of existing wells and drilling new ones
- The development of crop insurance programs and assistance for livestock losses
- The promotion of soil and water conservation cropping systems
- The sustainable management of rangelands

Their comparison with user's requirements and also with the currently adopted drought mitigation practices in North-Africa reveals no major difference. This may be due to the fact that since the agricultural sector is the most deeply impacted by drought, the necessity to cope with drought and to mitigate its impacts figure among the national priorities and has been given big importance. Nevertheless, as mentioned in the previous point and due to an alarming decrease of water table is some major aquifers, the recourse to groundwater in North-African countries is now strictly regulated and the recourse to other water resources such as the reuse of treated waste water is better encouraged. However, the major shortcomings in terms of currently adopted drought mitigation practices, and the main user's needs in the agricultural sector are more related to decisions support tools than technologies. Indeed, moving from a drought crisis management to a risk-based management approach requires improved assessment tools to better target mitigation actions and response programs. The history of the Australian drought policy is quite a good example of a shift from a crisis management to a risk management. Indeed, until 1992, drought management in Australia was mainly achieved though relief and subsidies actions implemented by States and national governments. From 1992 and onwards, the Australian drought policy promotes producers to adopt self-reliant approaches and the role of the government is to provide farmers with skills/tools like research into climate variability and prediction, decisions support tools (drought risk and impacts assessments, early warning systems, seasonal weather forecasts), training and education, tax incentives and social support. The direct government

intervention is warranted only when drought is exceptional. (Wilhite, 2005) Australian and U.S drought policy experiences:

- Drought monitoring and early warning systems

In developed countries, drought monitoring and early warning systems are very efficient in helping the process of drought risk mitigation. Indeed, drought is typically a slow-onset phenomenon, which means that it is often possible to provide early warning of an emerging drought. Such information allows for a shift from reactive to proactive hazard management and represents a change in focus from disaster recovery to disaster prevention. The Drought Monitor run by the US's National Drought Mitigation Centre the U.S. and the drought monitoring system of the Bureau of Meteorology of the Australian Government are excellent examples. In Portugal, the organizational model of drought management focuses on the permanent availability of information to all authorities, economic agents and the public in general and is therefore used as a decision support tool to tailor appropriate drought mitigation and preparedness strategies. In addition, the Drought Alert and management system (SPGS) was developed in order to allow the anticipation of the potential impacts of drought situations on different water uses, in accordance with the socio-economic classification of drought severity, and then promote the implementation of efficient mitigation measures. In Spain, there is now a link between the national drought indicator system and the actions to be taken in the drought management plans developed for all the river basins. Thus, on the basis of the values of several hydrological indicators, different drought status ranking from the normal state to the emergency state are defined and the most adequate mitigation strategies are applied according to the different drought thresholds. In France also, drought emergency plans are structured according to different staged levels defining slight limitations of withdrawals, partial ban on withdrawals or even total ban on withdrawals (according to uses). In the United-States, the state drought management plans also identify different restriction levels for the domestic, business, industrial and rural sectors. This last point underlines and emphases a major requirement in North-Africa. Indeed, the various mitigation actions that are currently implemented and that are for most of them reactive measures are no tailored on the basis of specific drought thresholds and severities previously identified and described.

- Agricultural drought hazard assessment

Since they allow to identify and map the areas presenting the higher drought risks and then tailor the most adapted mitigation actions, agricultural drought hazard assessments and mapping are also an important component of user's requirements in North-Africa and a major

shortage of what is presently available. Indeed, at the continental level, there are very few examples of drought hazard assessment while numerous examples are available globally. Probably the unique example for the entire continent is the Global Risk Data Platform (Giuliani & Peduzzi, 2011) developed by the United Nations Environment Programme (UNEP) that, although useful, is based on a qualitative assessment during a period of 30 years, using a static (stationary) approach.

- Drought impacts assessments

On another hand, drought leads to extensive direct and indirect impacts on economy, environment and society. NDMC proposed a checklist of historical, current, 11 and potential drought impacts, including 90 indices, which were classified into 15 categories. The centre also created a national drought impact database to assist in documenting and understanding the effects of drought. Users can query the Drought Impact Reporter database to search for impacts that are occurring or have occurred in their region (see http://drought reporter.unl.edu). Impacts are grouped by category, such as agriculture, water, energy, environment, fire, social, etc. This type of activity will help planners identify the range of impacts that are important in a region. In Australia, external sites relating to drought include: Drought Situation Reports for Queensland; Areas of NSW suffering drought conditions; Drought Information for Victoria; Drought Information for South Australia. However, in north-African, impact assessment is yet incomplete and sometimes inaccurate although it is an important component of user's requirements

- Drought Vulnerability assessments

One of the main aspects of drought planning and mitigation includes vulnerability assessment (Wilhite, 1993, 1997, 2000b; Knutson et al., 1998), since vulnerability plays a critical role in the relationship between a hazard and society. Available information on regional drought vulnerability could aid decision makers in identifying appropriate mitigation actions before the next drought event and lessen impacts of that event and are consequently important components of drought mitigations requirements in North-Africa. With a map of drought vulnerability, decision makers can visualize the hazard and communicate the concept of vulnerability to agricultural producers, natural resource managers, and others. In this context, The U.S National Drought Mitigation Centre has developed a guide, "How to Reduce Drought Risk", to help entities better understand their own drought risk and develop locally based risk reduction measures. The Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS), the World Food Programme's Vulnerability Analysis and Mapping (VAM) system, and the Food and Agriculture Organization of the United Nations

(FAO) food security system could gather information of vulnerable populations, and help decision makers target mitigation actions. In Australia, the CSIRO Climate Adaptation Flagship produced a series of report to meet the need for immediate and strategic policy-relevant insights into the vulnerability of Australian agriculture to climate variability and change. For example, the first report (Pearson and Langridge, 2008) reviews:

1) Alternative models for conceptualising and measuring vulnerability documenting the most operational and accessible methods and models that are publicly available data
2) Collates existing research into the likely impacts of climate change on the physical productivity of Australian agriculture Pearson, L. and Langridge, J. (2008) 'Climate change vulnerability assessment: Review of agricultural productivity' CSIRO Climate Adaptation Flagship Working paper No.1. Web-ref http://www.csiro.au/resources/CAF-Working-Papers

9.3.1.2 Domestic sector

At the global level, drought mitigation measures in the domestic sector focus on the development of awareness campaigns and the adoption of different stages of water use restrictions according to drought levels. In 2009, Australia went beyond these practices by implementing in the city of Sydney water use rules instead of water restrictions. They define how and when domestic water should be used and are applied when dam storage levels has been around 60% for 12 months. In addition, the Australian Capital Territory (ACT) currently applies permanent conservation measures on potable water and issue severe fines in cases where they are not respected.

The Comparison of these measures with user's requirements in North-Africa shows that the major needs are related to the implementation of policies on water restrictions, especially in Morocco and Tunisia. Indeed, even though awareness campaigns are conducted to encourage water saving behaviors, they have to be completed by the implementation of water restrictions.

In North-America drought mitigation measures related to saving water in the domestic sector may take two forms: Non-price and price policies:

- Non-price policies that decrease household demand for water include water restrictions on selected uses, education campaigns to encourage voluntary conservation, and subsidies for adoption of water efficient technologies. Water agencies ban selected uses of water by prohibiting landscape irrigation or restricting watering of landscaping to selected days or times of day. Education campaigns

encourage particular types of watering techniques such as the use of hand irrigation or drip systems. Education informs households of the ideal time of day for outdoor water use as well as encourages overall changes to water-use behavior. Subsidy programs offer rebates for the installation of low-flow toilets and low-flow showerheads, and, in the desert southwest, switching from swamp coolers to refrigerated air conditioners, using high Center for Energy and Environmental Resources (CEER)-rated compressors.

- Price policies help curbing household water use by providing a monetary penalty/incentive for amounts of water use. Water agencies can implement a price policy that would move households from fixed, per unit, uniform rates to a moderately increasing blockprice schedule. Another option would be to give each household a specific water allocation, with penalties for noncompliance.

This last example of price policy is already applied in Tunisia and Morocco who have adopted a progressive domestic water pricing. Water restrictions are applied in Algeria since decades, even since during French colonization (French colons beneficiated from higher water quotas per habitant and day!!!)

Demand-side water management non-price and price restrictions were implemented in California during the statewide drought from 1985 to 1992. Analyses of consumer behavior have been conducted for the communities of Santa Barbara and Goleta, selected for their differing policy regimes and socio-economic characteristics (MacDonnell 1990). Both communities used increasingly strict price and non-price policies to reduce demand..

In 1986, Goleta promoted rebates for substituting new low-flow toilets for traditional toilets in homes and businesses; in 1987, the program was expanded to include low-flow showerheads. In 1988, Santa Barbara introduced a program dispensing free low-flow showerheads and rebates for replacing traditional toilets for low-flow toilets. In 1989, as the drought progressed, price restrictions were introduced in both Santa Barbara and Goleta. Santa Barbara moved away from fixed per-unit uniform water rates to a moderately increasing block-price schedule. The pricing strategy for Goleta was based upon historical usage patterns; each household was entitled to a base water allocation per year, with marginal price penalties for households exceeding their allotment. In 1990, as water shortages grew more severe, more aggressive policies were needed to curb water demand. Santa Barbara prohibited some water uses such as all landscape irrigation and drip systems; a second price strategy of steeply increasing price blocks replaced the prior pricing strategy. Goleta responded to increased water scarcity by returning to uniform pricing rates, but at

higher rates; specific water users were not penalized for their water usage. (Kelic *et al*., 2009).

9.3.1.3 Industrial and commercial sectors

Industry's vulnerability to extreme weather events arises from site characteristics, for example coastal areas or drought-prone river basins *(high agreement, much evidence).* Because of their financial and technical resources, large industrial organizations typically have a significant adaptive capacity for addressing vulnerability to weather extremes. SMEs typically have fewer financial and technical resources and therefore less adaptive capacity. The food processing industry, which relies on agricultural resources that are vulnerable to extreme weather conditions like floods or droughts, is engaging in dialogue with its supply chain to reduce water use. Companies are also attempting to reduce vulnerability through product diversification (Kolk and Pinkse, 2005).

9.3.2 Equatorial Lakes Region

9.3.2.1 Tanzania

Mitigation requirements for users in Africa	State-of-the-art drought mitigation practices
Awareness measures (e.g. awareness rising campaigns for tree planting, drought resistant cropping, stopping leakages & tap water running, etc.)	Awareness measures (e.g. awareness rising campaigns)
Very limited low level conservation measures practiced	Low level conservation measures (e.g. increased fines for water wasting, cash incentives for recycling household)
High level conservation measures during emergence situations (e.g. e.g. for Domestic supply: limiting watering lawns, parks, washing cars, filling pools, up to a total ban on this type of secondary uses or even time restrictions in public water supply; for Agriculture: from prohibition to irrigate one day a week, several days a week at certain times or until a total ban on irrigation; for Industry: gradual reduction of activity, recycling of certain waters cleaning, changing certain procedures, etc.)	High level conservation measures during emergence situations (e.g. e.g. for Domestic supply: limiting watering lawns, parks, washing cars, filling pools, up to a total ban on this type of secondary uses or even time restrictions in public water supply; for Agriculture: from prohibition to irrigate one day a week, several days a week at certain times or until a total ban on irrigation; for Industry: gradual reduction of activity, recycling of certain waters cleaning, changing certain procedures, etc.)
Structural measures can be also considered such as: intensification of the use of groundwater resources, reallocation of water resources, use of saline and brackish waters, water transfer, etc.	Structural measures can be also considered such as: intensification of the use of groundwater resources, reallocation of water resources, use of saline and brackish waters, water transfer, etc.

9.3.2.2 Kenya

The aim of mitigation practice is realized only if it is sustainable and owned by the users.

1) Since the networks and institutions relay on high level staff from international and local institutions, there is risk in gaps in blending indigenous interventions.

2) Institutional outreach is limited and may be lacking at local level. For example ICPAC has four metrological and two water resource experts, resources for engaging institutions for dissemination remains a challenge.
3) Due to the dissemination modes adopted the products are accessible and sensitisation needs stepping up.
4) The input data is not adequate for the methods/techniques/models used due to poor climate data networks.
5) There are challenges in establishing what the reliability of the indicators are.
6) The reliability of spatial scale of the output information is suitable for application by users to make practical decisions.
7) With phenomena of climate variability the forecast accuracy is limited, but provides indicative outlooks.
8) There are challenges in funding, and timing of the product release; observation and data management; understanding of local and regional processes; modelling and downscaling of climate; information exchange and dissemination strategies; climate change issues; stakeholder management and policy issues.

9.3.3 Eastern Nile Region (Ethiopian Plateau)

The definition of accurate and suitable indicators for drought analysis and monitoring must be a basic objective of any drought mitigation plan in Africa. These indicators must be based on carefully processed climate information. The starting point of the creation of drought geospatial infrastructures must be the development of a database of several candidate drought indicators to overcome the current gaps, based on homogeneous climate information data for the entire continent. In Africa there are important problems in the collection and access to climatic information. Nevertheless, at present there are current low-resolution geospatial climatic products like the dataset of African climate data available at the Global Historical Climatology Network (GHCN) and other climatic sources (WMO telecommunication net, Climate Prediction Centre precipitation, etc. see http://climexp.knmi.nl/) that may be used to produce climate layers. In addition a global SPEI dataset is already available for the African continent at a spatial resolution of 0.5_ (Beguería, Vicente-Serrano, & Angulo, 2010), which can be used to assess drought risk and drought vulnerability in a variety of systems. The development of distributed layers of drought indices, and their implementation in Geographic Information System (GIS) technologies, will be a definite advance in assessing the spatial and temporal variability of droughts in the African continent and to feed

methodologies and systems to generate information directly related to management decisions and early warning systems.

In some countries such as South Africa, India and Australia power is vested in local government institutions to pattern administrative structures and mobilize resources to be able deal with the functions of disaster management (Viljoen and Booysen, 2006; IGNOU, 2006). In others (such as Cuba, South Korea, Ethiopia) one finds meticulously organized structures from the center to small village level with some degree of autonomy and leverage in decision accorded to each level in the hierarchy (Sims and Vogelmann, 2002, Kim and Lee, 1998).

9.3.4 Eastern Nile Region (Down Stream)

9.3.4.1 Sudan

The user's requirement mitigation practices in Sudan are different from state of the art for mitigation practices in USA and Europe, in terms of

1. Dissemination of the information about the drought occurrence and persistence (Frequent, reliable information or data)
2. Lack of decision Support systems and sophisticate Models and software
3. Awareness measures (drought tolerant crops or short maturity varieties, amount and scheduling of irrigation, domestic uses, waste water recycling)

9.3.4.2 Egypt

When comparing the mitigation practices with relevant to the user requirement in Egypt there are no big difference with the globally requirements. Most of the economic impacts of drought are associated with agriculture and the income generated from crops. In times of drought or low water flow, the lack of water can often cause a decline in crop yields, and thus a reduction in income for farmers and an increase in the market price of products since there is less to go around. So, for domestic usage changing some social habits, raising the awareness level and improving the water supplies services to reduce losses in the network. For agriculture use aims at controlling land degradation factors and reducing their risks and implications. In addition, the National program of agricultural drainage in cooperation with the World Bank and other institutions besides private sector contribution in some areas to improve the land productivity. The Major mitigation requirements for users in Egypt could be summarized as following:

- Developing the awareness measures (e.g. awareness rising campaigns for tree planting, desertification and land degradation, stopping leakages & tap water running, etc.)
- Conservation measures practiced.

- Other structural measures can be also considered such as: intensive use of groundwater resources, reallocation of water resources, use of saline and brackish waters, etc.

9.3.5 Southern Africa

9.3.5.1 Botswana and South Africa

The main mitigation actions implemented for each of the identified droughts are listed in: Table 31

Table 31: List of drought mitigation actions per the user requirement

Mitigating Action	Botswana	South Africa	State of the Art
Giving priority to drinking water	X	X	X
Public awareness campaigns	X	X	X
Rescheduling of farmers' credits		X	X
Restricting summer crops		X	X
Wells digging and irrigation	X	X	X
Farmers cropping strategies			X
Water use efficiency		X	X
Drought relief program		X	X
Saving livestock	X	X	X
Livestock watering points		X	X
Controlled forest grazing		X	X
Livestock feeding program	X	X	X
Livestock vaccination campaign		X	X
Boreholes, wells and small dams	X	X	X
Diversification of income sources		X	X
Harvesting of rainfall water	X	X	X
New drought tolerant crops	X		X
Natural forest plantations			X
Agroforestry		X	X
Food aid	X	X	X
Horticulture		X	X
Local seed production		X	X
Fruit production		X	X
Irrigation systems		X	X
Irrigation management		X	X

9.3.5.2 Mozambique

The following are the user requirements for drought mitigation practices in Mozambique.

- Disclosure of information in disaster situations;
- Organize and coordinate the collection, analysis and dissemination of weather information, including the trends and their consequent impacts on the population;
- Provide regular information to managers and their respective donors;
- Promote mutual assistance and exchange of information among international organizations;
- Present weather conditions for different agricultural seasons;
- Build and rehabilitate damaged irrigation systems and water courses; and
- Increase the use of pumps combined with small-scale irrigation systems by gravity. This practice would help to increase the irrigated areas, and therefore the impact of the use of pumps in local agricultural production.

9.3.5.3 Zimbabwe

The following are the user requirements for drought mitigation practices in Zimbabwe.

- Awareness campaigns

  In the case of Zimbabwe drought and water use management awareness campaigns are scarce, which is different from state of the art were these are done regularly .For instance in Belgium were these are even organized through printed (newspapers and magazines) and audio-visual media (TV and radio).
- Construction and maintenance of dams

  Construction and maintenance of dams is a user requirement in Zimbabwe. Thus the user requirements in Africa converge with the state for the art drought mitigation strategy in this regard. The only difference lies in implementation and the speed with which this is done. In the case of Cyprus the government sped up the process of construction of dames, whereas in Zimbabwe dam construction takes a considerable length of time. Most dams were built long ago and there is no dam maintenance programme in place.at the moment many community dams need rehabilitation.
- Fines for water wasting and incentives for water household recycling

  This is a drought mitigation practices some countries in Europe which is not common for the case of Zimbabwe.

The table below shows some common state of the art drought mitigation practices which are not common with the user requirements in Zimbabwe.

Table 32 State of the art drought mitigation practices

State of the art drought mitigation	Country where this is done
1. Construction of seawater desalination plants.	Cyprus
2.a water pricing policy has also been developed	Denmark
3.The water scarcity management plan(which sets up water use priorities)	France
4.Recycling water	All
5.National Program for Efficient Water Use	Portugal
6.Drought Alert and Management System	Portugal

10 ASSESSMENT OF DROUGHT ADAPTATION PRACTICES IN AFRICA

10.1 USER REQUIREMENTS FOR DROUGHT ADAPTATION IN AFRICA

10.1.1 North Africa

In a previous point (11.1), we have reviewed user's requirements in North-Africa for drought mitigation practices. In the following section, we will try to focus on adaptation requirements although the limits and differences between mitigations and adaptation practices seem sometimes in the literature very weak. Thus, several references list some drought adaptation practices among drought mitigation strategies even though they account for long term actions aiming to prepare populations to cope with a future with less water availability. Indeed, in Morocco, 11 BMC of water are now devoted to domestic, industrial and agricultural sectors. But, due to population increase and higher standards of living, leading to higher demands in all sectors, the "carrying capacity" of current water resources utilization will be reached by 2020 (Ait Kadi, 2004) in "Chapter 11: From water scarcity to water security in the Maghreb region: Case of Morocco in Environmental changes in the Mediterranean 2000-2050, ntonio Marquina Barrio, North Atlantic Treaty Organization. Scientific Affairs Division - 2004 - Nature). In addition, the perspectives of an increase of water scarcity in the context of climate change sharpens the needs for major water savings and prospects for the development and prospects of additional water resources. These perspectives imply consequently deep and permanent changes in user's habits that will help them adjust to new surroundings.

10.1.1.1 Domestic sector

In the domestic sector, drought adaptation implies permanent and deep changes in user's water consumption through:

- The development and generalization of educational programs aiming to restructure actual wasteless consumption patterns. There is a need towards a return to a near past where our grand-parents did not have running water and shared a "sacred" vision of water.
- The development of household water saving (low-flow showerheads, toilet displacement devices or ultra low flush toilets, and faucet aerators) and water harvesting devices. Water savings from using the above mentioned household water savings devices are estimated at an average of 15% of the total domestic water use (CUWCC, 2000)
- Use of landscape water conservation devices that targets outdoor water use.
- Recycling and reuse of domestic wastewater

- Fight against abusive water use through the implementation of vigilance committees, of individual counters, and through the review of tariff systems
- Fight against water losses in distribution networks
- Implementation of water saving measures in building standards

10.1.1.2 Industrial and commercial sectors

In the industrial and commercial sectors, water conservation needs include the development and implementation of:

- Water saving devices such as self-closing faucets in industrial and public areas such as commercial centers, factories, schools, theaters, airports….
- The development of water conservation programs inside factories
- The improvement of water use efficiency

10.1.1.3 Agricultural sector

The agricultural sector is the main user of water resources and is thus by far the main sector to be impacted by the increasing water shortage, especially since priority is given to potable water. User's needs for drought adaptation in the agricultural sector can be categorized and summarized as following:

a) Crop production

Drought is the most important factor limiting the production of many crops in the Maghreb Region, especially cereals that remain the predominant speculation and fruit crops. It has adverse effects on both yield and quality. Some of the actions that can be incorporated in regular development activities to improve the capacity for dealing with drought are:

- Breeding and release of drought tolerant varieties, breeding for short season varieties
- Modification and adaptation of the cropping calendar
- Shift from traditional crops to less water consuming species
- Development of dryland farming practices that conserve soil moisture and allow crops to use water efficiently. They include supplementary irrigation, adding fertilizers in proper amounts, no-till and reduced tillage systems, cereal-clean follow rotations, or the replacement of follow by feed legumes or food legumes, reduction of seeding rates to obtain low plant populations, weeding and adapted pest management, mulching and adapted soil preparation.

b) Revenue diversification through the development of non-farming activities:

c) The improvement of water use efficiency and water savings in agriculture through:

- The generalization of less consuming irrigation systems such as drip irrigation
- The choice of crops of shorter seasons and/or lower water requirements,

- Reducing water losses during conveyance and distribution
- The promotion of participatory water management
- Research and extension on the above measures
- Training and awareness on water conservation and effective resources management, through media, education and training programs
- Revision and readjustment of water pricing

10.1.1.4 Water sector: Integrated Water Management

Adaptation needs in the water sector are both related to the supply management, i.e. increasing of the available water supplies and to demand management, namely improving the efficient use of the available water supply and the development of water conservation measures. Since agriculture is the main water user, it is the first sector to be concerned by these practices although they count also for the other sectors.

The needs for the development of water conservation measures and for a more efficient use of the available water supply have been previously described within the description of each user's sector needs while on a trans-sectoral approach, the increasing of the available water resources may be achieved through:

- Rehabilitation of traditional and development of new water harvesting practices
- Construction of big, small and collinear dams for the mobilization of conventional water that has not yet been mobilized. That accounts for Morocco and Algeria, since Tunisia has mobilized practically everything and is now more oriented towards the development of non conventional water resources (Agoumi, 2002). In Morocco, in order to satisfy the demand by 2030, the national strategy for water has planed the construction of 60 big dams and 1000 small and collinear dams.
- Development of water transfers from different regions.
- Development of non-conventional water resources (waste water, desalination, artificial recharging)

10.1.2 Equatorial Lakes Region

10.1.2.1 Tanzania

The main user requirements in terms of policies, strategies and guidelines to adapt to identified drought conditions in Tanzania are presented in Table 33.

Table 33: User requirements as policies, strategies and guidelines for drought adaptation actions in Tanzania

Adaptation to drought conditions	Requirement of users	To whom and when action is required
Policies	• National Adaptation Programme	• Central government

	of Action (NAPA) against climate change and environmental degradation	• Environmental matters line ministries • Disaster Management Office (DMO) • Tanzania Meteorological Agency (TMA)
Strategies	• Estimation of impacts which droughts can have on agriculture and the uncertainty involved in the estimates • Estimation of soil degradation, which is important for estimation of crop/agricultural yields • Prediction of rainfall for specific local areas • Rainwater harvesting • Assessing whether certain crops could play a particularly important role in assuring future food security under climate change • Following financial bottlenecks of developing countries, there is a need to come up with low-cost drought management measures	• Ministry of Agriculture and Cooperatives • Ministry of Water • Disaster Management Office (DMO) • Tanzania Meteorological Agency (TMA) • Vice President's Office – Environmental Affairs
Guidelines	• Farming guidelines for adapting cultivation practices to drought occurrences so as to achieve stable or increased yields • Guidelines on promising methods for rainwater harvesting • Crops varieties selection guidelines • Guidelines on food storage and processing to reduce post-harvest losses and optimize usage of harvest • Guidelines on methods of increasing agricultural production • Guidelines on adapting the adverse effects of droughts and of a changing climate • Guidelines on suitable models for impact studies	• Smallholders farmers • Rural and urban communities • Practitioners

10.1.2.2 Kenya

Effective adaptation to drought requires communities to be informed of available theoretical and practical aspects in drought phenotyping, through both anticipatory and reactive adaptation.

Table 34: User requirements as policies, strategies and guidelines for drought adaptation actions in Kenya

Systems	Anticipatory	Reactive	Responsibility
Natural		Changes in length of growing season Changes in ecosystem composition Wetland migration.	Governing agencies
Human	Purchase of insurance Construction of house on stilts Redesign of oil-rigs.	Changes in farm practices Changes in insurance premiums Purchase of air-conditioning.	Individual citizen (Farmers)
	Early-warning systems New building codes, design standards Incentives for relocation.	Compensatory payments, subsidies Enforcement of building codes Beach nourishment.	Implementing agencies

10.1.3 Eastern Nile Region (Ethiopian Plateau)

Coping mechanisms practiced in all sites are similar. The major ones are:

- Reducing number and size of meals per day
- Eating foods that are not normally eaten, for example wild fruits
- Reduce or avoid expenses for cultural ceremonies that are said to be extravagant
- Temporary movement of some of family members to better areas
- Work as daily laborers in nearby towns
- Selling jewelries
- Food aid
- Food and cash for work
- Feeding livestock cactus, sisal and aloe leaves
- Selling livestock

Climate change adaptation strategies

The economic policy of Ethiopia aims at ensuring rapid and sustainable development through an agriculture-centered strategy known as “Agriculture Development Led Industrialization strategy (ADLI)” (Ramakrishna and Demeke, 2002). Hence, the country's development policies and strategies are geared towards poverty eradication. In line with this strategy, adaptation strategies designed by the government and under implementation are similar in all the study sites. The major ones mentioned are:

Farmers own strategies

- Introduction and scaling out of cactus as source of feed and especially in Ara Alemsegeda, May Keyah and Khen.
- Growing eucalyptus in homesteads for own construction and fuel wood consumption and sale as additional source of cash income
- Saving and minimizing cultural ceremonies
- use of early maturing varieties through selection from their own and other areas

Government initiated strategies

Adaptation strategies designed by the government and accepted by the community and being implemented are massive soil and water conservation activities and afforestation. Percolation ponds are constructed to reduce run off and raise ground water level. Gullies are being treated using gabion check dams and are changing to productive lands. Hillsides treated with various soil and water conservation structures are protected from human and animal intervention and zero grazing is introduced. The rehabilitated communal hillsides and gullies are being distributed to land less youth and other farmers for beekeeping and crop production. Runoff diversion to farm lands and run off storage for supplementary irrigation is also part of the strategy. Productive Safety Net Programme is also one of the government strategies. The main objective is to fill the food gap of the chronically food insecure farmers so that the farmers do not sell their assets to buy food and to develop community assets through the programme public work activities. In the mean time, the Safety Net Program beneficiaries participate in agricultural development packages so that they can ensure food security. Introduction of early maturing crop varieties is another government strategy. Many varieties are being introduced out of which wheat varieties are widely accepted.

Pastoralists moving livestock to areas where the grazing was better and surface water was more widely available. In addition, Save the Children staff observed new drought responses, including pastoralists hiring trucks to transport their breeding animals out of drought-affected areas and the early cutting of irrigated maize to supplement livestock feed

10.1.4 Eastern Nile Region (Down Stream)

10.1.4.1 Sudan

There is no specific plan for adaptation practices in the country. In order to cope with drought events and mitigate their impacts, a wide range of measures need to be considered:

1. Established an Early Warning System in the most vulnerable communities (e.g. Rainfed areas, nomads region).
2. Put into action the government drought mitigation plans and regulation in all the drought management phases.
3. Empower the vulnerable communities to participate in drought management strategies and plans.
4. Allocation of adequate means of drought management and mitigation.
5. Adopt the feasible adaptation projects to the vulnerable communities.

10.1.4.2 Egypt

The Middle East and North African countries are subject to a number of extreme events that recur more or less on seasonal cycles. Egypt is no exception. Sandstorms and flash floods occur regularly across Egypt. In recent years, severe sandstorms, dense haze, and flooding have occurred with increased severity and frequency. They have had negative socioeconomic impacts on almost all sectors, including agricultural productivity, livestock, public health, the environment, and tourism. The causes of these events are linked to anomalies in global surface temperature, jet stream location and strength, and the location of the Inter-tropical Convergence Zone (ITCZ). Most of these anomalies are affected by global warming, and the increase in sandstorms, haze, thunderstorms, and flash flooding phenomena in Egypt is taken as an indicator of climatic changes

10.1.5 Southern Africa

10.1.5.1 Botswana

The main user requirement on adaptation actions for each of the identified droughts are listed in Table 35:

Table 35: List of user requirement drought adaptation actions in Botswana

Adaptation requirement/ Action required
• Drought early warning systems • Conservation farming • Water rationing • Resource Management • Management of ground water • Expansion of protected areas • Tree planting at homesteads • Control of deforestation • Importation of water • Desalination/demineralization of water • Inter-basin water transfers • Management of water resources • Construct small and large dams • Water infrastructure management and development • Management of water networks

- Water harvesting
- Water recycling
- Cultural practices
- Water conservation technologies
- Soil and water conservation
- Integrated Water Management
- Drought resistant crop varieties
- Food-for-work programmes
- Planting short maturing crops
- Livestock health programmes
- Multi-activity agriculture

10.1.5.2 Mozambique

According to MICOA (2007), there is not a specific plan of adaptation for droughts in the country. However, MICOA has developed the National Adaptation Action Program (NAPA) in 2007 aimed at reducing the impact of climate change and to establish climate change adaptation initiatives.

The users of the information for drought adaptation are the Farmers, Local Government, ARA-SUL, INAM, MICOA, FEWSNet, SETSAN and INGC. The following policy options are recognised:

- Recovery and expansion of the hydro-meteorological network that was severely damaged during the civil war;
- Introduction of modern technologies for data collection, transmission and processing, including a systematic exchange of information with the neighbouring countries;
- Establish agreements on shared watercourses in more critical situations.

The following strategic options are recognised:

- Maintenance and multiplication of pre-basic and basic seed of improved varieties in quantity that gradually will fulfil the essential seed production;
- Development of appropriate and alternative technology packages for the various sectors of social production with emphasis on low-cost technologies and adaptation of technical recommendations based on agro-ecological;
- Rehabilitation of the network of stations and agricultural research centers in order to cover the main agro-ecological regions;
- Development of technologies to reduce drought risks;
- Creation of financial reserves and materials considering the area's most prone to occurrence of droughts;
- Integration of preventive sectoral development programs;

- Development of arid zones by introducing conservation practices in agriculture and non-farm activities for income generation, water supply and rainwater harvesting techniques.

10.1.5.3 South Africa

The main user requirement adaptation actions implemented for each of the identified droughts are listed in Table 36.

Table 36: List of user requirement drought adaptation actions in South Africa

Adaptation requirement/ Action required
• Drought early warning systems
• Conservation farming
• Water rationing
• Management of water resources
• Management of ground water
• Expansion of protected areas
• Tree planting at homesteads
• Control of deforestation
• Importation of water
• Desalination/demineralization of water
• Inter-basin water transfers
• Construct small and large dams
• Water infrastructure management and development
• Management of water networks
• Water harvesting
• Water recycling
• Cultural practices
• Water conservation technologies
Soil and water conservation
Drought resistant crop varieties
Food-for-work programmes
Planting short maturing crops
Livestock health programmes
Multi-activity agriculture

10.1.5.4 Zimbabwe

The main user requirement adaptation actions implemented for each of the identified droughts are listed in **Table 37**:

Table 37: Main user requirement adaptation actions implemented

From who the action is required	Required action	When the action is required
Government (EMA, Ministry of Agriculture, Research councils and Universities)	More research on climate change and drought related issues	Constantly
Meteorological Services Department (MSD).	Local scale weather forecasting and advance warning of extreme events.	Weather forecasts(daily, monthly and seasonal) Warnings: at least a month in advance.
Government	Provision of drought tolerant varieties.	Off rainy season At least a month before the onset of the rain season.
Government	Declaration of disaster; Assessment of droughts.	
Government	Policies that promote more involvement of local institutions	
Government	Policies that promote of local or indigenous strategies in drought adaptation.	
Local institutions, NGOs and government	awareness campaigns; and educational on drought and climate change related issues	Constantly
Government	Review of the Drought Plan to cater more for long term adaptation and a more proactive plan.	
NGOs ,Government and local institutions	Promotion of soil and water conservation	All year round
Local council	Spearhead adaptation at local scale	constantly
All drought adaptation organisations related	Coordination of adaptation programmes and relief and communication.	
Government (Ministry of Agriculture);NGOs	Promotion of better post-harvest management	Before and after harvest

10.2 COMPARISON OF DROUGHT ADAPTATION PRACTICES IN USE IN AFRICA FROM D.2.2 WITH THE USER REQUIREMENTS

10.2.1 North Africa

To better illustrate this section, we will categorize the gap in adaptation into 3 parts: the hardware technologies, the software techniques and the orgware. The first two parts will be treated in this chapter while the third one will be a part of the institutional analysis.,

10.2.1.1 Hardware

Concerning the adaptation technologies, which are disseminated in North Africa, such the development of dams, irrigation systems and water harvesting, the comparative studies demonstrate a gap with requirements in terms of quantity and the extent of technologies dissemination.

a) Dams

While the gap with user's requirements needs an acceleration of dams 'construction to be addressed in Algeria, Morocco shows one of the highest levels of development in this sector. Indeed, during the last decades, the country has invested heavily in dams, water supply capacity, and large-scale irrigation systems to secure water for urban and agricultural demands. Today, Morocco has 128 big dams in activity, which are able to mobilize 17.2 billion m3 while Algeria totalize 59 dams, with a total storage capacity of 6 billion m3, and Tunisia has 29 big dams. Giving the climate change, which is accelerating drought process, North Africa countries need to mobilize more water, it can be done, in Morocco and especially in Algeria, through the construction of more dams, since capacities of water mobilization are still possible. In Tunisia, to meet the user's requirements, the country must develop more non-conventional water since it has already mobilized practically all its capacity. In Morocco, to achieve the needs requirements, the government has fixed the objective to build 60 big dams and 1000 small and collinear dams.

b) Irrigation systems

For this sector, we can observe a big gap for the time being. Indeed, in the most irrigated areas of north-african countries, the flood-irrigation system remains dominant and It is estimated that with this system, only about half of the water that enters the field is used by the crop; the other half goes unused mostly through evaporation and deep percolation below the root zone.

However, in Morocco, the development of drip irrigation at a very large scale is one of the big national strategies of drought adaptation and many subsides are giving to farmers to improve their water irrigation systems. We can say that the gap decreases over time, at least in Morocco, where the objective is to implement 555 000 ha per year until 2022 although it remains very important giving the user's requirements.

c) Non- conventional water

The non-conventional water resources in North Africa are coming from the following sources:

- Seawater desalination
- Demineralization of brackish water,
- Reuse of treated wastewater.

All these technologies are well known, but still underdeveloped because of the high cost of their implementation and use. Thus, we can note a big gap in the dissemination degree of the technology relatively to user's requirements. Concerning the wastewater reuse, while

many projects have been implemented recently in North Africa countries, an actual gap remains and the technology needs to be disseminated on a larger scale in order to fulfill user's requirements.

Generally, Morocco is behind the other two countries on the non-conventional water aspect; the desalinated seawater units are only present in some cities of south of Morocco (Laâyoune and Boujdour) and concern only the drinkable water. Moreover, as we explained in the point above, insuring more non-conventional water in Tunisia remains the main way to adapt to drought and to reduce the gap with needs. Tunisia being conscious about that, has planned to increase the amount of recycled water in the year 2020 to approximately 18% of the available groundwater resources.

d) Genotype : Breeding

Research technologies adopted to breed new genetic material are relatively developed in North Africa. To improve the efficiency of breeding programs, conventional approaches and biotechnological methods have been used. In Morocco, the most used varieties of cereals for example, are characterized by large adaptation to drought due to their optimal earliness and/or genetic tolerance to drought. For this last 20 years, the yield improvement of cereals corresponds to an increase of 2 to 4 quintals per hectare at the national level, although this period was characterized by many dry years (Karrou, 2000). For food legume crops, the most important result is the shift of the period of sowing from spring to winter, achieved by adapted varieties, which allows crops to take advantage from the rain season. In the case of forages, some varieties, more adapted to drought, were selected.

Thus, although breeding for drought adaptation strategies are in part taking place in North Africa countries, further efforts must be stimulated by, for example, developing a range of drought adaptive traits and associated genes to help breeders breed more drought adaptive varieties.

Moreover, not the totally of breeding efforts end on the field, we will discuss in further chapters this gap between the research and the application on the ground.

10.2.1.2 Software

a) Irrigation management

Besides the infrastructure of water harvesting and irrigation systems, an adapted water management is also based on best practices once the water irrigation reaches the plot. Indeed, the timing and the amount of water irrigation according to actual crop needs are crucial for drought adaptation and water use efficiency. Unfortunately, this management is based only on the traditional knowledge and the good sense of farmers, but the current rapid

rate of climate change, imposing new and potentially overwhelming pressures, requires that science and research results must be transferred to farmers. Indeed, to reduce effectively the gap at this side, we should develop a modern system of information and warning providing farmers assistance for irrigation scheduling in real time (Lahlou, 2012). Indeed, technology transfer is an important way to reduce gaps in North Africa countries.

b) Agricultural practices

Many conservation techniques, such no till and mulching (see D.2.2) can reduce evaporation and insure the saving of water, energy and time. Their adoption in dry land agriculture can substantially improve drought adaptation.

Moreover, when limited quantities of irrigation water are available, the application of a supplementary irrigation of only 60 to 70 mm at critical growth stages can increase yields of cereals by 70 to more than 100 % (Lahlou, 1990).

In addition, early planting can help the plant to use more water (rain received early) and to avoid terminal drought stress and high temperatures. If this technique is used, cereals can produce 40 % more than when the late sowing is practiced (Bouchoutroch, 1993).

However, the gap in terms of these best agricultural practices with user's requirements remains very important; an integrated approach including the above techniques has to be implemented in a systematic way, which is not the case. Indeed farmers are undertrained on these agronomic packages and need to combine their traditional knowledge with a fully scientific guide adaptation. At the time being, the traditional extension services are becoming obsolete.

c) Traditional water harvesting

Local communities of North Africa have been copping with drought by using accumulated practices of water harvesting. In rain water harvesting, three different groups of techniques were distinguished and developed in D2.2: flood water harvesting from far away (large catchments), rainwater harvesting from macro-catchment systems, and rainwater harvesting from micro- catchments. In spite of several thousand years of experience in this field, these techniques deserve to be improved in quantities and qualities because they play a major role in drought adaptation of rainfed agriculture. To meet needs, North African countries should implement techniques and technologies for increasing the water yield of a given catchment, or identifying areas suitable for certain techniques of water. The use of remote sensing and GIS can be used to assess the potential for water harvesting and advise on the appropriate water harvesting (Prinz *et al,* 2002,).

10.2.2 Equatorial Lakes Region

10.2.2.1 Tanzania

The identified droughts adaptation practices and user requirements from historical drought events in Tanzania are shown in Table 38

Table 38: Experiences from historical drought events and the user requirements for drought adaptation in Tanzania

Drought	Drought adaptation practices	User requirements
Agricultural drought (crop failures) during 2005/2006 (FSIT, 2006; TRCS, 2006; IFRCRCS, 2006);	• Movement of people looking for work and indiscriminate logging as people try to cope by engaging in charcoal production • Maize prices are 85% higher than normal, whilst the cattle prices plunged to levels where a single cow would cost 20 kilos of grain • The Government of Tanzania targeted 613,405 food insecure people in 36 districts with emergency food distributions. About 21,499 metric tonnes of maize were released from the government owned Strategic Grain Reserve (SGR), at a highly subsidized price of TZS 50 per kilo • The FSIT survey in January 2006 set a target of 3.7 million people to be reached with subsidized food sales through local cooperatives until May. Of these, 565,000 people were to be given free food • On 14 February 2005, the government officially requested international assistance and asked for 100,000 metric tonnes of food. The UN's World Food Programme (WFP) was expected to coordinate international food donations • The Government also embarked on a campaign to raise resources domestically. At one of the function that was hosted by the President, local businessmen pledged over TZS 3 billion (approximately USD 3 million) in cash and kind to meet the crisis. • At the same time, the government was forced to introduce power rationing in response to falling water levels in its hydro-electric dams • The Government also suspended import duties on grain imports by commercial companies in an effort to boost supplies. Whilst the	• Information on when droughts are expected • Information on what can be done to adapt drought impacts • Information on expected rainfall and their duration • Information on schedules for power rationing in response to falling water levels in its hydro-electric dams • Comprehensive emergency actions, which include water and sanitation, health and livelihoods programming (possibly including livestock interventions)

	recommended price for commercial sale of maize was TZS 300 per kilo, in some areas the price was already TZS 500, reflecting not only scarcity but also the high costs of transportation, added concerns that many of the affected people would not be able to afford to buy expected commercial imports of some 100,000 metric tones • Disaster Management Office, WFP, the United Nations Children's Fund (UNICEF), the International Committee of the Red Cross (ICRC) and others, formed a Federation and decided to issue a preliminary emergency appeal to support approximately 75,000 people in three northern districts (Arusha, Kilimanjaro and Manyara) for three months. The appeal, sought to mobilize resources for the local procurement and distribution of some 2,600 metric tonnes grain for the period March to May 2006 • The preliminary appeal was used as a base for a more comprehensive emergency appeal, which should include water and sanitation, health and livelihoods programming (possibly including livestock interventions) at a later stage	
Bagamoyo (Eastern Tanzania) drought in 1991-1992 and 1996	• Tanzania Red Cross Society and in cooperation with the Federation undertook relief operation for the drought victims	• Information on when droughts are expected • Information on what can be done to adapt drought impacts
Lushoto (North-Eastern Tanzania) flood and drought in 1993-1994 and 1996	• Tanzania Red Cross Society and in cooperation with the Federation undertook relief operations for flood and drought victims	• Information on when droughts are expected • Information on what can be done to adapt drought impacts
Semi-arid parts of Tabora Region (Mbola, Mpenge and Isila villages from Uyui District, and Tumbi from Tabora Urban) (Mid-Western Tanzania) in 2009 Farmers, research and extension officers perceived increase in drought, temperature and dry spells as being associated to climate change and such changes have occurred in the recent ten years	• The majority of farmers have developed mechanisms of responding to erratic rainfall through splitting their plots and sowing or transplanting at different times in the season. Although this practice could be one of local adaptation measures, it resulted into further fragmentation of the already small fields and sometimes led to counter productivity as distribution of input resources across split plots may not be the same • Farmers in the study area have responded to the impact of climate change and variability through various local adaptations including expansion of areas under cultivation to	• Information on when droughts are expected • Information on what can be done to adapt drought impacts • Information on expected rainfall and their duration • Information on suitable crop varieties • Information on suitable seeds • Information on suitable planting

as compared to the previous decades	compensate for reduced yields during droughts, partly by reducing fallows, switch to more drought-resistant crops such as sorghum and cassava • Some farmers reported growing alternative crops such as sunflower however; increasing pests and diseases incidences has hindered such effort. Another adaptation measures reported is diversification to non-farm activities such as brick and charcoal-making, casual labour and carpentry	dates
Meteorological drought in Kilimanjaro and Arusha regions during 1998/1999 Severe drought in Kilimanjaro and Arusha regions during 1999/2000 (ACT, 2000)	• Food aid to sustain people's lives in these areas. In 1999, for example, a total of 2,850 tons of maize were distributed in Mbulu, Hanang, Babati, and Karatu Districts by the ELCT Mbulu Diocese with assistance from Haydom Lutheran Hospital, the Norwegian Ministry of Foreign Affairs and the people of southern Norway • Increasing prices for food as supplies were squeezed • Decreasing prices for livestock due to distress sales • Migration of men in search of paid labour leaving women, children and elderly to fend for themselves • Migration of pastoralists to agricultural areas resulting in conflict with agriculturalists over water sources and grazing • Declining attendance at local schools • Increased felling of trees to produce charcoal for sale as an alternative source of income • In Mwanza, famers compelled to eat their seed stocks • In Shinyanga, eating porridge only once a day is now a common way of survival for many families	• Information on when droughts are expected • Information on what can be done to adapt drought impacts • Information on expected rainfall and their duration • Information on suitable crop varieties • Information on suitable seeds • Information on suitable planting dates •

10.2.2.2 Kenya

The droughts adaptation practices and user requirements from historical drought events in Kenya could be analysed as below

- The most effective interventions have been those that facilitated access to under-utilized grazing and watering resources. Those districts in Kenya with little new access to these natural resources are the most vulnerable.
- So-called ‘commercial de-stocking’ remains the least cost-effective drought intervention in Kenya. Long distances to markets, poor timing of interventions and

lack of economies of scale all play important roles in making this kind of de-stocking unviable. But more than anything else, lack of an existing dynamic marketing system virtually precludes a commercial de-stocking operation from being cost-effective.

- 'Livestock-fodder-aid' comes a close second in terms of poor cost-effectiveness. Shipping substantial quantities of bulky commodities such as hay to remote locations is extremely costly and moreover has had little if any measurable impact.
- Slaughter off-take, preferably carried out on the spot, with the meat distributed rapidly to needy families, is a popular intervention with beneficiaries and can provide substantial benefits. Those that sell a live animal often benefit also from the distribution of its meat. And the availability of this high-protein food can benefit household nutrition while allowing the selling households to maintain a little purchasing power a little longer.

More specific findings

- The number of livestock-related interventions and the funding associated with these both increased considerably over the interventions carried out during the last drought in Kenya, in 2000/2001.
- Once established, risk management systems tend to become static, but effective risk-management systems need to be adaptive and to build in mechanisms for people to 'learn'.
- Few interventions were made by mid-2008, when the drought was already apparent. Early interventions are preferable as they are more effective. Yet 63 per cent of all interventions, and all destocking programs, were conducted after June 2009, when the drought was at its peak.
- Centrally managed interventions from Nairobi, such as the provision of fodder and the Ministry of Livestock Development-funded market off-take through the Kenya Meat Commission, had little impact and would have been many times more effective if funds had been made available through Drought Management Structures. (Considerable harm was done when publicized sales of stock never materialized, with large numbers of the animals herded to specified collection points suffering horribly and dying for lack of water and fodder.)
- Unmanaged resource-related conflicts among ethnic groups were reported to be a major constraint to an equitable use of the diminishing natural resource base.
- Bringing in water with tankers, maintaining and developing boreholes and destocking by slaughter in the affected areas were generally considered to be the most effective

interventions. Most ‘other water’ and animal feeding interventions were considered ineffective.

- Being more effective is not simply a question of spending more money; significant gains can be made by improving the way current resources are spent. (Across all types of interventions, no significant relationship was found between the effectiveness of a given intervention and its cost per individual reached.)
- The problems of many unsuccessful interventions, such as animal feed and health, were due largely to inefficiency of implementation and/or poor timing.
- A third more animals were moved in 2008/2009 than in 2000/2001. As disease killed many of the animals that migrated, animal health interventions should be included in future migration strategies.
- Hay provisioning, which when well done might be an appropriate intervention, was generally too late and too little to have any significant impact on supporting animal herds through the drought.
- Apart from Turkana and Samburu districts, no information on livestock marketing was disseminated or off-take exercises publicized, resulting in late off-takes and a greater expenditure of resources for off-take during the emergency stage than during the alert/alarm stage.
- Bulletins put out by EWS (Early Warning Systems) provide overly generalized information, with no specific livestock focus, making the information inappropriate for livestock interventions. The information also often appears late, is too generic for district-specific interventions, and defines no thresholds for the release of contingency funds.
- A lack of publicly available near-real-time and historic rainfall data hampered the real time analysis of rainfall anomalies. From a timeliness perspective, rainfall data is the most appropriate source of information for early warning, as it allows the longest response time to scale up relief operations. A number of organizational issues in the hands of government could improve this situation.
- Analysis of monthly vegetation greenness anomalies does not appropriately reveal rangeland drought conditions relevant for livestock, as livestock manages to cope with shorter periods of reduced forage availability. A twelve-month running average of NDVI (normalized difference vegetation index) detected historic droughts much more precisely, indicating the usefulness of running average techniques for rangeland early warning purposes.

- Satellite imagery allows near real time to screen opportunities for migration and identify for remedial conflict resolution in areas of high insecurity.
- The reporting on livestock body condition, milk production and productivity proved to be inconsistent across districts, frequently incomplete and with units of measurement unspecified, indicating the need to harmonize the collection of livestock statistics.

10.2.3 Eastern Nile Region (Ethiopian Plateau)

Maize based livelihoods in drought prone regions of eastern Africa provide a fertile learning ground to assess potential climate change adaptation options and their implications. The farmers in a similar agro-ecological environment but with different socio-economic and institutional settings have variously adapted to living with drought and the inherent weather risk co-determines the livelihood portfolio, agricultural intensification incentives and system development pathways. This helps identify a number of challenges and opportunities for development. A number of generic lessons thereby stand out for the sub-region: (1) A persistent preference for maize despite being drought prone; (2) A need to reduce maize production risk; (3) A need to develop input and output value chains; (4) A need for a dynamic system perspective; and (5) A need for viable options in each subset. There indeed is no blue-print to enhance maize productivity in the sub-region. Instead, each country should assimilate the best-bet options appropriate to their respective situation and enable the diverse farmer communities to enhance their precarious livelihoods and to continue to adapt to the increasingly erratic weather associated with climate change.

Challenges

- Increasing humanitarian needs of pastoralists. Climate change and many years of pastoralist marginalisation will create more humanitarian needs in the region.
- Lack of coordination in recent interventions and insufficient regional mechanisms to address the regional root causes and impacts. Interventions on pastoralist issues in the region have suffered from a lack of coordination, synergy and targeting including a failure to link relief to recovery. This has resulted in duplication and cost-inefficient responses.
- The exclusion of pastoralists in policy making and the design of response strategies that affect their lives and insufficient understanding of pastoralism (and inadequate research into pastoralist needs to inform response) have also fuelled poor design and implementation of interventions and projects in pastoral areas.
- The need to scale up successful pilot based community-based adaptation projects to ensure documentation and rapid replication in addition to improved drought

preparedness planning, disaster management structures and risk reduction to support natural adaptation.

- Lack of consensus on whether pastoralism is a development or humanitarian issue. It is possible that the pastoralist issue is both, thus necessitating new ways of working with new partners

Therefore:

- Inherent adaptive capacity of pastoralists should be strengthened to enhance autonomous adaptation.
- Cross agency and cross regional partnerships are essential to ensure greater coordination of activities to support disaster risk reduction and climate change adaptation for pastoralist communities.
- More effort is needed to support governments meet the regional challenges of pastoralism (given the trans-boundary impacts) and to work with other governments to resolve the challenge.
- Involvement of pastoralists in decision-making is fundamental

10.2.3.1 Livestock improvement

There is some indigenous knowledge and practices developed by traditional herders which have been tested and found useful. It is vital that this knowledge is documented and synthesized for widespread use in the country or elsewhere. Such knowledge should be used as the basis for future research and development. Some of the livestock keeping communities may require new technologies, while others need to build on traditional technologies and practices. For example, the coping mechanisms pastoral communities have been employing for generations can be used to design and develop new ways to cope with increasing climate variability. The important thing is to identify the best-bet technologies and seeks ways of making them available to the livestock communities. In livestock research, the gap between past research programmes and development interventions to adapt to the impacts of climate variability and climate changes on livestock production and productivity, for example where disease / pest pressures change need to be bridged.

Drought and flood have lead to livestock deaths, loss of reproductive and productive efficiency, deterioration in quality and productivity of grazing lands and increased destitution of the pastoral community have occurred several times recently, at progressively shorter intervals (recently less than five years). However, documented information on the magnitude of displacement, loss of life and productivity of the livestock is rare. The meteorological data available from various stations have not been utilized to verify the magnitude of climate

variability and changes which have led to the catastrophic loss of livestock. Geo-referenced early warning systems need to be developed for drought, flood and disease early warning, to aid traditional mobility patterns of the pastoralists. The major challenges to the livestock production are summarized below to indicate the way forward to improve the production and develop adaptation strategies for climate change.

Scarcity of feed: the feed resource base for livestock production in Ethiopia is natural grazing and crop residues. The quality and supply of these resources is seasonally variable. Grazing resources in the lowlands are diminishing due to expansion of cropping land, bush encroachment and overgrazing.

Lack of infrastructure: the infrastructure necessary to transport livestock or livestock products from remote rural communities, where production is concentrated, to urban markets is lacking. Livestock are generally trekked long distances for marketing, often without adequate water and feed. They are also trekked similarly long distances in search of feed and water. There are very limited market centers and stock routes with the necessary facilities such as feeding and watering points.

High mortality rates: About one-half of all lambs/kids born die due to various causes. This is a very important constraint limiting productivity. For example, annual mortality in all classes of stock averages 23 percent for sheep and 25 percent for goats.

Inadequate veterinary coverage: results in high mortality and morbidity. Certain diseases are also causing Ethiopian animals and products to be banned from export markets.

Long marketing channels and lack of market information: Producers do not have access to market information; consequently the system lacks market orientation, which is an important driving force for increased production.

Low product quality: Poor quality of live animals and small ruminant meat and meat products prevents penetration into many export markets.

Absence or inadequate provision of credit services: Livestock owners have difficulty obtaining credit to begin or expand production, purchase inputs, increase stock, etc.

Low average reproductive rates: Typical reproductive rates average as low as 55 lambs and 56 kids born per 100 mature females per year in the central highlands.

10.2.4 Eastern Nile Region (Down Stream)

10.2.4.1 Sudan

The main adaptation actions implemented for each of the identified droughts are as mentioned below:

1. Planting short maturing crop varieties
2. Reduce biomass fuel consumption (improved stoves)

3. introduce different cultural practices (planting in furrow bed, or planting on flat)
4. introduce new technologies (different type of machines, using mulching, infield water harvesting)
5. construct small scale dams

10.2.4.2 Egypt

A meaningful national action plan for Egypt would be comprised of sub-components, each of which is geared to address the specific attributes of each agro-ecological zone distinguished in Egypt. The general priorities in desertification in Egypt as presented in the National Environmental Action Plan (NEAP) tackled several issues, these are:

- Degradation of irrigated farmland as a result of using low quality water in irrigation,
- Degradation of rain-fed farmland (northern coastal belt and northern Sinai rainfall 100-250mm), for insufficient water harvesting and water spreading processes.
- Degradation of rangeland (northern coastal belt) through overgrazing, degradation of plant cover,
- Encroachment of sand formations, especially from the Western desert, on the Nile Valley land (southern Egypt) and on the High Aswan Dam reservoir (in Egypt and Sudan).
- To formulate meaningful options that ensure that the introduction of irrigation into the area does not threaten the sustainable use of the marginal land or the livelihoods of the present local population.
- To conserve the ecosystem from invading pests and pollutants.
- To provide and enhance green areas for better and healthier microclimatic conditions.
- To formulate rational and innovative policies for waste management treatment and reuse of solids and effluents.
- To promote public awareness campaigns dealing with environmental issues using all available media means.
- To develop environmental institutional aspects with appropriate capacity building and training in issues specific to characteristics of the surrounding ecosystems.
- To combat damaging flash floods through appropriate water spreading and water conservation techniques; and to prevent and alleviate damages of flash floods to the infrastructures and available resources including adverse socio-economic impacts.
- To conserve, manage and utilize the highly valued and diversified natural flora and fauna resources.

10.2.5 Southern Africa

10.2.5.1 Botswana and South Africa

The main adaptation actions implemented for each of the identified droughts are listed in: Table 39

Table 39: List of drought adaptation actions per the user requirement

Adaptation Action	Botswana	South Africa
Water harvesting	X	X
Water infrastructure		X
Multi-activity agriculture	X	X
Market gardening;	X	X
Dry land farming practices	X	X
Management of water networks	X	X
Construction of large dams	X	X
Cultural practices	X	X
Water conservation technologies	X	X
Construct small scale dams	X	X
Capacitation of farmers	X	X
Management of water resources		X
Inter-basin water transfers.		X
Water conservation.	X	X
Importation of water		X
Control of deforestation.	X	X
Expansion of protected areas.	X	X
Resource Management	X	X
Managing wildlife	X	X
Recycling of water		X
Water rationing	X	X
Management of ground water		X
Drought early warning systems	X	X
Crop monitoring	X	X
Crop diversification	X	X

10.2.5.2 Mozambique

The main adaptation practices implemented by each institution involved on drought and the user requirements are listed in **Table 40**.

Table 40: List of Drought adaptation practices per user requirements

Institution	Adaptation Practices	User requirements
National Institute of Disaster Management (INGC)	Encourage the adoption of mechanisms for risk insurance and other prevention instruments or mutual assistance.	Disclosure of information published in disaster situations; Organize and coordinate nationwide meteorological data collection, analysis and dissemination including its trends and consequent impacts on the population; Provide regular information to managers and their respective donors; Promote mutual assistance and exchange of information among international organizations.
National Institute of Meteorology (INAM)	Weather monitoring across the country.	Weather monitoring across the country.
Ministry for Coordination of Environmental Action (MICOA) - (DNGA - National Directorate of Environmental Management)	Improve the management and inspection	Implementation of the strategy and action plan for biodiversity conservation in Mozambique; Preparation of National Action Programme for Adaptation (NAPA); Assessing the need for national capacity and self-assessment of overall management of the environment; Action plan to combat drought and desertification including drought.
Ministry of Agriculture (MINAG)	Intensify vegetables production and other annual crops; Multiplication of raw sweet potato and cassava cuttings as varieties of drought-tolerant materials; Production and seed multiplication	Presenting the weather for the different growing seasons; Develop adaptation strategies such as improved crop resistance to drought. Build and rehabilitate damaged irrigation systems and water (small dams).

Institution	Adaptation Practices	User requirements
FewsNet	Strengthening the capacity of local risk management; Strengthening local management capacities.	Improved early warning system; Improving access to and use of integrated information for reducing disaster risk; Support the elaboration of contingency plans for disasters response; Providing information and analysis of disaster, with a view to an effective emergency planning.

10.2.5.3 Zimbabwe

The main adaptation actions implemented for each of the identified droughts are listed in Table 41.

Table 41 Drought adaptation practices in Zimbabwe

Adaptation actions
Water harvesting
Recycling of water.
Water rationing.
Management of ground water resources.
Reforestation.
Construction of dams for irrigation
Growing drought tolerant varieties
Early planting and staggering planting dates.
Strategic grain reserves (food storage programmes).
Conservation Farming
Development of drought early warning systems
Animal production and livestock health programmes
Use of soil and water conservation techniques
Precision application on soil nutrient amendments e.g. N micro dosing
Improved cropping pattern
Post-harvest management

Crop monitoring
Crop diversification.
Construction of boreholes

Most of drought adaptation practices in table 13 tally with the user requirements for drought adaptation. The major challenge is that most of the practices are not implemented mainly due to lack of funds. Conservation faming is being promoted in Zimbabwe and there have been a lot of training programmes done by various NGOs in conjunction with the Ministry of Agriculture and FAO.

10.3 COMPARISON OF GLOBALLY AVAILABLE STATE-OF-THE-ART DROUGHT MITIGATION PRACTICES WITH REQUIREMENTS OF USERS IN AFRICA

10.3.1 North Africa

This section of the report will compare available state-of-the art drought adaptation practices with requirements of users in Africa. The state-of-the art drought adaptation practices used as a basis of comparison are mainly from countries of the Mediterranean basin (Experiences from Spain, Italy, Portugal, France, Cyprus, Greece) that share through this common geographical feature some climate similarities with North-Africa, and from Australia and United-States which have developed very efficient drought management strategies.
In the agricultural sector, we have presented drought adaptation adopted in North- Africa in 2 parts: the hardware technologies, the software techniques.

In terms of hardware, the comparison with user's requirements and also with the currently adopted drought practices in the other countries reveals gaps mainly in terms of dissemination level. Indeed, all the identified needs and all the listed technologies in the state of the arts are well known and present in North Africa too, but still need to be distributed on a larger scale in order to fulfill user's requirements and to be consistent with the state of the art. This is especially the case of breeding and the efficient irrigation systems (Drip irrigation); Dams development registers a smaller gap, at least in Morocco. The non-conventional water development can be considered well developed in Tunisia, followed by Algeria, while Morocco displays the highest gap in this field.

In terms of software, although a number of adaptation actions issues need to be addressed, most of the identified techniques are consistent with requirements and with the state of the art. However, and because of the intensity of current drought episodes, an adequate

adaptation strategy should integrate agronomic packages, including different options and choices among the known software strategies, according to given situations. Considering this statement, we note a significant gap both, with user's requirements and with the state of the art, although these techniques have been essential elements for research programs. To transfer efficiently these techniques and strategies on the field, financial support, awareness and communication can provide a development of better and more complete adaptation packages by combining traditional and scientific knowledge.

10.3.2 Equatorial Lakes Region

10.3.2.1 Tanzania

Below are the state-of-the-art mitigation strategies for coping with drought as a consequence of climate change, which can be considered in Tanzania. Table 42 shows a comparison of user requirements in Tanzania.

- Strengthening resilience against climate variability
    - Improve water use efficiency
    - Mulching to conserve soil moisture
    - Manage evapo-transpiration so as to achieve water saving
    - Improve water management institutions
- Improve human and financial capacity
- Improve drought events monitoring and documentation
- International cooperation
- Practice effective knowledge sharing especially for the highly vulnerable sectors such as water and agriculture and the sub-Saharan region
- Adjustment to technical and design standards, and regulations
- Establish investment priorities
- Introduce/Improve new crop varieties to changes in cropping seasons
- Build infrastructure to reduce the damage from extreme events and increase water storage capacities

Table 42: Comparison of requirements for users in Tanzania to adapt to drought with state-of-the-art drought adaptation practices

Adaptation requirements for users in Africa	State-of-the-art drought adaptation practices
Adaptation to climate-change strategies as indicated in the National Adaptation Programmes of Action (NAPA) document	Adaptation to climate-change (medium to long term window of time) and reduction of water scarcity levels
Conjunctive use of surface and groundwater resources	Conjunctive use of surface and groundwater resources

Use of crops with less water requirements and adapted to regional climate	Use of crops with less water requirements and adapted to regional climate
Use of water use efficiency crops and options	

10.3.2.2 Kenya

IGAD Climate Prediction and Applications Centre (ICPAC) is a specialized institution of the Intergovernmental Authority on Development (IGAD). Skilful climate prediction and timely early warning forms the foundation of any operational climate centre. ICPAC provides 10 days, monthly and seasonal climate prediction products that are required by IGAD, the KMS, and other national, regional and international partners. The Division uses two empirical techniques to provide climate outlooks namely dynamical and statistical approaches. Some of the climate modeling methods requires enormous computing power and skilled human capacity. Improvement of ICPAC and national computing capacity, human resources and development of new prediction tools are the main priority of the Division. The other priority is to develop products required for specific sector applications.

Statistical climate prediction methods

The statistical prediction methods are based on empirical relationships between rainfall over specific parts of GHA and some global / regional/ local climate system indices. The major climate system indices that are used at ICPAC include evolution of monsoons, medium and upper level winds, Madden-Julian Oscillation (MJO), Quasi biennial oscillation (QBO), El Niño / Southern oscillation, Indian Ocean dipole IOD, tropical cyclones, sea surface temperature gradients among many others that have been derived from general circulation. Most of the statistical methods still do not explain most percentages of rainfall variances. A lot of efforts must therefore be made to improve the skills of the prediction models. At the moment ICPAC is collaborating with a number of partners such as IRI,NCEP/CPC, UKMO,FSU,NCMRWF among others to address climate prediction and early warning challenges in the region. The activities of the unit during 2005-2010 period include:

- Documentation of the methods and associated applications
- Develop improved prediction techniques for the ten-day outlook.
- Provide forecasts on temperatures and rainfall onset, cessation and distribution of dry/wet spells.
- Continuous verification of the prediction products to assess the skill of the forecasts disseminated to the users.
- Basic diagnostic research to improve the prediction products for various time scales
- Develop pilot projects to assess and communicate successful use of forecasts.

- Improvement of statistical techniques on the downscaling of prediction products to meet user requirements.
- Ensure user feedback is incorporated into forecast developments.
- Continue to improve the capacity of the member states on statistical and other new and emerging climate prediction technologies.
- Enhance collaboration with other relevant regional and international centres engaged in climate prediction and application services

Dynamical climate prediction approaches

The climate modeling and numerical weather prediction methods used at ICPAC provide the evolutionary spatial and temporal evolutionary dynamics of weather and climate evolutions over the GHA region. Currently, ICPAC is running the Regional Spectral Model (RSM) in a dynamical downscaling mode using a mini-super computer, an IBM RS6000. The RSM is nested in the low-resolution global model ECHAM 4.5 run operationally at the International Research Institute for Climate Prediction (IRI). The IRI global model provides the initial and lateral boundary conditions for the regional model, and the global model outputs are provided by the IRI. Statistical downscaling of the global model (ECHAM4.5) is also being done at ICPAC through a package that has been coded at IRI that uses Model Output Statistics (MOS). The ultimate objective of the section is to use an array of global climate models (GCMs), Regional Climate Models (RCMs), Numerical Weather Prediction Models (NWP), and other modeling technologies including downscaling and Super Ensemble techniques. The activities scheduled for the 2005-2010 period include:

Enhancing of NWP at ICPAC and NMHS.

- Adoption of operational FSU super ensemble NWP products for the GHA at ICPAC and NMHS.
- Adoption of 24 hour operational NWP models from other centers such as ECMWF, NCEP, NCMRWF, UK Met Office, and Germany
- Training of National experts in NWP
- Assist NMHS to source for software and hardware facilities for NWP operations

Enhancing Medium Range NWP at ICPAC in Support of 10day bulletins and NMHS.

- Set up and update continuously the operational databases necessary for the medium range and super ensemble real time runs.
- Extension of the FSU super ensemble NWP to 10days and its use in ICPAC dekadal bulletin.
- Verify and use 10day NWP products from other centers: COLA, NCMRWF and others and run Eta model operationally at ICPAC.

- Under take capacity building training on medium range NWP and it's operational challenges.

Climate modeling and downscaling for seasonal products at ICPAC

- Operational use of the ICPAC-IRI calibrated global ECHAM model and dynamical downscaling with the Regional Spectral Model (RSM) for prediction of October-December seasons.
- Operational use of Model Output Statistics (MOS) of the global model as statistical downscaling at ICPAC and NMHSs in seasonal forecasts.
- Creation and analysis of the ECHAM model database for seasons MAM, and JJA and evaluation of the skill of the ECHAM and RSM for these seasons.
- Configuration and adoption of FSU Super ensemble model products for seasonal forecasts.
- Identification of other models and modeling techniques being used operationally at other centers such as ECMWF, NCEP, BMRC, NCMRWF, UKMET Office, Max Planck Institute of Meteorology, and NCSU among others, and the customisation of those models in the region.
- Acquire a global model that can be run at ICPAC.
- Continuation of regional capacity building in dynamical climate modeling.
- Acquisition of PCs and clustering technology for parallel processing.

10.3.3 Eastern Nile Region (Ethiopian Plateau)

Early interventions can mitigate the effects of drought on pastoralists, reducing the need for major life-saving emergency response. By helping to protect pastoralists' assets, it may also prevent further vulnerability in the livelihoods system. Lautze has argued that the 'saving of livelihoods needs to be recognised as being as important as saving human lives in emergencies' (ibid.: 31). As noted, whilst there is increasing recognition in government circles and within aid agencies and donors of the importance of early livelihoods interventions, particularly in pastoral areas, the system is still overwhelmingly geared towards post-disaster responses largely centred on food aid.

Critical gaps in drought contingency planning

From the drought contingency plans and planning review, the following critical gaps have been identified as key.

The definition of drought dilemma in drought contingency planning

The mainstream definition of drought (based on impacts) is a critical gap identified in most contingency plans reviewed. The inconsistent and unclear definition of drought impede effectiveness of most drought contingency plans that are essentially not clear of what type of drought they are developed for. It was easy to see that most activities or combination of them in drought contingency plans were based on reactive response to an already looming crisis from an unidentified drought. The lack of consensus in drought definition often means that the activating of contingency plans is either late or lacks consistency even for adjacent districts or regions. Practitioners and communities are often aware of drought (mostly meteorological or hydrological) while the decision maker's battle with scientist's in interpreting early warning information.

Linking drought contingency planning to drought cycle management

According to Levine et., al. (2011), the concept of drought cycle management as a planning, decision making, funding and management tool in drought management has proven futile in actual drought risk management. While the drought cycle management, a cyclic process that defines what actions to be taken in different stages of ''a drought'', the plans themselves are static rather than dynamic with less or little changes in the specific stages of drought. This is particularly true in the designing of contingency plans during alert stages of drought cycle for activation (in similar way) during alarm and emergency stages of the drought cycle. Concentrating on development and mitigation activities has, therefore, been very difficult as focus is on short term repeated measures rather than larger scale – long term drought risk management. This reinforces the notion that we cannot look at the drought cycle in discrete phases; rather, we must find ways to increase DRR efforts at all stages – but particularly as part of our response and recovery efforts (Oxfam, 2008).

Drought contingency planning are neither administrative nor thematic focused

Because regions are interconnected by ecohydrologic systems, the impact of meteorological and hydrological droughts, for instance, may well extend well beyond the borders of the precipitation-deficient area. In their current form, drought contingency plans have been developed mostly based on administrative borders and boundaries on one hand and based on the agency mandate (preference being NGO borders based on geographic coverage and a little on thematic and/or its contribution during drought response) on the other. Thus, contingency plans are general, not for any real situation (thematic) or place (geographic), but have been applied for very generic contingencies – ranging from 'drought', 'flood', 'conflict' (Levine S. A. Crosskey, and Abdinoor M., 2011).

Drought contingency planning fail to coordinate interagency planning

Drought contingency plans are themselves insufficient to coordinate interagency drought contingency planning for effective preparedness and response. This is largely true in that most drought contingency plans are not only geographical focused but at times thematically defined. A good part of drought contingency plans reviewed are focused mostly on livestock (based on original intent of DCM). If this is not handled properly most of the drought contingency plans will react rather proactively to complex livestock and non livestock livelihood based responses. The most significant gap is that agencies' policies and mandates for drought contingency planning are more policy-led than operationally driven.

Drought contingency plans implementations are not enforceable

The countries in review, Kenya, Uganda and Ethiopia, have not enacted drought risk management policy and legal framework/strategy for action. Therefore the drought contingency plans are not based on national drought policies thus making coordination of interagency planning and early action from joint implementation basically impossible. The capacity of government agencies for drought contingency planning is not necessarily centrally managed and thus implementation of plans is not enforced from coordination and monitoring.

Drought contingency planning emphasize on formulation rather than evaluation

The majority of contingency plans reviewed put more emphasis on the plan's formulation and define clear actions for its implementation but little or no mention on its testing, evaluation and on pre-testing and refining the plans. From the respondents and contingency plans, it was easy to see that very little effort has been put in revisiting and refining drought contingency plans after drought. Regrettably, a few respondents pointed out that successive contingency plans developed were hurriedly done with little updates or reference to previous contingency plans.

Drought contingency plans developed to fulfil donor requirements

The majority of drought contingency plans had little or no consistency between seasonality and funding cycles. With many drought contingency plans developed around funding opportunities, it could mean that the contents and contexts of these plans and planning respectively will largely be donor driven and in view of fulfilment of donor requirements.

Drought contingency plans partially participatory

Though the majority of the plans had an element of joint or all stakeholders planning process, it lacked involvement of or often excludes stakeholders from local recipients of the plans and/or those who could affect the success of drought mitigation efforts through policy change and practice. The participant list of most contingency plans lacked representation from communities. It may be assumed that earlier consultations took place with communities and local government authorities. There is a need to include experienced agency and community staff in drought contingency planning for a period of time for continuity and that could easily link preparedness actions to mitigation.

Drought contingency planning is cyclic limiting community resilience to drought impacts

Though drought contingency plans have various activities to support drought risk reduction by including minimal preparedness, response and recovery actions, there is very little link between preparedness, early warning and early action/response. In fact, most drought contingency plans are response oriented with little emphasis on mitigation. This could be associated with technical capacity of those involved in contingency planning or timing and duration for its development is too short and not part of a bigger drought risk reduction strategy.

Sustainable drought contingency funds limited from inadequate early warning systems information management

The reviews conducted highlighted development of drought related early warnings as sufficient for decision making in many countries. However, the critical gaps identified are in linking drought preparedness to actualizing contingency plans from timely early warning information.

Bridging the Gap: A Conceptual Framework for Drought Contingency Planning

In an attempt to bridge the gap in drought contingency planning for effective drought preparedness and response, a more continuum and relief developmental thinking model is proposed. Though this is not yet a new framework or model it is expected to take note of the gaps in the activating contingency plans and funds triggered by early warning system.

There was consensus during discussions that drought contingency planning could take place at all stages of drought cycle with thresholds for its activation following the same pattern at all stages of the drought cycle. Definition of drought in question earlier on will revert the general, not for any real situation (thematic) or place (geographic) contingency plans that have been applied for very generic contingencies in the past. Not all contingency activities in the plans

require funding. If drought contingency planning (process and context analyses) is mainstreamed into sustainable development and drought risk reduction framework and practices, many contingency plan activities need not any financial implications for activation as they form part of community managed disaster risk reduction plans.

For drought contingency plans and planning to be effective, responsibilities and accountabilities for action and in action need to be specified and managed. More often in the past drought responses, no one was responsible for the in action and delayed responses or not activating the contingencies all together. More advocacies are required to push national and regional governments to enact drought management policies and strategies with legal frameworks to hold individuals or institutions accountable.

The HFA priority five indicators of success show that for effective drought contingency planning to be a success; strengthening drought preparedness and coordination from proactive exchange of information and early warning; contingency planning and response readiness is key. HFA priority indicators can be utilized for monitoring and accountability purposes in drought contingency planning and implementing drought contingency plans.

The way forward shall thus be building a more vibrant and autonomous disaster management system, that should be established upon the active partnership of all relevant actors (integrated approach), a system that should persevere in embracing strategies in prevention (mitigation), preparedness, response and recovery (a comprehensive approach), and a system of DM holistically devoted to both drought and non-drought hazards (all hazards approach) that have potentially been threats to the community and its assets in Ethiopia.

10.3.4 Eastern Nile Region (Down Stream)

10.3.4.1 Sudan

There is gab between user's requirements for drought mitigation practices in Sudan and the global state -of- the art in term of dissemination of the information about the drought occurrence and their impact and also the currently adopted drought practices. There are needs to transfer the technical packages that deal with mitigation practices to the local communities and also to combine the indigenous and scientific knowledge. Different institutes dealing with drought mitigation and adaptation implementing many actions that can summarized in the following points

- Provides technical packages for the framers and local communities (such as best crop varieties, land preparation, planting methods, and fertilizer application).
- Increase productivity and production by introduce water harvesting techniques (Terracing) and increase rain water use efficiency
- Distribute necessary tools and equipment's
- Training of local communities and Farmers on mitigation measures
- Improve crop diversity through awareness-raising on
  - community seed saving,
  - construction of grain storage
- establishment of seedling nurseries
- Identify communities most affected by drought
- Provide access to research finding to the policy makers and communities leaders
- Building small scale water harvesting dams and terraces
- Support regeneration of vegetative cover
- Improve pasture through supporting establish trees nurseries
- Community forest and Agro-forestry Farming

10.3.4.2 Egypt

Mitigation means actions that we can take before or at the beginning of drought to help reduce the impacts of drought. Mitigating drought involves a wide range of agricultural practices including finding additional water supplies and conserving water that is already available. However, it is not enough to make drought plans based only on agricultural practices. There are many other strategies at government level that are just as important. It is important to realize that we will not be able to defend drought overnight. Some of these strategies will take time to implement and to see the result. State of the art drought mitigation

- Water Reuse
- The water scarcity management plan(which sets up water use priorities)
- Applying the Integrated Water Resources Management
- Constructing Early Warning System
- Construction of desalination plants.
- Irrigation Development

10.3.5 Southern Africa

10.3.5.1 Botswana and South Africa

The main mitigation actions implemented for each of the identified droughts are listed in: Table 43.

Table 43: List of drought mitigation actions per the user requirement

Adaptation Action	Botswana	South Africa	State of the Art
Water harvesting	X	X	X
Water infrastructure		X	X
Multi-activity agriculture	X	X	X
Market gardening;	X	X	X
Dry land farming practices	X	X	X
Management of water networks	X	X	X
Construction of large dams	X	X	X
Cultural practices	X	X	X
Water conservation technologies	X	X	X
Construct small scale dams	X	X	X
Capacitation of farmers	X	X	X
Management of water resources		X	X
Inter-basin water transfers.		X	X
Water conservation.	X	X	X
Importation of water		X	X
Control of deforestation.	X	X	X
Expansion of protected areas.	X	X	X
Resource Management	X	X	X
Managing wildlife	X	X	X
Recycling of water		X	X
Water rationing	X	X	X
Management of ground water		X	X
Drought early warning systems	X	X	X
Crop monitoring	X	X	X
Crop diversification	X	X	X

10.3.5.2 Mozambique

The main adaptation and mitigation polices and strategies actions implemented for drought mitigation and adaptation are listed in Table 44.

Table 44: List of polices and strategies for drought mitigation and adaptation

???	Mitigation	Adaptation
Policies	Establishing a District	Recovery and expansion of

	Disaggregated Action Plan - based on real and identified priorities;	the hydro-meteorological network that was severely damaged during the civil war period; Introduction of modern technologies for systematic data collection, transmission and processing including a regular exchange of information with the neighbouring countries; Agreements on shared watercourses in the most critical situation.
Strategies	Cultivation of crops resistant to drought and the opening of new sources of water (wells traditional). Participate in food-for-work programs Plant vegetable crops for household consumption; Working with associations as a mitigation strategy	Development of arid zones by introducing conservation practices for agriculture and non-farm activities for income generation Introducing agricultural and water supply rainwater harvesting techniques.

10.3.5.3 Zimbabwe

The main mitigation strategies and drought mitigation requirements for users for coping with drought as well as the comparison with state of the art mitigation practices are discussed below:

i) Industry and mining

- Curbing /reducing pollution.

The Zimbabwe Water Act has a provision for the polluter pays principle recognized and water treated as an economic good.

- Reduction in land degradation

It is also mandatory for mining pits to be filled once the mining has stopped.

- Recycling of water

Most of the industrial water is recycled to minimise water wastage.

- Safe disposal of industrial waste

It is mandatory for industries to safely dispose of their waste and avoiding disposing them into stream and rivers .The Zimbabwe environmental management act has provisions for this.

ii) Agriculture

- Use of drought resistant crops

- Crop diversification
- Recycling water
- Promotion and up scaling of Conservation agriculture and soil moisture management methods
- Rehabilitation and construction of dams
- Environmental management and natural resources management
- Promoting superior local adaptation strategies

In state of the art the focus has been on the following

- Provision of climate risk and management tools to farmers (Australia)
- Incorporating climate change effects into the design considerations for major infrastructure.

11 ASSESSMENT OF EXISTING ORGANISATIONAL STRUCTURES FOR DROUGHT MANAGEMENT IN AFRICA

11.1 EVALUATION OF ORGANISATIONAL STRUTURES FOR DROUGHT MANAGEMENT IN AFRICA (D2.2)

11.1.1 North Africa

At the beginning of independence, north-African countries set up and strengthened the institutions working on environmental issues. The establishment of these institutions initially responded to the need for the protection of natural resources and the development of the rural sector and forestry. Thus, their goals initially focused on measures for water conservation, soil and vegetation through the development of protected areas and wildlife reserves, the protection mechanisms of arid lands against different types of degradation, etc. On climate issues in general, efforts have focused on the creation of national meteorological services for the collection of climate data. National centers for remote sensing and mapping were later introduced as useful tools for decision making.

In North-Africa, Environment ministries, through their strategic position and cross coordination of various environmental issues are currently positioning themselves as leaders on climate change issues. This is particularly the case of Morocco where the High Council for Water and Climate is the main consultative body on water and drought management. In Algeria, the National Agency for Climate Change was created in 2005 whereas Tunisia implemented in 2001 a focal point on Climate Change within its ministry of Environment.

This section of the report will analyze the ministerial services and department involved in drought and /or water departments with the aim of:

- Showing their strengths and weaknesses
- Discussing the challenges and opportunities to improve drought management

It will focus on Tunisia and Morocco, since there are not enough available data for Algeria and is, to a large extent, based on Medroplan project outputs. It will consider three main aspects:

- Institutional Organization
- Institutional performances during previous droughts
- Data and available information

11.1.1.1 Institutional Organization

In North-Africa, in terms of drought management, very few institutions work specifically on this issue. The main structures that are directly or indirectly involved in drought and/ or water

management are scattered among several departments (see D 2.2 for a detailed list of these departments and services) including:

- Water and Environment,
- Agriculture,
- Forestry,
- Energy and Mines,
- Industry and Transport.
- Interior

In Tunisia, the drought management system consists of 3 major successive steps (drought announcement by the maerh, proposition of a scheduled operation plan to the national commission composed of decision makers and beneficiaries, supervision of the implementation of these actions by the national commission, with strong collaboration of regional and specialized committees. In order to ensure an efficient drought management, three types of committees are established:

The Drought National Commission (DNC)

The DNC includes representatives of MAERH, and of ministries of Interior, Economic Development, Finances, Commerce, Transport, and Public Health. Its main missions are to: (i) to keep track of the drought circumstance; (ii) to elaborate the measures and provisions against the drought situation (intensity, duration, etc.); and (iii) to coordinate the execution of drought mitigation operation programs.

The Drought Regional Commissions (DRC)

For each one of the 24 Tunisian Governorates, there is a Drought Regional Commission (DRC).The members belong to the Regional Departments of all Ministries involved in drought mitigation. The UTAP is associated. The main task of DRCs is to present the situation of the different sectors and inform the national authorities about the necessary measures for drought management if observed in their regions.

The Drought Specialized Commissions (DSC)

The drought Specialized Sectors Commissions (DSC(s)) are responsible for the preparation of the drought indicators observed in each field. They propose an operation planning and scenarios for mitigation of the different eventual drought events. The DSC(s) include the Water Resources Management, livestock safeguard and Cereal Sector management and arboriculture committees.

In Morocco, most ministerial departments dealing with water management including agriculture, water and environment, forestry, interior, health, energy and mines, and finance, are also concerned with drought management. Overall coordination of drought management issues is the responsibility of the Permanent Inter-ministerial Council for Rural Development (PICRD), which is headed by the Prime Minister and has ability to officially declare the onset of drought. It is himself under the supervision of the Superior Council for Water and environement. The technical secretariat of this Council is under Ministry of Agriculture and Rural Development which heads the weekly meetings of the Interministerial Technical Commission once a drought episode is declared.
Overall drought management in Morocco is under the supervision of national and regional committees.

National advisory board

In addition to the political board represented by the Permanent Interministerial Council for Rural Development the other members of the national advisory board on drought are the National Drought Observatory, the National Meteorology Office, the Superior Council for Water and Climate and the National Environment Council. The first two structures have advisory role to their respective ministry on a continuous basis while the last two others have much less frequent consultative role on drought issues.

National executive board

The Inter-ministerial Technical Commission (ITC) is the basis of the executive board at the national level. It includes ministry representatives of Agriculture (MADR), Forestry (HCFWFD), Water (DGH, ONEP), Energy (ONE), Interior (MI), Health (MH), Finance and Credits (MF, CNCA). The ITC meets weekly to report to the Permanent Inter-Ministerial Council for Rural Development which, based on the Commission report and the information provided by the advisory bodies, may or may not declare drought and drought affected regions. If drought is declared nationwide, then the National Drought Mitigation Plan is set for execution. This is basically the reactive relief dimension of the plan that has to be implemented and supervised at the national, regional / provincial and local levels.

Regional and local setting of drought management

The Regional Drought Committee is headed by the Wali of the Economic Region, who normally supervises more than one province in the Region while the Province is headed by a Governor. The regional drought committee is responsible for all decisions pertaining to the national drought mitigation plan related measures and actions to be implemented in the

region. This committee includes representatives of key ministries (ONEP, ORMVA, DPA) and elected members of the rural and urban collectivities of the region, in addition to active NGO's operating in the region. The coordinating role and the composition of the Provincial Technical Committee at the province level are similar to those of the regional drought committee at the region level. At the local level, a number of Local Drought Committees / Specialized Drought Committees representing ministry line agencies and NGO's are responsible for detailed examination of the content of the proposed measures in order to match the needs of the local drought affected population, livestock and environment. At the different levels of implementation of the national drought mitigation plan, political pressure groups and elected members of the local communities become actively involved.

The institutional organization of drought management in Morocco and Tunisia is therefore well structured and defined theoretically on "the paper". Indeed, it is supported by a wide arsenal of legal bases like in most Mediterranean countries where the legislation has evolved as a consequence of severe drought episodes. These countries recognize drought as a direct consequence of water resources availability and management, therefore the legal base related with drought, when it exists, is directly derived from the water code of each country. (Iglesias *et al.*, 2007). In Morocco, the legislation related to drought is very advanced but its control is not very well developed. The new water law of 1995 includes many points related to water management under drought conditions. This law also introduces elements like water basin agencies and the creation of the Superior Council for water and Climate as the main consultative body for the formulation of the general orientation of the national water and climate policy, water national plans and integrated management plans on water resources. However, in Morocco, the new water law still coexists with ancient rules inherited from the Islamic law, this forming a mixed system not fully solved. Nevertheless, in Tunisia, the specific drought contingency plan (Operational Drought Management Plan setting is not based on a specific legal provision. It is implemented on the basis of a drought announcement and the decision taken by the Ministry of Agriculture (MAEH) to establish a drought committee and design an action program. Other demand management instruments like awareness campaigns for water conservation of adoption of water saving measures have a clear framework for implementation in Morocco and Tunisia where there are some specific contingency plans containing these kinds of mitigation measures (Iglesias *et al.* 2007).
Thus, this legal framework represents a strength of Tunisian and Moroccan drought management systems' organizational structures. In Morocco, it is reinforced by a policy of decentralization materialized by the integrated water resources management at the river basin level, the distinguish between drought management in irrigated areas that fall under

the jurisdiction of the ORMVA's and drought management in rainfed areas that is under the responsibility of Regional Directions of Agriculture. A law passed in 1990 provided a legal basis for establishing water user associations (WUAs), with responsibility for managing irrigation at the tertiary level. Nevertheless, although this legal framework and the policy of decentralization allowing the implementation of regional drought management strategies represents a strength of Moroccan drought management actions, their implementation and effectiveness are hampered by some weaknesses of their organizational structure, materialized by:

- The lack of coordination between the large number and variety of institutions involved in drought management and the conflicts of interests that emerge among them.
- The limited progress in mobilizing stakeholder participation and investment
- The inadequate financial resources.
- The division of responsibilities among many governmental jurisdictions.
- The lack of technical capacity and the insufficient human resources training regarding drought management
- The weak science-policy interface

11.1.1.2 Institutional performances

In Morocco, the analysis of the institutional performances during the major past drought episodes reveals that they are good in implementing reactive actions plans and adaptation actions but that proactive mitigation measures still stay scarce. Indeed, although the need for a shift from a crisis management to a more proactive approach based on risk management is a clear objective of drought management since the years 2000, it does not seem to be reached. Nearly 12 years after, no operational drought plans are available. Approaches to Drought management remain mainly oriented towards emergency relief and attention to DRM evaporates soon after humid periods come back. The best illustration can be given by the National Drought Observatory (ONS) in Morocco that was created in 2001 as the spearhead of this new drought management approach but is, a decade after its creation, not functional.

11.1.1.3 Data and available information

The ministerial departments involved in drought management and which are, for most of them, also implied in drought monitoring, gather large quantities of data and information. However, the main impediment to a plain and full efficiency of drought management actions is the weak bridge and transfer and use of information between drought monitoring and mitigation and the lack of definition and development of drought indicators and triggers that could guide the implementation of appropriate mitigation measures. In addition, there is a poor integration of information into government structures: Typically, data collection and

reporting functions are conducted separately by different ministries in the government, which often leads to data collection activities and policy-making processes being done independently with little or no information flow between the activities. People who collect and report data typically have no authority to make independent decisions and decision makers often do not have the full set of information from the field to make well-informed decisions.

11.1.2 Equatorial Lakes Region

11.1.2.1 Tanzania

Table 45 shows indicative evaluation of institutions organisation for effective drought management in Tanzania.

Table 45: Strengths, weaknesses and opportunities of institutions for drought management in Tanzania.

Institution	Strengths	Weakness	Opportunities
Government Institutions (Disaster Management Department (DMD); Food Security Departments in the MAFSC & MoW; National Bureau of Statistics (NBS); Regional Coordination Department in the Ministry of Regional Administration & Local Government; Tanzania Meteorological Agency (TMA); etc.)	Availability of vast national resources; Good organization structure and functions	Limited financial capacity; Limited human capacity; Limited knowledge sharing	National resources; International & regional cooperation
Prime Minister's Office- Disaster Management Department (DMD)	Good structure from the national level to the village level and functions for early warning and forecasting	Limited involvement of private sector	Reform policies with a favourable environment for the growth of the private sector in production; and in taking up the provision of services, processing and marketing,

			previously undertaken by the state
Ministry of Agriculture, Food Security and Cooperatives	Tanzania has a comparative advantage in the production of many crops; mainly export crops (except cashews), maize and paddy	No good policies for achieving high agricultural growth	Policy reforms
Disaster Management Department (DMD); Tanzania Meteorological Agency (TMA)	Good structure from the national level to the village level and functions for early warning and forecasting	Limited coordination of the functions and of different players; Limited financial capacity; Limited involvement of research institutions	Policy and regulation enforcement reforms

11.1.2.2 Kenya

Table 46 shows indicative evaluation of institutions organisation for effective drought management in Kenya.

Table 46: Strengths, weaknesses and opportunities of institutions for drought management in Kenya

Institution	Strength	Weakness	Opportunities
Ministry of Special Programmes	• Has the legal authority to manage drought nationally. • Has access to full government machinery. • Guides the policy on Drought Mitigation Programme.	• Does not have structures for managing on the local level. • Very poor in activating response to disasters. • Lacks state of the art organisation structure and set up.	• Has the ear of the government. • Can command substantial resource if well organised and responsive.
Ministry of State for Development of Northern Kenya and other Arid Lands	• Has the legal authority to manage drought in the arid lands. • Has access to full government machinery. • Guides the policy on Drought Mitigation Programme in the arid lands.	• Does not have structures for managing on the local level. • Since it was formed recently, it has very poor organisation structure and set up.	• Has the ear of the government. • Can command substantial resource if well organised and responsive.
Ministry of Water and Irrigation	• Has legal responsible for water resources mitigation policy. • Able to initiate large scale designs and construction of water storage facilities. • Is responsible for national irrigation planning and implementation programs.	• Lack of high calibre professional staff at project and regional level. • Has not updated the master plan for the sector thus fuzzy focus in project delivery.	• Has good institutional structure for water resources management and development. • Can command substantial resource if well organised and responsive.
Ministry of Regional Development Authorities	Coordinates all regional (basin) development policy. Coordinates, monitors and evaluates basin mitigation authorities.	• Lack of high calibre professional staff at project and regional level. • Lack implementation capacity • Has not updated the master plan for the sector thus fuzzy focus in project delivery.	• Can command substantial resource if well organised and responsive.
Ministry of Public Health and Sanitation and Ministry of Medical Services	Able to provide prompt health services in drought areas. Creates an enabling environment, regulate, and set standards and policy for health service delivery in drought risk areas.	• Lack of high calibre professional staff at project and regional level. • Has not updated the master plan for the sector thus fuzzy focus in project delivery.	• Has good institutional structure for sanitation management and development. • Can command substantial

Institution	Strength	Weakness	Opportunities
			resource if well organised and responsive.
ISDR and UNOCHA	Ability to drive and influence Drought risk reduction strategy policy. Recognition as an agency for policy guidance to the ISDR secretariat; and Can convene ad hoc meetings of experts on issues related to disaster reduction.	Limited in staff for extended programs.	Has forum within the United Nations system for devising strategies and policies for the reduction of drought as a natural hazard; Has access to substantial international human and institutional resources.
World Vision Action Aid Practical Action Plan International Care International	Has the ability to empower community Participate in rehabilitating and constructing shallow wells and boreholes Strengthening the capacity of water user associations to manage the water resources on a sustainable basis	Project area is specific and fund dependent. Sustainability of interventions not guaranteed.	Well managed program setup. Good will since neutral. Enjoys non partisan status so can be useful in resource conflict areas.
Kenya Red Cross	Able to carry out humanitarian work in times of peace or conflict; in natural disasters such as drought, famine, floods. Promote pilot intervention on resilience.	Covers a very wide range of activities. Relies on good will donations for programs.	Well managed program setup. Good will since neutral. Enjoys non partisan status so can be useful in resource conflict areas.
World Food Program	• Able to; • Coordinate the formulation and implementation of Policies and Institutional Framework for Drought Mitigation. • Coordinate the mobilization of resources for Drought Mitigation. • Coordinate all stakeholders in Drought Risk Reduction and Mitigation. • Monitoring and Evaluation of the Drought Mitigation Programme.	Does not have distribution network and rely on governments and NGOs to implement programs.	Access to a bigger pool of international resources.

11.1.3 Eastern Nile Region (Ethiopian Plateau)

The NAPA preparation process in Ethiopia has followed the annotated guidelines prepared by the LDC Expert Group (LEG). According to the guidelines the steps for preparing NAPA's include building NAPA team, synthesizing available information, conducting stakeholder consultation, synergy assessment, identification of adaptation options, development and evaluation of criteria, prioritizing adaptation projects and development of project profiles (UNFCCC/LEG, 2002).

The National Adaptation Program of Action for Ethiopia was initiated and coordinated by the National Meteorological Agency. A project Steering Committee with representatives from the following stockholder institutions has been established. The role of the steering committee is to provide overall guidance and oversight for the project.

- Ministry of Water Resources
- Ministry of Agriculture and Rural Development
- Ministry of Finance and Economic Development
- Disaster Prevention and Preparedness Agency
- Ethiopian Science and Technology Agency
- National Meteorological Agency
- Addis Ababa University
- Institute of Biodiversity Conservation and Research
- Ethiopian Rural Energy Promotion and Development Center
- CRDA representing NGOs

A Project Management Team consisting of a project coordinator, assistant project coordinator, secretary, accountant, technical coordinator, and data processor was established with in NMA to implement the day to day activities of the project. A National UNV was also employed to assist the project management team. Use was made of national experts as consultants to prepare various technical reports that were used as input to the preparation of NAPA. Multidisciplinary NAPA Team for Ethiopia is composed of experts from the following 14 institutions:

- Ministry of Finance and Economic Development (MOFED)
- Ministry of Water Resources (MoWR)
- Ministry of Agriculture (MoA)
- Ministry of Health (MoH)
- Ethiopian Science & Technology Commission (ESTC)
- Disaster Prevention and Preparedness Commission (DPPC)

- Environment Protection Agency - National Focal Institution for GEF & Focal Institution for CCD
- Ethiopian Agricultural Research Organization (EARO)
- Forestry Research Center - Ethiopian Agricultural Research Organization (FRC-EARO)
- Institute of Biodiversity Research & Conservation (IBCR) - Focal Institution for CBD
- Ethiopian Health & Nutrition Research Institute (EHNRI)
- National Meteorological Services Agency (NMSA) - Executing Agency for NAPA & Focal Institution for UNFCCC
- The Addis Ababa University (AAU)
- Christian Relief & Development Association (CRDA)
- One of the NGOs network in Ethiopia)

OIC Ethiopia Board of Directors consists of community leaders, private sector representatives (including the Chamber of Commerce of Addis Ababa) and representatives from line Ministries such as the Ministry of Labor and Social Affairs, Ministry of Education, and the Addis Ababa City Administration.

Ethiopia's institutional framework for disaster risk management has undergone numerous changes in mandate, structure, and scope over the past 30 years. Following the devastating 1973/4 famines in Northern Ethiopia, the Relief and Rehabilitation Commission (RRC) was established. During its 20-year existence, RRC focused on disaster response and the distribution of relief supplies. The ratification of the National Policy on Disaster Prevention and Preparedness Management (NPDPM) in 1993 led to a shift in thinking based on the perceived need to more closely link the relief and development agendas.5 With this in mind, the government restructured RRC to establish the Disaster Prevention and Preparedness Commission (DPPC), and gave it a mandate to focus on the links between relief and development.

In 2004, DPPC was renamed the Disaster Prevention and Preparedness Agency (DPPA), with a revised and more restricted mandate to focus on acute cases of emergency response. The responsibility to coordinate employment generation, one of the major strategies that link relief with development, was reassigned from DPPC to the newly created Food Security Coordination Bureau (FSCB). As such, DPPA was no longer responsible for addressing the underlying causes of disasters, and was responsible only to respond to fast-onset disasters or unpredictable events.

FSCB addressed national food security through a productive safety nets program, other food security-related projects that attempted to enhance assets and livelihoods, and a voluntary resettlement program. At the institutional level, DPPA was responsible for transitory vulnerability, while FCSB dealt with chronic vulnerability. In practice, though, many perceive that this distinction between chronic and transitory vulnerability is not so clear-cut in reality, and that there is some movement of households between categories

The recent (and ongoing) Business Process Re-engineering (BPR) process throughout the government during 2008-2009 has again restructured the institutional arrangement for disaster risk management, and established the Disaster Management and Food Security Sector (DMFSS) under the Ministry of Agriculture and Rural Development (MoARD), with a significant shift in policy direction. DMFSS now assumes all responsibilities of the former DPPA and FSC B. DMFSS oversees two directorates: the Food Security Program Directorate (FSPD) and the Early Warning and Response Directorate (EWRD). The diagram on the following page illustrates the current structure of DRMSS within MoARD. BPR, which began more than a year ago, has had a major impact on government capacity, resources, and continuity, and has resulted in staff reductions across ministries. Staff of DMFSS in the national-level MoARD was streamlined to reduce 60 percent of the staff, including some of the most experienced and skilled staff. There was less turnover at the regional DMFSS level, and a new cadre of DMFSS staff was created at the woreda (district) level. Thus, many of the current staff in DMFSS are new, and/or lack significant practical experience in disaster risk management. As some donors and NGOs are now beginning to re-engage with Government and try to re-establish partnerships with new staff, the DMFSS is in need for large-scale institutional and capacity building during this transitional and transformational phase. Under the new structure, DMFSS is undergoing a major shift in its approach from traditional reactive post emergency response and relief work to pro-active ex-ante preparedness and disaster risk reduction. The new approach to DRM is highlighted in the new DRM Policy, which is a revision of the 1993 NPDPM. The new DRM Policy is still not completed and needs to be submitted to the legislature for approval. The new and ambitious DRM policy is organized according to Hyogo Framework for Action (HFA) priority areas and addresses some of the weaknesses of the 1993 policy, including the focus on drought and lack of information on community vulnerability and flood preparedness. Despite DMFSS 's shift toward proactive ex-ante disaster risk management and explicit attention to HFA principles in the new policy, Ethiopia is not yet a signatory to HFA and has not established a national platform. Becoming a signatory to HFA would demonstrate Ethiopia's

commitment to the broad principles and strategies outlined in HFA, and would constitute an important political gesture for the new unit.

11.1.4 Eastern Nile Region (Down Stream)

11.1.4.1 Sudan

Table 47 shows indicative evaluation of institutions organisation for effective drought management in Sudan.

Table 47: List of institutions involved in implementing drought adaptation actions

Organization	Strengths	Weakness	Opportunities
Sudan Meteorological Authority	Long term historical data, good observation network, ability to predict; analysis and assess drought situations. Regular drought prediction and monitoring products	Fully coverage of the observation network. Lack of capacity, means and ways to disseminate data information and products. No especial unit for drought monitoring. Lack of sophisticate models and software	To be in the center of stage in the drought management and mitigation in Sudan.
Ministry of Agriculture	Human resources well trained in the field of risk assessment and management	No clear drought management policies. No especial drought units or department with the organization structure. lack of infrastructure	Team up with the SMA and national organization to define the strategy for how applying mitigation practices and how to manage the impact of drought in different sectors (rainfed, pasture areas)
Civil defiance authority	Interventions capacity during the natural disasters	No clear drought mitigation plans	Team up with the national organization to define a kind of strategy to manage and mitigate drought in Sudan.

11.1.4.2 Egypt

Egypt is setting up and strengthened the institutions working on water management and environmental issues. The establishment of these institutions initially responded to the need for the protection of natural resources. Thus, their goals initially focused on measures for water conservation and management, soil and vegetation through the development of protected areas and wildlife reserves, the protection mechanisms of arid lands against different types of degradation, etc. On climate issues in general, efforts have focused on strengthen a committee and developing a national action plan. This section is displaying the analysis of the major ministerial services and department which are concerned with or involved in drought and /or water departments Showing their strengths and weaknesses. Table 51 shows the assessment of organizational structures for drought management in Egypt in terms of strengths, weakness and opportunities

Table 48: Evaluation of organizational structures in Egypt

Organization	Strengths	Weakness	Opportunities
Ministry of Water Resources and Irrigation (MWRI), Nile Forecast Center NFC-Planning Sector	Long term historical data, good observation network, ability to predict;	Lack of capacity, means and ways to disseminate data information and products. Lack of Hydrologist.	To be in the center of stage in the drought management and mitigation in Sudan.
Ministry of Land Reclamation and Agriculture	Integration of the planed strategy with other ministries planning strategies. Human resources well trained in the field of risk assessment and management	No clear desertification strategy implemented. No especial units or department with the organization structure. lack of integration with other sectors	Exchange the meteorological data and the applied research results to manage the impact of desertification and drought in different sectors
Egyptian Environmental Affairs Agency (EEAA)	Building capacity of other concerning sectors	Lack of professional persons specialized , lack of data exchange	

11.1.5 Southern Africa

11.1.5.1 Botswana

The institutional framework is presented in Figure 27:

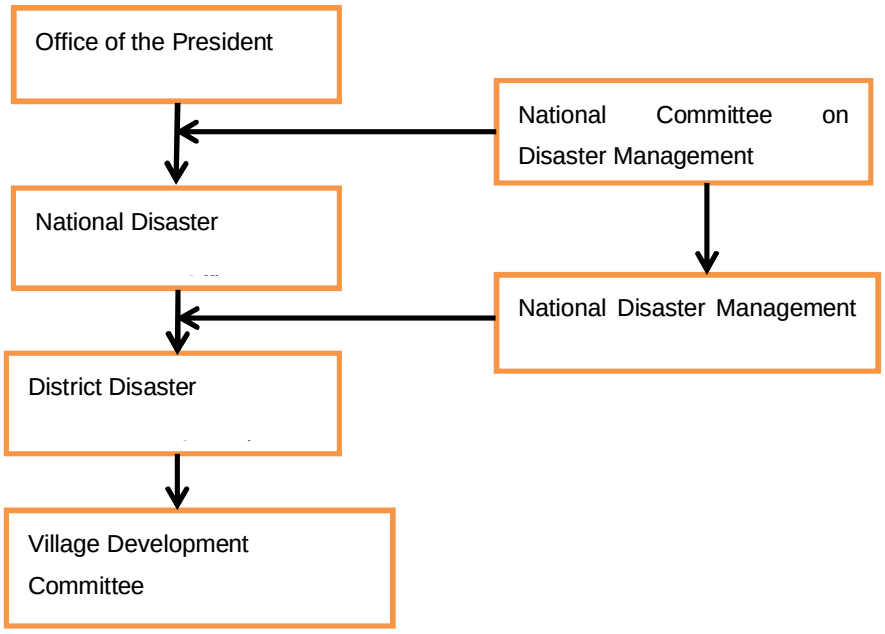


Figure 27: Disaster Management in Botswana

The institutions involved in adaptation to drought in Botswana are listed in Table 49

Table 49: List of institutions involved in implementing drought adaptation actions obtained from available literature

Institution	Responsibility	Contact details/Website
Office of the President (OP)	Management of disaster at National level	Mr. Nkosiyabo Moyo National Disaster Management Office E-mail address : nmoyo@gov.bw Telephone : +267 3950936 Fax : +267 3904017
National Committee on Disaster Management (NCDM)	coordinates the activities related to disaster risk management	
National Disaster Management Technical Committee (NDMTC)	Coordinates the activities related to disaster risk management	

Institution	Responsibility	Contact details/Website
District Disaster Management Committee (DDMC)	District commissioner in responsible for drought management at district level	
Village Development Committee (VDC)	implement activities related to disaster risk management in their respective jurisdiction	

The specific objectives of the disaster risk management plan are:

- to establish a set of working definitions for the integral components of disaster risk management in Botswana.
- to define measures to reduce vulnerability to disasters and build capacity and resilience at national, district and community levels

11.1.5.2 Mozambique

The SWOT analysis results of the institutions involved in drought mitigation and adaptation are listed in Table 50.

Table 50: SWOT analysis results of the institutions involved in drought mitigation and adaptation in Mozambique

Institutions	Strengths	Weaknesses	Opportunities
INGC	Coordinate the efforts of disaster management and receives support from public and private institutions.	Lack of a department that deals specifically with drought related issues; Lack of a drought forecast systems	Creating a department to deal specifically with drought Development of a drought early warning system
MICOA	Coordination and implementation of inter-sectoral vision of the correct use of natural resources (implementation of the strategy and action plan for the prevention of drought).	Lack of qualified personnel in drought management. Limited funding	Increase qualified personnel;
INAM	Monitoring weather parameters across the country	Lack of appropriate equipment and technology that can increase the credibility of the	Development of appropriated and most comprehensive technology particularly those

Institutions	Strengths	Weaknesses	Opportunities
		generated results	related to droughts.
FewsNet	Supporting the preparation of contingency plans for disaster response; Improved the utilization of information for drought prevention	The resolution of the generated results is not good enough	Need to improve the sampling mechanisms
ARA -Sul	River basin management units in place	Lack of a Department and personnel that deals specifically with drought Lack of a drought forecast systems	Creation of a drought management department Development of early warning systems.
Ministry of Agriculture (MINAG)	Development of decadal bulletins that present crop needs for different agricultural seasons	Lack of infrastructure to achieve its global goals	Development of a drought early warning system. Development of appropriate and comprehensive technologies

11.1.5.3 South Africa

The institutional framework is illustrated in Figure 28.

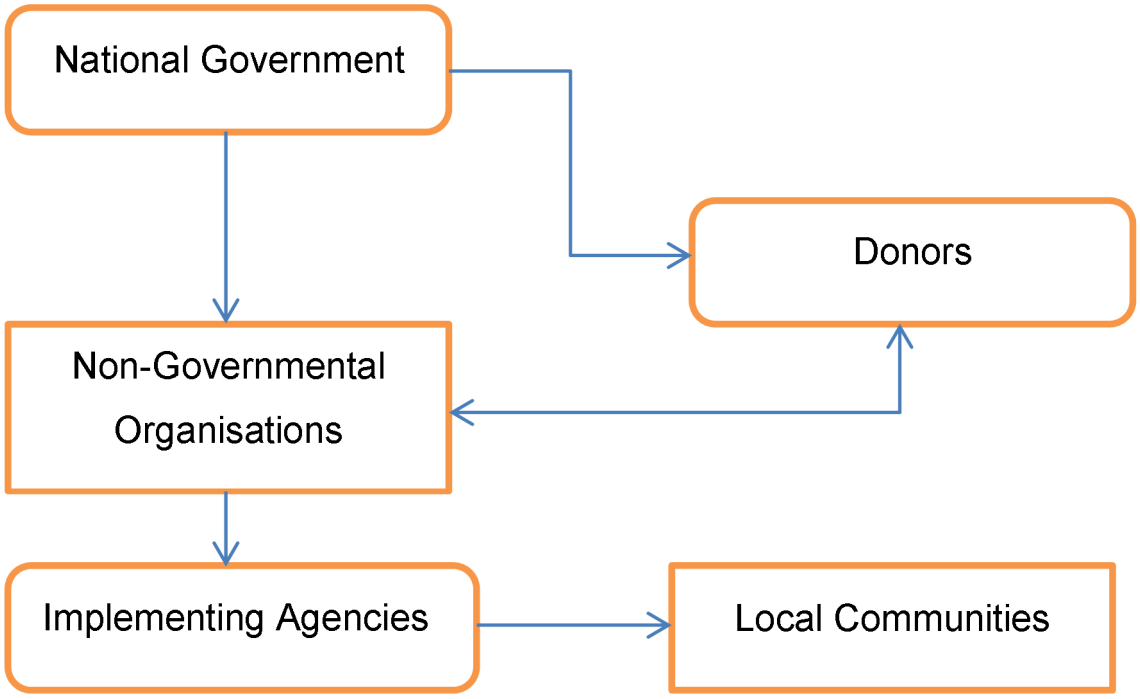


Figure 28: Drought Institution coordination framework in South Arica

The institutional framework at national level is presented Figure 29.

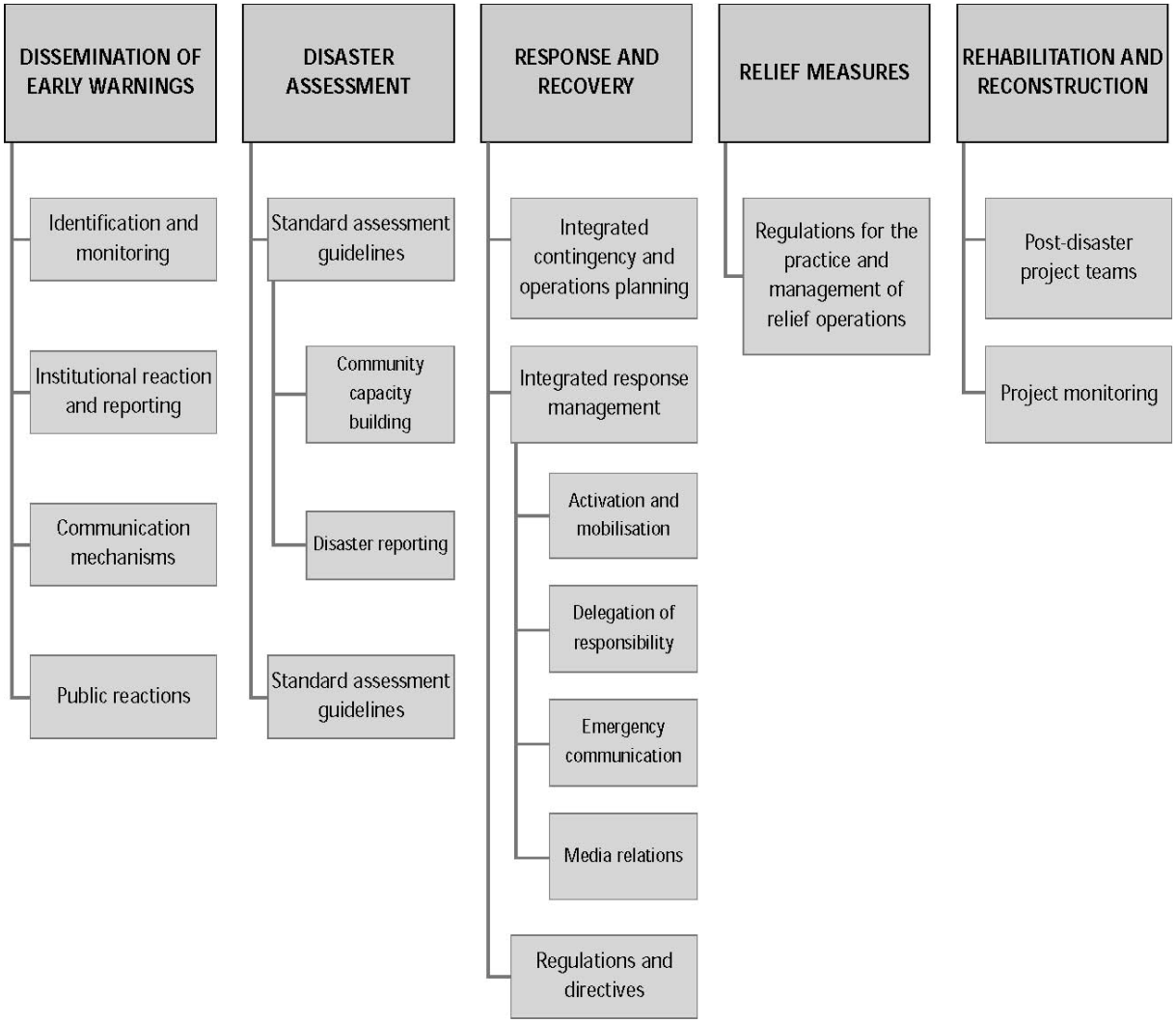


Figure 29: National Disaster Management Framework in South Africa

The institutional framework at provincial level is presented Figure 30.

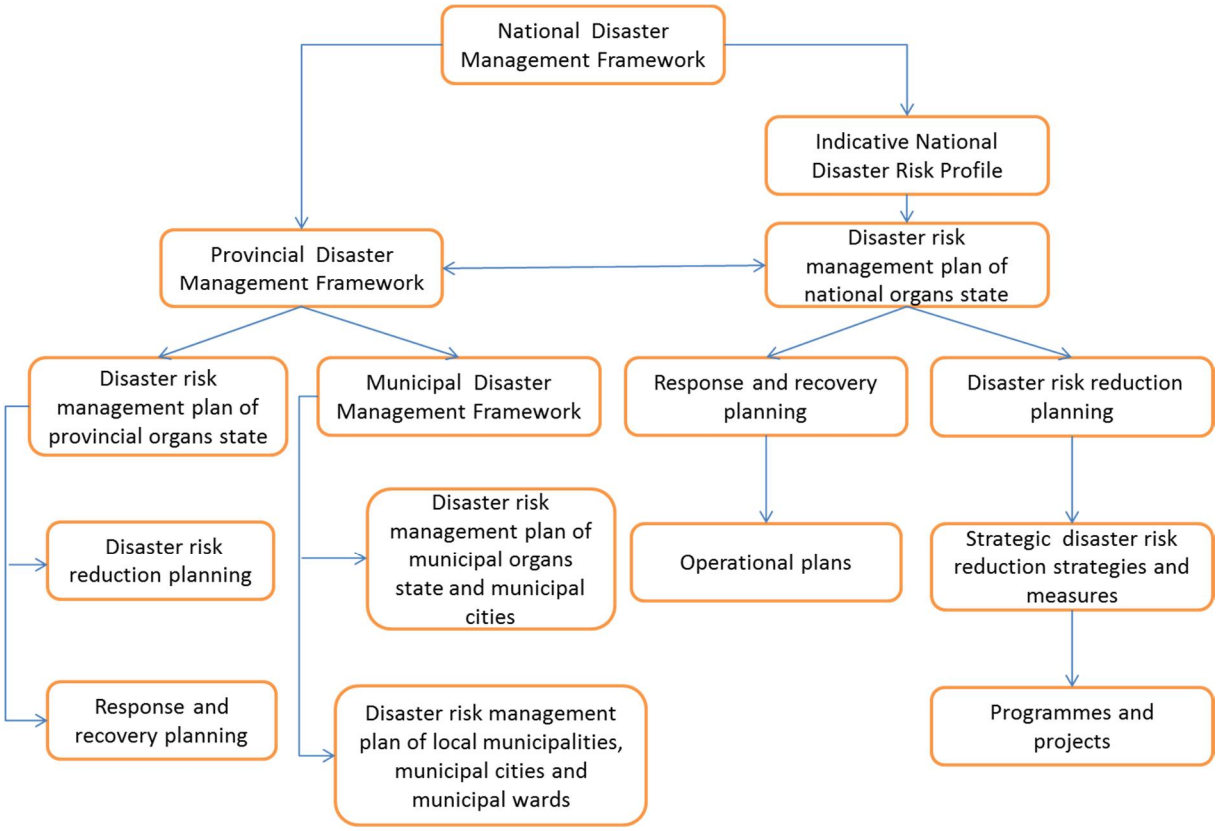


Figure 30: National, Provincial Disaster Management in South Africa

The institutions involved in adaptation to drought in South Africa a listed in Table 51

Table 51: List of institutions involved in implementing drought adaptation actions obtained from available literature in South Africa

Institution	Responsibility	Contact details/Website
National Disaster Management Centre	Integrated and co-ordinated disaster risk management policy that focuses on preventing reducing the risk of disasters, mitigating the severity of disasters, preparedness, rapid effective response to disasters, and post-disaster recovery the establishment of national, provincial and municipal disaster management centres disaster risk management volunteers	The National Disaster Management Ce ntre 87 Hamilton Street, Arcadi a, Pretoria, South Africa . 0001 Phone +27 12 334 0600 • Fa x +27 12 334 0810.
World Vision	World Vision identifies places at risk of disaster, prepares resources and staff in high-risk zones, and builds capacity and resilience among communities to help them protect themselves before an	Maposa Stanley: World Vision South Africa Mobile+27738254188. Email:stanley_maphosa@wvi.org Skype: ramaphosa2311

Institution	Responsibility	Contact details/Website
	emergency and rebuild afterwards.	P. Bag x 12 Florida 1710 |5 Main Avenue, Florida: Gauteng-Johannesburg South Africa. Phone:+27116711300 Fax: +27114724885 www.worldvision.co.za
World Bank	The World Bank is a vital source of financial and technical assistance to developing countries around the world. Our mission is to fight poverty with passion and professionalism for lasting results and to help people help themselves and their environment by providing resources, sharing knowledge, building capacity and forging partnerships in the public and private sectors	www.worldbank.org
Food and Agriculture Organisation (FAO)	Achieving food security for all is at the heart of FAO's efforts - to make sure people have regular access to enough high-quality food to lead active, healthy lives. FAO's mandate is to raise levels of nutrition, improve agricultural productivity, better the lives of rural populations and contribute to the growth of the world economy	www.fao.org
World Food Programme (WFP)	WFP is the food aid arm of the United Nations system. Food aid is one of the many instruments that can help to promote food security, which is defined as access of all people at all times to the food needed for an active and healthy life. The policies governing the use of World Food Programme food aid must be oriented towards the objective of eradicating hunger and poverty. The ultimate objective of food aid should be the elimination of the need for food aid	www.wfp.org
Department of Agriculture	- Agricultural risk management - Farmer settlement - Agricultural finance and cooperative development - Food security and rural development - Domestic marketing - International trade - Business and entrepreneurial development - Water use and irrigation development	Ms N. Vutula Chief Director: Communication and Information Room K FF 10 012 319 7348 CDCI@daff.gov.za Dr M. Visser Chief Director: Agricultural Production Room 234 012 319 6506 CDAP@daff.gov.za

Institution	Responsibility	Contact details/Website
	- Land use and soil management - Scientific research and development - Animal and aqua production - Plant production - Education and training - Agricultural information services - International relations - Land redistribution; land use planning; resource conservation; control of pests and noxious weeds; infrastructure; policy development; empowering small emerging farmers; agricultural statistics - Trade and industry; tourism; economic planning, research and policy - District health systems; social welfare programmes; poverty alleviation	http://www.nda.agric.za/ Dr P P Pheme, Private Bag X9487, Pietersburg 0700. Tel. (015) 295 7048/295 7090. Fax: 015-2913740. E-mail: PhemePP@agricho.vorprov.gov.za

11.1.5.4 Zimbabwe

Various institutions are involved in drought management within Zimbabwe including government departments, traditional institutions and NGOs. The private sector is not very visible in drought management, only NGOs are involved in different aspects of drought risk reduction; many offering short-term assistance (relief services) that satisfies immediate needs. Some also provide technical assistance and financial/material support for initiatives that help communities in rebuilding their livelihoods. Major activities include, harnessing of surface and ground water, rehabilitation of water sources, small livestock support, agricultural inputs, supporting irrigation schemes, supporting conservation farming, promoting planting of drought tolerant crops, promoting small gardens, food relief and capacity building in various aspects of drought coping and risk reduction. Informal institutions have not played a major role in drought risk reduction. It can be noted that local institutions like chiefdoms are only active in food distribution and trying to promote the concept of Isiphala senkosi (Chief's granary). Traditional norms and beliefs are no longer effective in reducing land degradation because law enforcement is now weak. The scale of intervention differs as some of the institutions give help to the needy on an individual basis whereas other institutions give help to a particular area as a whole. Most institutions indicate that they carry out a needs assessment before an intervention is initiated. However, some communities express dissatisfaction with some of the organisations who they feel do a superficial assessment that is not representative of the community needs. Government departments are commonly constrained by inadequate resources (both financial and material) to implement

programmes; they don't have transport or the resources for training farmers. High staff turnover due to poor remuneration has led to high farmer to extension worker ratio, particularly in the case of AGRITEX, with the result that extension workers are not able to cover all the farmers in their working areas. Most NGOs have a small number of staff, based at district level and not at ward or local level making monitoring of NGO projects weak. Challenges common to both NGOs and Government departments include political interference in day to day activities that sometimes derail implementation of drought risk reduction activities. The existing economic environment has also led to high staff turn-over in most government departments and shortages of inputs and materials required for drought risk reduction. The recurrent droughts have made it difficult for communities to recover, resulting in a continuous need for drought relief. Migration of some members of the household, especially the bread winners and able bodied, to neighbouring countries such as Botswana and South Africa has led to a shortage of labour affecting some drought risk reduction activities. The rate of adoption of appropriate mitigation initiatives has been a challenge in some communities with planned interventions either curtailed or not taken up at all. Funding for disaster reduction is limited. Most institutions do not have a budget for drought reduction. These institutional challenges increase the vulnerability of communities

Weaknesses

- Funding constraints

Budgetary resources are often not available for preventive measures, but also for disaster response. Most drought monitoring, early warning and forecasting institutions in the catchment lack the financial capacity to carry out drought forecasting activities and let alone to acquire up to date data collecting equipment .Funding stands out as the major challenge or hindrance for effective drought monitoring.

- Research and data sharing

With a few exceptions, countries in sub-Saharan Africa lack the capacity to conduct research on natural and human-induced hazards and disasters, or to apply the knowledge and deploy technologies to mitigate disasters.Data sharing is often inadequate between government agencies and research institutions, and the high cost of data also limits their application. Drought-related research is critical in the production of innovations and technology that lead to improved drought preparedness. Currently a coordinated and integrated drought research program does not exist at the national level and even at catchment level, despite the enormous impact of droughts every year on the nation's economy, society and the environment. Furthermore, drought research is scattered across many agencies, universities, and other research institutions, without formal coordination or planning to maximize the value of the research dollars spent and without effort to ensure that the priority needs of the public

and decision-makers are being addressed. The simple act of coordinating drought research within and between levels of government, as well as with private entities and universities, will help accelerate the development and provision of scientifically-based information products, thereby, enabling users to better prepare for, manage and respond to the impacts of drought in the catchment. Governments in Africa tend to rely on international donors rather than to build indigenous research capacity; that is, rather than investing in research they more often depend on donor funding for research projects in their countries. There is therefore a need to improve training and to build capacity so as to facilitate better use of research results in policy- and decision-making.

- Management of water resources

For the case of Zimbabwe management of river systems and monitoring is only limited to cities, towns and some growth points and as such most rural areas are not covered. Thus the is a difficult in controlling water use in remote areas especially in drought years.

- Poor technology

Remote sensing images provide excellent information relevant to studies of hazards, such as, for example, the hydrology, topography, and land use of catchments, and variables such as soil moisture and snow cover. However, in Zimbabwe; lack funds, infrastructure, software, and skills to download and interpret the remote sensing data. Free data sets (for example, Landsat, NOAA, MODIS, Meteosat), while very useful, often have low spatial and/or temporal resolution. While Landsat data has comparatively high spatial resolution, only historical data is available, as the system has ceased to operate. More accurate high resolution data obtainable from sources such as SPOT are very expensive.

- Summary

Disasters like flooding have rarely had direct costs such as human lives in Zimbabwe. Costs have mostly been confined to damaged livelihoods, hence responses to such disasters have largely been reactive than proactive. This short sighted response is despite that damaged or disrupted livelihood systems take time to rebuild and mend. There is currently a heavy bias towards emergency response and relief. Not much has been done in the area of disaster mitigation. Following major droughts (1992 and 2003) and the resultant livestock losses, focus has largely been on restocking efforts without addressing the critical issue of carrying capacity, sustainability thresholds and the ecological footprint of large numbers of livestock in a context of diminishing grazing area. Although a multi-sectorial hazard and vulnerability mapping exercise was undertaken, its results largely have circulated particularly to the grassroots communities who are the most affected and therefore logically the most in need of such information. The challenge has been how to package the information so that it is easily

understood and utilized by such grassroots communities. Another challenge is the fragmented nature of pieces of legislation dealing with disaster management and above all the weaknesses of the Civil Protection Act. It is apparent that environmental disasters affect people, more than anything else. However, in Zimbabwe, handle disaster management and environmental management are handled as separate entities. Under the current arrangement presided over by the Civil Protection Unit, it is the central government that initiates hazard reduction measures through relevant ministerial sectors. This is complicated by the fact that the Department of Civil Protection is housed under the Ministry of Local Government, Public Works and Urban Development and instead of the Ministry of Environment and Tourism. There is need to rethink this arrangement in the light of coordination, attitudes, and accountability. .Although there has lately been an acknowledgment of community early warning system based on indigenous knowledge systems; these have not been properly documented and widely shared. The interface between the scientific and the traditional still requires more negotiation. Indigenous knowledge systems on seasonal rainfall predictions have been documented for many parts of Zimbabwe. There is a striking similarity between some of the indigenous and contemporary climate indicators especially those related to wind direction, temperature and clouds. Observations of plant and animal behaviour dominate indigenous climate forecast systems in many parts of the country. Inter-annual fluctuations in fruit production in certain tree species have been used as an advance seasonal rainfall indicator. Animal behaviour is also used to predict weather conditions. At political level, it looks like it is a question of priorities. Like in most low-income countries, in Zimbabwe developmental priorities are still placed on health, job creation and education than on environmental protection and hence disaster mitigation and adaptation strategies receive comparatively lower priority in national policies and development plan.For climate change mitigation efforts to pay off there is need to promote such activities in such a way that the community buys-in ownership and that ensures sustainability of the exercise. As long as solutions are imposed, communities may remain alienated to life saving knowledge and at times remaining superstitious. Thus instead of appreciating and embracing the technology of lightning conductors, such knowledge is greeted with suspicion. In short Disaster Mitigation plans need to be incorporated or packaged into development projects so that they can easily accommodate disasters that may befall communities. Developing separate or standalone disaster management plans could be counterproductive. There is thus, need to implement projects which reduce communities' vulnerability to natural hazards there by strengthening community livelihoods. The media could be engaged to play a more significant role in dissemination of information from assessments, policies and strategies relevant to vulnerability

11.2 COMPARISON OF GLOBALLY AVAILABLE STATE-OF-THE-ART ORGANISATIONAL STRUCTURES FOR DROUGHT MANAGEMENT WITH THOSE IN AFRICA

11.2.1 North Africa

The increase of drought frequencies and severities at the global level during the last decades as a consequence of Climate Change led policy makers to couple already implemented relief actions with a proactive management strategy based on drought risk management and the implementation of mitigation actions. As a result to this new orientation:

- The United-States succeeded to develop drought management plans at different levels (state to farms) relying on a high performance and efficient national drought monitoring system and timely effective drought early warning systems. In addition, the drought management system is supported by several institutions and ministerial departments collaborating in an efficient and permanent manner, with a clear scope of activities and responsibilities for each of these services. The drought management system in the US also relies on a strong capacity building and awareness raise program at all users' levels, and with a special focus on end's users. It makes also the emphasis on the science-policy interface with a strong involvement of research institutes. However, USA still did not succeed to adopt a national drought policy and the main actions are conducted at the state level.
- The history of the Australian drought policy is quite a good example of a shift from a crisis management to a risk management. Indeed, until 1992, drought management in Australia was mainly achieved though relief and subsidies actions implemented by States and national governments. From 1992 and onwards, the Australian drought policy promotes producers to adopt self-reliant approaches and the role of the government is to provide farmers with skills/tools like research into climate variability and prediction, decisions support tools (drought risk and impacts assessments, early warning systems, seasonal weather forecasts), training and education, tax incentives and social support. The direct government intervention is warranted only when drought is exceptional. (Wilhite, 2005). Further reforms of the Australian drought policy aim to help better prepare farmers and rural communities for a changing climate on the basis of the economic assessment of drought support measures, the assessments of the social impacts of droughts on farmers and rural communities and a climatic assessment of the likely future climate patterns and the current exceptional circumstances standard of one-in-20-to-25-years event.

- At the European level, Drought management strategies are now relying on Drought management plans established for most drought prone countries at the national or river basin levels. There are also supported by the creation of drought dedicated structures to encourage experience sharing and regional collaboration on this important issue.

The comparison of these strategies and organizational structure of drought management with the ones currently developed at the north-African level and more particularly in Morocco since it is the best know example for us, reveal that even though this country decided also to move on to a more proactive drought management strategy more than a decade ago with the assistance and transfer of technology from the NDMC, it did not succeed to plainly fill this objective. Indeed, this analysis shows that the weaknesses previously identified in point 13.2 are in fact the strengths of these successful state of the art drought management strategies. They are mainly:

- A strong, efficient and permanent collaboration between institutions involved in DM and a clear definition of the scope of activity and duties of each one.
- An effective proactive action based on a efficient drought monitoring system and thus a good information flow between monitoring and mitigating activities.
- The development of drought management plans at national or even lower levels
- A strong involvement of Science
- The development of a national drought policy

This last point is of major importance. In this context, the WMO is organizing in March 2013, a high level meeting on national drought policies because:

- No concerted efforts have ever been made to initiate a dialogue on the formulation and adoption of national drought policies
- Only Australia has a national drought policy which provides a clear description of when and how communities affected by droughts could seek drought relief under a legal framework (Stefanski, 2012).

11.2.2 Equatorial Lakes Region

11.2.2.1 Tanzania

Table 54 shows a comparison of the state-of-the-art organisational structures for drought management with those in Tanzania

Table 52: Strengths, weakness and opportunities for drought management in Tanzania

Strengths	Weakness	Opportunities
Availability of the National adaptation programmes of action (NAPA) with a focus in the agriculture, water, energy, health and forestry sectors	inadequate efficiency as they lack equipment, personnel and funds; no comprehensive warning system in the country	Effective dissemination and use of early warning information, and public education programs at both the national and local level
Availability of National and private research institutes	No research into modeling and methodologies to drought management	Setting national research agenda; Set research funds; International & regional collaborations

11.2.2.2 Kenya

The lack of state of the art organization of structures for drought management within Africa continues to be a challenge. Globally they are effective when all components are functional. For example looking at the early warning system in use in the developed systems and regions:

Early warning (EW) is "the provision of timely and effective information, through identified institutions, that allows individuals exposed to hazard to take action to avoid or reduce their risk and prepare for effective response.", and is the integration of four main elements, (from International Strategy for Disaster Reduction (ISDR), United Nations (UN), 2006):

Table 53: Strengths, weakness and opportunities for drought management in Kenya

ITEM	GLOBAL REQUIREMENT	KENYA CONTEXT
Risk Knowledge	Risk assessment provides essential information to set priorities for mitigation and prevention strategies and designing early warning systems.	There is no program in place for a continuous assessments
Monitoring and Predicting	Systems with monitoring and predicting capabilities provide timely estimates of the potential risk faced by communities, economies and the environment.	There are systems in place for regions with recurrent events. The effort of NGOs seems to be with more vigour than government agencies.
Disseminating Information	Communication systems are needed for delivering warning messages to the potentially affected locations to alert local and regional governmental agencies. The messages need to be reliable, synthetic and simple to be understood by authorities and public.	Structured warning systems are in place on a national scale but there is very little sensitization on the ground within the communities.
Response	Coordination, good governance and appropriate action plans are a key point in effective early warning. Likewise, public awareness and education are critical aspects of disaster mitigation.	Response from government is always late or uncoordinated. The Red cross and other agencies take a lead role in response.

Failure of any part of the system will imply failure of the whole system. For example, accurate warnings will have no impact if the population is not prepared or if the alerts are received but not disseminated by the agencies receiving the messages. The basic idea behind early warning is that the earlier and more accurately we are able to predict short and long-term potential risks associated with natural and human-induced hazards, the more likely we will be able to manage and mitigate disasters' impact on society, economies, and environment.

11.2.3 Eastern Nile Region (Ethiopian Plateau)

Government capacity at all levels, but particularly at the national level, is a critical issue in the establishment and implementation of this new mandate and proposed DRM policy. Successful implementation of the new DRM policy will require the development of a concrete and detailed strategic framework and implementation plan. The failure to fully implement the existing NPDPM has been attributed to the chronic capacity problem at all levels and lack of legislation to enforce the implementation of the Policy. Major stakeholders, particularly key line departments, do not always accept and support the main DRM strategy - the Employment Generation Scheme (a mechanism to link relief and development) - as part of their mandates. Links between responsibility, authority and accountability have not been clearly understood and observed. This is a major priority for making the new DRM Policy an effective vehicle for DRM.

Lack of coordination and cooperation among development partners and among government branches, and the lack of a coherent, comprehensive approach to DRM, are the main challenges to the implementation of the new DRM mandate. DMFSS needs to take a strong lead in providing a coherent framework and policy for DRM at the national, regional, and local levels. There is also a need for DMFSS to play a significant coordination role among the many actors involved in DRM, and to provide the donor and NGO community with a clear picture of how the various DRM investments and interests in the country are aligned.

There is also a strong need for greater coordination by DMFSS for sectoral-level DRM activities within the line ministries. DMFSS is the lead agency for dealing with hazards including drought, flood, and food insecurity, and the coordination of DRM across the ministries. Line ministries address the integration of DRM issues at the sectoral level. The Ministry of Water Resources, for example, is responsible for flood preparedness and the coordination of responses to water and sanitation-related disasters including floods. The National Meteorological Agency (NMA) falls under this ministry and prepares and

disseminates monthly, seasonal, and annual climate bulletins and seasonal and annual hydrometeorological bulletins; NMA also finalized the Government's National Adaptation Program of Action (NAPA) in 2008 and is mobilizing financial resources for its implementation.8 The Ministry of Health oversees an emergency preparedness, early warning, response and recovery system for health emergencies linked to hazards including floods and drought. These DRM activities at the sectoral level need to be better coordinated by DMFSS to avoid duplication of efforts and develop common methodologies and baselines for risk profiling (see next section for more details on risk profiling)

There is a recognition that food security and early warning activities must be decentralized to regional and woreda (district) levels. In 1995 the new constitution established a decentralized federal system that divided the country into a series of semi-autonomous Regional States. Most responsibilities for the planning and implementation of development policies and programs were decentralized to this level. Each region has its own set of government institutions which largely replicate those at the federal level. Resources and responsibilities for service delivery and project implementation have been moved to the woreda offices. In practice, however, both woreda and regional policies are still guided by federal sector policies and by cross-sector strategies and programs. A second phase of decentralization in 2002 established the woredas as the center of socio-economic development and empowered woreda administrations. The woredas now have economic autonomy and receive direct block grants from the regional level. Each woreda now has an elected council, from which are elected a woreda administrator and deputy who exercise overall leadership. The administrator chairs the woreda cabinet, which consists of the heads of the various government departments found at this level. There is a Task Force on DRM, led by DMFSS, that is supposed to bring together all of the Ministries that deal with DRM at the sectoral level: Ministry of Water Resources, Ministry of Health, Ministry of Agriculture and Rural Development, Ministry of Environment, and NMA. This forum and other similar working groups and platforms, including the Early Warning Working Group (EWWG), Rural Economic Development – Food Security (RED-FS) Group, and the Sustainable Land Management (SL M) national platform, need to be better coordinated and integrated, with the clear establishment of roles and responsibilities. However, during and immediately after the BPR, this Taskforce has not been functioning. It is important to re-establish a functioning Taskforce on DRM to help finalize the new DRM Policy and to help lead the process for developing a detailed operational strategy and implementation plan.

11.2.4 Eastern Nile Region (Down Stream)

11.2.4.1 Sudan

Sudan Meteorological Authority has long term time series data which help in forecasting and prediction of the drought event and therefore drought management. But face many weakness points which includes lack of facilitates, infrastructure, software and Self finance and There are 34 weather stations and around 300 rainfall gauges all over the country. There is great development over the past years as the expanded network of stations and stations supported by the most advanced electronic devices. The opportunities is that the SMA can

- Disseminate of information to end user in suitable format and in right time.
- Establishing and coordination end user network.
- Sustainability of data flow.
- Verification and service feedback flow.

11.2.4.2 Egypt

There is no formal organizational structure of drought management in Nile Basin countries. In addition, the institutional framework is constantly changing. The meteorologists provide forecasts for stakeholders and decision maker to support taking actions. In Egypt, the Egyptian Meteorological Authority is consider the official source for the weather prediction but not fully co-operation to the other organizations concerning with meteorological information, each of these organizations or Ministries had it own research department or sectors concerning with collecting these type of data such as the Ministry of Reclamation land and Agriculture and the Ministry Water Resources and Irrigation. The data collected is non-uniform and the data exchange is also not executed.

11.2.5 Southern Africa

11.2.5.1 Botswana and South Africa

The institutions involved in adaptation to drought in South Africa a listed in Table 54

Table 54: List of institutions involved in implementing drought mitigation and adaptation actions

Type of Institution/Role	Botswana	South Africa	State of the Art
Water Infrastructure Development	X	X	X
Forecasting		X	X
Early Warning		X	X

Type of Institution/Role	Botswana	South Africa	State of the Art
Agriculture Extension Services	X	X	X
Food aid			X
Management of Water Infrastructure		X	X
Funding			X
Policy	X	X	X
Advocacy	X	X	X
Water supply (tankering etc)	X	X	X

Comparison of state of the Art and local drought management structures is listed in Table 54

Table 55: Comparison of state of the Art and local drought management structures

State of the Art Organisational Structures for Drought Management	South African Organisational Structures For Drought Management
Mainly coordinated by Ministry of Agriculture /Environment/Meteorological/Water departments with hands on experience and technical expertise for drought management	Coordinated by central government to provincial government, municipalities and local Communities
Clearly developed partnerships, lines of communication and local stakeholders were included in the design process of the plan.	Lines of communication exist between government structures but there is no clear link between government and local municipalities. Local stakeholders link with both government and municipalities in mitigation any drought event
Drought is managed at Basin Level depending on that spatial extent of the event before central government and cities and towns	at SADC level drought is also monitored and information is then disseminated to respective countries at central government level

11.2.5.2 Mozambique

The institutional framework for natural disaster management in Mozambique is illustrated in Figure 23.

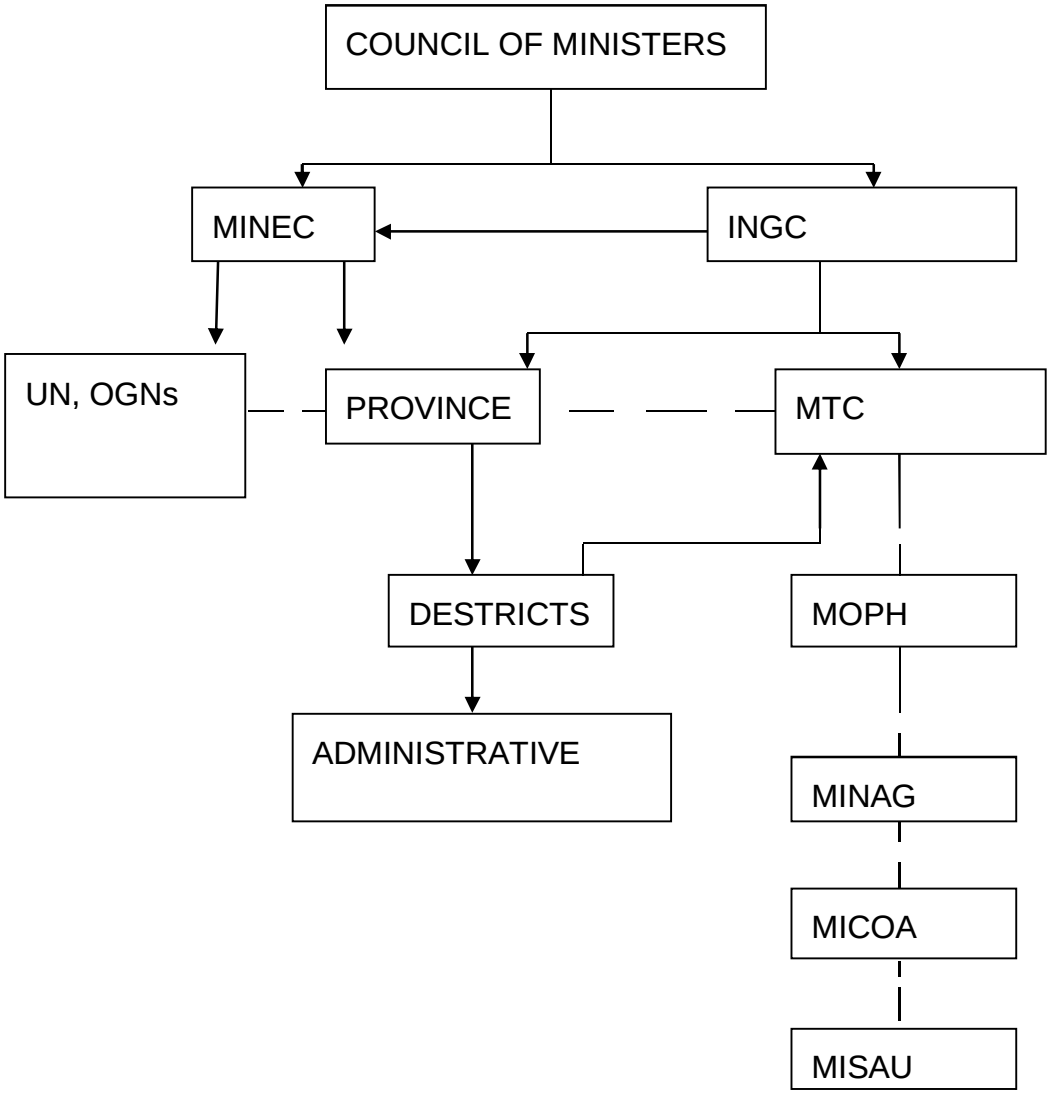


Figure 31: Institutions that coordinates disasters management in Mozambique (MICOA, 2006)

The organizational structure is the same at local level. After the information has been processed by INAM, the MINAG and INGC interpret this information in terms of crop water satisfaction index. The analyses are planned and done from September where other institutions are invited to provide their inputs. Thereafter, and through the extension officers this information is broadcasting to the provincial and district governments and then farmers.

Strengths

- Multi-sectorial work;
- Conservation of water used for small-scale irrigation and human and animal consumption;
- Use of local materials and basic construction techniques using local labour.

Weaknesses

- Limited use of a participatory methodology in designing mitigation and adaptation programs (i.e., NGOs are not invited for program planning and implementation);
- Absence of a consensus methodology to diagnose the magnitude of drought in a disaggregated manner.
- Inadequate monitoring mechanisms including impact assessment.
- Lack of harmonization and coordination in terms of funding for mitigation and adaptation programs.

Opportunities

- Greater involvement of local structures, especially the administrators, NGOs and District Agricultural Departments.
- Establishment of feedback information mechanisms to districts.
- Installation of a monitoring system to track not only the execution of intervention but also to measure the impact and report to donors (i.e., UN and Government) on the progress.

12 IDENTIFICATION OF POSSIBLE IMPROVEMENTS TO THE EXISTING SITUATION IN AFRICA

12.1 DROUGHT MITIGATION PRACTICES IN AFRICA

12.1.1 North Africa

The comparison of drought mitigation practices currently adopted in North-African countries with the globally state-of-the art practices and the user's requirements revealed that although policy makers recommend, since more than a decade, a shift towards a risk based drought management approach, it remains mainly oriented towards drought impacts relief actions. The possible improvements to this situation concern in priority the decision support tools that can guide the implementation of appropriate mitigation measures such as:

- **The Definition and development of accurate and suitable drought indicators and triggers** to ensure real-time information concerning the development of drought conditions. These indicators must be based on carefully processed climate information. Thus, since access to climatic information encounter some problems (see D 2.4), there is a need to look for the use of global data sets. At present there are current low-resolution geospatial climatic products like the dataset of African climate data available at the Global Historical Climatology Network (GHCN) and other climatic sources (WMO telecommunication net, Climate Prediction Centre precipitation, etc. see http://climexp.knmi.nl/) that may be used to produce climate layers. In addition a global SPEI dataset is already available for the African continent at a spatial resolution of 0.5° (Beguería *et al*., 2010) which can be used to assess drought risk and drought vulnerability in a variety of systems.
- Their integration in Drought early warning systems operating in real time and regularly up-dated
- **The development of seasonal weather forecasts** and forecasts of the likely evolution of the drought
- **The development of agro-meteorological monitoring**. The livelihoods of most rural populations in North-Africa are dependent on traditional agriculture that is dependent on seasonal rainfall. In this context, agro-meteorological monitoring refers to the continuous assessment of rainfall and agricultural conditions. Continuous monitoring of rainfall amount and distribution coupled with available crop growth models can be used for targeted areas, chosen on the basis of their agronomic importance and/or relevant meteorological events (e.g., areas with serious delay in the start of the rainy/growing season). The capacity for large-area crop monitoring is rapidly

improving because of improved satellite observations. Using satellite-based remote sensing technologies, scientists are now able to more accurately monitor cropped areas and estimate crop yields and production. The integration of crop model results, satellite-derived indicators of vegetation conditions such as the normalized difference vegetation index (NDVI), and field reports can often be used to identify widespread crop failures several weeks before the end of the growing season and then take specific and appropriate decisions.

- **An accurate drought risk assessment** quantifying the degree of hazard and the vulnerability of regional levels. The combination of state-of-the art methods of drought hazard analysis (spatial-temporal, non-stationary, multivariate extreme events analysis) would provide maps of the probability of occurrence of droughts in terms of their duration, intensity and magnitude, in order to identify (and quantify) the most drought-prone regions and the presence (or not) of long term time trends in the severity of droughts.
- **The assessment of the drought vulnerability** of several systems (water resources, natural vegetation and crops) to quantify the impact of drought in terms of both the system's resistance and resilience, and to produce drought impact curves to each system and region.

They include also:

- **Capacity building** for the consolidation of education, training and diffusion of best practices in drought response, preparedness and mitigation: Capacity building on drought management planning and specifically on the use of geospatial drought information products is of paramount importance for achieving the desired level of impact on the end-users and, in general, to improve the management of drought hazard. Training courses and workshops for institutional resource managers focused on urban and irrigation water management may provide efficient forums to discuss and understand the potential uses and limitations of Drought Preparedness Plans, geospatial data and drought information systems in their planning and decision-making activities. Organizations such as the FAO Regional Office for the Near East (FAO-RNE), the International Centre for Agricultural Research in the Dry Areas (ICARDA) and the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) have been historically involved in promoting capacity building through training courses, workshops and seminars on drought risk management.

Nevertheless, capacity building must go beyond these initiatives and focus on different levels, at the same time improving the use of current technologies and information on drought conditions and predictions that provide drought monitoring and early warning systems for better and early decision making.

- **Community-to-community visits and training-by-doing**: In field exchange and peer assistance tools should be used widely to improve diversification of livelihoods, crops and livestock, such as introduction of early-maturity, short-duration and drought-tolerant crop varieties and changing cultivation practice.
- **Raising awareness** about the importance of continued actions to build community resistance in drought prone areas even when the rains come.
- **Raising awareness** in the media about interventions in drought mitigation
- The enhancement of drought mitigation concern and actions in the domestic and industrial sectors
- **The development of Awareness and Education Programmes**: Education programmes would have to be designed aiming not only to raise public awareness of the development and implementation of Drought Management Plans but also to ensure that people are aware of way to respond when drought occurs. The information provided should be tailored to the needs of stakeholder groups and would ideally be presented through press and various events.

12.1.2 Equatorial Lakes Region

12.1.2.1 Tanzania

Below is a list of opportunities to improve drought mitigation practices in the drought areas of Tanzania

- Good soil water management
- Watershed management
- Agro-forestry practices that help to capture carbon dioxide in the atmosphere, increases soil fertility and water storage and enhance agricultural production
- Improve human and financial capacity
- Improve drought events monitoring and documentation
- International cooperation
- Practice effective knowledge sharing especially for the highly vulnerable sectors such as water and agriculture and in the sub-Saharan region

12.1.2.2 Kenya

Drought management and mitigation can be effected through the development of technologies. Mitigation measures may be centred on improvements in production and management of crops, land and water resources through various techniques (e.g. the development of crop varieties and breeds that tolerate drought, adapted livestock management, deficit and supplemental irrigation, water harvesting and no-till or minimum tillage systems). Through these means, there must be support of national programmes and agricultural research systems in the region to promote better natural resource management to increase agricultural productivity and resilience to drought. The approaches tested with some levels of success have included;

- Encouraging infrastructure improvement to facilitate movement of relief from endowed areas of the country in good time when needed.
- The animal off take programs for pastoralists.

12.1.3 Eastern Nile Region (Ethiopian Plateau)

There is a distinct lack of information however, upon which to develop policy in the fields of:

- Drought losses
- Marketing
- Financial institutions (formal and informal)
- Savings

This partly reflects the more recent literature that emphasises the rationality of pastoral production systems and coping strategies. These are no doubt effective, being based upon generations of experience, but are under pressure as livestock: human ratios continue to fall. Under these circumstances there is a need to reassess the role for savings and financial institutions for pastoral households and the manner in which pastoralism contributes to the generation of different forms of capital assets. Livestock owners may need these institutions to survive but increasingly they will also be important for those households who have ceased to rely on livestock for their livelihood and have diversified into other income generating activities.

Two fundamental requisites for reinforcing drought mitigation and preparedness in the long term are: i) an accurate drought risk assessment quantifying the degree of hazard and the vulnerability of the different regions; and ii) real-time information concerns the development of drought conditions and providing forecasts of the likely evolution of the drought. This was acknowledged by the World Summit on Sustainable development (24 Auge2 Sep 2002) by the UN and the Johannesburg Plan of Implementation of the Agenda 21

(http://www.un.org/esa/sustdev/documents/WSSD_ POI_PD/English/WSSD_PlanImpl.pdf), who pointed to priority policy actions which included ".(e) Providing affordable local access to information to improve monitoring and early warning related to desertification and drought."

The Review of implementation of Agenda 21 and the Johannesburg Plan of Implementation by the Commission on Sustainable Development of the UN Economic and Social Council (5e16 May 2008) stressed that "the establishment and effective operation of systems and networks for drought monitoring, early warning and drought impact assessment are essential to the identification and formulation of effective and timely response actions".
Thus, drought mitigation actions and preparedness plans must be based on complete, transparent and integrated drought risk information. This should include geospatial information based on the analysis of past drought events in order to facilitate the elaboration of mitigation and preparedness plans, but also real-time information about the current drought conditions and their expected impacts in order to facilitate sound decision-making.
Drought indicators based on climate data and remote sensing products are at present the best available tools to monitor drought over large regions and time periods. The use of multi-scaling drought indicators is necessary in order to address the drought impacts to a variety of ecosystems and societies (Lorenzo-Lacruz et al., 2010; Vicente-Serrano & López-Moreno, 2005; Vicente- Serrano, Beguería, López-Moreno, Angulo et al., 2010, Vicente- Serrano, Beguería & López-Moreno, 2011; Vicente-Serrano, López- Moreno, & Beguería et al., 2011; Vicente-Serrano, López-Moreno, & Gimeno et al., 2011). In addition it is necessary to assess the degree of physical hazard in Africa by analyzing the historical data set of past drought events, as characterized by drought indicators. Drought hazard assessment must be expresses in terms of probability of occurrence of drought of varying severity and must be spatially explicit, i.e. must identify spatial differences in the degree of hazard. But integrated drought risk assessment must go beyond the mere calculation of the physical drought hazard and it must consider the vulnerability of the ecosystems and societies to drought. Vulnerability assessment can be done based on historical data of the systems exposed to drought, and must result in vulnerability curves indicating the expected impact on those systems of drought of varying severity. Thus early warning is only possible if such a combination of hazard and vulnerability assessments is made.

Moreover, real-time drought monitoring is indispensable to guarantee the operability of drought preparedness plans. Drought monitoring can be based on the drought indicators used for analyzing the drought events of the past, calculated using available sources of information on climatic data and satellite imagery. In addition the drought monitoring systems

should include forecasting at the seasonal time scale since it is made possible, based on current Global Climate Models (Palmer et al., 2004), and should be included in any drought information system as part of the drought management tools. Finally, it is necessary to understand the stakeholder and institutional arrangements, roles, responsibilities and capacity requirements so as to involve these stakeholders and institutions in drought initiatives, to develop appropriate products, to underpin the development of capacity as needed and to embed the products and knowledge developed within the drought mitigation plans.It can be concluded that there are different key issues determinant for drought mitigation in Africa, which the use of geospatial datasets and real time information could help to solve:

- The development of a comprehensive data base of climatic drought indices for Africa could allow the completion of a historical drought data base of Africa which would permit the understanding of the behaviour of this phenomenon over the entire continent and what kind of changes have been recorded in the last decades.
- The combination of state-of-the art methods of drought hazard analysis (spatial-temporal, non-stationary, multivariate extreme events analysis) would provide maps of the probability of occurrence of droughts in terms of their duration, intensity and magnitude, in order to identify (and quantify) the most drought-prone regions and the presence (or not) of longterm
- time trends in the severity of droughts.
- The assessment of the drought vulnerability of several systems (water resources, natural vegetation and crops) to quantify the impact of drought in terms of both the system's resistance and resilience, and to produce drought impact curves to each system and region.
- State-of-the art remote sensing techniques allow using near real-time EO data to directly monitor the impact of drought to natural vegetation and crops.
- The knowledge of the connections between drought and its atmospheric and oceanic meteorological precursors across Africa may improve drought forecasting by means of the
- integration of model-based long-term weather forecasts and empirically based predictions based on atmospheric and oceanic precursors with the purpose of producing long-term drought condition predictions.
- The possible implementation of a drought monitoring, early warning and forecasting system for the entire Africa based on the methods and the geospatial datasets indicated above.

In addition, these issues must be linked with:

- Formal (institutional) and informal setups to cope with drought risk in Africa and to determine the best approaches for improving capacity building on drought risk management.
- The development of capacity building tools for improving drought risk perception, introducing the concepts and tools of drought management, and for training the potential end-users in the use of drought information tools available in the drought monitoring systems.

12.1.4 Eastern Nile Region (Down Stream)

12.1.4.1 Sudan

Mitigation measures could be through on improvements of crop production, water resources management (irrigation scheduling, water harvesting, short maturity varieties) and livestock management (number of animal per area, increase carrying capacity). Raise the awareness of local communities. Involve the media (T.V. and Radio) in dissemination of the research findings. The mitigation practices can be adopted by many ways:

- Bring all the drought mitigation actors into the center of stage.
- Establish a national Drought Management and Mitigation Plan.
- Make use of all available data to produce National Drought Monitoring System.

12.1.4.2 Egypt

Mitigation measures could be through on improvements of crop production, water resources management (irrigation scheduling, water harvesting, short maturity varieties) and livestock management (number of animal per area, increase carrying capacity). Raise the awareness of local communities. Involve the media (T.V. and Radio) in dissemination of the research findings. The mitigation practices can be adopted by many ways:

- Bring all the drought mitigation actors into the center of stage.
- Establish a national Drought Management and Mitigation Plan.
- Make use of all available data to produce National Drought Monitoring System.

12.1.5 Southern Africa

12.1.5.1 Mozambique

The lack of data and information in many districts is related to limited broadcasting programmes through formal and informal channels regarding drought related issues. Possible improvements include the following:

- The opportunities to improve drought mitigation practices are related to the development of a drought mitigation program to be used by users as drought related national institutions does not have a specific program.

- Increased knowledge of mitigation improved techniques among the rural population through small training sessions.
- Distribution of agricultural inputs beyond seeds.
- Increase equipment for opening and maintenance of reservoirs, could increase the number and quality of those in rural areas.
- Equip farmers with management techniques and approaches to conduct their small scale irrigation schemes.

12.1.5.2 South Africa

The most common mitigation actions implemented in Botswana and South Africa are food aid, drought relief programs, growing of drought tolerate crops, saving livestock, improved water use efficiency and installation of boreholes, wells and small dams. There is a need to improve on the following areas in order to improve drought mitigation in these areas:

- Training and public awareness campaigns: increased public awareness in situations where the country is approaching a drought season
- Improved early warning systems e.g. seasonal climate outlooks: there is a need to improve early warning systems available in the basin. Currently farmer's uses information from South African Weather Services, SARCF and practices form the department of water affairs. The purpose of these is to provide a forecast for the region and at local level for the farmers on the availability of water but has limitation that it does not provide information at local scale.
- Integrating scientific and Traditional monitoring: based on the survey conducted in the basin there in a need to integrate indigenous knowledge with the scientific knowledge to improve drought early warning and this will in turn improve drought mitigation
- Effective Transfer of Information to Policy- and Decision-makers: To facilitate and improve a close link between relief efforts and development programmes, different bodies at different levels need to be assigned and adhere to specific responsibilities at different levels. The policy document should discuss general drought management issues and reviews government capacities and structures to deal with drought preparedness, mitigation and response issues

12.1.5.3 Zimbabwe

Throughout the recent drought periods in Zimbabwe, the response by the Government of Zimbabwe (GOZ), local communities and authorities, as well as donors, has focused on

short-term emergency response.(FAO,2004) Most local government authorities lacked the capacity to react to these disasters, let alone prepare for them in an effort to mitigate the possible impact of drought.(FAO,2004).

The GOZ realized the need to develop appropriate action plans to counter both the short-term and long-term effects of drought, to develop institutional capacity, and to invest more resources in order to meet the needs of the most vulnerable population groups. To address these issues, the GOZ developed the National Policy on Drought Management (NPDM), which was formulated in 1998 and approved in 1999 (GOZ-NEPC, 1999). The policy aims at a congruence of relief effort and planned development to strengthen economic fabric of the disaster-prone areas so as to mitigate the suffering of the affected population and enhance their capability to face the challenge of such disasters in the future. To ensure that there is a close link between relief efforts and development programmes, different bodies at different levels need to be assigned specific responsibilities. This policy delineates functions and responsibilities in disaster management at various levels. The policy document discusses general drought management issues and reviews government capacities and structures to deal with drought preparedness, mitigation and response issues.

The Civil Protection Act [Chapter 10:06 of the Laws of Zimbabwe], complemented by sections of other laws, provides a legal framework for the management of disasters in general including those induced by droughts in Zimbabwe. Disaster preparedness programmes are initiated by GoZ through relevant sector ministries and local administration takes the responsibility for implementing and maintaining its effectiveness (Marjanovic and Nimpuno 2003).The current system uses the existing government, private sector and NGOs whose regular activities contain elements of disaster risk prevention and community development (Marjanovic and Nimpuno 2003;UNISDR 2004).

Table 56: Comparison of state of the Art and local drought management structures

State of the art organisational structures for drought management	**Zimbabwean organisational structures for drought management**
Mainly coordinated by Ministry of Agriculture /Environment/Meteorological/Water departments with hands on experience and technical expertise for drought management	Coordinated by Local government
Clearly developed partnerships, lines of communication and local stakeholders were	Not very clear partnerships, lines of communication and local stakeholders were

included in the design process of the plan.	included in the design process of the plan.

Weaknesses in drought management by institutions in Zimbabwe

- **Lack of integrated approach**

There is need for an integrated approach for effective drought monitoring, which involves thorough investigation of all available information resources and tools that are available at catchment level. Meteorological services department (MSD) provides climate information and predictions for the whole country .However, the collection of agricultural and hydrological data is typically fragmented among many agencies and ministries because of the government structure of most of the countries (WMO, 2006). In the case of Zimbabwe and Mzingwane catchment collection of agricultural data is done by mainly Agricultural Technical and Extension Services department (AGRITEX) and other collaborating NGOs .Hydrological data is collected by mainly Zimbabwe National Water Authority (ZINWA).

- **Density of data collection stations**

Meteorological and hydrological data networks are inadequate in terms of the station density for collecting all major climate and water supply parameters required for these systems in the catchment.. The key forecasting organisations (MSD; ZINWA e.t.c) rely more on in-situ input data collection methods .The number of stations are limited as stated earlier, leading to inadequate output data or forecasts and as such inadequate information for the users. Data quality is also compromised because of missing data and/or an inadequate length of record. In most cases the output information to be relayed to users tends to be more generalised.

- **Early warning products**

Information delivered through early warning systems is often too technical and detailed for decision makers to effectively use. Information need to be usable and dependable. In this respect, ENSO bulletins need to be more user-oriented (users, in an early warning context, are not always climatologists or meteorologists), providing assessments of the likely impact (e.g., risk analysis) on rainfall and other weather conditions in particular parts of the catchment. Forecast by Meteorological Services Department (MSD) are relevant only to seasonal timescales and relatively large areas and may not fully account for all factors that influence weather and climate. This information has to be tailor made for specific users to ensure its successful use in the drought management process.

- **Unreliable forecasts and loss of trust from users**

Forecasts are often unreliable on the seasonal timescale and lack the specificity required for use in agriculture and other sectors. Most of these early warning or forecasting products need to be downscaled to give reliable information and facilitate effective drought mitigation .

- **Dissemination of data/forecasts**

Delivery systems for disseminating drought information and data to users in a timely manner are often not well developed, limiting their usefulness for decision support. In addition, the quality, collection, and dissemination of meteorological data are key factors for their reliability and use of the drought monitoring products in drought mitigation and adaptation.

Climate change

Observed increase in climate change variability in most Southern African countries and particularly in Zimbabwe has increased uncertainty in seasonal rainfall prediction and poses a greater challenge to scientists in their efforts to improve forecasts and their reliability. Pertinent action is therefore needed in order to address this challenge to ensure drought risk reduction efforts are successfully met in a climate driven changing environment.

- **Funding constraints**

Budgetary resources are often not available for preventive measures, but also for disaster response. Most drought monitoring, early warning and forecasting instutions in the catchment lack the financial capacity to carry out drought forecasting activities and let alone to acquire up to date data collecting equipment .Funding stands out as the major challenge or hindrance for effective drought monitoring.

- **Research and data sharing**

Data sharing is often inadequate between government agencies and research institutions, and the high cost of data also limits their application. Drought-related research is critical in the production of innovations and technology that lead to improved drought preparedness. Currently a coordinated and integrated drought research program does not exist at the national level and even at catchment level, despite the enormous impact of droughts every year on the nation's economy, society and the environment. Furthermore, drought research is scattered across many agencies, universities, and other research institutions, without formal coordination or planning to maximize the value of the research dollars spent and without effort to ensure that the priority needs of the public and decision-makers are being addressed. The simple act of coordinating drought research within and between levels of government, as well as with private entities and universities, will help accelerate the development and provision of scientifically-based information products, thereby, enabling users to better prepare for, manage and respond to the impacts of drought in the catchment.

- **Delays in responding to early warnings**

According to the Early Warning Unit and the Drought Monitoring Centre significant time lag between warning and action, created emergencies, this in turn elevated the demand for drought relief. Different users take varied time to respond either to forecasts or warnings issued .An example is the Drought case of 1992, when the drought warning was issued as early as March 1991, by SADC REWS and the Zimbabwean government only responded as;

late as March 1992.As such this stalled resource mobilisation and thus the effects of this drought was significant. It was not until such stocks had dropped to critical levels that reactions were initiated, by which time it was already too late to avoid the maize shortages which hit countries like Zambia and Zimbabwe during the early part of 1992(Pawadyira and Ndlovu 1993) The time taken lag between a warning or forecast and response, can cause a big difference in drought mitigation and adaptation.

12.2 DROUGHT ADAPTATION PRACTICES IN AFRICA

12.2.1 North Africa

The nature and the intensity of drought in north- african countries, accentuated by the huge threat of climate change, demands that efforts to set up a successful drought adaptation plan incorporate a multi-disciplinary set of stakeholders, including meteorology science experts, hydrologists, agricultural practitioners and technicians, local communities and policy makers.
In addition, in North-Africa countries, drought adaptation faces a number of challenges: growing water deficits, growing demographic pressure, persisting gaps in service access, slow changes in legislation. Thus, for adaptation to be effective, we must play simultaneously on the improvement and the setting of what we classified in previous chapters as Hardware technologies, software techniques and orgware.
Our study on adaptation showed that the biggest gap we have in North Africa is at the orgware level. Technologies and used techniques need to be addressed and disseminated at a larger scale and in an integrated way.
Thus, national development plans should integrate drought adaptation and new institutional arrangements need to be implemented that take into consideration the increasing interconnections between all these issues and integrate an interdisciplinary approach involving traditional knowledge, science and Policy, with an accent on sensitization, training, outreach and behavior adjustments. The drought adaptation can therefore be viable, effective and sustainable and in general:

- A multiple water development strategy of collecting, producing, recycling and conserving water has to fit in national plans.
- Socio-economic and policy decision-making processes have to integrate ongoing adaptation strategies and actions in their plan.
- Local resource users should be involved in all aspects of the planning, designing, implementation, and monitoring of water management and drought adaptations strategies.

- Water resources management, including the best agricultural practices has to be more developed and disseminated at a larger scale and outreaching directly the users.
- Opportunities of accessing to new technologies by users have to be improved, with training on their use and demonstration for their benefits.
- Access to collected meteorological, agronomical, hydrological, remote-sensing data have to be facilitate to institutions, users and public.
- Best practices and stakeholders trainings have to be permanently implemented and the knowledge updated.

More concretely:

(a) on water

- Best Management of water demand
- Best development of water offer:
- Preservation and protection of water and land resources:

(b) and in agriculture

- Select crop types and varieties that are more drought tolerant
- Diffusion of best practices at larger scales

12.2.2 Equatorial Lakes Region

12.2.2.1 Tanzania

The list below presents opportunities to improve drought adaptation practices in the drought areas of Tanzania.

- Strengthening resilience against climate variability
  - Improve water use efficiency
  - Mulching to conserve soil moisture
  - Manage evapo-transpiration so as to achieve water saving
  - Improve water management institutions
- Improve human and financial capacity
- Improve drought events monitoring and documentation
- International cooperation
- Practice effective knowledge sharing especially for the highly vulnerable sectors such as water and agriculture and the sub-Saharan region

12.2.2.2 Kenya

The identification of poverty alleviation components in any adaptation intervention would be a tangible point of sale to the affected communities. The adaptation must also address the

inherent indigenous approaches of the community to drought adaptation practices. Some key practices include;

- Short season crop introduction.
- Improved animal (cattle, camel and goat) husbandry for pastoral communities
- Introduction of low density high yielding animals in drought prone areas.

12.2.3 Eastern Nile Region (Ethiopian Plateau)

Agricultural adaptation to climate change is a complex, multidimensional, and multi-sca process that takes on a number of forms (Bryant et al., 2000). Bryant et al. (2000) identify four main components of adaptation: (1) the characteristics of the stress, (2) the characteristics of the system, including the cultural, economic, political, institutional and biophysical environment, (3) multiple scales, and (4) adaptive responses. Overall, 37 percent of farmers in Ethiopia did not adapt to either perceived changes in rainfall or temperature. Figure 32 presents the range of adaptation options employed by farmers in Ethiopia. Only adaptation responses mentioned by more than 1 percent of farmers are reported. Among those farmers who did adapt to climatic changes, the most common adaptation strategies include use of different crops or crop varieties, planting trees, soil conservation, changing planting dates, and irrigation. Other responses reported less frequently, such as seeking off-farm activities, migrating to urban areas, changing farming type, using new technologies, and water conservation, are included in the ‘‘other’’ category.

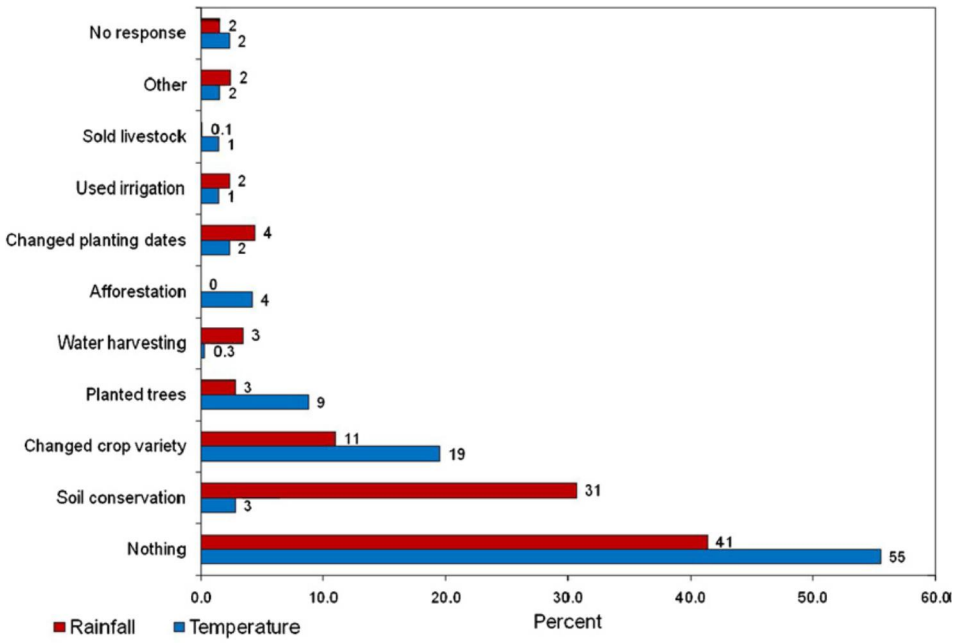


Figure 32: Adaptation to perceived temperature and rainfall changes in Ethiopia (n = 995).

Figure 33 indicates farm level of adaptation.

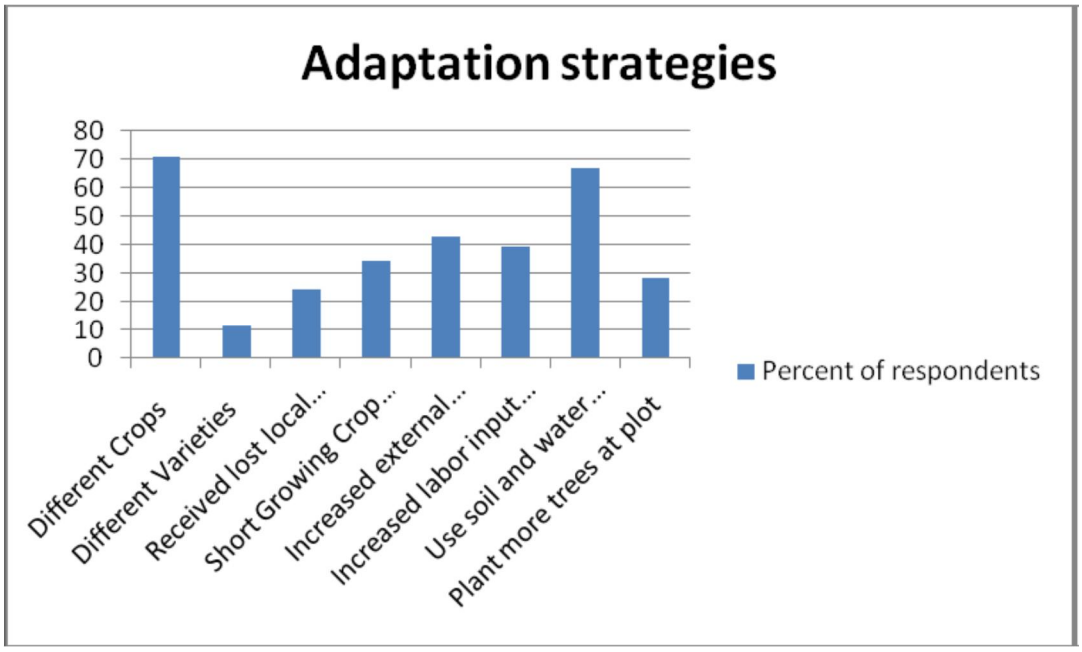


Figure 33: Some of the farmers adaptation procedure are indicated below

Camel introduction

Instead of cattle camels are introduced. Camels survive longer without water, are better adapted to the change in pasture quality and continue producing milk under the harsher conditions of the present. Also, they can be used to transport water over greater distances.

Income diversification

In the past the pastoralist population was for their livelihood merely dependent on the income from animal production. Nowadays in order to survive many communities have started to search for alternative sources to add to the family income. e.g. rainfed and irrigated agriculture, charcoal production, honey production, maize milling, small handicrafts. Some families send their children to school, so they will be able to earn a living outside the traditional ways.

Destocking and marketing

Since feed is becoming scarcer, especially in the drier period, all animals compete with each other for the little feed available. Instead of all animals losing condition or even dying, it is better to select some animals and sell or slaughter them. The meat of slaughtered animals can be used as emergency food for the vulnerable population. Especially in the areas where

the pastoralists are living, marketing possibilities for their livestock are limited. In order to improve their economic position the marketing facilities are improved.

The Cordaid approach: Drought Cycle Management

In the Drought Cycle Management (DCM) approach drought is accepted as a recurring hazard in the lives of communities living in the arid and semi arid areas. Drought is therefore included in the planning and implementation of all development work. The Drought Cycle is divided in 4 phases, each having their own types of interventions. This approach requires a flexible attitude of all the stakeholders, because if the situation for the pastoralist community changes the interventions must follow.

Working together

Cordaid cooperates in both countries with ECHO, FAO, Postcode Lottery and IIRR on one side and local governments and partner organisations on the other side. In total 18 Cordaid partner organisations work with several communities each. Together with the communities they assess the risks for their livelihood, the capacities within the communities to cope with these risks and the possible measures to be taken to increase the capacities (disaster risk reduction). Based on these assessments different activities are developed and introduced in the respective communities. Much attention is given to the exchange of experiences between the partners, but also with organisations outside the partner network. As structural changes cannot be realized by the communities alone, the cooperation of local and national authorities is required. Therefore at all levels the information is shared with the responsible authorities. Cordaid also connects with knowledge institutes and trade and industry, in order to learn from their experiences and involve them in efforts to improve the livelihood of the people living in the arid and semi arid areas.

Drought Cycle Management (MCD) in practice adaptation measures

Water harvesting

Availability of water for human consumption and livestock is one of the major problems for the communities during the dry period. In order to increase the availability of water several methods of rainwater harvesting have been introduced like underground water tanks, water collection from roofs, sand dams and the construction of water ponds. These measures have an additional advantage for the women, bringing the water closer to the communities.

Flood dams

Apart from the more frequent droughts climate change has also intensified rainfall. Together with degradation of the soil cover in the arid and semi arid areas this intensification of rainfall has caused an increase in flash floods, damaging the fields and properties of the communities. In order to protect these properties trees are being planted on hill sides to hold the water and the soil and dams and canals are being built to divert the fast rising riverbeds.

Early warning systems

In most of the communities Disaster Risk Reduction committees are established. These committees coordinate the activities in their respective communities, but also monitor the living conditions in their environment. Simple and practical tools have been developed. In case of an approaching hazard, the committees are in a position to contact the local authorities and other stakeholders and together they propose intervention strategies, in order for the community to be able to cope with the threat.

Many factors work as barriers to adaptation which affects farmers' ability to adapt to climate change. These factors include accessibility and usefulness of climate information (Roncoli et al., 2002), the policy and institutional environment (Eakin, 2003, 2005; Agarwal, 2008), and the socio-economic position of the household (Ziervogel et al., 2006), among others.

12.2.4 Eastern Nile Region (Down Stream)

12.2.4.1 Sudan

There are many opportunities to improve drought mitigation practice in the country, that through

1. Dissemination of Timely usable information,
2. Frequent, reliable information or data
3. Networking between governmental bodies (SMA) and other stakeholders
4. Interaction with local communities

12.2.4.2 Egypt

Overview of the gaps/opportunities in drought practices in Egypt. The very important item should be considering is changing of the communities' culture. The Stakeholders only cooperate when there is a running project or a disaster and there is no continuity linking. In addition, the lack of communication with end users (they don't get information on floods/droughts) and the communication with other stakeholders/ ministries

The drought and flood adaptation opportunities are summarized as the following:

Opportunities - media

- Public trusts the media more than the specialists.
- It is very important to talk to the media and digest the information so that the media can inform more correctly.
- Guidelines on how to communicate with media.
- Workshops to train the media on technical aspects
- Explain to the media the concept of uncertainty in forecasts
- Integration of different projects on drought
- Coordination between institutions of the same country

Opportunities – Local community

- Feedback from end users is very important;
- Use indigenous knowledge to help improve forecasts;
- Educate community to change culture and reduce vulnerability
- Increase awareness;
- Improve communication with local community in order to avoid disasters (floods). Involve local leader/religious leaders
- Promote involvement of government and link scientists to the community and the media.
- Satellite data can be used to fill gaps of measurements.
  Exchange of data/experience between countries and institutions is important.

12.2.5 Southern Africa

12.2.5.1 Mozambique

Opportunities for improvement include the following:

- Development of a drought adaptation program to be used by users as related drought national institutions does not have a specific program.
- Increased knowledge of improved techniques of adaptation among the rural population through small training sessions.

12.2.5.2 South Africa

Communities in South Africa are engaged in activities to be able to survive future droughts and climate change, depending on duration and magnitude of deficit. This is being done through changes in processes, practices, and structures to moderate potential impacts of future drought. The most common adaptation actions being water harvesting, construction of water infrastructure, traditional/cultural practices and technologies, water conservation, crop monitoring and crop diversification. Non-governmental organisations and governments may

increase funding for infrastructure which becomes basins for adaptation especially at local level

12.2.5.3 Zimbabwe

- Public participation and involvement

Opportunities for improved participation and the recognition of public values, concerns and priorities in shaping policies are necessary to create linkages between diverse levels, and to build collaborative and sustainable drought management systems. The most effective way to protect communities against food insecurity and famine resulting from drought is to strengthen these diverse adaptation and mitigation strategies well in advance, especially those that enable them to preserve their productive assets, such as animals, seeds and tools. These responses should include creating opportunities for participation in regional and sub-regional processes as well as creating more effective decentralization and devolution policies at the national level.

- Building inter-linkages in drought adaptation practices

The inter-linkages concept promotes building cooperation across institutional boundaries and between different interests at and across multiple scales. A key objective of the interlinkages approach is to demonstrate the importance of the environment and its sound management to other sectors, and thus to ensure that holistic approaches are taken to problem solving so that advancements can be made in human well-being, human vulnerability to environmental change can be minimized, and the environmental base can be sustained. Adopting an inter-linkages approach in the formulation of policy and the development of programmes can help to ensure that interventions are more relevant, robust and effective, and that these policies are based on principles that are cross-sectorial and interdisciplinary.

- Drought resistant varieties

Drought tolerant crops offer opportunity to produce even in drought years.

- Hybrid and genetically modified crop varieties to boost production

As has been the case with other countries especially those in state of the art countries production of hybrid and genetically modified varieties has offered them an opportunity to boost their production capacities.

- Technological progress in improving drought monitoring and early warning systems

An infrastructure to develop, integrate and maintain a suite of drought decision support and simulation tools is fundamental for the success of drought monitoring early warning and forecasting systems. It will be built on existing institutions in the catchment with complementary expertise at local, regional and national levels.Since the occurrences of

severe droughts in the 1980s, national and international agencies have sought to improve their ability to predict food insecurity in sub-Saharan Africa and have implemented a number of early warning systems to monitor drought that may indicate the likelihood and magnitude of food insecurity (Speranza et al., 2008; Hutchinson, 1991). International research on the ENSO phenomenon offers opportunities to improve long-range climate prediction for Zimbabwe. Remote sensing observations have also increasingly been used to assess the vegetation conditions and estimate rainfall at the national and regional drought monitoring centres (Chamaille-Jammes et al., 2006; Nicholson, 2005; Olsson et al., 2005). At present, Zimbabwe's ability to monitor and disseminate critical drought-related information has been enhanced by new technologies such as automated weather stations, improved satellite observations, advanced computing technology, and improved communication techniques (e.g., web delivery).This presents a great opportunity for improving monitoring, forecasts and drought earl warning in the catchment.

- Integrating scientific and Traditional monitoring.

Traditional knowledge indicators are still in use and considered more reliable than scientific forecasting. About 62% of the interviewed respondents in the Mzingwane catchment believe that traditional forecasting methods are reliable. About 45% of the respondents are already in a way integrating both in the sense that they use both forecasts .This present an ideal opportunity to promote integration of scientific and traditional forecasting methods and successful drought management . Rural communities have developed specific coping strategies. These indigenous knowledge systems should be investigated, validated, and standardized, as they are often site-specific. Traditional knowledge in one region might not be applicable in another, and climate change may result in hazards beyond the knowledge bank of indigenous systems. It is essential to identify best practices for reducing hazards and disasters that can be used as a model for other people.

- Using improved seasonal climate outlooks

There has been a concerted regional and international effort to use climate information for practical applications in food security Early Warning Systems. Currently, this is done in the form of Regional Climate Outlook Forums (RCOFs), where seasonal forecasts are prepared before each major growing season (WMO, 2008). The purpose of the Forums is to provide a consensus forecast for the region before each major rainy season and detail the possible implications for food security (Haile, 2005). In general, if appropriately developed, seasonal forecasts can help concerned stakeholders, such as agricultural planners, make proactive decisions on seasonal agricultural strategies (e.g., planting schedules, fertilizer distribution, and seed choice), future food and marketing needs, and further allocations of grazing areas for livestock. The seasonal outlooks can also be used by external agencies that assess food

security and relief food requirements. In addition, information on possible droughts and disasters will help government officials, donors, and NGOs to prepare and allocate adequate resources to alleviate the potential problem.

- Drought Policy

The National Policy on Drought Management (NPDM), which was formulated in 1998 and approved in 1999 (GOZ-NEPC, 1999). The policy aims at a congruence of relief effort and planned development to strengthen economic fabric of the disaster-prone areas so as to mitigate the suffering of the affected population and enhance their capability to face the challenge of such disasters in the future. To ensure that there is a close link between relief efforts and development programmes, different bodies at different levels need to be assigned specific responsibilities. This policy delineates functions and responsibilities in disaster management at various levels. The policy document discusses general drought management issues and reviews government capacities and structures to deal with drought preparedness, mitigation and response issues. The already available drought policy can for reviewed and developed for better and effective drought management.

- Training and public awareness campaigns

Helps communities and society to better prepare for droughts. As such they can apply local practices in drought mitigation.

- Effective Transfer of Information to Policy- and Decision-makers

There is a need to establish dialogue among scientists, policy- and decision-makers. As environmental degradation is not only a technical/scientific problem, any discussion of environmental degradation should involve policy- and decision-makers. Research is needed on how to translate research results into policies that minimize the human and economic cost of hazards, for example, in land use planning and environmental issues.

12.3 ORGANISATIONAL STRUCTURES FOR DROUGHT MANAGEMENT

12.3.1 North Africa

On the basis of the analysis of the institutional structures for drought management in North-African countries and their comparison with the globally state-of-the art systems allowed to identify the following ways of improvement:

- **The promotion of a perennial and efficient collaboration of ministerial departments and services** involved in drought management, not only limited to

drought periods and the decentralization of responsibilities for implementing drought management policies.

- **The reinforcement (and/ or creation) of institutions or at least ministerial services or cells** specially dedicated to drought monitoring, awareness-raising and disseminating information and the establishment of close relation-ships with drought management systems.
- **The development of Public Private Partnerships (PPP**): Due to the broad ranging nature of the threat, drought and water scarcity and their consequences, neither public nor private entities can entirely resolve the issues alone. Collaboration between private and public sectors are thus essential.
- **The promotion of a participatory approach to drought management**: Community participation is essential for increasing community ownership and ability to replicate and sustain activities. There is need for policy to promote linkages between the community, the government, the private sector, civil society, faith based and grassroots based organizations, and research agencies. Community participation, both in decision making and implementation, is also essential in order to move from policies to practices. Participation is required to develop policies and strategies that are relevant, feasible, and equitable at the local level. It may also help create a larger sense of "community" ownership among stakeholders that will foster commitment and responsibility when implementing drought policy.
- The emphasis on the roles of community organization such as water users associations
- **The effective development and use of drought plans**: Drought management should be carried as a current element of the general water planning and management, which means that a risk analysis must be carried out to assess its probability of occurrence and measures to be applied, must be planned ahead. DMPs should identify the most adequate mitigation measures, adapted to the different established drought thresholds and phases. During a normal phase, the measures derive from the regular management practices. As the drought progresses and a critical situation takes place, measures go from control and information, to conservation and restriction types, prioritizing uses. The main contents of plans are: drought diagnosis, program of measures and management and follow-up system. A crucial and innovative aspect of DMP is to establish an adequate link between basin drought status and actions to be taken.

- **The mainstreaming of drought management into an integrated management framework** for coping with drought impacts on different sectors. Indeed, drought management is not related to water management alone, but also affects and is affected by other policies (e.g. for agriculture, development and adaptation, environmental protection).
- **The promotion of regional collaboration and share of experiences**: A North-African Drought Preparedness Network could provide the opportunity for nations and regions to share experiences and lessons learned (successes and failures) through a virtual network of regional networks; for example, information on drought policies, emergency response measures, mitigation actions, planning methodologies, stakeholders involvement, early warning systems, automated meteorological networks, the use of climate indices for assessment and triggers for mitigation and response, impact assessment methodologies, reduction of demand/water supply augmentation programmes and technologies, and procedures for addressing environmental conflicts. Working individually, many nations and regions will be unable to improve drought coping capacity. Collectively, working through global and regional partnerships, we can achieve the goal of reducing the magnitude of economic, environmental, and social impacts associated with drought. For example, the "Drought Assessment and Mitigation in South-West Asia" website <www.iwmi.cgiar.org/droughtassessment/ index.asp> brings together scientific community and civil society organizations in West India, Pakistan and Afghanistan in the attempt to identify gaps in current drought assessment and management practices and to share lessons and experiences that the countries can learn from each other.
- **The development of the Science-Policy interface (SPI)**: An essential aspect of the planning process is achieving integration of the science and policy aspects. The understanding of policy makers regarding scientific issues and technical constraints, as well as the understanding of scientists on the existing policy constraints are limited. Efforts should, therefore, be made so as to enhance communication and understanding between the science and policy communities, if the planning process is to be successful. The integration of science and policy during the planning process will enable setting research priorities and taking into consideration various alternatives on how to better succeed in bridging gaps among these groups so as to maintain a strong working relationship

- **The Enhancement of Research on drought management**: Despite the fact that drought and its impacts concern many scientific research fields, from soil erosion, desertification, water quality and quantity deterioration, biodiversity, meteorological and hydrological modelling to economic and social aspects, it can be useful to cluster drought-related research themes along the drought management cycle. In this regard, the following research clusters can be defined: Drought forecasting, Early warning systems, Networks on data collection and analysis, Development of drought triggers, Climate change impacts, Drought preparedness, Planning methodologies that integrate drought risk- Best management practices, Improvement of legislation on drought preparedness and mitigation

12.3.2 Equatorial Lakes Region

12.3.2.1 Tanzania

Below are opportunities to improve institutional framework for drought management in Tanzania.

- Stakeholders' participation
- Incorporate concepts of Integrated Water Resources Management (IWRM) in drought mitigation and adaptation practices, and in drought management
    - Improve drought events monitoring and documentation
- Freshwater savings from wastewater re-use
- Establish food/agro processing centres for sharing of resources

Increased capacity of universities, research institutes and farming communities for management of water resources and for post-harvest processing and preservation of

12.3.2.2 Kenya

The hierarchy of rural structures from clan (Village), division and county structures must inform the national policy and management intervention planning. In this case a two way bottoms up and vice versa applies. In Kenya formation of water resource users associations (WRUAs) are currently encouraged. They are supervised by the river basin authority and are used to make local assessments and priority on resource needs.

12.3.3 Eastern Nile Region (Ethiopian Plateau)

Institutional and cultural constraints include:

• Donor and government intervention (famine relief) during drought crises, which engenders a culture of dependency in pastoral populations

• In Ethiopia pastoralists have witnessed revolving funds for veterinary drugs disappearing because of poor control and supervision (Ndofor 1998) and may be reluctant to become involved in saving and credit schemes
• Proximity of national borders and the danger that those responsible for managing funds may migrate with the funds
• Traditional lending of stock to relatives/friends who have become destitute (although this is reported to be dying out in Southern Ethiopia (Ndofor 1998)
• Muslim non-acceptance of interest
• Physical security of funds mobilised in pastoral communities

Some pastoralists in Northern Kenya and Southern Ethiopia already use trusted friends/shopkeepers as savings and credit institutions. If they sell animals they then deposit money with a shopkeeper and later withdraw money in cash or goods (Ndofor 1998; Buchanan-Smith and Barton 1999). Shopkeepers may also offer credit in kind or cash to be repaid when the next animal or animals are sold. Pastoralists who market large stock can receive large amounts of money and need a depository for safekeeping. Shopkeepers/traders having contacts in towns are able to bank on pastoral households' behalf.

Unfortunately pastoral households using these informal arrangements may pay high prices for goods and receives low prices for stock using and may be unaware of the cost of their borrowing. It seems likely that the shopkeeper will make a charge for credit although this has not been investigated. As there are limited alternatives these informal institutions do provide banking services of a kind. However there have not been any investigations of these forms of credit and saving in northern Kenya.
In the African pastoral context there is a need for information about:

- National policies and legal frameworks with regard to credit union development and micro-finance.
- Potential complementarily between micro-finance and the formal banking sector. Are there links, which would help to overcome the difficulties associated with depositing cash?
- Whether NGOs and CBOs (pastoral associations) are involved or interested in developing credit, finance and savings institutions and providing management and training.
- The potential demand for credit and other financial services from pastoral households
- Pastoralists' confidence in formal sector financial institutions

12.3.4 Eastern Nile Region (Down Stream)

12.3.4.1 Sudan

There are many opportunities in Sudan to improve institutional frameworks for drought management

1. Capacity building through networking with the national, regional and international drought centres.
2. Technology transfer approaches.
3. Intensifying the ground observation networks.
4. Application of the models and software

12.3.4.2 Egypt

In Egypt, as mention above there are no specific organizations for drought management. four sectors of Ministries of Water resources and Irrigation (MWRI) forecast the river Nile discharge and the results and outputs goes to the River Income Committee (RIC). The RIC discuss and manage the flood and drought downstream of the HAD. A lot of constrains facing the management processes are:

- Tackling Several ministries with drought management; duplication of efforts (concurrent monitoring systems);
- Hydrological data is not consistent inside (and outside) the country;
- Each ministry has own monitoring network, data set and methodology and is not exchanging data with others.
- Generally data is not freely available.

12.3.5 Southern Africa

12.3.5.1 Mozambique

Opportunities for improvement include the following:

- Development of a drought mitigation and adaptation program to be used by users as related drought national institutions does not have a specific program.
- Increase information on the needs of the rural population in developing systems for drought mitigation and adaptation.
- Equip farmers with management techniques and approaches to conduct their small scale irrigation schemes.
- Increase availability of systems most commonly used in rural areas to enable access and use by for farmers.
- Increase knowledge of improved techniques of adaptation among the rural population through small training sessions.

- Distribution of variety of agricultural inputs beyond the seeds.
- Promote stakeholders forums for discuss better solutions to deal with drought.

12.3.5.2 South Africa

There are different types of institutions that are on the formal institutional frameworks for drought management. The most common actions being agriculture extension services, food aid, policy, advocacy, funding and water supply. More institutions identified are not found on the formal framework hence a need exists to improve on such. Stakeholders play a major role in drought management as they can share experiences, as well as identifying linkages amongst themselves. Institutions can draw some experiences gained in tackling previous droughts. This provides an opportunity to address the weakness and failures encountered

12.3.5.3 Zimbabwe

- **Drought policy**. An already existing National Policy on Drought Management (NPDM) provides bedrock to other opportunities in drought management. Thus with a drought policy in place, only a review of this policy is needed to cater for smooth coordinated drought management by institutions in Zimbabwe.
- **Exchange programmes**. Institutions can also take advantage of better developed institutions with similar roles regionally to learn and improve their effectiveness in drought management. Examples of institutions that could seek cooperation with those abroad are ZINWA and Ministry of water in Zimbabwe can learn from similar South African institutions and adopt better management methods. Furthermore local drought institutions can also adopt better institutional frameworks in developed countries.
- **Stakeholders' forums.** Stakeholders can take advantage of these and share experiences, as well as identifying linkages.
- Experience from previous droughts

  Institutions can draw some experiences gained in tackling previous droughts. This provides an opportunity to address the weakness and failures encountered.

REFERENCES

1. ABARES 2012, Drought in Australia: Context, policy and management, ABARES report to client (GHD Pty. Ltd.) prepared for the Australia China Environment Development Partnership, Canberra, March 2012.
2. Adler, R.W. (2011) Balancing Compassion and Risk in Climate Adaptation: U.S. Water, Drought and Agricultural Law, 46p. http://ssrn.com/abstract=1809946
3. Agarwal, A., 2008.In: The role of local institutions in adaptation to climate change, Paper Prepared for a workshop on ‘‘Social Dimensions of Climate Change’’, organized by the Social Development Department, The World Bank, Washington, DC, March 5–6, 2008.
4. Agoumi A. (2002). Vulnérabilité des pays du Maghreb face aux Changements climatiques. www.leishmaniosealgerie.com/wp-ontent/uploads/2012/01/Vuln%C3%A9rabilit%C3%A9-au-CC-au-Maghreb.pdf
5. Ait Kadi, M. (2004). Chapter 11: From water scarcity to water security in the Maghreb region: Case of Morocco. in Environmental changes in the Mediterranean 2000-2050. Antonio Marquina
6. Amani, H. And Standen, H. (2004). Review of Drought Preparedness and Response Tanzania. Tanzania Food Security Information Team (FSIT), Disaster Management Department-Prime Minister’s Office and the National Food Security Department-Ministry of Agriculture and Food Security. 61pp.
7. Austin Water Utility, Water Conservation Division, City of Austin, Texas (2012). Drought Contingency Plan, June, 15p. PWS # 2270001
8. Australian Capital Territory, 2010. Utilities Water Conservation Measures Approval 2010
9. Australian Natural Resources Atlas, 2008. http://www.anra.gov.au/topics/water/overview/index.html
10. Bahir M. et A. Mennani, (2002) Problématique de la gestion des eaux souterraines au Maroc. Estudios Geologicos, 58 : 103-108.
11. Bazza M., (2001). Inferences of a Drought Mitigation Action Plan. Expert Consultation and Workshop on Drought Preparedness and Mitigation in the Near East and the Mediterranean. Organized by FAO/RNE, ICARDA and EU, Aleppo (Syria) 27-31 May 2001. FAO Regional Office for the Near East, Cairo (Egypt).
12. Beck Consulting (2007). Northern Cheyenne Tribe Drought Mitigation Plan. Red Lodge, June 34p.
13. Beguería, S., Vicente-Serrano, S. M., & Angulo, M. (2010). A multi-scalar global drought data set: the SPEIbase: a new gridded product for the analysis of drought variability and impacts. Bulletin of the American Meteorological Society, 91, 1351-1354.

14. Belmamoun B. (2009) Communication sociale et approche participative au service de la gestion intégrée des ressources hydriques et des projets d'alimentation en eau potable.) Conférence sur la gouvernance de l'eau Tunis 8-9 juillet 2009)
15. Benson, L.V., Berry, M. W., Jolie, E. A., Spangler, J. D., Stahle, D. W. and Hattori, E. M. (2007) Possible impacts of early-11th-, middle-12th-, and late-13th-century droughts on western Native Americans and the Mississippian Cahokians. Quaternary Science Reviews 26, p. 336-350.
16. Bouchoutrouch, M. (1993) Yield and yield components, water use and weed infestation as affected by planting date of wheat in semi-arid environment. Mémoire présenté pour accéder au grade d'ingénieur en chef. DIF-INRA Rabat, Morocco
17. Boudjadja, A., Messahel, M., Pauc, H. (2003) Ressources hydriques en Algérie du Nord. Revues des sciences de l'eau, 16 (3) : 285-304.
18. Boulder, City, Public Works Department, Utilities Division, Colorado(2010), Colorado Drought Plan vol. I. Drought Planning and Response Plan, march 15, 15p.
19. Bruce, S., Leedman, A. and Sims J. (2006). The Australian National Agricultural Monitoring System – a national climate risk management application. Proceedings of the 13th Australian Agronomy Conference. 10-14 September 2006 Perth, Western Australia.
20. Bryan, E., et al., Adaptation to climate change in Ethiopia and South Africa: options and constraints.Environ. Sci. Policy (2009), doi:10.1016/j.envsci.2008.11.002
21. Bryant, R.C., Smit, B., Brklacich, M., Johnston, R.T., Smithers, J., Chiotti, Q., Singh, B., 2000. Adaptation in Canadian agriculture to climatic variability and change. Climatic Change 45, 181–201.
22. Bzioui B. (2005) Rapport sous regional sur la mise en valeur des ressources en eau en Afrique du nord. www.pnud.org.ma/pdf/sub_regionalreport_19juin_fr.pdf
23. Cap-Net (2009). Drought Mitigation Measures in Hydro-Climatic Disasters, in: Water Resources Management, a training Manual. March p. 139
24. CEC (2007a), Communication from the Commission to the European Parliament and the Council – Addressing the challenge of Water Scarcity and Droughts in the European Union, Commission of the European Communities, Brussels.
25. CEC (2007b), Green Paper from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - Adapting to climate change in Europe – options for EU action {SEC(2007) 849}, Commission of the European Communities, Brussels.
26. CEC (2010), Accompanying document to the Second follow-up report to the Communication on Water Scarcity and Droughts in the European Union COM (2007)

414 final, Report from the Commission to the Council and the European Parliament, SEC (2010) 573, European Commission, 2010, Brussels.

27. CHG (2007), Plan Especial de Sequia de la Cuenca del Guadiana (Drought Management Plan for the Guadiana River Basin), Confederación Hidrográfica del Guadiana, Ministerio de Medio Ambiente, Badajoz, Spain.
28. Christensen, K. (2003). Cooperative Drought Contingency Plan Hualapai Reservation. December, 64p.
29. Cork, S., Price, R., Connell, D. (2010). Capacity to adaptively manage climate change. Final report. Murray-Darling Basin Authority. MDBA Publication No. 209/11.
30. CPS (2005); Relatório de Balanço da Seca 2005 (2005 Drought Balance report), Secretariado técnico da Comissão para a Seca 2005, Instituto da Água, Ministério do Ambiente, Ordenamento do Território e do Desenvolvimento Regional, December 2005;
31. CSIRO, 2008. Wheat genome, hunt for drought adaptation. Brochure.
32. DG ENV (2007a), Water Scarcity and Droughts – In depth assessment, Second Interim Report, Directorate General Environment European Commission, Brussels.
33. DG ENV (2007b), Drought Management Plan Report – Including Agricultural, Drought Indicators, and Climate Change Aspects, Water Scarcity and Droughts Experts Network, Directorate General Environment, European Commission, Brussels.
34. Drought Management Guidelines. Tech. Rep. EU-MEDROPLAN.
35. EA (2012a), Head Office Drought Plan, Environment Agency, England, January 2012
36. Eakin, H., 2003. Rural Responses to Climatic Variability and Institutional Change in Central Mexico. University of California at San Diego, Center for U.S.-Mexican Studies 1004, Center for U.S.-Mexican Studies, UC San Diego.
37. Eakin, H., 2005. Institutional change, climate risk, and rural vulnerability: cases from Central Mexico. World Development 33 (11), 1923–1938.
38. ECA (2009). Shaping Climate Resilient Development: A framework for decision making, Economics of CC Adaptation Working Group (Climate Works Foundation, GEF, European Commission, Rockefeller Foundation, McKinsey and Co., Standard Chartered Bank, Swiss Re)
39. ECCA (2012), European Centre for Climate Adaptation, 2012
40. EEA (2009), Water Scarcity and Droughts: Towards a European Water Scarcity and Droughts Network, European Topic Centre on Water, European Environment Agency, 2009.
41. EEA (2010). Data and maps – European Environmental Agency (EEA), available online in http://www.eea.europa.eu/data-and-maps/

42. Egypt National Capacity Self Assessment (NCSA)"National Strategy And Action Plan For Capacity Development", December, 2007.
43. Estrela T (2006) La gestión de las sequías en España. Ingeniería y Territorio. Catástrofes naturales 74: pp 52–57, Barcelona
44. Estrela, T.; Vargas, E. (2012), Drought Management Plans in the European Union. The case of Spain, Water Resour Manage, DOI 10.1007/s11269-011-9971-2, published online in 11th January 2012.
45. Ewert, J. Adapting urban water systems to climate change. Case study Melbourne, Australia. Melbourne Water
46. Exceptional circumstances information handbook, A guide to policy, processes and assistance measures. 2010 http://www.daff.gov.au/__data/assets/pdf_file/0013/150322/ec-handbook.pdf
47. FEWS-NET (2005). Mozambique Food Security Update: Maputo.
48. FSIT (2006). The Rapid Vulnerability Assessment (RVA) of Food Insecure Districts in Tanzania Mainland for the 2005-6 Market Year, Food Security Information Team (FSIT), February 2006.
49. Giuliani G. and P. Peduzzi (2011). The PREVIEW global risk data platform: a geoportal to serve and share global data on risk to natural hazards. Natural Hazards and Earth System Sciences, 11, 53-66.
50. Hamdy A., (2004) Drought Preparedness and Mitigation in the Mediterranean Region. In: Hamdy A. (ed.). Proc. Water Management for Drought Mitigation in the Mediterranean, 2nd Regional Conference Arab Water 2004, Cairo (Egypt), 15 April 2004, p. 3-37.
51. Hennessy, K., Fawcett, R., Kirono, D., Mpelasoka, F., Jones, D., Bathois, J., Whetton, P., Stafford Smith, M., Howden, M., Mitchell, C. and Plummer, N (2008). An assessment of the impact of climate change on the nature and frequency of exceptional climatic events, CSIRO and BoM.
52. IFRCRCS (2003). Tanzania: Appeal No. 01.11/2003, Appeal 2003-2004. International Federation of Red Cross and Red Crescent Societies (IFRCRCS)
53. IFRCRCS (2006). Tanzania: Drought, Information Bulletin, 3 March 2006. International Federation of Red Cross and Red Crescent Societies (IFRCRCS)
54. Iglesias A., B. Bonnacorso, M. Moneo, S. Quiroga et A. Guarrido (2007).Chapter 4. Institutional and legal framework for drought management. Options Méditerranéennes, Série B, N° 58. 35-59.
55. Iglesias, A., A. Cancelliere, D. Gabina, A. Lopez-Francos, M. Moneo, and G. Rossi. (2007).

56. INGC, UEM, FEWS-NET (2003). Atlas for Disaster Preparedness and Response in the Limpopo River Basin. Creda Communications. Cape Town, South Africa.
57. Jimenez, S. and Jimenez, A. (2011). Catastrophic Drought Highlights Inherent Weakness Within U.S. System of Emergency Management: A Need for Presidential Action. January, 32p.
58. Karrou, M. (2000) Contribution à la mise en place d'une approche intégrée de lutte contre la sécheresse chez les céréales au Maroc. In Options Méditerranéennes Série A, No. 40 : Actes du séminaire sur l'amélioration du blé dur dans la région méditerranéenne : Nouveaux défis. Saragoza (Espagne) 12-14 Avril 2000.
59. Kelic A., V. Loose, V. Vargas and E. Vugrin. (2009) SAND REPORT,SAND 2009-1360 Printed March 2009, Energy and Water Sector Policy Strategies for Drought Mitigation
60. Lahlou, O. (1990). Irrigation d'appoint et efficience d'utilisation de l'eau. Cas du blé. Mémoire de 3ème cycle pour l'obtention du diplôme d'Ingénieur d'état en Agronomie. IAV Hassan II. Rabat, Maroc
61. Lahlou, O. (2012) Technology Action Plan for climate change adaptation in the agriculture sector of Morocco. Technology needs assessment experience sharing workshop. Bangkok, Thailand: 10-12 September, 2012
62. Lawhon Isler, P., Merson, J., Roser, D. (2010). 'Drought Proofing' Australian Cities: Implications for Climate Change Adaptation and SustainabilityWorld Academy of Science, Engineering and Technology 70.
63. Leedman, A., Bruce, S. and Sims, J (2008). The Australian National Agricultural Monitoring System – a national climate risk management application, in Stefanski, R and Pasteris, P (eds.), 'Management of natural and environmental resources for sustainable agricultural development, Proceedings of a Workshop', 13–16 February 2006, Portland, Oregon, AM-10, WMO/TD-No. 1428. pp. 66–76, World Meteorological Organization
64. Loucif, N. (2003) Les ressources en eau et leur utilisation dans le secteur agricole en Algérie. Revue Homme, Terre et Eaux, 125.
65. Louisville, City, Public Works Department, Colorado (2004) Drought Management Plan, 27p.
66. Maia, R. (2011), Drought Planning and management on an European transboundary context: the case of the Iberian Peninsula, in Proceedings of the 34th World Congress of the International Association for Hydro- Environment Research and Engineering: 33rd Hydrology and Water Resources Symposium and 10th Conference on Hydraulics in Water Engineering, Australia, 2011.

67. MAOTDR (2007), Water Scarcity and Droughts. A Priority of the Portuguese Presidency, Ministério do Ambiente, do Ordenamento do Território e do Desenvolvimento Regional, Portugal, 2007, ISBN 978-989-8097-08-8.
68. Marchildon, G. P., Kulshreshtha, S., Wheaton, E., Sauchyn, D. (2007) Drought and institutional adaptation in the Great Plains of Alberta and Saskatchewan, 1914–1939. Nat Hazards, 21p. DOI 10.1007/s11069-007-9175-5
69. MEDROPLAN (2007), Drought Management Guidelines, Iglesias, A., Cancelliere, A., Gabiña, D., López-Franco, A., Moneo, M., Rossi, G. (eds), Mediterranean Drought Preparedness and Mitigation Planning (MEDROPLAN), European Commission – EuropeAid Co-operation Office, Euro-Mediterranean Regional Programme for Local Water Management (MEDA Water).
70. MICOA (2005). Avaliação da Vulnerabilidade às Mudanças Climáticas e Estratégias de Adaptação. Direcção Nacional de Gestão Ambiental: Maputo, pp. 20 – 30
71. MICOA (2007). National Adaptation Programme of Action (NAPA): Maputo, pp. 36 – 47
72. Miller, T.D. (2000). Opportunities for Drought Mitigation in Texas. Texas Agricultural Extension Service SCS-2000-22 4p.
73. Murray-Darling Basin Authority, 2012. PROPOSED Basin Plan. http://download.mdba.gov.au/revised-BP/PBP_reviseddraft.pdf
74. National Drought Policy Commission (NDPC) (2000) Preparing for drought in the 21st century. DNPC and USDA, 60p.
75. Navajo Nation Department of Water Resources, NNDWR (2003). Navajo Nation Drought Contingency Plan. 161p.
76. NBST (2011). National Bureau of Statistics (NBS) (Tanzania) and ICF Macro. Tanzania Demographic and Health Survey 2010. Dar es Salaam, Tanzania. 451pp.
77. NDMC (2011/2012). Droughtscape newsletter, Winter, 16p.
78. Nicholson, M., Bruce, S., Walcott, J. and Gray, J. (2011). Elements of a National Drought Policy: The Australian context. Paper for the World Meteorological Organisation Expert meeting to prepare a Compendium on national drought policy, Washington DC, 14–15 July 2011.
79. Ordu A.U., J. Kolster, et N. Matondo-Funani (2011). Usage agricole des eaux souterraines et initiatives de gestion au Maghreb: Défis et opportunités pour un usage durable des aquifers
80. Orlove, B. (2005). Human adaptation to climate change: a review of three historical cases and some general perspectives. Environmental Science and Policy 8(6), p. 589-600. doi:10.1016/j.envsci.2005.06.009

81. Pandey, D. N., Gupta, A. K. and Anderson, D. M. (2003) Rainwater harvesting as an adaptation to climate change. Current Science, 85(1), 10 July p. 46-59
82. Panu, T.C. Sharma (2002). Challenges in drought research: some perspectives and future directions. Hydrological Sciences Journal, 47:S1, S19-S30. http://dx.doi.org/10.1080/02626660209493019
83. Parson, E. A., Corell, R. W., Barron, E. J., Burkett, V., Janetos, A., Joyce, L., Karls, T. R., Maccracken, M. C., Melillo, J., Morgan, M. G., Schimel, D. S. and Wilbanks, T. (2003). Understanding Climatic Impacts, Vulnerabilities, and adaptation in the United States: Building a Capacity for Assessment, Climatic Change, 57(1), March, p. 9-42(34)
84. Pawadyira, M. S. and S. Ndlovu (1993). A review of early warning: The 1992 drought disaster in Zimbabwe Harare, Department of Civil Protection
85. Pearson, L. and Langridge, J. (2008) 'Climate change vulnerability assessment: Review of agricultural productivity' CSIRO Climate Adaptation Flagship Working paper No.1. Web-ref http://www.csiro.au/resources/CAF-Working-Papers
86. PMO (2006). Rapid Vulnerability Assessment Report on Food Insecure Areas in Tanzania for the 2006/07 Marketing Year, Main Report. Disaster Management Department in the Prime Minister's Office (PMO); National Food Security Division of the Ministry of Agriculture, Food and Co-operatives; Tanzania Food Security Information Team (FSIT), 36pp.
87. Prinz, D ; Amir H. Malik. (2002) Runoff farming: Institute of Water Resources Management, Hydraulic and Rural Engineering, Dept. of Rural Engineering.
88. Productivity Commission (PC) (2009). Government Drought Support, Final Inquiry Report no. 46, Commonwealth of Australia, Melbourne.
89. Reilly, J., Tubiello, F., McCarl, B., and Melillo, J. (2000).Climate Change and Agriculture in the United States. NSTC Draft document, National Assessment Synthesis Team, Chapter 13, 48p.
90. RMSI (2009). Mozambique (Economic Vulnerable and Risk Assessment). Final Report, Vol 1, pp26 – 36.
91. Roncoli, C., Ingram, K., Kirshen, P., 2002. Reading the rains: local knowledge and rainfall forecasting among farmers of Burkina Faso. Society and Natural Resources 15, 411–430.
92. Schwarzenegger, A., Chrisman, M., Snow, L.A. (2008). California Drought, An Update. State of California, Resources Agency, Department of Water Resources, June, 128p.
93. Setsan (2005). Estudo de Avaliação do Impacto da Implementação do Plano de Acção e Mitigação à Estiagem e Seca. Secretariado Técnico de Segurança Alimentar e Nutrição. Maputo, Moçambique.

94. Simpson, R.H. (1998) Stepping Stones in the Evolution of a National Hurricane Policy Weather Forecasting, 13, p. 617–620. doi: http://dx.doi.org/10.1175/1520-0434(1998)013<0617:SSITEO>2.0.CO;2
95. Sivakumar, M. V. K., Motha, R. P., Wilhite, D. A., Qu, J. J. (2011). Towards a compendium on national drought policy, proceedings of an expert meeting on July 14-15, Washington DC, USA. Sponsored by WMO, USDA, Univ. of Nebraska, Lincoln, George Mason University, 143p.
96. Specific mitigation actions to reduce short and long-term drought risks", Atef Hamdy, 2009, *cited from* www.ciheam.org/om/pdf/a95/00801363.pdf
97. Stefanki, R. (2012) Drought Management and Policies: WMO Drought initiatives, www.clivar.org/sites/default/files/Stefanski.pdf)
98. Sydney water (2011). Water Efficiency Report 2010-2011.
99. Texas, State of (2005). State Drought Preparedness Plan, Governor's Division of Emergency Management, Austin, Texas, July, 41p.
100. UNISDR (2009). Drought Risk Reduction Framework and Practices. UNISDR, Geneva, Switzerland. 197p.
101. URT (2003). The National Operational Guidelines for Disaster Management, First Edition. Prime Minister's Office, United Republic of Tanzania (URT). 120pp.
102. USDA-FSA (2009) Emergency Disaster Designation and Declaration Process. Fact Sheet, 3p.
103. Vargas (2008), Drought Management in Spain, International Network of Basin Organizations, Zaragoza, 2008, available online in http://www.riob.org/IMG/pdf/EVargas_Droughts.pdf
104. Vicente-Serrano S.M., S. Beguería, L. Gimeno, L. Eklundh, G. Giuliani, D. Weston, A. El Kenawy, J.I. Lopez-Moreno, R. Nieto, T. Ayenew, D. Konte, J. Ardö and G.G.S. Pegram. (2012). Challenges for drought mitigation in Africa : The potential use of geophysical data and drought information systems. Applied Geography 34: 471-486.
105. Water demand in strategic sectors, Meladen Todorović (CIHEAM-IAMB), 2010, WSSERMed project Workshop 23-24 November, 2010 Cairo-Egypt.
106. Wateract 2007, Act No. 137 of 2007 as amended, ComLaw Authoritative Act C2012C00229. Australia.
107. Werick, W.J. and Whipple, W. Jr (1994). Managing water for drought. National Study of Water Management During Drought, US Army Corps of Engineers, Institute for Water Resources. September, 200p. IWR REPORT 94-NDS-8

108. White, D.H. and Walcott, J.J. (2009). The role of seasonal indices in monitoring and assessing agricultural and other droughts: a review, Crop and Pasture Science, 60(7): 599–616.

109. Wilhite D.A. (2005). Australian and U.S drought policy experiences: Are lessons learned transferable to Africa? First African drought adaptation forum. 31 january- 02 February, 2005. Nairobi, Kenya.

110. Wilhite, D. A. (2002). Combating drought through preparedness. Natural Resources. Forum, 26, 275-285.

111. Wilhite, D. A., Diodato, D. M., Jacobs, K., Palmer, R., Redmond, K., Sada, D., Smith, K. H., Warwick, J., Wilhelmi, O. (2006). Managing Drought: A roadmap for change in the US Conference Report, 31p.

112. Wilhite, D. A., Sivakumar, M. V. K. and Wood, D. A. (2000). Early Warning Systems for Drought Preparedness and Drought Management. WMO, 212p. AGM-2 WMO/TD No. 1037

113. Willow Park, City (2001). Drought Contingency Plan for the City of Willow Park, Texas, April, 10p.

114. Wlodarz, M. (2011) Sustainable adaptation to drought in agriculture – a literature review. Texas AandM University, 28p.

115. WMCN (2011), Water Management Centre the Netherlands. Focal point for water, Rijkswaterstaat, Ministry of Infrastructure and the Environment, 2011. www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Brochure%20Fran%C3%A7ais%20agriculture%20et%20eau_North%20Africa%20Quaterly%20Analytical.pdf

116. www.wamis.org/agm/pubs/ agm10/agm10_07.pdf

117. XEROCHORE (2010a), Extended Guidance Document after conference on Drought Management and Policy options (D 5.2), XEROCHORE Project, 2010.

118. XEROCHORE (2010b), Implementing a programme of measures, XEROCHORE Science Policy Brief nº4, 2010.

119. XEROCHORE (2010c), River Basin Management Plans, XEROCHORE Science Policy Brief nº5, 2010.

120. Ziervogel, G., Bharwani, S., Downing, T.E., 2006. Adapting to climate variability: pumpkins, people and pumps. Natural Resource Forum 30, 294–305.

121. Ziervogel, G., Bharwani, S., Downing, T.E., 2006. Adapting to climate variability: pumpkins, people and pumps. Natural Resource Forum 30, 294–305.

122. Zuni Tribe(2001). Zuni Drought Contingency Plan. The Zuni Tribe, Water Resources Section, Conservation Program, Zuni, New Mexico. December 18. 25p.

Websites

Dirmeyer, P., (URL accessed: July 2012) Floods and Droughts in a Changing Climate – Now and the Future. Earthzine, http://www.earthzine.org/2011/04/29/floods-and-droughts-in-a-changing-climate-%E2%80%93-now-and-the-future/

EPA (URL accessed: July 2012) Agriculture and Food Supply Impacts and Adaptation
http://www.epa.gov/climatechange/impacts-adaptation/agriculture.html

Kimery, A., (URL accessed: July 2012) FEMA, Dealing with the Drought. HStoday.us Published online on 1 June 2012.
http://www.hstoday.us/channels/fema/single-article-page/dealing-with-the-drought/1b167935a31e6a76fe095aad3960b3a1.html

Mulroy, P. (URL accessed: July 2012) A Federal Freshwater adaptation law in the US? Published online on 1 November 2011. http://adaptationaction.org/files/tag-drought.php

UN (URL accessed: July 2012). Climate Change – Adaptation.
http://www.un.org/wcm/content/site/climatechange/pages/gateway/adaptation

USDA (URL accessed: July 2012).Disaster and Drought Assistance
http://www.usda.gov/wps/portal/usda/usdahome?navid=DISASTER_ASSISTANCE

US State Plans: http://drought.unl.edu/planstateplans.htm

Bergman, C.J., Hayes, M. J., Bathke, D. J., Knutson, C. L. and Tang, Z. (2012b) Investigating the Experiences of Watersheds and Hydrologic Basins to Improve Drought Planning in the U.S
https://ams.confex.com/ams/92Annual/flvgateway.cgi/id/19943?recordingid=19943

Murphy, V. W. (2012) Climatological Context and Impacts of the 2011 Drought in Texas. Presentation, NOAA/ NWS, January at the 92nd American Meteorological Society Annual Meeting.
https://ams.confex.com/ams/92Annual/flvgateway.cgi/id/19887?recordingid=19887

Rose, B. (2012) Challenges to the Lower Colorado River Authority Created by the Exceptional Drought of 2011. Lower Colorado River Authority, Austin Texas.
https://ams.confex.com/ams/92Annual/webprogram/Paper202076.html

Svoboda, M. D. (2012). Status of State Drought Planning and Response in the United States, Presentation, NDMC. 24 January at the 92nd American Meteorological Society Annual Meeting.
https://ams.confex.com/ams/92Annual/webprogram/Paper197725.html

ACTEW
http://www.actew.com.au/

http://www.actew.com.au/Water%20Conservation%20Measures%20and%20Restrictions.aspx
http://www.actew.com.au/Water%20Conservation%20Measures%20and%20Restrictions/Permanent%20Water%20Conservation%20Measures.aspx

Australian Natural Resources Atlas
http://www.anra.gov.au/topics/water/overview/index.html

Commonwealth Environmental Water Holder
http://www.environment.gov.au/ewater/about/index.html

ACT (2000). Tanzania: Drought, Action by Churches Together (ACT), October 12, 2000. http://www.cidi.org/report/6108, accessed on 11th September 2011.

DAFF
http://www.daff.gov.au/agriculture-food/drought/ec
http://www.daff.gov.au/abares
http://adl.brs.gov.au/brsShop/data/nams-factsheet.pdf
http://www.daff.gov.au/agriculture-food/drought

European Centre for Climate Adaptation
http://www.climateadaptation.eu/

Grain Research Development Corporation
http://www.grdc.com.au/About-Us
http://www.climatekelpie.com.au/

National Farmers' Federation (NFF)
http://www.nff.org.au/

National Water Commission
http://nwc.gov.au/commission

Standing Council on Primary Industries
http://www.mincos.gov.au/about_scpi

Sydney Water
http://www.sydneywater.com.au/Water4Life/WaterWise/

URT (2009). United Republic of Tanzania (URT). National progress report on the implementation of the Hyogo Framework for Action. An HFA Monitor update published by Prevention: http://www.preventionweb.net/english/countries/africa/tza/