CHAPTER 3

NATURAL RESOURCES*

The wealth of natural resources and widely varying landscapes of the Mediterranean Basin make it an outstanding ecoregion. Yet with human and industrial development this environmental heritage is gradually deteriorating. Despite almost 30 years of international efforts to protect this unique ecosystem, it remains fragile and is continuing to decline as the result of growing pressure on the environment. The impact of climate change, the risks for biodiversity in the zone, soil erosion and the pollutant emissions caused by energy consumption are now threatening the sustainability of the Mediterranean region.

In an area where soil and water resources are deemed to be scarce – at least as far as the southern shores are concerned –, the situation regarding the land reserves needed for agricultural production is liable to be critical by 2020. With the advent of major climate changes the time has come to bring up the forecasts that are shared increasingly by the scientific community on Mediterranean climate trends, whose effects on these resources, and in particular on water, can be absolutely decisive in the future. In this context, the energy question also becomes crucial, both in the Mediterranean region and elsewhere, and one which is bound to affect the agro-food sector.

Climate disruption in the Mediterranean region

The Mediterranean Basin is situated in a transition zone between two very different climate systems, so that perturbation of the global meteorological system can cause radical changes in the characteristics of its climate (Gualdi et Navarra, 2005). This is what the trends in temperature and rainfall and the increase in extreme events seem to indicate.

Significant changes in temperatures

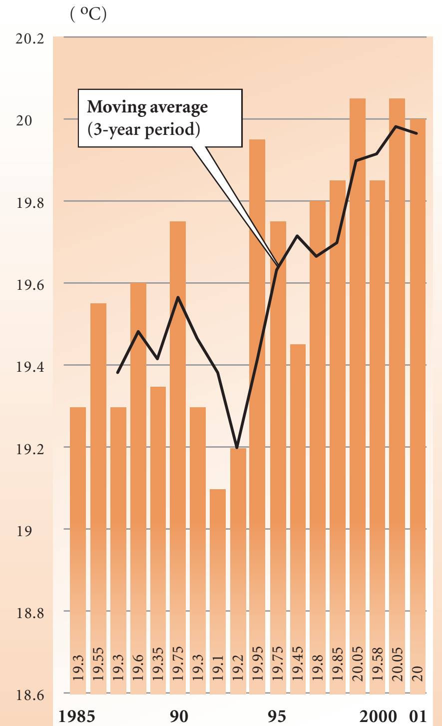
It is now an acknowledged fact that so-called greenhouse gases (GHG) – methane, nitrogen dioxide, chlorofluorocarbon, sulphur hexafluoride and, in particular, carbon dioxide – are enriching the atmosphere to the point where it is reflecting even more infrared rays to the ground, thus causing manifest warming.

In the specific case of the Mediterranean Basin, thermal changes are being intensified by variations in the temperature of the ocean surface, and the considerable and prolonged

*- This chapter has been based on documents prepared by Nicola Lamaddalena (Ciheam-MAI Bari) and Roberta Giove (Ciheam-MAI Bari).

warming of water bodies can in turn affect the climate, particularly in coastal regions. The variation in the temperature of water bodies is a good indicator of climate trends. When one examines the trends in the average temperature of the water of the Mediterranean, one observes that it is clearly tending to rise – a rise of almost 1° was recorded in the 1990s alone (Chart 1).

Chart 1 - Trends in mean annual surface temperature of the Mediterranean Sea, 1985-2002



Source: ENEA, 2003.

Atelier de cartographie de Sciences Po, 2008

When one compares the temperatures recorded in the 1990-2003 period with those recorded between 1950 and 1980 (Giuliacci, 2004), one finds that the average temperature increased not only in practically all Mediterranean countries but also during all seasons:

- a rise in temperature of about 0.4°C-0.6°C was recorded over the winter season, except in the Balkans and Greece, where there was a slight decrease;
- temperatures rose by about 0.4°C-0.8°C during the spring season, except in the Balkans, where they dropped;
- a rise in temperature was observed (0.6°C-1.2°C) during the summer season, with higher values in Italy and Spain and lower values in Greece and north of the Alps;
- and during the autumn season, increases of up to 1°C were recorded in Algeria, Libya, Egypt and the south of Italy, whereas in Spain and in the Balkans the temperature was dropping.

Supposing that the concentration of CO_2 doubles by 2060, the temperature of the Mediterranean could rise by 5°C. The Intergovernmental Panel on Climate Change (IPCC) anticipates that temperatures will rise throughout the Basin (Giannakopoulos *et al.*, 2005). The greatest rise in temperature is expected in the countries farthest south, in the Balkans, in Spain and in the north of Italy, with variations of 4°C-5°C in the summer season and of 2°C in the winter season.

The following seasonal changes are thus forecast:

- a rise of approximately 2°C throughout the Basin during the winter period, except in the south of Turkey;

- a rise in temperature everywhere during the spring season, except in the south of Italy;
- rises in temperature of up to 4°C-5°C during the summer season, particularly in Spain, the north of Italy, the Balkans and Algeria;
- and a rise of 2°C in all countries during the autumn period.

Growth in GHG emissions expected in the Mediterranean region

Glasshouse gases are one of the main causes of climate disruption; their volume increased by 15% throughout the world between 1990 and 2005. This increase also concerns the Mediterranean Basin (Benoit et Comeau, 2005),[1] where annual GHG emissions are evaluated at 5.4 tonnes per capita, whereas the world average is only 4 tonnes. The north of the Mediterranean region is responsible for 70% of total Mediterranean CO_2 emissions, which amount to 1 900 million tonnes (i.e. 8% of world emissions). One inhabitant of the Mediterranean emits just over half of the CO_2 emitted by an inhabitant of the European Union (EU), however, and almost 4 times less than an American. If the trend continues, the volume could have reached the 3300 million tonnes mark by 2025. A veritable explosion in GHG emissions is predicted in some Mediterranean countries - mainly Malta (+ 300%), Turkey (+ 262%), Lebanon (+ 138%), Algeria and Tunisia (+ 135%). It should be noted that all of the Mediterranean countries in the EU and some of the countries on the southern shores (Algeria, Egypt, Israel, Jordan, Morocco and Tunisia) have ratified the Kyoto Protocol.

Evolving rainfall system

It is extremely important to identify variations in the rainfall system: inadequate rainfall causes water stress and is also responsible for the desertification process, whereas prolonged heavy rainfall causes floods and landslides. Average annual rainfall is decreasing throughout the Mediterranean Basin (Giuliacci, 2004), although the decreases are more marked in the north of Spain, in Greece and, to a lesser extent, in the north of Italy as well as on the French Mediterranean coast. Seasonal analysis shows more interesting results, on the other hand:

Climate trends in the Mediterranean region

Spring	Summer	Autumn	Winter
Rainfall is dropping in practically all countries with more marked decreases in the north of Italy, in Greece and in Spain.	Rainfall is dropping in the north of Italy and in Spain.	Heavy rain in Italy and the Balkans; sharp drops in rainfall in Algeria, Tunisia and Spain.	Rainfall is dropping in Italy and Greece and on the Algerian and Tunisian coasts. Slight increases in rainfall on the Egyptian and Libyan coasts.

1 - The figures quoted on the subject have been drawn from Benoit et Comeau (2005) and the Mediterranean Energy Observatory (MEO).

The forecast for the period up to 2060 is increasingly limited rainfall in the south and more abundant rainfall in the north. The summers will probably be drier for all of the countries in the region, on the other hand. More specifically, the following trends may be observed (Giannakopoulos *et al.*, 2005):

- a drop in rainfall throughout the Basin during the winter period, and in particular in Morocco and Algeria, where rainfall could decrease by 40% to 50%;
- in the spring, a situation similar to the current situation;
- in summer, a drop in rainfall in all of the countries in the Mediterranean Basin, with decreases of up to 60% (Cyprus being the only country where rainfall could increase by 40%);
- in autumn, a stable situation compared to the situation at the beginning of the 21st century.

Trends in the snow cover and agricultural adaptation

In some Mediterranean countries – in particular Lebanon, Turkey, Morocco and Algeria – the precipitation system involves rainfall and snowfall: part of the winter rainfall is stocked at altitude in the form of snow before being released when temperatures rise again in the spring and summer. Snowmelt thus plays an essential role in regulating discharge. As global warming progresses, the discharge in winter will be greater, when demand is low; on the other hand, in April, May and June, when the demand for irrigation water is at its height, the remaining snow pack will be insufficient for augmenting discharge. A survey conducted in Lebanon by the Beirut College of Engineering and the HydroScience Group in Montpellier (Combined Research Unit of the French National Research Agency - CNRS) has provided a basis for evaluating this phenomenon more accurately: According to the survey, the dates on which low-flow levels are reached will be brought forward by 20 days if the temperature increases by 2° and by over one month in the case of a 4° increase. These changes in river processes will entail changes in flood patterns. In Lebanon, the coastal zones may be the scene of rain-fed floods in February and March and of snow-melt floods after the khamsin sandstorms (wind from the Arabian Peninsula) in May and June. If temperatures rise by 4°, there will be an increase in winter floods of 30% or more. More rapid melting of the snow cover would have limited effects on agriculture, provided that crops can be planted and harvested earlier, which is possible by means of variety selection. However, this trend also requires that new storage capacities be built in order to offset the prolongation of the period of water shortage.

Increased meteorological perturbation in the Mediterranean region

Progressive global warming, caused mainly by greenhouse gases, is leading to an increase in extreme climatic phenomena in many regions of the world. Due to their intensity and duration, meteorological events of this nature can be an important risk for man and the environment. Marked summer droughts, prolonged heat waves, regular flooding and major changes in precipitation volume are already frequent occurrences in the Mediterranean region, but they are liable to intensify. Indeed some scientists state that the hot dry climate of the Mediterranean riparian countries could move up to the north of the European continent in the course of the 21st century (Seneviratne, 2006).

According to the forecasts for the mid 21st century (Giannakopoulos *et al.*, 2005), situations of extreme drought will become even more acute, particularly on the northern shores of the western Mediterranean (in Portugal, Spain, France, Italy and the Balkans) but also in Turkey. The number of dry days in these countries (i.e. with daily rainfall below 0.5 mm) could increase by at least three weeks per year, whereas minimal variations are forecast for the south of the Basin. The number of hot days (with temperatures above 30°C) is liable to increase in Spain, Morocco, Algeria, the centre of Italy, the Balkans and central Turkey.

The obvious connection between climate change and agriculture

Several biological phenomena seem to be connected with the acceleration of global warming, which has been underway for about 30 years Wheat harvest dates have come forward by 20 days since 1980. Maize planting dates have moved forward by 3 to 4 weeks. Crop cycles have become shorter for all cereals, and similar trends have been observed in the case of perennial crops (tree farming and wine-growing). Fruit trees are flowering earlier, irrespective of species and region. In the case of apricots, for example, the blossom time seems to have moved forward by 10 to 20 days on average over the last 20 years in the south-east of France. But at the same time temperatures are varying more widely, and this exposes the buds to higher risk of spring frost.

Vines are the species most sensitive to climate warming, and here again the flowering time is becoming progressively earlier. Grapes are also ripening earlier. In France, grapes are now beginning to ripen in July, a hotter month than August, and the sugar content is thus increasing with the result that the alcohol content in wines is also rising. This trend is positive in principle, since it is no longer necessary to chaptalise wines, but it can also involve loss of typicality, particularly in the case of RDO wines, which by definition are associated with specific regions.

Source: adapted from an interview with Bernard Seguin, INRA (National Institute of Agronomy Research), "L'agriculture face au changement climatique", Paysans, May-June 2007.

Soil, a much-coveted resource

Varied soils used very unevenly

The territories bordering on the Mediterranean are regions of tremendous biological diversity and also have a wide variety of soils with varying suitability for agricultural production. These soils are being threatened by human activities, particularly in the south and east of the Basin.

There are several factors which contribute to soil diversity. One of the first distinguishing factors is the nature of the bedrock, the parent material of surface soil. Dolomites and limestones are the main bedrocks of the soils of the Middle East, for example, and of those in the south of the Mediterranean region. Soils can also originate from the accumulation of elements that are imported by wind or water. The wind from the Sahara Desert thus contributes to the massive input of exogenous materials, sometimes over very great distances. Further differentiating factors are climate, vegetation and anthropic activities. Beyond that, soil depth, a decisive factor for agriculture, is directly related to climate: in the arid zones of the Mediterranean region, the combination of high temperatures and low humidity does not facilitate soil formation, and this is a contributing factor in the forming of skeletal soils, which are often unsuitable for agriculture.

The World Reference Base for Soil Resources (WRB), which was developed by the FAO (1998), the International Soil Reference and Information Centre (ISRC) and the International Society of Soil Science (ISSS), classifies soil types in the following main groups: histosols, lithosols, anthrosols, vertisols, fluvisols, gleysols, solonchaks, solonetz, andosols, kastanozems, phaeozems, umbrisols, gypsic yermosols, calcisols, luvisols, cambisols, arenosols, and regosols. Cambisols, which have high calcium carbonate content and are quick-drying, are the most prevalent soil type in the zone (accounting for 29% of soils in France, 37% in Italy, 40% in Spain, and 20% Turkey). They are followed by luvisols, which are found mainly in Greece (45%) and Albania (38%), poor-quality lithosols (27% of soils in Greece, 23% in Israel, 29% in Algeria) and yermosols (30% of soils in Algeria and Egypt, 44% in Libya and 26% in Syria).

This land covers approximately 840 million ha, but only 28% is used for crops (cereals and trees) and pastures, whereas 8% is covered by woodland and forests. The remaining 64% is either dedicated to other (urban and industrial) uses or consists of desert zones. Only 47% of the 243 million ha of agricultural area available in the Mediterranean region (63% of which are located on the southern shores) are deemed to be arable land. Approximately 76 million ha of the total 117 million ha of cropland are under annual crops: cereals (50 million ha), oil crops (6.2 million ha), horticultural crops (over 5 million ha) and vegetables (3.7 million ha). Some 18 million ha are under permanent crops (half under fruit trees and half under olive trees). The main fruit trees are citrus (grown on over 1 million ha) followed by vine, peach trees and apple trees. The main producers are Italy, Spain, France, Turkey and Egypt.

There is also a major difference in land resources between the two shores of the Mediterranean, which, according to a study conducted by the Mediterranean Observatory ISMEA-IAMB in 2004 (ISMEA-IAMB, 2004), can be measured by two indicators: per capita land resources and arable land per farmer. In the European Mediterranean countries the average area of arable land available per capita is approximately 0.40 ha, whereas 11.4 ha are available per farmer; the respective values for all other countries are 0.25 ha and 1.9 ha. Measured by these criteria, Egypt is the most disadvantaged country with the smallest acreage per farmer and practically the smallest per capita area (0.05 ha/caput). This obviously entails a certain degree of food dependency and means that it is difficult for farmers to invest.

Land resources under growing threat

The development of arable acreage varies from one country to another. Although it has increased in some (particularly in Egypt), it is decreasing in most countries. The trend is expressed in rates of increase/decrease, but it must be borne in mind that where Malta's acreage has shrunk by 3.1%, for example, this concerns barely 400 ha per year, whereas Portugal's 2% decrease means a loss of 61,000 ha. Urbanisation is the main cause of this decrease in arable land, which is often good-quality land, since settlements have always developed around the best soils. According to the ISMEA-IAMB study, approximately 150,000 ha of primary land were converted to urban zones in the period from

Table 1 - Land use in the Mediterranean region, 2003

Country	Total area[1] (1 000 ha)	Agricultural area[2] (1 000 ha)	Per capita agricultural area (ha/caput)	Arable land[3] (% of the agricultural area)	Irrigated land[4] (%)
France	55,010	29,690	0.49	62.1%	13.3%
Greece	12,890	8,431	0.77	32%	37.9%
Italy	29,411	15,074	0.26	52.8%	25.7%
Portugal	9,150	3,748	0.37	42.4%	28.1%
Spain	49,921	30,185	0.73	45.5%	20.2%
Cyprus	924	144	0.18	69.4%	28.6%
Malta	32	11	0.03	90.9%	18.2%
Albania	2,740	1,121	0.35	51.6%	50.5%
Northern Mediterranean	**157,338**	**87,283**	**0.40**	**56%**	**25%**
Algeria	238,174	39, 956	1.24	18.9%	6.9%
Egypt	995,451	3,424	0.05	85.3%	99.9%
Jordan	8,824	1,142	0.20	25.8%	18.8%
Israel	2, 171	570	0.09	60%	45,3%
Lebanon	1,023	329	0.09	51.7%	33.2%
Libya	175,954	15,450	2.73	11.7%	21.9%
Morocco	44,630	30,376	0.98	27.9%	15.4%
Palestinian	602	345	-	22.9%	7.7%
Syria	18,378	13,759	0.76	33.4%	24.6%
Tunisia	15,536	9,784	0.98	28.5%	8.0%
Turkey	76,963	39,180	0.54	59.6%	20.0%
Southern Mediterranean	**681,800**	**154,315**	0.70	39%	27%
Total Mediterranean	**841,878**	**242,719**	0.6	47%	28%

Source: our calculations based on Faostat 2006.

(1) Total area less the area of the inland waters
(2) Sum of the area of arable land, land under permanent crops and permanent grassland and pastures
(3) TLand under temporary crops (acreages harvested twice being counted only once), permanent grassland for cutting or grazing, market gardens or vegetable gardens, temporary fallow land (less than five years).
(4) The data on irrigated area refer to acreage that has been developed with a view to watering crops.

1978 to 1998. The city of Barcelona expanded by over 15 000 ha in the peripheral zone between 1982 and 1989. In Egypt, the Ministry of the Environment has estimated that in the period from 1960 to 1990 urban development claimed agricultural land at a rate of approximately 10,000 ha per year.

Tourism is partly to blame for this artificial development of arable land. The industry has grown tremendously in the Mediterranean, given the region's many historical sites of great value, the length of its coasts and its favourable climate. In 2005, almost 300 million people visited the region, which has been the world's leading tourist destination since the 1990s, accounting for almost one-third of international tourist flows. There is no sign of land resources becoming stabilised in the years that lie ahead, whereas the population is steadily increasing and tourism is liable to continue to develop.

It is, of course, possible to cultivate land that has not yet been used, but this requires investment-intensive land reclamation schemes such as those developed in Egypt and Turkey, where the mediocre quality of land necessitates a great deal of development work if it is to be usable for agricultural purposes. Despite these difficulties, Egypt nevertheless improved 2.65 million feddans (1 feddan = 0.42 ha) between 1952 and 1997 (Ayeb, 2001). However, despite these possibilities of developing new zones, arable land resources (crops, fruit trees or vine) will continue to diminish under anthropic pressure.

And in addition to this downward trend in the quantity of land available, soil quality could also continue to deteriorate. The soils of the Mediterranean region form a very fragile ecosystem, which can be rendered sterile by the combination of a number of factors, a process which can be measured in terms of limited biodiversity: whereas in good conditions 1 gramme of soil can contain up to 600 million bacteria belonging to between 15,000 and 20,000 different species, in desert soil these values drop to 1 million bacteria and 5,000-8,000 species. This decrease in the presence of micro-organisms obviously makes plant assimilation very improbable.

Human-induced soil degradation is a phenomenon common to all regions of the world. The International Soil Reference and Information Center (ISRIC) has conducted a UNDP-funded Global Assessment of Human Induced Soil Degradation (GLASOD) (Oldeman *et al.*, 1991) showing that approximately 11.5 billion ha of vegetation zones are degraded, 17% by erosion, and that degradation is imminent on 1 out of 6 hectares. In the Mediterranean region wind and rain erosion (edaphic conditions) is another important factor here. The episodes of sudden rainfall characteristic of the rainfall system and the strong winds in the region damage the soil, which is often shallow, particularly when the crop system leaves areas unplanted for much of the year.

It is the land on the eastern and southern shores that is most exposed to these degradation hazards. The extension of cropland is generally to the detriment of woodland and rangelands, and this decrease in plant cover allows the edaphic factors to have adverse effects. The development of the sandy steppeland in North Africa has exposed these areas directly to these erosion factors. By contrast, in the northern Mediterranean, any agricultural land that is deemed to be marginal is abandoned, and this limits soil deterioration, although the return to spontaneous vegetation in these areas can lead to fires, which destroy the soil. Cropland degradation in the North is connected more with the expansion of parcels, the simplification of crop systems and the decrease in pastureland.

And finally, the increasing concentrations of salts are a crucial problem. There are two factors causing this rise in salinity: the intensive use of fertilisers, and irrigation. Irrigation can have a direct effect, when the water has itself a high salt content (groundwater subject to marine intrusion, for example) or, more indirectly, when drainage is inexistent or defective and irrigation water thus stagnates and dissolves the mineral salts. Salinisation can also be an effect of the growing retention of surface water on the continent and the constant re-utilisation of that water in agriculture, which inevitably results in the accumulation of salts in the endorheic drainage system (this phenomenon is known as anthropic salinisation) (Lahmar et Ruellan, 2007). This phenomenon is becoming acute in some countries, particularly in Egypt and Jordan and in Tunisia, where 30% of the irrigated land has been affected.

Blue gold?

Badly distributed water resources

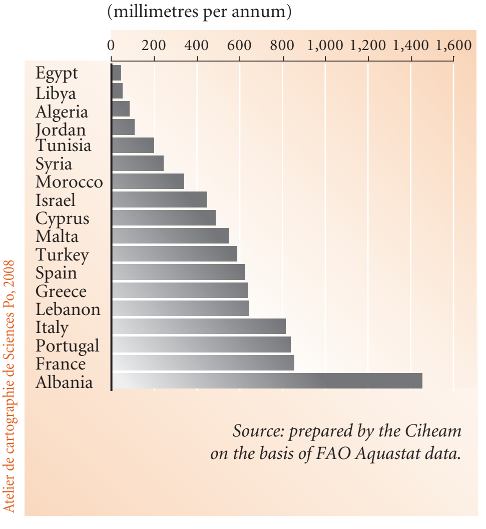
The Mediterranean region will be particularly vulnerable in a world panorama where "water stress" is intensifying. Water has indeed become a crisogenic factor. Half of the "water-poor" world population (i.e. with less than 1000 m^3 per capita per annum) is concentrated in the region. The Blue Plan estimates that a potential 165 million people will be concerned by 2025, 63 million of whom will suffer water shortage (less than 500 m^3 per capita per annum) (Benoit et Comeau, 2006), and that almost 30 million Mediterraneans, i.e. approximately 7% of the total population in the region, will not have access to drinking water. Rural populations, which are in many cases for, are often the first to be exposed to the problem.

It is mainly the southern shores which are concerned; 75% of water resources are situated in the north of Europe (Latin Europe and the Balkans), 13% in the Near East (including 10% in Turkey alone), and only 10% in the southern-shore countries. With only 3% of the Earth's fresh water resources but 7% of the world population, the Mediterranean Basin is thus an arid region where water has become the new gold that must be preserved or captured… Annual rainfall in the Mediterranean region is around 130 km^3 per year, but only six countries – Morocco, Algeria, Italy, Spain and, in particular, Turkey and France – have higher rainfall.

The volume of this average annual precipitation must be compared to the total area of each country in order to better understand exposure to water stress. Thus, although Egypt and Albania receive approximately the same volume of annual rainfall, when one considers the total area of these countries (the ratio is then expressed in millimetres), the comparison no longer holds, since the ratio for Albania is 30 times higher than the ratio for Egypt. On the basis of this calculation, initial examination of the water situation in the Mediterranean Basin reveals that the situation is critical for the countries on the southern shores (Chart 2).

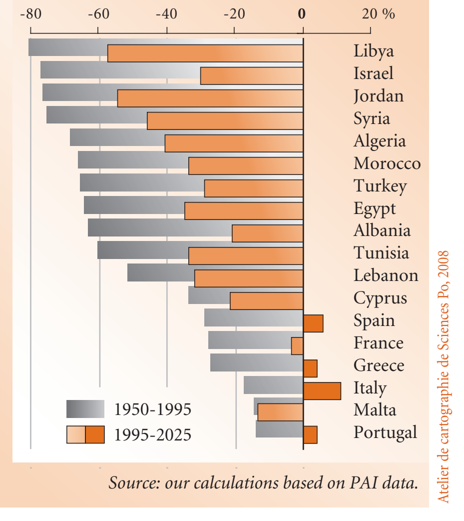
This imbalance is even more flagrant when one evaluates per capita water resources; the value is highest in Albania, France, Portugal, Greece and Italy, although there may be local shortages. The data published by Population Action International (PAI), which were obtained on the basis of an average population trend projection the, highlight the marked disparity between North and South. In the period from 1995 to 2025, available water resources should remain constant in the northern countries, whereas they will decrease by 40% in the southern Mediterranean and by 38% in the east of the region. They may even increase in Italy, Spain, Greece and Portugal – where the population is expected to decrease – barring any climate changes (Chart 3).

Chart 2 - Annual average area-related precipitation in the Mediterranean countries, 2003



Source: prepared by the Ciheam on the basis of FAO Aquastat data.

Chart 3 - Variation in per capita water resources, 1950-2025



Source: our calculations based on PAI data.

Long-standing access threatened

The Mediterraneans have been using their water resources for a long time, despite scarcity and access difficulties. A distinction must be made between available resources and exploitable resources, which, unlike the former, can always be accessed by water engineering techniques. In Egypt, there is very little difference between these two types of resource, since the development of Lake Nasser is providing the means for mobilising practically all of the water supplied by the Nile, contrary to the situation in France, Turkey or Spain, where there are wide differentials, the reasons being technical (mainly topographic), environmental (environmental standards preventing excessive abstraction), or geopolitical (existence of downstream countries which do not allow excessive siphoning, as in the case of Turkey).

Although hydraulic engineering techniques were first used in the region more than 2000 years ago and were rapidly developed in the Arabian world, it was not until the 1950s that water supply management became an important policy issue. In view of population pressures, States have endeavoured to build more and more dams, pumping facilities and water supply infrastructures, thus managing to cover their populations' drinking water needs as well as industrial and agricultural water demand with varying degrees of efficiency. Since 1970, water abstraction[2] in the region as a whole has increased by 45%. But while increases have been moderate in the European countries, where intensive farming has reached its limit, and in certain countries in the South (Cyprus, Malta, Israel and Egypt) where demand for water is subject to technical and political constraints, it has more than doubled in all of the other countries (ISMEA-IAMB, 2004). Since rain-fed agriculture is less productive and, in particular, less reliable, most of the water abstracted is used for agricultural purposes in countries in the south and east of the Basin, where irrigation helps to augment food supply to provide for booming populations. The agricultural sector accounts for 85% and 80% of total water consumption in these countries respectively. In the period from 1981 to 2001, the countries that were most active in expanding the area of irrigated land were Syria (124%), Algeria (114%), Jordan and Libya (109% each) (ISMEA-IAMB, 2004).

Despite the commitment and efforts made to achieve more efficient use of water in the irrigation sector, the sector is still very uneconomical: only 45% of the water abstracted for irrigation on average actually reaches the plants (Hamdy *et al.*, 2001). According to the FAO data on the year 2000, in certain countries in the South, such as Jordan, Algeria and Morocco, less than half of the water allocated to agriculture is actually used. This wastage is due to the high evaporation rate of stored water and considerable losses in the water supply networks, but also to the continuing use of traditional irrigation methods which are often extremely "water-greedy". Attention should be drawn in this connection to the high levels of water consumption in agriculture: whereas one person needs 20 to 50 litres of water per day (by way of comparison, an American consumes 600 litres a day and a European approximately 150 litres), almost 3,500 litres of water are needed in order to produce enough food and meet the daily minimum requirement of 3000 calories. It thus takes approximately 70 times as much water to produce food for one person than it does to cover that person's domestic needs (UNDP, 2006). Environmental problems associated with some major dams also raise questions about the sustainability of the development of large-scale hydraulic engineering. The Aswan Dam for example may have enabled Egypt to reduce its food bill, increase farm incomes and mitigate the social crisis, but it reduces the downstream flow rate, causing pathogens to flourish and fish stocks to fall, and it furthermore traps the alluvia carried down from Ethiopia, making agriculture more dependent on fertilisers.

Measures to upgrade the dilapidated irrigation systems, to rebuild the networks and to promote small and medium-scale hydraulic engineering works are an absolute priority. Thought must also be devoted to agricultural policy and to choosing economic crops at a time when drinking water needs are rising steeply as the result of the population explosion. Although access to safe water has progressed in most southern Mediterranean countries in the past few years, there are still disparities between urban and rural areas, and tremendous progress is needed if the living conditions of the populations in the region are to be improved. Some States such as Tunisia, Algeria, Turkey and Jordan, have appreciably improved access to the sanitation systems so that 85% to 95% of the population is now covered. Other countries such as Morocco and Egypt are still severely handicapped: in 2004 about one-quarter of their respective populations still had no

2 - Abstraction includes the losses that can occur in the course of distribution and therefore differs from consumption, which denotes the quantity of water which actually arrives at the final destination. Where there is significant loss, consumption level is sometimes much lower than abstraction level; the opposite can be the case where there is a significant quantity of unconventional water.

access to an efficient facility (UNDP, 2006). Investment in water treatment and water supply infrastructures is thus urgently needed on the southern and eastern shores of the Mediterranean, with the essential aid of international cooperation.

Signs of growing water stress

Increasing water abstraction in a region with the general disadvantage of low rainfall is obviously putting pressure on the natural water resources. This pressure can be measured by a "water exploitation index" expressed as a percentage and defined as the ratio between the volume of water abstracted from renewable natural water resources and the average volume of renewable natural water resources:

$$I = \frac{V \text{ abstr.}}{V \text{ avail.}} \ (\%)$$

If the index is below 25%, water exploitation can be considered negligible. Between 25% and 50%, exploitation is still acceptable. Between 50% and 75%, it is high, and if the index is above 75% water resources are overexploited. The index is relatively high for all of the coastal regions of the Mediterranean countries, particularly those in the south and east. The FAO has identified four groups, as has the Blue Plan (but the members of each group can vary) (chart 4).

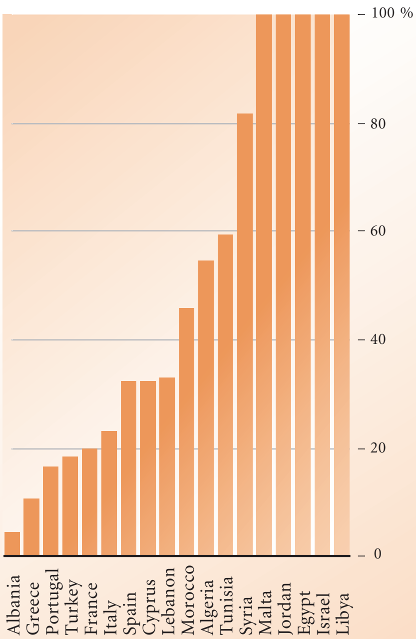
As regards river basins, the situation in the Mesopotamia region around the Tigris and Euphrates rivers is a matter for serious concern. According to the WWF, these two rivers form the third most exposed basin in terms of vulnerability to water quality degradation due to the large number of major dams which have been built, are planned or are under construction in the region. While this overexploitation affects surface water, its impact on groundwater resources is even greater, with disastrous and even irreversible effects on water quality. The exploitation of groundwater has increased considerably over the last decade as the result of population pressure and increasing irrigation water requirements. Indeed some countries go as far as abstracting large volumes from deep aquifers, some of which are non-renewable (Algeria, Egypt, Libya and Tunisia). In areas with shoreline aquifers overpumping sometimes causes marine intrusion resulting in deterioration of the quality of the water, which becomes brackish and thus unsuitable for domestic consumption but also for agriculture, since the soil can even become sterile. The situation is already alarming in many coastal zones, particularly in Greece, Israel, Italy, Cyprus, Malta, Spain, Tunisia and Turkey.

A further sign of water stress is the fact that half of the Mediterranean wetlands have disappeared, a development which obviously affects the ecosystems and biodiversity. According to UNEP data, the Mesopotamian wetlands have been particularly hard hit, since the construction of a large number of dykes and dams on the Tigris and Euphrates has reduced wetland area by 90%.

When scarcity exacerbates rivalry

Many States are virtually totally dependent on water resources from neighbouring countries. This is the case with Egypt, Syria, Israel and Portugal, which draw a large proportion of their resources from groundwater sources or sources outside their territories (Table 2).

Chart 4 - Water exploitation index, 2003



Source: our calculations based on Faostat 2005 data.

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In a context of water stress, this cross-border aspect can be a cause of contention. This rivalry is most evident in the Near East and sometimes even verges on violence around the Jordan basin. Back in the early 1950s, the Israelis established a supply policy in an attempt to respond to symbolic necessity (development of the land of their ancestors), to meet geopolitical requirements (occupation of the territory) and to satisfy economic needs (creation of wealth), the cornerstone of that policy being the construction of the National Water Carrier, which carries water from Lake Tiberias (the Sea of Galilee) to the Negev Desert. Since this lake is fed by Lebanese and Syrian rivers (the Hasbani and the Banias), and since the River Jordan receives part of its waters from Jordan further downstream (the River Yarmouk), the Israeli stance until now has been to prevent excessive abstraction by other countries, by methods including military means (capture of the Golan Heights in 1967, occupation of South Lebanon until 2000, threats against Lebanon and its plan to draw water from the Hasbani-Wazzani system) in September 2002. The Six-Day War in 1967 enabled Israel to augment its water resources,

Table 2 - Dependency index

Country	Dependency index (%)	Country	Dependency index (%)
Albania	35	Lebanon	- 9
Algeria	4	Libya	0
Cyprus	0	Malta	0
Egypt	97	Morocco	0
France	12	Portugal	45
Palestinian	18	Syria	73
Greece	22	Spain	0
Israel	55	Tunisia	9
Italy	5	Turkey	
Jordan	23	-	-

Dependancy index: ratio between the supply of external resources and the total volume of water available at the national level.

particularly by taking control of the West Bank aquifers. The water allocation regime which the Israelis have imposed on the Palestinians is particularly unfavourable: since 1967, certain measures (quotas, control of drilling, penalty pricing) have been preventing the Palestinians from using the water of the aquifers to which they stake a claim. Israel is thus benefiting tremendously from the groundwater which flows towards its territory thanks to the topography of the region. All in all, two-thirds of the water used by Israel consists of foreign resources, a factor which tends to weaken the country's position, despite the military deterrence strategies it can exert on its neighbours. Some, even in Israel, no longer hesitate to question a model of development where agriculture, which draws 65% of water resources, now accounts for only 2.5% of value added and of total employment.

The basin of the Nile, which, with a total length of 6700 km, is the longest river in the world, is also the scene of tension over water management policy. The only country concerned here is Egypt, which is situated downstream and has often suffered both floods and periods of drought. In order to ensure that the land would be irrigated throughout the year and to contain excessive flood waters, a reservoir dam was built at Aswan in 1902; its height was subsequently raised twice, in 1912 and in 1933, since its storage capacity (a maximum of 5 billion m^3) was too limited to allow perennial irrigation throughout the Egyptian Nile area. The construction project, which was implemented in 1952 just after the Egyptian Revolution led by the Free Officers, was the core issue in a geopolitical morass at the time (threats by France and England to intervene in 1956 were directly connected with the Egyptians' intention to nationalise the Suez Canal in order to finance work on the dam), but it did of course have socio-economic objectives. The aim was to develop (land and water) resources in order to cope with an unfavourable socioeconomic context: the country's essentially rural population – some 20 million at the time – was suffering from both land shortage (arable land being concentrated in the hands of a few) and the lack of perennial irrigation. With a population growth rate of 3%, the Egyptian planners could only conjecture that living conditions in Egypt would deteriorate unless a land policy (based on redistribution) and a water control policy were implemented.

Egypt made water supply management the focus of its development policy, sometimes to the detriment of its neighbours, in particular Ethiopia, which provides 86% of Nile discharge, whereas it only abstracts 0.3% at the present time. Addis Ababa is now seeking to circumvent this constraint in order to meet the needs of the population of 17 million people. The fall of Mengistu in 1991 and the end of the war in Eritrea in 2000 enabled leaders in the country to turn their attention to development projects, which could entail a drop in Nile discharge of 4 to 8 billion m^3. Similarly in Sudan, whose relationship with Egypt has been conflictual despite the water-sharing agreements signed in 1959, the construction of the Merowe Dam, which has been underway since 2003, is liable to reduce discharge downstream. Other upstream countries such as Tanzania or in Uganda, which contribute much less to Nile discharge, also have water catchment projects. Against this background, Egypt has two alternatives: it can either bring its military deterrent capacity to bear or embark on a water economy policy which will allow it to allocate part of the river to projects outside the Nile Valley, in the Sinai Peninsula and in the Libyan desert. In the latter case, regional cooperation through development could be achieved in concertation with the countries of the Nile Basin would be an essential approach. Given Egypt's participation in the Nile Basin Initiative, which was launched in 1999 and aims to achieve common management of the Basin's water resources, it would seem that Egypt and its Nile neighbours have chosen the second option for the time being. Although the success of this initiative is not yet assured, it could become an example of concerted use of water resources at a time when there is talk of possible water wars.

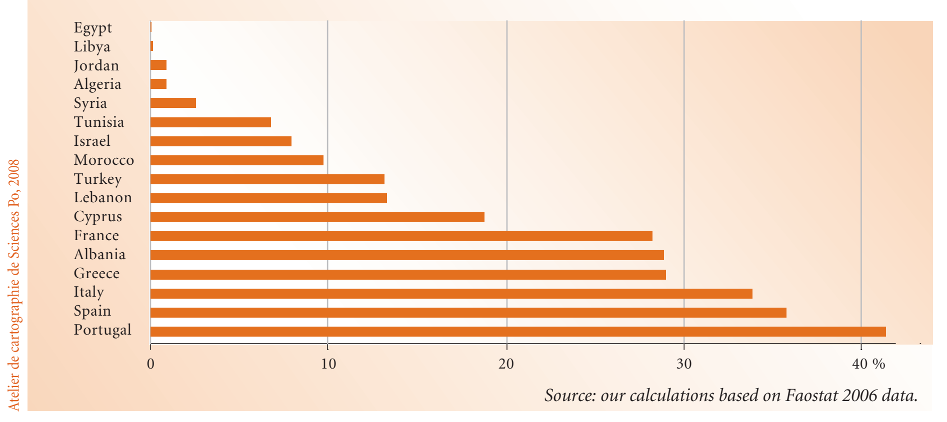
In the Tigris and Euphrates Basins the time for concertation does not yet seem to have come. Historically, it was more the downstream countries, Syria and Iraq, which developed these two rivers mainly with a view to protecting themselves against recurrent flooding. Having built 22 dams for providing hydroelectric power and irrigation water for more than 1.7 million ha, Turkey, which is seeking to become a major agricultural and industrial power and to develop the rebellious region in South-East Anatolia, is reducing the downstream discharge of these rivers, thereby provoking protests from Syria and Iraq. In the discussions held at the diplomatic level the parties talk at cross-purposes: Turkey asserts its right on the basis of a geographical fact – the Tigris and Euphrates are formed essentially in Turkey, which provides 98% and 45% of the rivers' discharge respectively –, whereas Damascus and Baghdad emphasise historical precedence. This disagreement, like those over the other river basins mentioned above, underlines how difficult it is to develop international law on water which can resolve conflicts. Despite the inadequacies of the law, inter-State co-operation will be all the more imperative in a context of unfavourable climate trends. From this point of view, the Nile Basin Initiative deserves particularly strong support. And as for the river basins where there is real tension, solutions are not impossible. By continuing to opt for a less "water-greedy" strategy, Israel can reduce water stress in the Jordan Basin (Blan 2006). In particular, the reduction of abstraction for the agricultural sector, which accounts for less than 3% of both GDP and total employment, could allow the Palestinians to use West Bank groundwater to a greater extent – a prospect which is imperative in the context of population growth in the Palestinian Territories, which will probably have a population of 6 million people by 2025.

Forest land, a threatened heritage

The Mediterranean forests are an excellent example of biodiversity. They are the habitat of some 290 tree and shrub species, 200 of which are mainly or exclusively connected with this geographical area (Blue Plan and FAO). Sixty of these species, i.e. almost 30%, are rare and under threat. Each type of forest is also a habitat for flora and fauna whose population depends mainly on humidity conditions, soil and sunlight. The largest forest rangers are situated in the North of the Mediterranean Basin, where water resources are most abundant (Chart 5).

Forests are subject to all sorts of attacks: while acid rain is affecting the north of Europe, deforestation is advancing in the Mediterranean region. It has various causes: urbanisation, agricultural development, intensive logging, etc. The factors are not always anthropic: although forest fires are to be explained to a large extent by the period of drought typical of Mediterranean summers, these fires are often the result of arson – irresponsible acts or property speculation. Some Mediterranean countries suffer heavy losses through these fires, whether they are of criminal origin or not: Spain and Italy lost 200,000 ha and 100,000 ha in the course of the 1990s, for instance, whilst Greece lost 200,000 ha in the summer of 2007 alone. A total of almost 600,000 ha are reported to burn in the Mediterranean each year.

Chart 5 - Share of forest and other wooded land in total area, 2006



Source: our calculations based on Faostat 2006 data.

The intensity of this deforestation could vary from one shore of the Basin to another in the future. In the North, rural decline phenomena are liable to be accentuated and to provide supplementary areas for spontaneous or non-spontaneous reafforestation - with fast-growing conifers, for example, Aleppo pine and Scots pine. Does biodiversity stand to benefit? The species that are more scattered along the coasts could disappear as the result of mass tourism (coastal Spain, Balearic Islands, the Riviera, Sicily and Crete). Although forestland progressed between 1990 and 2000, it is mainly in the south and east of the Mediterranean Basin that biodiversity is most vulnerable in view of the overexploitation of natural environments by man and his animals. Reduction could continue at a rate of 2% to 4% per year, depending on the country, over the next thirty years, and certain rarer species could become extinct. These rates do not allow for any marked episodes of drought, which would seem to be on the cards in the climate change context and would be liable to harms forests in the south and east. The fauna and flora associated with these forests would of course be liable to continue to dwindle, but over and above the threat of biodiversity collapse, this progressive loss of wooded lands in the southern and eastern Mediterranean region poses problems for the other resources, since forests are, inter alia, water cycle regulators and one of the factors preventing soil erosion.

In view of all of the hazards threatening forest ranges, there have been various moves to try to change the course of events. The idea of cooperation in the forestry field dates back to 1911 with the creation of Silva Mediterranea, a forum for consensus-building. This committee, which operates within the FAO, now aims to promote the concerted and sustainable management of forest areas. A Mediterranean Forest Action Programme was implemented in 1993 providing a reference framework for all of the national forestry planning schemes of the countries in the region. At a meeting in Rome in 2002 the members of the Silva Mediterranea committee made action to safeguard forest biodiversity a central priority along with that of the sector's contribution to sustainable development. This was in line with the plan of action devised by the UN Forum on Forests.

Energy: a new deal

Energy is a crucial production input. But while agriculture and industries – in particular those connected with farming – need energy, agricultural activities can also supply it. The ability of the countries in the region to maintain a fairly calorie-intensive model of agriculture depends on the rise in fossil energy costs; at the same time, that model can stimulate the replacement of fossil-fuel energies by renewable resources including those produced by agriculture (Chart 6).

Who produces? Who consumes?

Fossil energy (natural gas, coal and oil) is distributed very unevenly throughout the world, and the Mediterranean region is no exception when it comes to this sporadic distribution of deposits. Whereas there are extremely abundant deposits in the Arabian Peninsula, those situated on the fringe, i.e. in Egypt and Syria, are much more limited. Two countries in the west of the Mediterranean Basin, Algeria and Libya, supply the most oil, the volume they consume being much lower than output.

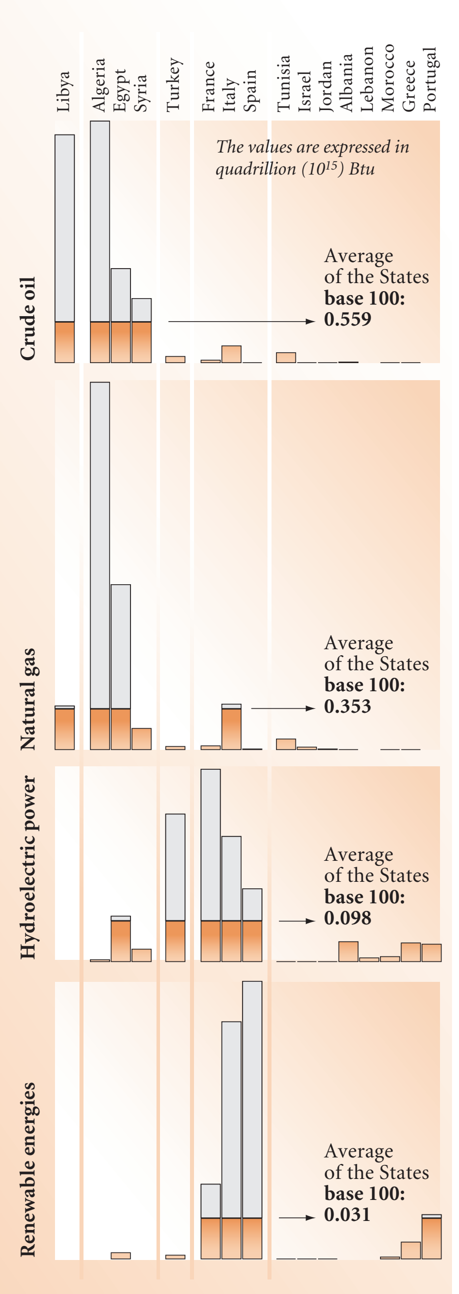
Natural gas is being regarded more and more as a panacea, since it is much less pollutant than oil and has the further advantage of high energy yield. Few of the Mediterranean countries can boast substantial output, however. Here again, Algeria is the leading producer in the region, followed by Egypt, Italy and Libya. Production in the other countries is marginal (France, Tunisia) or virtually inexistent (Morocco, Spain, etc).

The northern shores of the Mediterranean contain more coal, the main deposits being in Turkey, Spain, France and Greece. And it is the countries with heavy rainfall and topography conducive to water catchment which produce hydroelectric power, France, Turkey, Italy and Spain obviously being the main producers in view of their rainfall and the size and configuration of their territories (major mountain ranges). With its Aswan Dam, which receives in particular abundant volumes of water from Ethiopia, Egypt is the leading producer of hydroelectric power on the southern shores.

Some countries have developed nuclear energy using uranium fission in order to overcome their energy poverty. In the Mediterranean Basin, France is the only country that made a bet on this form of energy when it came to rethinking energy policy after the oil crises in the 1970s, and by 2004 it was producing 16% of world nuclear energy. While extending nuclear energy is clearly a solution for the Mediterranean region that brings advantages, there are nevertheless several obstacles. In particular, the fact that it is highly capital-intensive means that countries with limited financial capacities have fewer possibilities for developing it.

So-called clean resources, better known as renewable energies (solar and wind energy, biomass, geothermics), although still marginal, are now supplying a growing share of energy in countries less endowed with fossil resources. This is already the case in the countries in the North, Spain being in the lead, followed by Italy and France. Promoting

Chart 6 - Energy production, 2005



Source: Energy Information Administration (EIA), www.eia.doe.gov/iea/

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renewable energies in the Mediterranean is a crucial challenge and one that is highly relevant to the region given its considerable potential in terms of sunlight. The development of photovoltaic solar energy could be a promising avenue if the economic costs of installation were reduced. And biomass is just as important a resource.

In the final analysis, when one considers all forms of energy production in the Mediterranean Basin, Algeria emerges as the leading producer due to its wealth of fossil energies, while France, having opted for nuclear energy, comes second. Whereas energy production is dictated in part by natural contingencies, consumption in the various countries is related to a large extent to their economic dynamism but also to their populations. France, Italy and Spain thus rank highest as consumer countries. The northern shores absorb the largest quantities of energy, irrespective of energy type – as regards both natural gas (Italy and France consuming the largest volumes) and the other fossil energies (oil and coal).

Electric power, which is a secondary form of energy that is produced by transforming another form of (fossil or renewable) energy, is the predominant form of energy consumed, consumption having increased at a rate of 4.5% per year in the period from 1990 to 2004; it is used widely in the agricultural production process, particularly in crop irrigation. Thus, if it is obtained from fossil energies, a rise in the prices of these energies can result in a considerable rise in costs for the agricultural sector. This is the case in particular for the southern-shore countries, which are obliged to resort to irrigation. Algeria and Libya, which produce large volumes of oil, are the only countries that can ease this constraint.

Disturbing prospects

In the 2006 edition of the World Energy Outlook, the International Energy Agency (IEA) states that consumption of fossil fuels will remain predominant until 2030 and that oil, natural gas and coal will continue to be the main sources of energy until then, irrespective of scenario. According to some experts,[3] world oil output is set to peak around 2010-2050, whereas others predict the peak around 2025-2035. Jean Laherrère (ASPO) reckons that world natural gas output will peak around 2030. The onset of these peaks around 2030 would penalise both countries exporting gas and oil and importing countries. Since world coal reserves are notably greater, particularly in the United States, Russia and China, Jean Laherrère predicts a peak in world output around 2050.But the use of coal presupposes that its pollutant property be reduced. New technologies that have been developed in the past few years (gasification and combined cycle, "clean coal"[4] and fluidised-bed combustion), are already considerably reducing pollution and acid rain problems, and could be rendered more efficient in the years that lie ahead. The prospect of these peaks obliges policymakers to act now to direct the course of energy policy in Mediterranean countries to a maximum, particularly since climate degradation makes it imperative to reduce the use of fossil fuels and develop alternative forms of energy.

The limits have been reached

The sustainability of resources and thus of the Mediterranean area as a whole is one of the region's crucial challenges. The diversity and fragility of its environment require that the principles and objectives of sustainable development for the region be implemented in order to counteract the main trends:

- Over the last 30 years there has been growing evidence of climate change, with significant and unpredictable variations in temperature, an increasing number of extreme weather events and a drop in average annual rainfall, which makes it imperative to step up water supply and management measures ranging from supply policy to water economy strategies. If things are simply allowed to take their course in the future, climate change in the Mediterranean region could affect the southern and eastern shores in particular.

- Biodiversity is continuing to diminish, and the threats now facing the Mediterranean ecosystem are unfortunately commensurate with its wealth. The region is becoming an at-risk ecoregion, made vulnerable by desertification, deforestation and the loss of certain animal and plant species.

- Mediterranean land is suffering in particular: while galloping urbanisation is encroaching on farmland (particularly in the South), land reserves are being degraded as the result of mismanaged intensification. Even if public policies succeed in protecting endangered land resources, the margins for manoeuvre in terms of food supplies are to be found more in exploiting existing resources more efficiently rather than in increasing production acreage.

3 - ASPO (Association for the Study of Peak Oil)

4 - A so-called "CCS" (carbon capture and storage) technology has been developed for coal, consisting of capturing the CO_2 emitted during the production of energy and transporting it to sites where it can be stocked (for example, in deep rock layers, depleted oil fields, impermeable geological layers, etc.)

- Water, the focus of this environmental tension, is now more than ever a matter for concern. As it becomes increasingly scarce in the south and east of the Basin it is increasingly coveted in a region already known for its water shortages and its propensity to make the blue gold a strategic issue in inter-State and intra-regional relations. Water is now an object of competition between sectors, the major part of water resources being allocated to agriculture in the Mediterranean region. At the same time, access to clean water for the population remains a problem, and measures to improve basic infrastructures are imperative.

- Energy remains a fundamental issue amongst the many different challenges in the environment field. The post-oil era has already begun and it inevitably has implications for agriculture and food production. While it is difficult to predict the extent of the consequences, it is already conceivable that production costs will rise and that consumers and producers will thus be penalised. On the other hand, this rise in prices may lead to more focus on geographical proximity as a means of limiting transport costs, which would benefit farmers. Despite the imminence of production peaks, there is little sign of any change of course in the energy field at the present time. Efforts have been made, however, to diversify energy resources: the use of renewable energies such as biofuels is often cited as an avenue for the future in a region characterised by extensive agricultural activities. Whe shall come back to this subject later.

This overview confirms the growing consequence of the environmental variable in the geopolitical analysis of the region. Certain terms are appearing (such as 'ecological refugee', 'environmental diplomacy', or 'sustainable development') which illustrate that the environment and international political action are closely and irreversibly linked. This correlation undoubtedly calls for strengthened cooperation amongst the Mediterranean States in responding to the growing ecological challenges in the region, an imperative that is becoming all the more crucial as environmental tension, whether global, regional or local, exacerbates or creates new inequalities within the Mediterranean zone and within its societies.

Since the Mediterranean region, one of the richest ecoregions and natural zones in the world, is in jeopardy, it must become the world laboratory for lasting and sustainable development. This challenge will inevitably involve a change in attitude and practices on the part of all of the players involved in the region, and more specifically in the role and practices of farmers. For, given the environmental issues at stake, the challenge they face is indeed tremendous: they must produce more, they must produce more efficiently, and they must produce without polluting.

Bibliography

AEE, *Mapping the Impacts of Recent Natural Disasters and Technological Accidents in Europe*, report, Copenhagen, 2003.

AEE, *Cambiamento climatico ed alluvioni in Europa*, report, Copenhagen, 2005.

AEE, *The European Environment. State and Outlook*, Copenhagen, 2005.

Allaya (M.) (dir.), *MedAgri 2002. Annuaire des économies agricoles et alimentaires des pays méditerranéens et arabes*, Montpellier, MAI, 2002.

Ayeb (H.), "L'Égypte et le haut barrage d'Assouan", *Hérodote*, 103, 2001, p. 137-151.

Baldi (M.), Crisci (A.), Maracchi (G.), Meneguzzo (F.), *Il Clima che cambia: stato della ricerca e prospettive future, Florence,* IBIMET-CNR, 2003.

Bartram (J.), Thyssen (N.), Gowers (A.), Pond (K.) and Lack (T.), *Water and Health in Europe*, Geneva, WHO Regional Publications: European Series 93, 2002.

Benoit (G.) et Comeau (A.) (dir.), *Méditerranée. Les perspectives du Plan bleu sur l'environnement et le développement*, La Tour d'Aigues, Éditions de l'Aube, 2005.

Benoit (G.) and Comeau (A.) (eds), *A Sustainable Future for the Mediterranean. The Blue Plan's Environment and Development Outlook*, London, Earthscan Publications, 2006.

Blan (P.) (dir.), "Eau et pouvoirs en Méditerranée", *Confluences Méditerranée*, 58, 2006.

Blue Plan-FAO, *Les Espaces boisés méditerranéens: des atouts majeurs pour le développement rural*, 2003.

Cerón (J.-C.) and Pulido-Bosch (A.), "Groundwater Problems Resulting from CO_2 Pollution and Overexploitation in Alto Guadalentín Aquifer (Murcia, Spain)", *Environmental Geology*, 28 (4), 1996, p. 223-228.

Chiacchierini (E.), Amendola (C.), Restuccia (D.), Vinci (G.), "Pianeta acqua: un problema globale. Gestione delle risorse idriche nel bacino Mediterraneo", *Rivista Scienza e Tecnica*, 412, 2004.

Climagri, "Trasferimento delle metodologie realizzate nell'ambito del progetto climagri ai paesi in via di sviluppo del bacino del mediterraneo", Proceedings of the Climagri Colloquium, Cagliari, 16-17 January 2003.

Conti (F.), "Le acque per uso industriale e agricolo", meeting, May 2004.

Crisci (A.), Gozzini (B.), Pasqui (M.), Zipoli (G.), "Costruzione di scenari climatici futuri ad alta risoluzione destinati allo studio del loro effetto sull'agricoltura italiana", Proceedings of the Climagri Colloquium, Cagliari, 16-17 January 2003.

ENEA, *Rapporto Energia e Ambiente 2005*, Volume 1, *L'analisi*, Rome, 2005.

FAO, *World Reference Base for Soil Resources. 84th World Soil Resources Report*, Rome, 1998.

FAO, *Water Report. Review of World Water Resources by Country*, Rome, 2003.

Gardner Outlaw (T.) and Engelman (R.,), *Sustaining Water: Population and Future of Renewable Water Supplies*, Washington (D.C.), Population Action International, 1997.

Giannakopoulos (C.), Bindi (M.), Moriondo (M.), Le Sager (P.) and Tin (T.), *Climate Change Impacts in the Mediterranean Resulting from a 2°C Global Temperature Rise,* Gland, WWF, 2005.

Giuliacci (M.), "Come è cambiato il clima nel Mediterraneo", in *Incontriamo il Mediterraneo*, Naples, Edizioni Albatros, 2004.

Gualdi (S.) e Navarra (A.), *Scenari climatici nel bacino Mediterraneo*, Bologne, Istituto Nazionale di Geofisica e Vulcanologia, 2005.

Hamdy (A.), Lacirignola (C.) and Trisorio-Liuzzi (G.), "The Integration of Soil and Water Resources Management toward a Sustainable Agricultural Development in the Mediterranean", *Options méditerranéennes*, "Interdependency Between Agriculture and Urbanization: Conflicts on Sustainable Use of Soil and Water", 44, Bari, 2001.

INEA, *Emergenza idrica nel Sud-Italia*, Rome, 2002.

IPCC, *Emissions Scenarios,* Report of IPPC Working Group III, 2000.

ISMEA-IAMB, *Lo sviluppo rurale nelle politiche di integrazione del bacino del Mediterraneo*, Bari, Osservatorio permanente sul sistema agroalimentare dei paesi del Mediterraneo, 2004.

Lahmar (R.) et Ruellan (A.), "Dégradation des sols et stratégies coopératives en Méditerranée: la pression sur les ressources naturelles et les stratégies de développement durable", *Cahiers Agricultures*, 16 (4), July-August 2007.

Margat (J.) and Vallee (D.), "Mediterranean Vision on Water, Population and the Environment for the XXI[st] Century", contribution, *The World Water Vision of the World Water Council and the Global Water Partnership*, Blue Plan, 1999.

Margat (J.), *Progress towards Water Demand Management in the Mediterranean Region. Contemporary Trends and Water Demand Change Perspectives in the Mediterranean Countries*, Blue Plan, Sophia Antipolis, 2002.

Marullo (S.) e Guarracino (M.), *L'anomalia termica del 2003 nel mar Mediterraneo osservata da satellite,* Rome, ENEA, 2003.

Morgillo (A.), Brunetti (A.), Salvati (L.), "La siccità in Italia: spunti di discussione sul clima, sugli aspetti pedoclimatici e sul bilancio idrico", communication to the conference on *L'Agrometeorologia nel Mediterraneo*, Acireale, 6-7 June 2002.

Moulid (M.), "Impact de l'énergie électrique sur les coûts de pompage et de production des cultures. Cas du Souss-Massa", *Hommes, terre et eaux*, 79, 1990.

Oldeman (L. R.), Hakkeling (R. T. A.) and Sombroek (W. G.), "World Map of the Status of Human-Induced Soil Degradation: A Brief Explanatory Note", ISRIC and UNEP, 1991.

UNEP, *Human Development Report 2006. Beyond Scarcity: Power, Poverty and The Global Water Crisis*, New York (N.Y.), 2006.

Quezel (P.), "Biodiversité végétale des forêts méditerranéennes, son évolution éventuelle d'ici 30 ans", *Revue méditerranéenne*, 20 (1), March 1999, p. 3-8.

Seneviratne (S.), "Land: Atmosphere Coupling and Climate Change in Europe", *Nature*, 443 (7108), September 2006, p. 205-209.

World Conservation Union, *Climate Change and Water Resources in the Mediterranean; Water: A Vital Resource Threatened by Climate Change, a Needed Adaptation of its Management*, Malaga, 2003

WWF, *Europe Feels the Heat. Power Sector and Extreme Weather*, *Power Switch Campaign*, Gland, 2005.

WWF, *Stormy Europe. Power Sector and Extreme Weather*, *Power Switch Campaign*, Gland, 2006

Websites

clima.casaccia.enea.it

lada.virtualcentre.org

reports.eea.eu.int

www.apat.gov.it

www.ecoage.com

www.emwis.org

www.enerecosrl.com

www.fao.org

www.grida.no
www.inea.it
www.ipcc.ch
www.naturmed.unimi.it
www.nonsoloaria.com
www.panda.org
www.planbleu.org
www.populaction.org
www.runic-europe.org
www.sisef.it
www.ual.es
www.unep.org
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