Adaptation of water-energy system related to climate change: National study - Morocco

Synthesis

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Data relating to the water-energy system and climate change in morocco

As current knowledge stands, it is estimated that, in Morocco, average annual potential natural water resources amount to almost 22 billion m^3- around 18 billion m^3 of surface water and 4 billion m^3 of groundwater. Per capita natural resources are verging on the threshold of 500 m^3/inhab/yr, commonly recognised as the absolute shortage threshold meaning that the country is likely to face a permanent water shortage.

Developing this potential has always been a key concern for Moroccan economic policy, given its strategic role in the development of irrigated agriculture as well as the country's water and food security. Considerable water infrastructure has been set up, mobilizing almost all economically exploitable natural water resources on tap. These efforts, extending over the past four decades, have made it possible to:

- Satisfy demand for and secure the supply of drinking water to most towns in Morocco, even during periods of drought;
- Develop large scale irrigation over almost 1.6 million hectares. Depending on rainfall in a given year, it supports between 45 and 75% of the country's agricultural production and 75% of agricultural exports. It also provides almost 120 million days of work and encourages regional and local development;
- Develop the agro-food industry (13 sugar refineries, 13 dairies, hundreds of packaging and agro-food processing plants);
- Produce hydro-power thanks to the plants associated to the dams. Studies for water resource development plans have assessed this production at almost 3 500 GWh/yr.

These developments are currently facing new challenges, amongst which:

- Over-exploitation of groundwater and disruption of the balance which existed between traditional abstraction and the possibilities for natural replenishment. This has led to a drop in piezometric levels, reduced flow with some springs even drying up, disruption to water supply in traditionally irrigated sectors and the deterioration and decline of traditional irrigation and oases. This trend may well become even more marked in the future with water resources expected to dwindle as a result of climate change;
- Limited water use efficiency: irrigation systems and drinking water supply networks are far from efficient and are responsible for the loss of large volumes of water;
- An alarming deterioration in water quality as a result of delays in building sewage and wastewater treatment systems;
- The rate at which dam capacity is being lost as a result of silting;
- Significantly less rainfall driven by climate change. This drop has had a major impact on dam levels. Successive droughts over the last 30 years have significantly reduced inflow into dams (1970-2000 average 20 to 50% down on 1945-70), reflected in low water levels (50% on average over 10 years) and major shortfalls in the supply of irrigation water (52% on average over 10 years). This state of affairs basically results in an energy production gap of almost 1 200 KWh (50% of the objective established in perfectibility studies) and in limited agricultural intensification leading to the low profitability of capital invested in water infrastructure,

Scientific investigations conducted on climate forecasts in Morocco (Wilby 2007) have shown that climate change is likely to result in:

- Summer temperatures rising by up to 1.8 °C by 2020, 3.7°C by 2030 and 6.2 °C by 2080;
- A drop in rainfall in the order of 5 % to 15% by 2030 and 10 to 25% by 2050.

A 3°C rise in temperature and a 15% drop in rainfall by 2030 would substantially reduce annual run-off and therefore the volume of water mobilized by existing and planned dams. An analysis of droughts observed over the past thirty years shows that the shortfall recorded for run-off is almost double that of rainfall.

In terms of prospects, basin-wide water accounts, which compare available resources with water demand in order to establish a representative picture of the water situation, indicate that most basins will be in deficit by 2030. The following table presents the outcome for water balances for scenarios with and without the impact of climate change covered by tables 18 and 45.

Table 1 - Summary of water balances with and without climate change

	No account taken of climate change		Account taken of climate change	
	2030	2050	2030	2050
Water demand (Mm³/yr)	13 044	13 269	13 608	14 397
Water resources (Mm³/yr)	12 212	12 694	9 820	9 005
Global deficit (Mm³/yr)	-832	-575	-3 788	-5 392
Number of basins in deficit including non-conventional resources (Of 9)	6	4	7	7
Number of basins in deficit not including non-conventional resources (Of 9)	7	8	9	9

These solutions feature high levels of energy consumption, as is the case with seawater desalination and the water transfer project, for example. Consumption in the water sector is expected to increase from almost 1 450 GWh in 2010 to almost 6 145 GWh in 2030 (0.7 to 0.8 kWh/m³), in other words four times current consumption. Table 2 shows the volumes pumped as well as energy consumption.

Table 2 - Energy consumption in GWh

Sector	2010		2030	
	Water (Mm³)	Energy (GWh)	Water(Mm³)	Energy (GWh)
Drinking and industrial water	850	550	1 550	2 350
Irrigation	4 400	900	6 500	3 880
Sanitation	-	-	650	215
Reuse of wastewater	-	-	300	200
Total	5 250	1 450	9 000	6 145

The main impact of climate change on the water sector identified in this study can be summed up as follows:

- Increased water demand following a rise in temperature;
- Decreased rainfall virtually throughout the land;
- A reduction in potentially exploitable water of about 10 billion m³ per year;
- Decreased potential for hydro-power production from existing and planned dams, estimated at about 1 500 GWh per year;
- Changes in available resources: changes to flow rates in rivers and aquifer replenishment, deterioration in water quality;
- Increased vulnerability of certain ecosystems following the rise in temperature and changes to rainfall distribution in time and space;
- More costly access to water;
- Conflicts over use, etc.

The cost of such impacts, estimated according to the cost of alternative solutions and lost earnings from irrigated agricultural areas would amount to over 70 billion dirhams.

Key messages

- Climate change has become a reality in Morocco, with its effects already visible on the environment. The significantly lower rainfall levels recorded over the last thirty years have seriously curtailed dam inflow rates, resulting in low dams water levels. This is reflected in limited agricultural intensification, with the result that capital invested in water infrastructure is not particularly profitable and that groundwater is more heavily abstracted, leading to its over-exploitation.
- Energy production has been clearly affected by the impact of climate change, reflected in decreased water reserves and smaller heads in all dams. It has been estimated that production amounts to barely 50% of the expected objective established by studies relating to integrated water resource development plans. This decrease means that the water sector consumes more energy than it produces.
- The forecasts are not optimistic. Models relating to climate change indicate that rainfall may well have decreased by over 20 % by 2050 whilst evaporation and variability are set to increase (Wilby 2007). This would further aggravate the water shortage situation in basins throughout Morocco.
- The country has limited options for tapping into additional resources. Virtually all run-off into the country's rivers is already accounted for, with 128 large dams and several smaller structures (World Bank 2007a; World Bank 2007b). The additional volume of water stored following the construction of 59 planned dams will be very limited.
- When account is taken of the future impact of climate change, which is expected to reduce water input by almost 30% (due to a 15% drop in rainfall) as well as increased evaporation, this may well further reduce the potential contribution to be made by dams and water transfer programmed projects.
- If the trend scenario for water resource management, which consists of continuing efforts to mobilise resources, over-exploiting groundwater and conducting programmes to protect and enhance water resources (clean-up, water savings, development of catchment basins…..) continues to be applied at the low rate of recent years, this will negatively impact economic and social development in Morocco as well as its natural environment. This scenario is likely to produce only limited results, possibly even reducing the added value currently generated by the water sector (stagnation in terms of agricultural land, save for the areas covered by Al Wahda and Dar Khrofa dams), a slight increase in drinking water and hydro-power production, a shortage of groundwater in some regions along with impairment of its quality, lower quality water resources, drying-up of springs and shrinking wetlands areas.
- The main challenge which Morocco will be called upon to address over forthcoming decades will be adapting to a decrease in renewable water resources. The country will have to manage these resources carefully, establish an effective and transparent mechanism for allocating resources and ensure that water transport infrastructure minimises loss and is flexible enough to respond to the highest levels of demand. Surface water quality will need to be improved and groundwater protected against seepage by encouraging municipal and industrial investment in sanitation and by applying environmental legislation to companies and public bodies which discharge wastewater. One positive step would be the adoption of an innovative set of public policies aimed at curbing water consumption.
- Mobilising non-conventional water resources will constitute a key component of future water policy. Seawater desalination could become a new strategic source of water in urban areas close to the coast and the reuse of treated sewage could boost the amount of water available locally for irrigation in tourist centres and possibly in agriculture. These new technologies, however, will not suffice to bridge the growing divide between supply and demand, hence the pressing priority to manage demand. All things considered, whether for the purpose of irrigation or for drinking water, water savings represent the most economical resource.
- Developing non-conventional resources and managing water demand would further drive up energy consumption in the water sector, which would account for almost 10% of the country's consumption and should be included in the country's energy demand as of now.

- The water sector in Morocco has to date paid scant attention to the issue of climate change and often ignores its impact on future water resources. Studies will be needed to assess the impact and cost of climate change and draw up adaptation solutions.
- The widespread use of modern irrigation systems is likely to lead to surging energy needs in the agricultural sector. Switching towards currently available and efficient technological options such as underground irrigation using perforated pipes would make for major savings of both water and energy as a result of their enhanced irrigation yield and lower pressure requirements (0.6 Bar instead of 3 Bar for drip irrigation). Moreover, the revolution in renewable forms of energy (wind, biomass and solar) in terms of technological development and cost can help curb the consumption of fossil energy by fostering decentralised renewable energy projects for driving pumping stations.
- Investment forecasts for the production of electrical energy will require the equivalent of the water consumed by a population of about 3 to 4 million inhabitants in 2030 in order to meet the cooling needs of thermal power stations inland. When returned to the environment, the quality of this water has been impaired through heating. More concerted planning and action will consequently be required between the water and energy sectors if further aggravation of the water deficit is to be avoided.
- Water requirements in the phosphates sector will rise from the current level of 66 Mm^3/yr to over 158 Mm^3/yr in 2030. The quantity of water consumed per tonne of phosphate concentrate produced amounts to between 1 and 3 m^3. The OCP Group's development strategy takes account of this demand. In order to protect strategic underground resources, growth in the phosphates industry will be achieved on the back of constant levels of freshwater extraction, with the following steps being taken: i) geographically shifting extraction upstream in the Oum Rbia basin, ii) desalinating seawater and treating wastewater in order to satisfy new needs.
- In the interests of a better energy future for Morocco, a new energy strategy has been drawn up on the basis of realistic technological and economic options. The strategic objectives established are intended to ensure secure energy supply, guarantee the availability and accessibility of energy at the lowest cost and to reduce energy dependency by diversifying sources, developing national energy potential and promoting energy efficiency across all sectors of activity. Morocco has thus set itself the objective of achieving 12% potential energy efficiency by 2020, with renewables accounting for between 15 and 20% of the national energy balance. By the same date, solar, wind and hydraulic energy will account for some 42% of installed capacity (14 580 MW) compared with 26% in 2008 (5 292 MW).