Drought conditions and management strategies in Morocco

Said EL KHATRI[1] and Tarik EL HAIRECH[2]
[1] Direction de la Météorologie Nationale, Casablanca, Morocco elkhatri@gmail.com
[1] Direction de la Météorologie Nationale, Casablanca, Morocco tarik.elhairech@gmail.com

1. Background:

Morocco has been experiencing more frequent drought events over the last two decades. Drought frequencies have risen from one event every 10 years at the beginning of the 20th century to 5 or 6 events every 10 years at the beginning of the 21st century (Agoumi, 2003). Review of literature on drought in Morocco also indicates that occurrences of drought during the 20th century grew steadily (Mhirit et al., 2011). Besides, many regions in Morocco (namely, Oujda, Taza, Kenitra, Rabat, and Meknès) became more arid (according to the aridity index of De Martonne) between 1961 and 2008, (Driouech, 2009). Table 1 lists some of the important drought events during the last two decades. It can be observed that drought has considerable negative impacts on the economy and people of Morocco in terms of crop production losses, reduction in GDP, and loss to livelihood (figure 1). It also demonstrates that drought is a major obstacle for agriculture and food security in the country. With several indications suggesting an increased frequency in drought events in Morocco, the average annual impact might become even greater in the future. It is, therefore, crucial that policymakers take heed of the severe implications of droughts, especially for the most vulnerable in society, such as resource-poor, small-scale farmers, and poorer urban households.

Drought event	**Remarks**
1994-1995	Reduced incomes due to drought caused GDP to fall by 7.6% in 1995 The production of cereals fell from 9.5 million tons in 1994 to 1.6 million tons in 1995 due to drought
1996-1997	Reduced incomes due to drought caused GDP to fall by 2.3% in 1997
1998-1999	Reduced incomes due to drought caused GDP to fall by 1.5% in 1999
1999-2000	275,000 people affected. Economic Damages: USD 900 million
2000-2001	The country imported about 5 million tons of wheat in 2001 (compared to 2.4 million tons in normal years).
2004-2005	Reduced economic growth rate from 3.5 to 1.3 % for 2005
2006-2007	700,000 people affected. Grain production reached only half of the normal year's levels.

Table 1 socioeconomic Impacts of recent droughts in Morocco (RMSI, 2012)

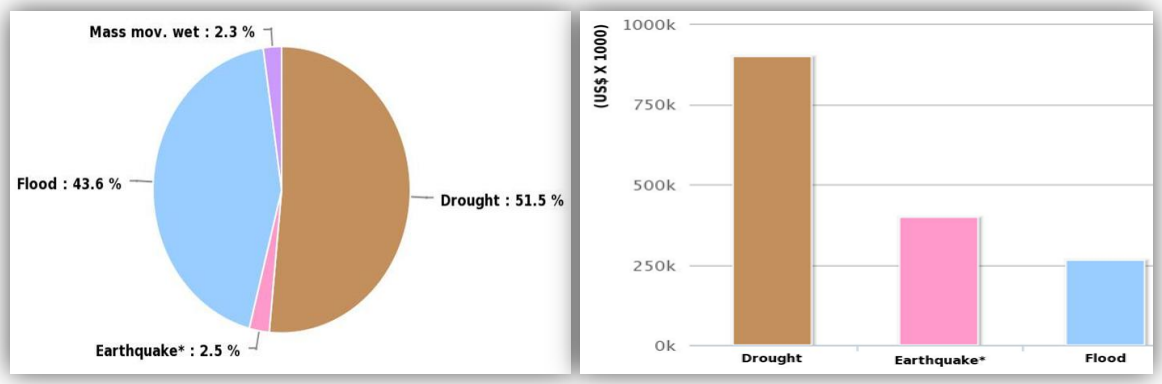

Figure 1 Percentages of population affected in Morocco (left) and Estimated accumulated economic damages for Morocco (right). Source of data: "EM-DAT: The OFDA/CRED International Disaster Database, University Datholique De Louvain, Brussels, Bel." Data version: v11.08

2. Drought monitoring and early warning systems:

Morocco's experience over the years has allowed the country to gradually adopt several drought monitoring and early warning systems. The list below describes briefly those systems and their stakeholders.

The seasonal forecasting system of DMN: Since 1994, The Direction de la Météorologie Nationale (DMN) has explored both statistical and dynamical approaches to providing seasonal predictions of precipitation in Morocco through two major projects, Al Moubarak (based on statistical models) and El Masifa (based on both dynamical and statistical models). These studies have led to adoption of a model which uses SST anomalies over the tropical Pacific Ocean on October-November-December to make prediction of precipitations for February-March-April over Morocco. Also, the skill of the Arpège-Climat dynamical model from "Météo-France" has been evaluated, and this model is now running on the DMN supercomputer. This experience at DMN in seasonal forecasting is quoted as a successful story (Troccoli, 2008). The products are disseminated to many users especially high authorities, agricultural and hydrological services. Furthermore, Morocco was chosen for leading seasonal forecast for Regional Climate Centre of North Africa.

The Moroccan National System for crop monitoring and cereal yield prediction: A national system for monitoring crop and agro-meteorological prediction of cereal crops, called 'CGMS-MOROCCO', is operational since 2011 (Balaghi et al. 2012). It was initiated by the National Institute of Agronomic Research (INRA) as part of the E-AGRI project (Balagui, 2014). CGMS-MOROCCO is managed by a national consortium (INRA), (DMN) and the Directorate of Strategy and Statistics (DSS of the Ministry of Agriculture Morocco). CGMS-MOROCCO is the first web-based Moroccan monitoring system for crop and agro-meteorological prediction of cereal crops in Morocco. Crop monitoring and forecasting is an essential component of the climate risk management in agriculture (see example in appendices). CGMS-MAROC allows to instantly predicting grain yields two to three months before harvest. Forecasting the production of crops early before harvest allows decision makers to be prepared in

advance for eventual consequences of abnormal deviations of the climate, particularly for strategic commodity crops to food security like cereals.

The SMAS project (Système maghrébin d'alerte précoce à la sécheresse) aiming to establish a Maghreb-wide system for early warning to drought was coordinated by OSS (Observatory of Sahara and Sahel) and implemented in Algeria, Morocco and Tunisia from 2006 to 2009 in the framework of the LIFE-Pays-Tiers Program, financed by the European Union. At the Moroccan level, the DMN, the CRTS (Royal centre of Spatial Teledetection), the MAPM (Ministry of Agriculture) and the HCEFLCD (High Commission for Waters and Forests and the Fight against Desertification) were involved in the project. Each institution contributed by the production of an ensemble of drought indicators depending on their capacity. These indicators were compiled in drought early warning bulletins that were produced on a monthly basis from November to April in 2008 and 2009 and available on the CRTS website.

3. Vulnerability assessment:

Morocco's economy is vulnerable to water scarcity. For example, its economy expanded only 2.4% in 2012, dragged down by drought-weakened agriculture sector, which was much lower than the government promised 7% growth. (http://www.ihs.com/products/global-insight/industry-economic-report.aspx?id=1065977754)

The most vulnerable sector in Moroccan economy is Agriculture. Indeed, Only 15 percent of the country's lands are irrigated, while the rest are rain-fed crops. Morocco's 1.4 million hectares of irrigated crops consume, on average, 85% of available water resources (as low as 60 to 70% in a dry year), while 12% and 3% of resources are used for public water supply and industry, respectively. Agricultural sector in Morocco accounts for:

- 15 percent of the GDP
- 40 percent of all employment
- 70% farmers have no more than 2.1 ha of land and struggle with frequent drought, in the absence of any appropriate protection mechanisms.

In Morocco, food security is based on cereal production which is sensitive to climatic risks. Domestic production of cereals is highly exposed to climate risk as it is mainly localized in the arid and semi-arid areas of the country, characterized by limited soil and water resources.

Cereal imports were consistent since 1980, representing nearly half (48.7%) of the cereal production and most of imported food products and import cost. Annual cereal imports amounts to 2.6 million tons on average for the period of 1980-1981 till 2010-2011, most of it composed of soft wheat which accounts for 77%, followed by durum wheat (12%) and barley (11%). Cereal imports are in constant progression since early 1990s, fluctuating over time and ranging from 10% of average cereal production (during season of 1994-1995) following the good harvest of 1993-1994 to 244% during 2000-2001 following the dry season of 1999-2000. However, cereals are imported even during record productive seasons like during 2008-2009 (10.2 million tons of production), where significant quantity was imported during the next season (2.56 million tons), that is 25% of the 2008-2009 total cereal production.

4. Emergency relief and drought response:

Morocco has longstanding experience in the development and implementation of programs to alleviate the impacts of drought. These programs are based on interventions aimed at:

- Securing safe drinking water for rural populations in particular
- Reserving livestock through feed distribution
- Implementing income and job-creating activities (maintenance of rural roads and irrigation infrastructures)
- Conserving forests and natural resources.
- Artificial modification of Weather

5. Practices to alleviate drought impacts:

The man measures and practices applied by Morocco are (Ouassou A. et al. 2005):

- In 1995, Morocco established the water law, which emphasis on integrated water resources management through better water use efficiency, resource allocation practices, and protection of water quality.
- In 2001, Morocco created a National Drought Observatory (NDO).
- Morocco is adopting an insurance approach in cereal production.

Preparation to drought and water scarcity situations: supply side management measures:

- Maximizing storage of rainwater (more than 140 dams)
- Use of marginal resources (groundwater)
- Aquifer recharge
- Improved efficiency of water distribution networks
- Water transfers
- Desalination
- Waste water reuse

Demand side management measures:

- Water metering
- Mandatory rationing
- Restriction on municipal use
- Water markets (tariffs) and full cost recovery
- Water saving campaigns for voluntary actions
- Awareness campaign minimize drought damages
- Increase in the regulation capacity for irrigation purposes
- Increase in the regulation capacity for urban supply

Strategies to reduce risk in agriculture fall into three categories: (1) In irrigated agriculture, save water by minimizing losses and improving water use efficiency; (2) In pasture and forest areas, make use of actually evaporated water by developing pasture and fruit trees ecosystems; (3) In rainfed areas, increase productivity by dry farming techniques which consist on improving water harvest, storage and use at farm and plot levels (Balaghi R. et al. 2007).

6. The need for knowledge and skills on drought management:

In Morocco, as in many developing, there are gaps in the management of drought and water scarcity. Certainly, many organizations are involved in drought management including:

Main advisory authorities:

- Economic and Social Council (Committee on Environmental Affairs and Regional Development)
- Superior Council for Water and Climate
- Council for Agricultural Development
- Permanent Inter-Ministerial Council for Rural Development
- National Drought Observatory

Executive administration authorities

- Ministry of Water (National Meteorological Office; Directorate General of Hydraulics, Water Basin Agencies, National Office of Water Drinking and Electricity)
- Ministry of Agriculture and sea fishing (Regional Offices for Agricultural Development)
- High Commissariat of Water, Forest and Fight against Desertification
- Ministry of Interior (Directorate General of Local Collectivities, Directorate of Utilities and Services Licensed); Ministry of Finance; Ministry of Health; Ministry of General Affairs

But it is important to implement an independent organization or unit responsible for the management of drought. This unit should be responsible for coordination between the various departments and agencies. In fact, in every organization there is a unit that is responsible on drought issues according to his specialty. A standard and complementary drought management approach is needed. This begins by strengthening the sharing of information on drought and the establishment of a global early warning system. Mitigation plans are in emergencies but should be updated regularly.

In principle, the ability to provide early-warning forecasts of drought could be a powerful tool for avoiding many of the economic costs associated with the misallocation of resources that arise because farmers, herders, and other decision makers have to commit resources each year before key rainfall outcomes are known (Solh M. et al.2011).

“Insofar as drought protection is concerned, a concerted national strategy should be initiated by the drought management plans at the level of all river basins, aimed at:
a. Characterization of droughts: identification and proposal of monitoring indicators.
b. Implementation of structural measures: diversification of sources of water supply.
c. Development of contingency plans.
d. Development of financial mechanisms such as insurance and funds for natural disasters” (Alaoui M. 2013)

References:

Agoumi, A. (2003) *Vulnerability of North African Countries to Climatic Changes*: *Adaptation and Implementation Strategies for Climate Change*. International Institute for Sustainable Development, Winnipeg

Alaoui, M. (2013). Water Sector in Morocco: Situation and Perspectives. *Journal of Water Resources and Ocean Science*. Vol. 2, No. 5, pp. 108-114

Balaghi, R.,2014.The Crop monitoring and yield forecasting system of Morocco CGMS-MAROC.Crop Monitoring As an E-agricultural Tool For Developing Countries - Dissemination Event on: *The Operational Crop Monitoring and Forecasting in Morocco. E-AGRI project Dissemination Event.March 26th 2014, Rabat,* Morocco.http://www.inra.org.ma/environ/docs.asp?codedocs=93&codelangue=23

Balagh R., Tahri M., El HairechT. 2012. Bulletin de prévision de la récolte céréalière. Campagne agricole 2011-2012.3p. http://www.inra.org.ma/docs/environ/bullprev1112fr.pdf

Balaghi R., Jlibene M., Mrabet R., 2007. Gestion du risque de sécheresse agricole au Maroc. *Sécheresse* vol. 18, n°3, p1-8

Driouech, 2009. Distribution des précipitations hivernales sur le Maroc dans le cadre d'un changement climatique : descente d'échelle et incertitudes. *Thèse de doctorat. Université de Toulouse. France. 164p. http://ethesis.inp-toulouse.fr/archive/00001300/01/driouech.pdf*

Mhirit, O., Khattabi, A., Rouchdi, M., Yessef, M., and Chouraichi, M. (2011). Adaptation du Programme d'Action National de Lutte Contre la Désertification aux Spécificités Zonales (Rapport général provisoire). *Projet : Protection de la Nature et Lutte Contre la Désertification (PRONA-LCD).*

Ouassou A., Ameziane T., Ziyad A. and Belghiti M., 2005. Application of the Drought Management Guidelines in Morocco. *MEDROPLAN Mediterranean Drought Preparedness and Mitigation Planning*, Chapter 19

RMSI, 2012. Morocco Natural Hazards Probabilistic Risk Analysis and National Strategy Development Drought Hazard Report. *Department of Economic and General Affairs, Kingdom of Morocc,74pp*

Solh, M. and Saxena M.C. (eds) 2011. Food security and climate change in dry areas*: proceedings of an International Conference, 1-4 February 2010, Jordan. PO Box 5466, Aleppo, Syria: International Center for Agricultural Research in the Dry Areas (ICARDA) viii +669pp, P49*

Troccoli, A. (2008. *Seasonal Climate: Forecasting and Managing Risk: Forecasting and Managing Risk.* Springer Science & Business Media

Appendices

Right : Example of SMAs bulletins produced in 2008 for Morocco

Down: The two crop monitoring and forecasting bulletins published in April 2012 and 2013 (freely available at www.cgms-maroc.ma).