INTEGRATING EARLY WARNING IN DISASTER PREPAREDNESS AND RESPONSE IN MOROCCO

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Morocco is characterised by a contrasted geomorphology and a diversified climate dominated by the aridity. The most remarkable pattern of the rainfall is the variability in both space and time. The precipitation is erratic and irregular, leading to extreme hydrometeorological events, mainly drought and floods.

Drought, in Morocco, is being a structural stress and there are some indications that droughts are becoming more prolonged and their impacts more severe. The recent drought period extends from 1999 to mid 2002 and affects approximately 50 to 90% of the entire territory. The severity of the drought is being felt mostly in rainfed areas situated in the rural zones where the bulk of the population depends on rainfed farming, and traditional livestock rearing. Drought causes losses in crop production, exacerbates cutting in the main source of income for the rural populations, induces shortage of drinking water and affects the irrigation as a result of the reduced inflow of water in the dam reservoirs.

Flooding also is being a recurrent hazard in Morocco. During the last decade only, the country has experienced some of the worst floods not only in terms of number of people killed or number affected but also in terms of damages to infrastructures like roads, telecommunications, industrial zones and human settlements. Flash floods occur frequently in vicinity of the Atlas Mountains Range because of extreme air convection activity. These flash floods are caused by intense orographic small-scale showers giving rise to strong and rapid torrents. The risk of damage from these torrents is greater in drier areas with poor soil and less vegetation than in those with forest cover. Expansion of informal settlements or wild camping into the flood zone is putting many more people at risk of flooding, as illustrated in Ourika Valley, Marrakesh District, during the floods of August 1995[1].
Morocco is also vulnerable to floods caused by heavy rain even if they are not generated by brutal storms or showers. These floods occur because of inappropriate drainage systems and land use change. They can affect both urban and rural areas. In November 2002, twenty thousand people are in need of immediate assistance after heavy rains and floods hit western Morocco.

Besides drought and floods, meteorological conditions also play key roles in the outbreak of other natural extreme events as shown in the following table:

Hydrometeorological Phenomenon and Geographical zones most vulnerable	Socio-economic sectors affected
Hailstorms affecting the mountainous zones in Central Morocco.	Agriculture (Rosaceous fruit-farming)
Heavy sea and severe swell affecting the open sea and coasts, mainly in the Atlantic ocean side	Coastal infrastructures Fisheries and Marine navigation
Wind blast and gale occurring under specific weather conditions hitting mainly the Atlantic and Mediterranean Littoral	Agriculture Infrastructures (telecommunications and electricity facilities)
Dust storm an sandstorm affecting the southern regions	Infrastructures (airports, road networks, etc.) and agriculture
Heat waves due to Saharan air invasion, Chergui and Sirocco: hot and dry southward and eastward winds	Agriculture Livestock
Bush and forest fire occurring directly because of high temperatures and drought (low soil humidity) or indirectly because of their large scale propagation due to the wind	Forest cover Rural populations Agriculture

Impacts of disasters include loss of lives and livelihoods, damage to infrastructure and communications, interruption of economic activities, and increased risk of disease outbreaks. In urban centres these phenomena are being emphasised due to high population growth rates. In suburban and rural areas, these impacts are worsened by poverty and marginalization.

Addressing these environmental problems has always been a major concern for the government. Special focus on drought and flooding disasters has been made.

In the area of drought warning, Morocco 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 ENSO[2]. The main objective of the program is to help the decision-makers to foresee the periods of drought in order to mobilise the necessary means to face it. The project is supported by international co-operation and has two main components: ALMOUBARAK[3] mounted in association with the University of Oklahoma (USA) and co-financed by the USAID, and ALMASIFA[3] implemented in association with the research centres of the met services of France, Algeria and Tunisia [4] and co-financed by the European Commission.

Although this project is still now under experimentation (*implementation of an experimental bulletin based on the models outputs, titled "Long Term Prediction Bulletin"*), it also allows capacity building to better understand the drought mechanisms in Morocco helping to implement a warning system for it.

Concerning the monitoring of the hydrometeorological phenomena, Morocco has a diversified measuring network providing relevant weather and water based information such as rainfall, evaporation, flow and water level etc. at different time scales. In order to compensate for the weakness of the spatial coverage of the traditional observing stations, new observing methods such as radar or satellite-based remote sensing systems were introduced.

In this area, and since the end of 1995, Morocco is equipped with an operational weather Doppler radar network, which meets some forecasters and hydrologists needs. The goal of this network is the detection and the identification, in real time, of sever storms related to convective situations and the instantaneous evaluation of the spatial repartition of the rainfall leading to improving the Very Short Range Forecast of these events.

The radar products are used jointly with satellite data and imageries (METEOSAT's PDUS, NOAA's HRPT, TOVS)[5], radio-sounding data and ALADIN[3] model outputs to provide forecasts at different ranges: medium, short and very short range forecast. In case of situations of heavy rain or convective storms, this information is processed to issue Special Weather Warning Bulletins (*Bulletins Météorologiques Spéciaux*, BMS) for specific recipients (water resources management authority, department of equipment an transportation, department of agriculture, prefectures, relief and civil protection authority, urban sewage services, etc.)

In the area of flood disaster response, many measures have been taken by Moroccan authorities to mitigate the impact of heavy rains and flooding extreme events in the future after learning lessons from disasters occurred in the past. Thus, the government has already commenced to integrate these natural disasters into land planning strategies at different levels: definition of the building zones in urban and periurban environment, design and the construction of infrastructures in zones vulnerable to floods, management of the hydraulic public domain, river-basins and catchment areas using afforestation, soil stabilisation and specific hydraulic equipment, construction of dams and dikes, etc.

An example of the lessons learned from the past is the Ourika Valley flood disaster[1]. The severity of this disaster led the Government of Morocco to undertake operational initiatives including:

- Hazard Reduction Programs and mitigation measures: To reduce the flood risk at the most dangerous sites, engineering measures have been taken such as re-design of flood channel, flood dams, protective dykes, etc.
- Monitoring networks: including measuring stations, automated weather and hydrological systems with radio or satellite telemetry, etc. Special efforts are being made to cover all the vulnerable hydraulic basins with appropriate monitoring systems. The parameters measured include rainfall intensity, river flow and water levels.
- A guidelines booklet titled "Rainfall and Flood Natural Disasters Management, Practical Guidelines" edited and regularly updated by the Ministry of Equipment gives details about the preparedness and risk management procedure to be followed by the national and local authority to manage flood hazards. The key elements are: (i) The organisation of material and human resources involved (duty personal, technicians, telecommunications), (ii) The organisation of the monitoring bureau (Command Post), (iii) Forecasting organisation (weather bulletins, alerts thresholds, warning management), (iv) Organisation and management of the intervention plan and (v) Intervention assessment.

In the other hand, Morocco has adopted a reform of the institutional framework of water sector by adopting the law 10-95 on water. The decentralisation, according to the this law, of the water planning activity led to the implementation during the few last years of 7 Hydraulic Basins Agencies (*Agences de Bassins Hydrauliques ABH*) covering the total territory. Monitoring and fighting floods using in-situ automated monitoring systems and protective infrastructures are among the missions of the agencies. The co-ordination between the local services involved in flood management will be better undertaken under this new decentralised institutional structure.

Although some substantial advances made by Morocco in the area of disaster management, the development of warning systems and their integration in disaster preparedness and response are still inhibited by different factors. The key-factors are financial costs, geographical constraints lack in human capabilities, weak co-ordination at the institutional level and lack in public education and awareness.

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[1] *This disaster caused 730 persons killed, approximately 35000 affected and losses of goods and damages to infrastructures were estimated to USD$ 9 Millions.*

[2] *Sea Surface Temperature (SST), Northern Atlantic Oscillation (NAO) and El Niño Southern Oscillation (ENSO).*

[3] *ALMOUBARAK and AL ALMASIFA are climatic models. ALADIN is an area limited meteorological model.*

[4] *Météo-France, the Office National de la Météorologie (ONM, Algeria) and the Institut National de la Météorologie (INM, Tunisia).*

[5] *PDUS: Meteosat's Primary Data User station, HRPT: NOAA High Resolution Pictures Transmission, TOVS: Tiros Operational Vertical Sounder.*