CLIMATE CHANGE IN THE MEDITERRANEAN

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Strategies for integrated water and energy resources management to address climate change

As a "hot spot" of climate change, the Mediterranean will be, in the twenty first century, the site of particularly marked changes in terms of rises in temperature and decreases in average rainfall, inter-annual variability and extreme meteorological events.

These climate changes will exacerbate the existing and already significant pressures on water and energy resources in the rim countries. The projected decrease in water resources should lead to a fall in power production notably from hydraulic origin. The energy needs for water, accounting already for about 10% of the total power demand in the Southern and Eastern Mediterranean countries, should at the same time increase.

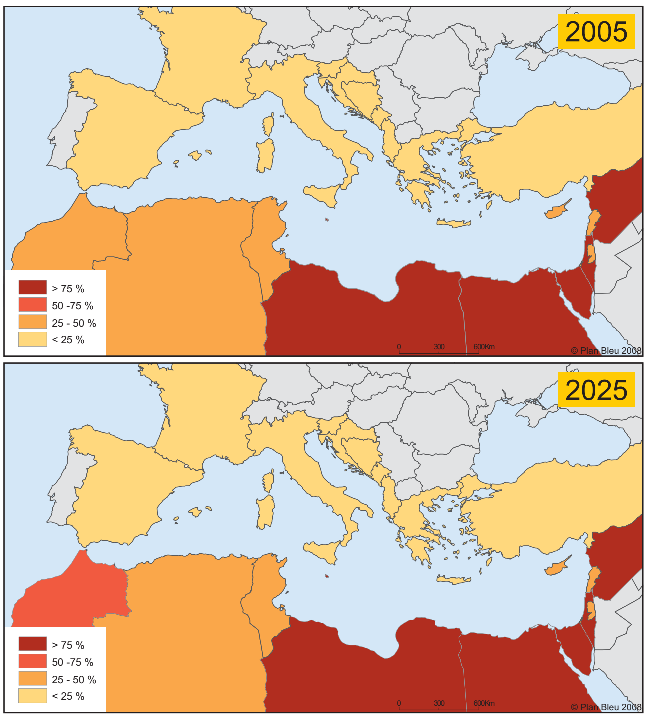
In such a context, the "water-energy" systems of the Mediterranean countries will have to adapt.

Increasing pressures on water and energy resources

In the Mediterranean rim countries, water resources are limited and very unevenly distributed over both space and time. The Southern countries receive only 10% of the total rainfall. While the resources are already overexploited in several locations (Figure 1), the increase in water needs is set to remain quite strong as a result of demographic growth in the South and East, development of irrigated areas, industry and tourism. The Mediterranean countries' water demand, having doubled up within the second half of the twentieth century, is expected to increase by about 50 km^3 by 2025 to reach some 330 km^3/year, that is, a level hardly compatible with the renewable resources.

The total commercial primary energy demand of the whole rim countries is, likewise, increasing very rapidly. It is expected to rise by 65% by 2025. In the Southern and Eastern Mediterranean countries (SEMC), where fast development is reported, the energy demand growth rate could be four times higher than in the Northern Mediterranean countries (NMC). Having already grown fifteen fold between 1970 and 2005, their final power consumption is likely to double up by 2020 (Figure 2).

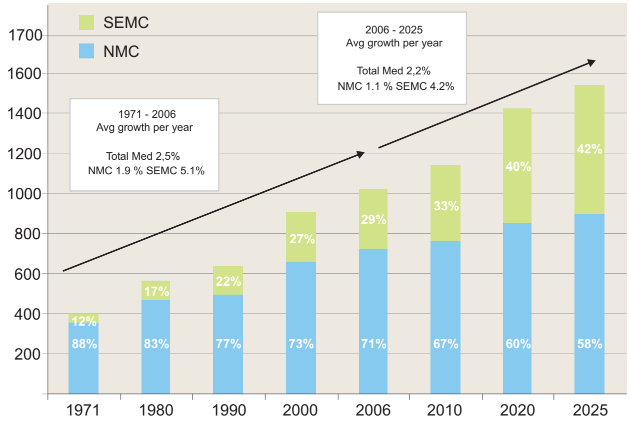
Figure 1: Exploitation index of renewable natural water resources per country, 2005 and 2025



Source : Bleu Plan, 2008

Note: Indices nearing or exceeding 75% reveal very strong pressures exerted on water resources; ratios between 50 and 75% point significant medium-term risks of structural stress; indices between 25 and 50% indicate that countries may endure local or fluctuating stress.

Figure 2: Primary energy demand in the Mediterranean: Trend evolutions (in MToe)



Source: OME (Mediterranean Energy Observatory), 2006

In addition, the pressures on water resources and the rise in energy demand will be exacerbated by the impacts of climate change. The climate models reveal temperature rises likely to range between 2.2 and 5.1°C for the time frame 2100 and a decrease in average rainfall in the range of 4 to 27%, with a particularly marked decline in the summer. These evolutions are likely to induce a decrease in the available water resources on the three rims of the Mediterranean basin, together with a rise in water demand, especially in the agricultural sector.

Climate change adaptation measures could, in their turn, induce an increase in energy demand, the latter being quite sensitive to air temperature evolutions. However, energy consumption is one of the major causes of global warming. In the Mediterranean, the growth rate of CO_2 emissions is particularly high, with respect to the global average, inasmuch as fossil energies account for the larger part of energy supply, particularly in the SEMC.

Water and climate change: Towards a decrease in the electricity generating potential?

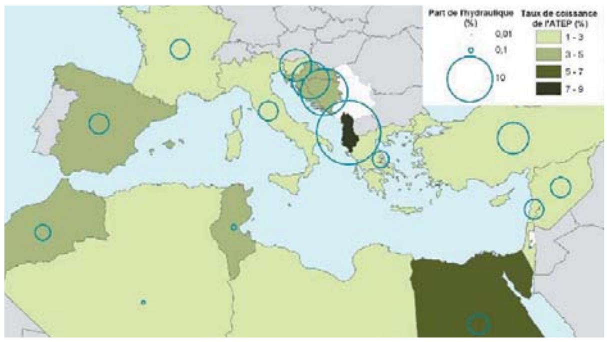
Water is essential for power production. It is not only the "fuel" of hydropower plants, but also the cooling source of fossil fuel-fired and nuclear thermal power stations. In 2005, 13% of the electricity produced in the SEMC was generated by hydropower plants, the remainder being generated by gas, oil and coal-fired power stations. In the North, hydropower accounted for 12% of the electricity produced, and nuclear power stations provided 40% of this production (Figure 3).

Power production is, thus, highly dependent on the quantitative and qualitative availability of water resources. The safety of the transport and distribution network can, moreover, be lastingly affected by extreme climatic events (storms, sticky snow episodes…) whose frequency and intensity are likely to increase. The evaluation of the impacts of climate change and their taking into account constitute, in this regard, priority stakes for energy producers.

Certain countries have already reported a significant drop in their hydropower production due to a decrease in surface water inflows to dams. Thus, in Morocco for instance, the national average of these inflows has dropped by about 20% over the past 30 years due to a change in the rainfall regime. Hydropower production has reported significant variations and has amounted, on average, to a mere half of the expected production. To make up for this deficit, the country had to opt for the production of thermal power, which is a greenhouse gas emitter.

The rise in river temperature can, furthermore, induce a significant decrease in power generation as regulations impose limits on the temperature of cooling water released to surface waters downstream from the power plants. During the summer 2006, the power of certain French stations was thus made temporarily unavailable. The maximum power drop reached 5 000 MW on Rhone River (EDF, 2007), which is considerable in view of the network safety and stability requirements.

Figure 3: Share of hydropower in the energy balance in 2004 and growth of total primary energy supply (1990-2004)



Sources : Bleu Plan, IEA (International Energy Agency) data

Besides the analysis of the observed data, it is necessary to evaluate the future impacts of climate change on water resources. Simulations conducted on European scale show that the Southern European countries are likely to report a decrease in their river flows in the range of 10 to 30% by 2070 (Lehner & al., 2001). As regards the snow cover, the simulations conducted in the French Alps reveal a quite significant alteration for the time frame 2050, with a lesser available snow stock and a thaw occurring about a month earlier. Spring and summer river flows will be altered to the same extent, as well as the summer lowest water levels which will be more frequent and more difficult to sustain.

Table 1: Water and electricity demands in 2005 and 2025 in the Mediterranean countries

	NMC		SEMC		Total Mediterranean	
	2005	2025	2005	2025	2005	2025
Water demand (km3/year)	128	132	152	200	280	332
Electricity demand (TWh)	1209	1665	392	1130	1601	2795
of which for water (TWh)	51	92	30 à 45	200	81 à 96	292
% electricity for water	4,5	5,5	7,5 à 11,5	18	5 à 6	10,5

Sources : Plan Bleu, OME, 2007

These evolutions are likely to significantly impact the seasonal management of the major hydropower reserves and the peak energy reserve, as well as induce a decrease in the hydroelectricity generating potential which it would be necessary to take into account in setting realistic long term objectives in matter of renewable energies. For certain countries, such as Egypt, where hydropower production rests entirely on the exploitation of Nile water, the high uncertainties related to the impacts of climate change on the evolution of river flows make it quite difficult to estimate the future hydropower potential.

20% of the electricity demand for water management in the South and East in 2025

The average power consumption for water varies considerably in the Mediterranean region, in particular between the countries where water is produced in a conventional way and those in which non conventional water production is significant (seawater desalination, water transfers…). It was estimated, in 2005, at 0.4 kWh/m3 in France and at 1.5 kWh/m3 in Israel. To estimate the average energy needs on Mediterranean scale, the following values have been considered: between 0.2 and 0.3 kWh/m3 of water produced and treated in the SEMC, and 0.4 kWh/m3 for the NMC (Rouyer, 2007).

The current power needs for water production and mobilisation, including pumping, treatment of drinking water, transport and distribution, treatment of wastewater, desalination and transfers, would thus account for 5% (NMC) to about 10% (SEMC) of the total power demand (Table 1 and Figure 4). A large portion of this power demand for water relates to irrigated agriculture which claims about 65% of the total water demand in the Mediterranean (and over 80% in the SEMC).

Energy needs for water are expected to increase significantly due to:

- increase in water demand, accelerated by climate change,
- exploitation of increasingly deep-lying aquifers,
- water transfers over increasingly longer distances,
- development of non conventional water production (desalination, wastewater treatment for reuse), particularly as a climate change adaptation option, and to address crisis situations (cf. box).

Accordingly, by 2025, power consumption per cubic metre of water mobilised is likely to be in the order of 1 kWh in the SEMC and of 0.7 kWh in the NMC (Rouyer, 2007). Within this time frame, the power needs for water management in the Mediterranean would range between 5% (North) and 20% (South and East) of the total power demand.

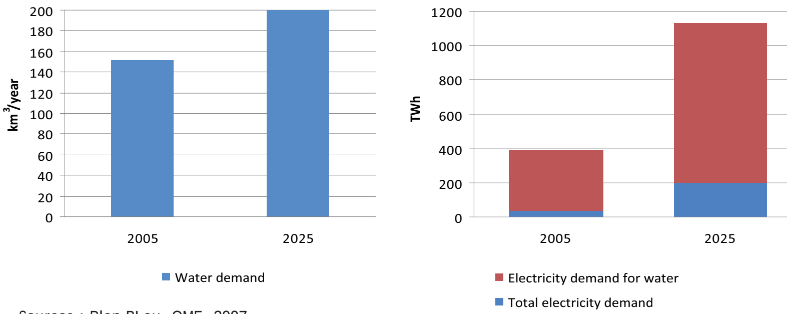
However, these total estimates per geographical region do not specify whether certain countries will be more constrained than others by high increases of their power needs for water and they take into account electrical energy only.

A necessary adaptation of the "water - energy" system to climate change

The first response to the increase in water demand consists in putting in place demand management policies likely to reduce losses and misuses, while meeting the needs of the various uses. Within the same spirit, the first response to the increase in energy demand consists in improving energy efficiency which offers a quite significant potential in the SEMC in particular.

Besides, in certain countries, an increase in water supply -to be organized via better resource management or via non conventional forms of water supply- proves also to be necessary. While seawater or brackish water desalination thus constitutes one of the possible responses to the increasing scarcity of water

Figure 4: Water and electricity demands in 2005 and 2025 in the Southern and Eastern Mediterranean countries



Sources : Plan BLeu, OME, 2007

resources (cf. box), the reuse of treated wastewater proves to be a less costly solution in terms of energy (1kWh/m³, instead of 4 kWh/m³ for seawater desalination) and one that is more "virtuous" for the preservation of the resource.

An increase in energy supply is, and will remain, necessary, while diversifying the energy mix via the tapping of renewable resources. A proper analysis of the long term impact of climate change on river flows and temperatures is, in this regard, of paramount importance for the design and future management of the power production fleet. Improving the efficiency of the existing hydropower plants and the installation of pumping energy transfer stations are solutions envisaged to address the increase in energy needs. The development of micro-hydropower plants, the hydroelectric power and wind power linkage and tapping the potential offered by marine energy constitute other fields worthy of investigation or exploration.

Desalination: A costly solution to adapt to the increasing shortage of water resources

First developed in insular situation and in coastline area, notably to meet tourism needs, fresh water production by desalination of seawater or brackish water now extends all around the Mediterranean. It accounts for as much as 60% of drinking water supply in Malta. Spain, ranking in 4th position in world production, has the peculiarity of allocating a significant portion of the desalinated water to the agricultural sector. In Cyprus, desalination contributes in addressing the situations of recurrent droughts by minimizing drinking water rationing measures. The total capacity installed Mediterranean-wide could be multiplied by six by 2030 to reach 30 million m³/d.

Large-scale desalination remains a high energy-consuming, greenhouse gas emitting and costly option. The cost of water produced by seawater desalination would, thus, range from 0.4 to 0.6 €/m³ for large plants, that is, almost twice as high as that of "conventional" water, and this, exclusive of the high seed capital. Desalination has, moreover, environmental impacts connected not only with the development of infrastructures, but also with brine disposal.

To minimize greenhouse gas emissions, renewable energies can be used to supply small-sized desalination stations on isolated sites or be combined with high output conventional desalination processes, such as multi-effect distillation associated with solar captors, and reverse osmosis associated with photo-cells or wind turbines. The recourse to nuclear energy, envisaged for large-scale stations, has -in its turn- to contend with the high cost of seed capital, as well as with the problem of public acceptance.

Sources : Plan Bleu, Boyé, 2008

Thus, in the Mediterranean, the interactions between water and energy will be increasingly stronger and more and more sensitive to climate change, hence the need to put in place -in each country and on regional level- strategies for integrated water and energy resources management, within a prospective vision. Regional cooperation, facilitating the exchange of experience among Mediterranean countries on the linkages between water, energy and the environment, has a fundamental role to play in contributing towards the adaptation of the " water - energy" system to climate change.

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