



JOINT MEDITERRANEAN EUWI/WFD PROCESS



Mediterranean Water Scarcity and Drought Report

Produced by the

**MEDITERRANEAN WATER SCARCITY AND DROUGHT
WORKING GROUP**

<http://www.emwis.net/topics/WaterScarcity>

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1 INTRODUCTION

Water Scarcity and Drought was identified as one of the themes to be addressed in the framework of the Mediterranean – EU Water Initiative / Water Framework Directive Joint Process launched in 2004. At the last Euromed Water Directors meeting in November 2006, a first draft report was presented and it was decided to continue the activities of the Water Scarcity and Drought Working Group for a 2nd phase (2007-2009).

It was agreed that the Working Group would produce a report on the assessment of water scarcity and droughts in the Mediterranean Region.

This report is backed by information on the economic, social and environmental impacts of water scarcity and droughts in the region. It also identifies best practices and “success stories” for water saving measures in the region in order to formulate recommendations which will be discussed by the EuroMed Water Directors Forum in 2008.

In order to assess the scope and impacts of water scarcity and droughts in the Mediterranean Partner Countries, a questionnaire was designed in order to collect the necessary data to write the report and enrich it with quantitative and qualitative data. The questionnaire had 2 sections:

- Section A was an in depth assessment of the current situation with regards to water scarcity and droughts, and consists of data collection of information at river basin or local level. This questionnaire is similar to the one used at the EU level in 2006
- Section B is an inventory of measures taken by Mediterranean countries to manage water scarcity and droughts in proactive and reactive ways.

Replies to this questionnaire were received from Albania, Israel, Morocco, Tunisia, Turkey, Palestine, Jordan & Bosnia and Herzegovina. However, replies were mainly focused on section B. Therefore, this lack of information on required data limits the analysis.

This report therefore attempts to present an overview of drought and water scarcity issues in the Mediterranean countries whenever quantitative or qualitative data are available. It also gives an interesting insight into the expected impacts of climate change in the region.

2 EXECUTIVE SUMMARY

The draft Mediterranean Water Scarcity and Drought report presents in section 3 a series of definitions related to water scarcity and droughts. Section 4 focuses on existing indicators of water scarcity and droughts. Sections 5 and 6 are devoted to the scope and impacts of these issues in the Mediterranean Region. Section 7 presents examples of water management measures implemented or planned in the Mediterranean Region in order to mitigate the impacts of water scarcity and droughts. Section 8 addressed the issue of public participation. Section 9 goes thoroughly into drought risk management measures. The two final sections describe the expected impacts of climate change in the same Region and goes thoroughly into the concept of virtual water.

Section 3 of the report provides appropriate definitions and descriptions of the phenomena of drought, aridity, water shortage, desertification, water scarcity, water stress as well as of water resources, water demand management and water conservation.

Section 4 describes the indicators and indices currently used across the world to describe the events of drought. This section recalls that indicators are essential to ensure an efficient follow up of the extent and impacts of water scarcity and droughts in the Mediterranean Region. This is also an opportunity to remind that water scarcity and droughts are two different phenomena which therefore require specific and adapted indicators.

Sections 5 and 6 provide initial information on the extent of water scarcity and droughts in the Mediterranean Region. Winter precipitation trends over the whole eastern Mediterranean showed an overall fall in rainfall during the period 1948-2000. Added to this, a significant increase in the index of maximum number of consecutively dry days was revealed. Due to a significant lack of information available in the countries of the region, the overview is far from being exhaustive and reveals an important need to improve the collection of data at national level. The section provides more information on the impacts of water scarcity and droughts in the same region. The social, economic and environmental impacts of a severe drought which affected Israel, Jordan and the Palestinian Territories in 1998-2000 are described in detail. This section points out the social ramifications of situations of drought and water scarcity, such as impacts on human health due to insufficient access to potable water or political tensions between countries or regions related to the allocation of water resources. However this issue also presents an opportunity to develop cooperative efforts between countries or regions in order to ensure sustainable water management.

Section 7 presents examples of water demand and water supply management measures. The introduction to the section reminds the relevance of the principles of the Communication on water scarcity and droughts adopted by the European Commission on 18 July 2008. Policy making should be based on a clear water hierarchy. Additional water supply infrastructures should be considered as an option only when other options have been exhausted including effective water pricing policy and cost-effective alternatives. This section recalls the significant water saving potential assessed by Plan Bleu for all the Mediterranean Region. According to the Plan Bleu study, the improvement of water demand management would make it possible to save 25% of water. The most important potential concerns irrigation with possible savings five time higher (in volume) than in the domestic sector. Agriculture accounts for more than 60% of total water demand (all Mediterranean countries included) and for more than 80% of Southern and Eastern countries' water demand. The water saving

potential in agriculture represents 65% of the total water saving potential identified in the Mediterranean Region by 2025. In most arid and semi-arid countries of the Mediterranean Region, water efficiency of irrigation is below 45%. Significant challenges therefore remain to be addressed in terms of technological innovations and advisory services. The section describes the benefits emerging from a reduction of water abstraction in terms for environmental preservation and energy savings. The other economic sectors also need to address the water saving potential with the adoption of appropriate measures like the setting up of drinking and industrial standards or the introduction of water efficient technologies.

The current development of water demand management policies by a number of Mediterranean countries is also pointed out. However the limits of the initiatives in terms of quantified objectives have also been identified and are highlighted in the section. Economic instruments including water pricing are pointed out as effective instruments to move towards water demand management. The usefulness of economic incentives is also pointed out. The need to further raise public awareness and communicate on the impacts of water scarcity and droughts as well as on good practices is also mentioned as a key priority. This also requires a further development of the knowledge on the issue and more efficient systems of data collection. The overview of all possible water demand measures shows that addressing water scarcity and droughts requires a set of complementary policy options including regulatory, economic, technical and educative measures.

The report also describes the possible water supply measures that can be planned in addition to the water demand management measures when the water hierarchy principle is respected.

The different types of alternative options including desalination, waste water reuse and aquifer recharge are described with a short description of the associated opportunities and risks.

Section 8 describes how public participation can contribute to efficient water demand management via an active involvement of all interested parties and the consultation of the broad public.

Section 9 specifies the types of measures that can be implemented in order to prevent droughts and mitigate their impacts on the economy, the society and the environment. The example of the Jucar river basin shows that the priority needs to be put on prevention measures in order to reduce drought impacts to the greatest extent possible.

The fifth section of the report focuses on the expected impacts of climate change on the Mediterranean Region. Predictions covering the entire Mediterranean Region suggest up to 35% rainfall reductions by 2071-2100, reducing inland water flows and water yields. The IPCC projects, under an A1 scenario, a 4 to 27% average decrease in precipitation for the south eastern Mediterranean with significant spatial and seasonal variation. Further and following current trends, a tendency to a more extreme climate with more uneven distributions is projected. A 46% increase in 'significantly drier than normal' years is expected for the study area, along with an exponential increase in drought probability. Across the region, climate change is expected to reduce water availability severely, in places by up to 60% in the coming century. Water shortages are likely to worsen and in places become critical. All these figures show that in a number of places across the Mediterranean Region, all the economic activities will have to adapt to the evolution of water availability. The expected impacts of climate change will also be exacerbated by the projected increasing economic development and growing population. The average population growth of Israel, Jordan and

Palestinian Territories is estimated at 4%, which means that the population is expected to double in the coming two decades. The need to manage the risk of increasing tensions between and within countries related to water distribution at regional level will constitute another key challenge.

The last section of the report deals with the concept of virtual water. The 'virtual water' of a product is the amount of water consumed in its production process. The trade of food leads to virtual flows of water from countries exporting food and manufactured goods to countries importing these commodities. In theory a water scarce country can import products that require a lot of water rather than producing them on its own territory. This is supposed to result in water savings. But due to other considerations related to climate conditions for growing special fruits and vegetables or to trade conditions, importing countries are not necessarily those which are water scarce. Virtual water flows related to exchange of cereals are quantitatively significant in the Mediterranean Region. Most of the Mediterranean countries are net importers of virtual water, except France. Even if virtual water flows are supposed to result in water savings, this needs to be further assessed in light of the national strategies for food security.

3 *METHODOLOGY AND DEFINITIONS*

3.1 *THE CONCEPT OF DROUGHT*

Drought is a normal, recurrent feature of climate, although it is erroneously considered as a rare and random event. It differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate. Drought should be considered relative to some long-term average conditions of the balance between precipitation and evapotranspiration (i.e., evaporation + transpiration) in a particular area. It is also related to the timing (principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness (i.e., rainfall intensity, number of rainfall events) of the rains. However, these are only conceptual definitions that are unable to give an operational definition of drought.

3.2 *OPERATIONAL DEFINITION OF DROUGHT*

An operational definition of drought helps people to identify the onset, end, and degree of severity of a drought. This definition is usually made by comparing the current situation to the historical average, often based on a 30-year period of record (according to World Meteorological Organization recommendations). The following characteristics of drought are usually considered:

- Meteorological characteristics

The meteorological characteristics are usually defined on the basis of the degree of dryness (in comparison to some “normal” or average amount) and the duration of the dry period. Their definitions must be considered as specific to a region since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

- Agricultural characteristics

The agricultural characteristics link various meteorological (or hydrological) characteristics to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapo-transpiration, soil water deficits, reduced groundwater or reservoir levels, and so forth.

- Hydrological characteristics

The hydrological characteristics are associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e., stream flow, reservoir and lake levels, groundwater). The frequency and severity of the hydrological characteristics are often defined on a watershed or river basin scale.

- Hydrological with respect of the land use characteristics

Although climate is a primary contributor to hydrological characteristics of droughts, other factors such as changes in land use (e.g., deforestation), land degradation, and the construction of dams all affect the hydrological characteristics of the basin.

- Socio economic characteristics

This occurs when physical water shortage starts to affect people, individually and collectively or, in more abstract terms, most socio-economic definitions of drought are associated with the supply and demand of an economic good.

These operational definitions can also be used to analyse drought frequency, severity, and duration for a given historical period.

3.3 *WATER STRESS CONDITIONS*

The following figure shows the processes which derive from drought conditions:

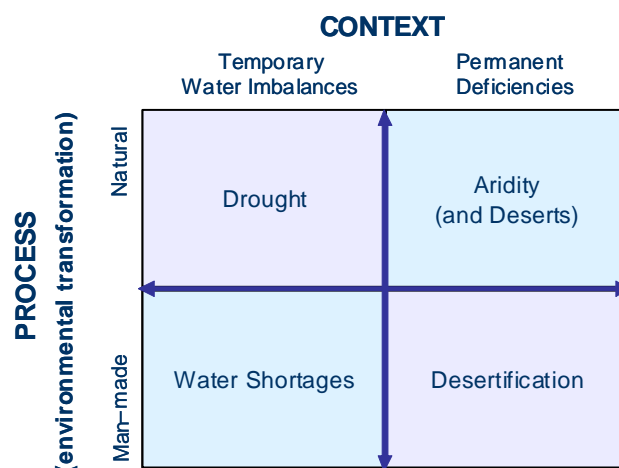
- Aridity is a natural phenomenon describing generally low water availability over an ecosystem due to low precipitation and/or high evaporation rates. While drought is a deviation from the average situation, but still within the ecosystem's natural variability, aridity is a permanent feature.
- Water shortage is a situation in which water supply is inadequate to meet demand. The term "water shortage" has the following specific meanings:
 - a dearth, or absolute shortage
 - low levels of water supply relative to minimum levels necessary for basic needs.

It can be measured by annual renewable flows (in cubic meters) per head of population, or its reciprocal, viz. the number of people dependent on each unit of water (e.g. millions of people per cubic kilometre).

The cause of a water shortage may depend only on a drought event, but more often shortage is also caused by man-made actions like water contamination, inadequate planning or equipment, in general by an incorrect water resources management.

- Desertification is the land degradation in arid, semi-arid, sub-humid and dry areas, due to various causes, among which the climatic and anthropogenic activities. It is a permanent feature consisting in the progressive reduction of the surface layer of the soil and of its fertility.

Figure 3.1 Typology of water stress condition



Source: Typology of water stress condition (Vlachos, 1982)

Other useful definitions about Supply/Demand Imbalances are:

Water Scarcity

In popular usage, “scarcity” is a situation where there is insufficient water to satisfy normal requirements. However, this common-sense definition is of little use to policy makers and planners. There are degrees of scarcity - absolute, life-threatening, seasonal, temporary, cyclical, etc. Populations with normally high levels of consumption may experience temporary scarcity more severely than other societies who are accustomed to use much less water. Scarcity often arises because of socio-economic trends having little to do with basic needs.

The term “water scarcity” has the following specific meanings:

- an imbalance of supply and demand under prevailing institutional arrangements and/or prices,
- an excess of demand over available supply,
- a high rate of utilization compared to available supply, especially if the remaining supply potentials are difficult or costly to tap.

As this is a relative concept, it is difficult to capture in single indices. However, current utilization as a percentage of total available resources can illustrate the scale of the problem and the latitude for policymakers.

Some causes of water scarcity are natural, others are of anthropogenic. The impact of natural processes can be aggravated by human responses. Human behaviour can modify our physical environment in a way that the availability of usable water resources is reduced. The demand for water may be artificially stimulated, so that at a constant rate of supply the resource becomes “scarce”.

Water Stress

Water stress is generally related to an over-proportionate abstraction of water in relation to the resources available in a particular area. The ratio between total freshwater abstraction and total resources is a broad indication of the availability of water and the pressure on water resources.

Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. It frequently occurs in areas with low rainfall and high population density or in areas where agricultural or industrial activities are intense. Even where sufficient long-term freshwater resources exist, seasonal or annual variations in the availability of freshwater may at times cause stress. Water stress induces deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc) and quality (eutrophication, organic matter pollution, saline intrusion, etc). Such deterioration can result in health problems and have a negative influence on ecosystems.

Water Demand Management

Water demand management refers to the implementation of policies or measures which serve to control or influence the amount of water used (European Environment Agency (EEA) Glossary).

The relationship between water abstraction and water availability has turned into a major stress factor in the exploitation of water resources in Europe. Therefore, it is logical that the investigation of sustainable water use is increasingly concentrated on the possibilities of influencing water demand in a favourable way for the water environment. Demand management includes initiatives having the objective of reducing the amount of water used (e.g. the introduction of economic measures and metering), usually accompanied by information and educational programmes to encourage more rational use. According to the EEA, management can be considered as a part of water conservation policy, which is a more general concept, describing initiatives with the aim of protecting the aquatic environment and making a wiser use of water resources.

Water Conservation

While there is no universally accepted definition of water conservation, this term is often used in the sense of “saving water” through efficient or wise use. People do not always agree on the meaning of “efficiency” because there are various degrees of efficiency. In terms of utility management activities for dealing with water shortages, conservation can mean both short-term curtailment of demand and long-term resource management. Short-term curtailment of demand can be achieved through a vigorous public information programme, which can include both voluntary and enforced actions. The curtailment is temporary, and after a shortage is over consumers usually resume their former water use habits. Long-term resource management involves efficient use and resource protection strategies designed to achieve permanent changes in how water is managed and used, including policy changes like the removal of subsidies for thirsty crops in water-scarce areas. Water supply companies and authorities often undertake activities under normal circumstances to promote efficient use of water.

Today, water conservation has many meanings. It means storing, saving, reducing or recycling water.

Water Resources

The concept of water resources is multidimensional. It is not only limited to its physical measure (hydrological and hydro-geological), the “flows and stocks”, but encompasses other more qualitative, environmental and socio-economic dimensions. The water resources of a country are determined by a number of factors, including the amount of water received from precipitation, inflow and outflow in rivers and the amount lost by evaporation and transpiration (evaporation of water through plants). The potential for storage in aquifers and bodies of surface water is important in facilitating the exploitation of this resource by humans. These factors depend on geography, geology and climate. Freshwater resources are continuously replenished by the natural processes of the hydrological cycle. Approximately 65 % of precipitation falling on land returns to the atmosphere through evaporation and transpiration; the remainder recharges aquifers, streams and lakes as it flows to the sea. The average annual runoff for the member countries of the EEA is estimated to be about 3100 km³ per year (314 mm per year). This is equivalent to 4500 m³ per capita per year for a population of 680 millions.

4 WS AND D MONITORING

4.1 GENERAL CONSIDERATIONS

Water scarcity and drought monitoring is an essential element in the decision making process for planning proper measures of prevention and mitigation of the impacts, providing the information about the possible duration, intensity and extension of the events. Distinguishing between water scarcity and drought events is not an easy task due to the difficulties in differentiating the natural impact of drought from the anthropogenic pressure and the improper management of water.

Several meteo- hydrological indices have been developed and it is necessary to select a combination of indices or the most adapted to describe in a synthetic and efficient manner the evolution of drought in time and space over the affected socio-economical-environmental systems, taking into account the several types of drought (meteorological, agricultural, hydrological, operative and socio-economic).

For water scarcity, it is also necessary to monitor the water quantities available for the different sources and the water uses and demands for the different civil and economic sectors involved, in order to identify and evaluate the reasons of the imbalances and activate proper measures.

In both cases, characterization of the events should include preliminary analyses of the sources of information including time scale and data reliability.

A correct management of crises periods and their characterisation depend on the indices adopted for the identification of the event and the chosen thresholds for preventing and mitigating impacts.

4.2 DROUGHTS INDICES

The onset and termination of droughts are difficult to determine. We can, however, identify various indicators of drought, and tracking these indicators provides us with a crucial means of monitoring drought. The indices are generally able to synthesize the complex interactions between the climatic variables and the associated processes. The indices are also useful to a quantitative evaluation of climatic anomalies in terms of intensity, duration, spatial extension and frequency, and to facilitate the exchange of information on drought conditions between the monitoring system users. In any case, the availability of large number of indices highlights the difficulty in reaching an exhaustive and single definition of drought.

Drought indices assimilate thousands of bits of data on rainfall, snowpack, streamflow, and other water supply indicators into a comprehensible big picture. A drought index value is typically a single number, far more useful than raw data for decision making.

Although none of the major indices is inherently superior to the rest in all circumstances, some indices are better suited than others for certain uses. The current trend in the monitoring and early warning centres is to utilise a range of different drought indices in the context of a public information system on the hydro-meteorological variables and on the state of the water resources.

Several indices and methods have been proposed since the 1960s in order to identify and monitor drought events with reference to a particular drought definition. Some indices refer to the meteorological characteristics of droughts and are based on precipitation, generally measuring how much precipitation for a given period of time has deviated from historically established norms. Other indices describe the hydrological or the agricultural characteristics of drought or the water deficit in the water supply systems.

In international publications different indices have been discussed and applied, amongst which:

- Percent of Normal;
- Deciles;
- Palmer Drought Severity Index (PDSI);
- Palmer Hydrological Drought Severity Index (PHDI);
- Palmer Moisture Anomaly Index (Z-Index);
- Surface Water Supply Index (SWSI);
- Standardized Precipitation Index (SPI);
- Rainfall Anomaly Index (RAI);
- Reconnaissance Drought Index (RDI);
- Run Analysis;
- Crop Moisture Index;
- Soil Moisture Anomaly Index;
- Normalized Difference Vegetation Index (NDVI)

4.2.1 *Percent of Normal*

This index is computed by dividing the actual precipitation by the "normal" precipitation (typically considered to be a 30-year mean) and multiplying by 100. This index can be calculated for a variety of time scales. Usually these time scales range from a single month to a group of months.

One problem is that the distribution of the precipitation, on time scales less than one year, is not gaussian. For this reason the mean usually differs from the median. This introduces an error in the evaluation of the deviation from the values of the cumulated precipitation considered "normal" for a specific time-space scale. The equation for this index is:

Figure 4.1

$$I = \frac{\langle P \rangle}{\langle P \rangle_{30}} \times 100$$

Values of the index less than 100 means drought conditions exist.

4.2.2 Deciles

The distribution of the time series of the cumulated precipitation for a given period is divided into intervals each corresponding to 10% of the total distribution (decile). Gibbs e Maher (1967) proposed to group the deciles into classes of events as listed in the following table:

Table 4.1

Class	Percent	Period
Decile 1-2	20% lower	Much below normal
Decile 3-4	20% following	Below normal
Decile 5-6	20% medium	Near normal
Decile 7-8	20% following	Above normal
Decile 9-10	20% more high	Much above normal

4.2.3 Palmer Drought Severity Index (PDSI)

Palmer (1965) developed this index based on the supply-and-demand concept of the water balance equation. The objective of the index is to measure the departure of the moisture supply for normal condition at a specific location. The PDSI is based on precipitation and temperature data, on the local Available Water Content (AWC) of the soil and other meteorological parameters. The Palmer Index has been widely used but it has some limitations. Among these we mention: the index is highly sensitive to the AWC of a soil type and that there are some difficulties in comparing the results obtained in regions with a different water balances. The Palmer Index varies between -6.0 and +6.0. The index classification is shown in the following table:

Table 4.2 Index classification

PDSI	Class
4.0 or more	Extremely wet
3.0 to 3.99	Very wet
2.0 to 2.99	Moderately wet
1.0 to 1.99	Slightly wet
0.5 to 0.99	Incipient wet spell
0.49 to -0.49	Near normal
-0.5 to -0.99	Incipient dry spell
-1.9 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Sever drought
-4.0 or less	Extreme drought

4.2.4 Palmer Hydrological Drought Severity Index (PHDI) and Palmer Moisture Anomaly Index (Z-Index)

The PDSI is a meteorological drought index but Palmer’s methodology involves the use of data referring to hydrological drought conditions (precipitation, evapotranspiration, and soil moisture), when the actual water supply is less than the minimum necessary water supply in the area under consideration. For each month, the computing of three intermediate indices X1, X2, X3 and a probability factor was envisaged by Palmer, who expressed the onset and the termination of drought in terms of the probability that the dry spell has started or ended.

All three intermediate indices are calculated using the following empirical expression:

Figure 4.2

$$X_j = 0.897 X_{j-1} + \frac{Z_j}{3}$$

Where Z j represents the value of the moisture anomaly index or Z-index for the month j. If the probability factor lies between 0 and 1, then PDSI takes the value of X1, if the probability factor lies between 0 and -1, then PDSI takes the value of X2 and if the probability factor is greater than 1 or smaller than -1, then PDSI takes the value of X3. The X3 term responds much slower than PDSI to soil moisture changes and is an index for the long term hydrological moisture conditions known as Palmer Hydrological Drought Index (PHDI). Z-Index provides an indication of the persistence of the drought phenomenon, whereas PDSI denotes the drought severity. Palmer Moisture Anomaly Index (Z-index) can track

agricultural characteristics of drought, as it responds quickly to changes in soil moisture values, better than the more commonly used Crop Moisture Index., described below.

4.2.5 *Surface Water Supply Index (SWSI)*

The Surface Water Supply Index (SWSI) was developed by Shafer and Dezman (1982) to complement the Palmer Index. It is designed for large topographic variations across a region and it accounts for snow accumulation and subsequent runoff. The procedure to determine the SWSI for a particular basin is as follows: monthly data are collected and summed for all the precipitation stations, reservoirs, and snowpack/stream flow measuring stations over the basin. Each summed component is normalized using a long-term mean. Each component is weighted according to its typical contribution to the surface water within that basin.

Like the Palmer Index, the SWSI is centred on zero and has a range between -4.2 and +4.2. The SWSI suffers the same limitations as the PSDI.

4.2.6 *Standardized Precipitation Index (SPI)*

The SPI was developed by McKee et al (1993). It was designed to quantify the precipitation deficit for multiple time scales. These time scales reflect the impact of a drought on the availability of the different water resources. Soil moisture conditions respond to precipitation anomalies on a relatively short scale. Groundwater, stream flow, and reservoir storage reflect the longer-term precipitation anomalies. For these reasons, McKee et al. (1993) originally calculated the SPI for 3, 6, 12, 24, and 48 month time scales. The calculation of the index only needs precipitation record. It is computed by considering the precipitation anomaly with respect to the mean value for a given time scale, divided by its standard deviation. The precipitation is not a normal distribution, at least for time-scales less than one year. Therefore, the variable is adjusted so that the SPI is a Gaussian distribution with zero mean and unit variance. A so adjusted index allows to compare values related to different regions. Moreover, because the SPI is normalized, wet and dry climates can be monitored in the same way. The index calculation is based on the following expressions:

Figure 4.3

$$SPI = + \left(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3} \right), t = \sqrt{\ln \left(\frac{1}{H(P)^2} \right)} \quad \text{per } 0 < H(P) < 0.5$$

$$SPI = - \left(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3} \right), t = \sqrt{\ln \left(\frac{1}{(1 - H(P))^2} \right)} \quad \text{per } 0.5 < H(P) < 1$$

Where P is the cumulated precipitation for the given time-scale, H(P) is the cumulative probability of the observed precipitation and c0, c1, c2, d1, d2, d3 are mathematical constants. The classification shown in the following table is used to define drought intensities resulting from the SPI computation:

Table 4.3 SPI computation

SPI values	Class
>2	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
<-2	Extremely dry

4.2.7 Rainfall Anomaly Index (RAI)

The RAI was developed by Van Rooy (1965). It is a meteorological index based on precipitation and classifies precipitation anomalies in 9 categories, ranging from extremely wet to extremely dry. The form of the index is:

Figure 4.4

$$RAI = \pm 3 \frac{P - \bar{P}}{\bar{E} - \bar{P}}$$

Where the measured precipitation minus the average precipitation is divided by the average of the difference between the average of 10 extrema and the average precipitation. The prefix is positive for positive anomalies and the average of extrema is the average of the 10 highest recorded precipitation values, the prefix is negative for negative anomalies and the average of extrema is the average of the 10 lowest recorded precipitation values.

4.2.8 Reconnaissance Drought Index (RDI)

The RDI (Tsakiris et al., 2006) is based on both precipitation and potential evapotranspiration. It calculates the aggregated deficit between precipitation and the evaporative demand of the atmosphere. The mean initial index represents the normal climatic conditions of the area and is equal to the Aridity Index proposed by the FAO. RDI is a useful index for the reconnaissance assessment of drought severity for general use giving comparable results within a large geographical area, such as the Mediterranean region.

4.2.9 Run Analysis

The Run Analysis is a method to identify drought periods and evaluate the statistical properties of drought. According to this method a drought period coincides with a negative run, defined as a consecutive number of intervals where a selected hydrological variable remains below a chosen truncation level or threshold (Yevjevich, 1967), that should be chosen in such a way to be considered representative of the water demand level (Yevjevich et al., 1983, Rossi et al., 1992). The run method permits the deriving of the probabilistic features of drought characteristics (such as duration, cumulative deficit) analytically or by data

generation, once the stochastic properties of the considered variable are known. Recently the run method has been applied to assess the return period of droughts (Cancelliere et al.,2004).

4.2.10 Crop Moisture Index (CMI)

The CMI, developed by Palmer (1968), reflects moisture supply in the short term across major crop-producing regions and is not intended to assess long-term droughts. The CMI is the sum of an evapotranspiration deficit and soil water recharge. These terms are computed on a weekly basis using PDSI parameters, which consider the mean temperature, total precipitation and soil moisture conditions from the previous week.

4.2.11 Soil Moisture Anomaly Index (SMAI)

The SMAI, developed by Bergman et al. (1988), is used to characterize droughts on a global basis. A running assessment of percent soil saturation moisture is performed calculating soil moisture with Thornthwaite method relative to a two-layer soil model to track the movement of water.

4.2.12 Normalized Difference Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) values derive from the elaboration of satellite images and make use of the different responses of the vegetation cover to the spectral bands of the visible (red) and the near infrared, and provides a numerical non-dimensional value that lies between -1 and $+1$. Such value is in relation with the state of health of the vegetation, both as biomass and leaf area (Leaf Area Index), and the biochemical processes correlated to it (photosynthesis). In the applications, NDVI values mainly range between -0.2 and $+0.6$ on land, with water bodies, snow cover and clouds showing values close to zero or slightly negative.

The (NDVI) is widespread in the monitoring and forecasting of crop production, and is utilized by insurance companies in agriculture.

5 SCOPE OF WS AND D AND DELINEATION

5.1 WATER SCARCITY OVERVIEW IN THE MEDITERRANEAN

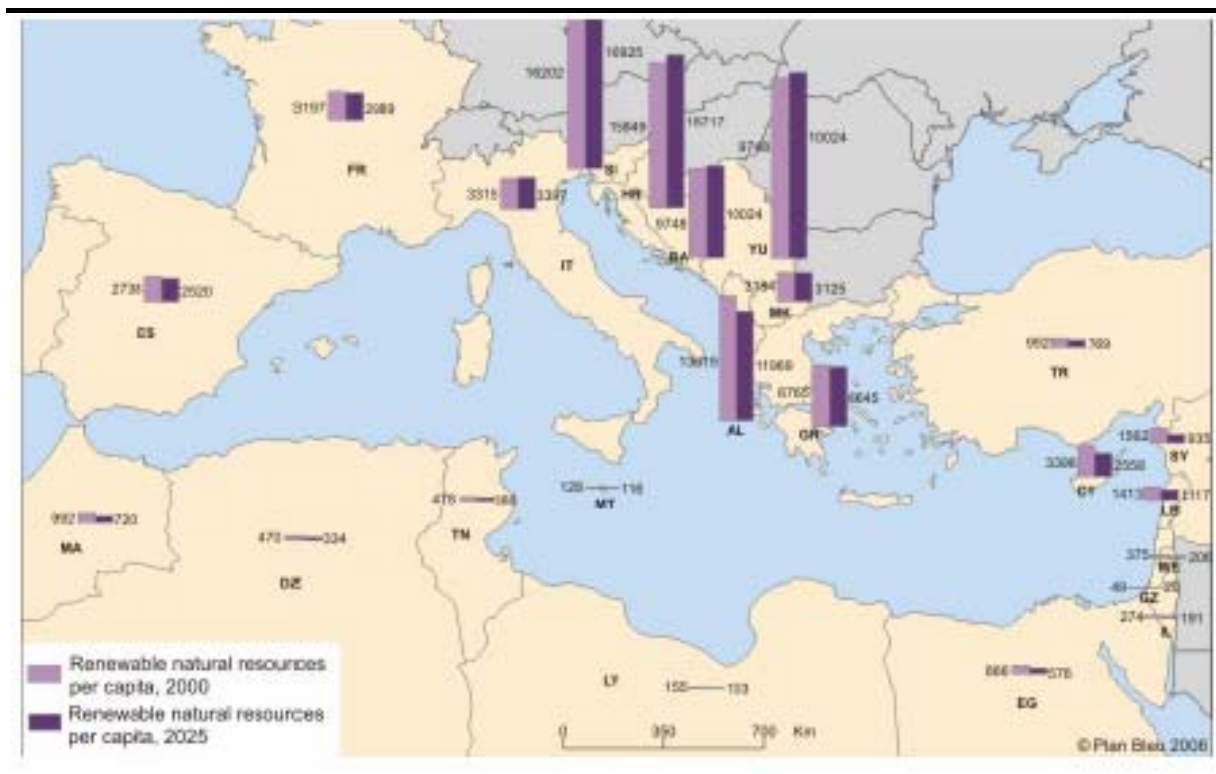
During the second half of the 20th century, water demand, i.e. the amount of resource abstraction (95% of total withdrawal, including losses during transport and use) plus unconventional production practices (desalination, wastewater reuse...), has increased twofold. By 2025, the significant increase in pressures on water resources, gauged by the exploitation index of renewable natural water resources, highlights strong and sometimes alarming contrasts as regards the "future of water". Today, in some countries, water withdrawals are already or even exceed the limit threshold of renewable resources. Current and future situations are even more alarming when the index is calculated at the scale of the Mediterranean catchments areas, rather than at the country scale. Pressures can also be qualitative. Many aquifers, show excessively high contents of pesticides or nitrates. Twenty-seven million Mediterranean's are deprived of access to improved sanitation systems, mainly in the South and in the Middle East. And everywhere, many rivers are subjected to chronic pollution due to non-treated domestic and industrial discharges.

The most severe water scarcity in the world is in the Middle East, and critical water shortages in the Eastern Mediterranean region as a whole affect the region's social and economic potential, increase land vulnerability to salinisation and desertification and raise the risk of political conflict around this limited resource (Brooks & Mehmet 2000, Jagerskog 2003, Tropp & Jagerskog 2006). According to Allan (2002), the region "ran out of water in the 70s" and is currently surviving on virtual water and in cases on over-exploiting its own renewable water resources. Per capita water consumption in the study region is variable and generally low, reflecting equity issues which relate to access and rights to water, as well as availability (Phillips 2004). In the Gaza Strip and West Bank, Palestinian water consumption is well below World Health Organization standards of 100 litres per day (UNEP 2003). The World Water Development Report (2003) classifies Jordan as facing an extreme situation of water scarcity. Jordan is overexploiting its water resources by between 10 and 20 percent at the expense of natural ecological systems (Tropp & Jagerskog 2006). Similarly in Israel the coastal plain aquifer has been overexploited since the 1960s, although this has stopped in recent years (Benoit & Comeau 2005, Ministry of National Infrastructure 2006). Consequentially, water levels are dropping and salinization and salt water intrusion are taking place. Lebanon, with an abundance of water resources relative to the region, is predicted to face water shortages and be unable to meet its local demands by 2025, purely as a result of demand increases, not taking climate change into account (Bou-Zeid & El-Fadel 2002). Combined with water scarcity, poor water efficiency exacerbates water shortages. Most countries in the region already find it increasingly difficult to cope with increasing water demands from their growing and urbanizing populations and those of adjacent countries with which they share water resources (Bou-Zeid & El-Fadel 2002, Bucknall 2007).

5.2 CURRENT SITUATIONS OF WATER SCARCITY AND OUTLOOK

In the Mediterranean, the situations or the risks of water shortage are generally ascribable to the high and increasing demand despite limited renewable water resources. In some places it is exacerbated by poor water quality.

Figure 5.1 shows renewable water resources per country for the Mediterranean region in 2000 and contrast them with figures projected for the year 2025. Figure 5.1 Observed and Predicted Renewable Natural Resources Per Capita Per Year in Mediterranean Countries 2000 and 2025 (Blue Plan 2005)



5.3 THE WATER EXPLOITATION INDEX AT NATIONAL LEVEL

Water scarcity is defined as a situation where insufficient water resources are available to satisfy long-term average requirements. In other words it is the shortage of water resources to serve water demands. It refers to long-term water imbalances, combining low water availability with a level of water demand exceeding the natural recharge. Few indicators are today available to correctly illustrate the extent of water scarcity at river basin or national level: the index of demand satisfaction, the index of demand reliability, the index of resources use, the index of reliability increase and the water exploitation index. These indices may be used to diagnose the causes of potential water shortage and to anticipate possible solutions. However, the sole indicator used so far at European level is the Water Exploitation Index.

Hence, water-scarcity can be defined by the water exploitation index (WEI). The Water Exploitation Index (WEI) in a country is the mean annual total demand for freshwater divided by the long-term average freshwater resources. It illustrates to which extent the total water demand puts pressure on the water resource. It points out the countries that have high water demand compared to their resources.

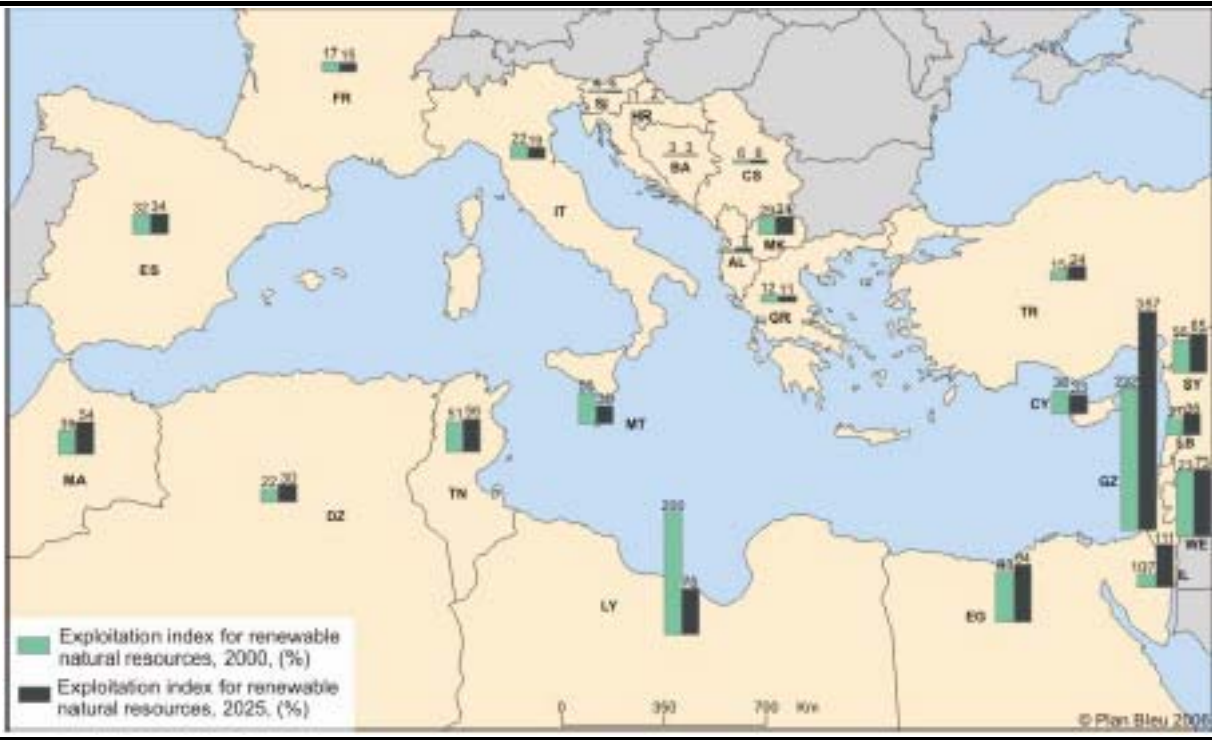
The warning threshold for WEI which distinguishes a non-stressed from a stressed country is around 20 %. Severe water stress can occur where the WEI exceeds 40 %, indicating unsustainable water use.

By using this index, water saving efforts can be focussed in areas of water stress and take account of the success of existing measures and resource developments. This will allow us to make sure the action we take is the most appropriate for the areas concerned. The advantage of this method is that it uses consistent information that is collected periodically by the statistical institutes across the Mediterranean along with long-term forecasts of water use.

Few indicators are today available to correctly illustrate the extent of water scarcity at river basin or national level. This indicator is today calculated at national level in European countries, on basis of Eurostat information provided by Member States. It indicates that at least all Mediterranean EU Member States (Cyprus, Malta, Italy, Spain, Portugal, and Greece) are impacted by water scarcity, with a total population concerned of 130 million inhabitants (27% of the EU population). However, this indicator is a national value and does not correctly reflect water scarcity situations encountered at river basin level.

Blue Plan has predicted the Exploitation Index per country in 2025 compared to 2000 figures, as per Figure 5.2 below.

Figure 5.2 *Observed and Predicted Exploitation Index for Renewable Natural Resources Per Country, 2000-2025 (Blue Plan 2005)*



5.4 FURTHER AREAS OF RESEARCH

The questionnaires sent to Mediterranean Partner Countries to assess the scope and impact of water scarcity and drought in the Mediterranean Partner Countries had 2 sections:

- Section A, an in depth assessment of the current situation with regards to Water Scarcity and Drought, and consists of data collection of information at river basin or local level. This questionnaire is similar to the one used at the EU level in 2006.

- Section B, an inventory of measures taken by Mediterranean countries to manage water

	Reduction of irrigation consumption:		Water recycling in the industry			
	New irrigation techniques	new crops demanding less water	Freeze the increase in the irrigation surfaces	Conversion of irrigated areas to dry farming	Restriction on annual crops	
Turkey	Yes	Yes				
Morocco	Yes		Yes	Yes	Yes	Yes
Tunisia	Yes	Yes	Yes	Yes	Yes	Yes
Palestine	Yes	Yes	No	No	No	No
Jordan	Yes	Yes	Yes	Yes	Yes	Yes
Bosnia and Herzegovina	No	No	No	No	No	Yes

scarcity and droughts in proactive and reactive ways.

Responses were received from: Albania, Israel, Morocco, Tunisia, Turkey, Palestine, Jordan & Bosnia and Herzegovina. However, these responses were mainly focused on section B. They highlight the measures taken by these countries to struggle against drought and water scarcity situations by combining:

- An approach privileging supply side management (*Table 5.1*), and preaching an increase in the water resources to serve and satisfy in the best way the demand. It can be noticed that all the countries are using marginal resources (groundwater) and that most of them are making water transfers and are looking for new storage facilities.
- An approach focusing on the demand side (*Table 5.2*) in order to reduce water consumption. The first measures taken are saving campaigns and various actions to reduce irrigation water consumption.

•
Table 5.3).

Table 5.1 *Preparation to Drought and Water Scarcity Situations: Supply Side Management Measures*

Countries/ Actions	New storage facilities	Use of marginal resources (groundwater)	Aquifer recharge	Improved efficiency of water distribution networks	Relaxing environmental constraints	Water transfers		Waste water reuse	
						Desalination	Other	reuse	Other
Turkey	Yes	Yes				Yes			
Morocco	Yes	Yes	Yes	Yes		Yes	Yes	Yes	
Tunisia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Palestine	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	
Jordan	Yes	Yes	Yes		Yes	Yes	Yes	Yes	
Bosnia and Herzegovina	No	Yes	No	Yes	No	No	No	No	No

Table 5.2 Demand Side Management Measures

	Water metering	Mandatory rationing	Restriction on municipal use	Water markets (tariffs) and full cost recovery	Water saving campaigns for voluntary actions	Awareness campaign to minimize drought damages	Increase in the regulation capacity for irrigation purposes	Increase in the regulation capacity for urban supply
Turkey			Yes		Yes	Yes		
Morocco	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tunisia	Yes	Yes	No	No	Yes	Yes	Yes	No
Palestine	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jordan	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Reduction of irrigation consumption:				Water recycling in the industry				
	New irrigation techniques			new crops demanding less water	Freeze the increase in the irrigation surfaces	Conversion of irrigated areas to dry farming	Restriction on annual crops	
Turkey		Yes		Yes				
Morocco		Yes			Yes	Yes	Yes	Yes
Tunisia		Yes		Yes	Yes	Yes	Yes	Yes
Palestine		Yes		Yes	No	No	No	No
Jordan		Yes		Yes	Yes	Yes	Yes	Yes
Bosnia and Herzegovina		No		No	No	No	No	Yes

Table 5.3 Reduction of Irrigation Consumption

There therefore needs to be effort in the future to collect the type of data necessary to understand a little bit more the panorama and scenarios of water scarcity and drought in the Mediterranean. This effort could be carried out with the water monitoring working group of the Med Joint Process.

6 IMPACTS OF WS AND D

6.1 INTRODUCTION

All the definitions are related to the impacts of a dry spell on the human activities: the impacts of drought may be environmental, economic and social

The environmental impact is the result of damages to plant and animal species, wildlife habitat, air and water quality; forest and fires, degradation of landscape quality; loss of biodiversity, and soil erosion. Some of the effects are only short-term and normal conditions are quickly re-established. Other environmental effects linger for some time or may even become permanent. For example, the degradation of landscape quality, including increased soil erosion, may lead to a permanent loss of biological productivity of the area.

The economical impact occurs in agriculture and related sectors, including forestry and fisheries, which depend on the surface and groundwater supplies. In addition to obvious losses in yields in crop and livestock production, drought is associated with the increase in insect infestations, plant disease, and wind erosion.

The impact of scarcity and drought is important from environmental, social and economic points of view. If it is quite easy to obtain figures on impacts for drought events because they are limited in time and impacting specific sectors, the impacts and the costs associated with scarcity are largely more difficult to obtain:

6.2 CASE STUDY: THE IMPACTS OF WATER SCARCITY AND DROUGHT IN FRANCE

The droughts of 2003 and 2005 resulted in environmental, social and economic impacts in France as described below.

6.2.1 Environmental Impacts

It is difficult to estimate fish's mortality during the summer of 2005, but approximately 400km of river dried up completely, with an associated important impact on fish mortality. In all the French territory, 67 departments did put into place a network of observation of ecosystems. The most important crisis for ecosystems was located in the west of France.

- High fish mortality was registered within the two following districts: Loire-Bretagne, Rhône-Méditerranée. But the mortality of fishes was less important than in 2003, because the temperatures of water were not so high. The fish species the most in danger were cyprinids and salmonids.
- In a lot of rivers, ecosystems suffered from alga development and increased phenomena of eutrophication inducing the asphyxia of certain rivers.
- The low levels of flows combined with higher temperatures disturbed the migration of salmonids in some departments and rivers such as: Manche, Morbihan, Finistère, and Garonne river basin.

6.2.2 Social Impacts

In 2005 and contrary to 2003, there was no major crisis for the distribution of drinking water, thanks to the early warning system, consumer water savings, the restrictions on other uses and the not too high temperatures. Only a few small cities were affected by temporary shortage (“stop”) of the drinking water services as a result of lack of funds to secure drinking water supply. Approximately 14 cities and around 30 000 inhabitants were provided with water coming from lorries carrying water tanks. But the situation was not far from being critical for 2 entire regions in Poitou Charentes and Pays de la Loire. For these regions the alert procedures were in place till mid September 2005. The problem of drinking water was estimated to have touched about 1 million inhabitants within these two regions. From a qualitative point of view, no major alterations were noticed except small municipalities.

6.2.3 Economic Impacts

Agriculture

Agricultural impacts varied from one region to another and according to the type of crop.

- For cereals, the yields and quality of 2005 crops were not too far from the average.
- For the « autumn crops » such as corn and soya, an average decrease of about 10% of the yield was observed. For the corn, in 2005, the decrease was estimated at about 20% compared to the yield of 2004.
- In 2005, 17 departments received « calamity fund » subsidies from the Ministry of agriculture. In 2003, 83 departments received such subsidies.

The figures in the table below correspond to the subsidies given by the ministry of agriculture to the farmers, in order to compensate their losses (crops, animals death, etc) due to drought.

Table 6.1 Subsidies Paid to Compensate for Agricultural Losses Resulting from Droughts

Year	Amount paid at national level Million €
2003	590
2004	24
2005	250

Energy Production

Energy production was also disrupted during the droughts:

- In 2003, the high temperatures led to exceptional measures for cooling water, and nuclear power plants were no longer allowed to abstract and discharge water used for their refreshment. Many nuclear power plants stopped producing energy during the summer of 2003. In 2005, only the Tricastin nuclear power plant was stopped for 3 days.
- With regards to hydropower, some constraints were established during the summer (providing water from the dams for ecological purposes) in order to maintain a certain flow, preserving ecological uses in some rivers. The water provided from the dams in

summer was missing in winter when electricity producers had to face peaks of consumption.

The boxes below show the direct and indirect impacts of the droughts on energy production.

Box 6.1 Direct Drought Impacts on Energy Production

Direct drought impacts on hydroelectricity

Drought periods are characterized by a lack of water (rain, snow, underground, etc.) which induces low levels in lakes and low regimes in rivers. As hydroelectricity production is related to the amount of water stored in the upper reservoirs and which can flow through turbines, its production level varies with climate and can be low in case of droughts. Run-off river hydroelectricity production may be replaced by nuclear or fossil-fired plants while peak production has to be replaced by production means which can be available at short term (gas turbine, etc).

Direct impacts on thermal production

Rivers with lower regimes have a lower cooling power: as a consequence it may result in some cases into a reduction of electricity production potential. One has to note that low regime induces a higher sensitivity of rivers to heating which in turn induces a lower cooling capacity.

Direct impacts on uses relying on hydraulic reservoirs

As by definition water is lacking for every use during drought periods and also for other uses than energy, its management has to take that point into account. Irrigation for example may need more water than usual and lead to a non-respect of other criteria like recreational level in lakes (which are too low to ensure all what is expected from them).

Moreover the agreements on water management between energy production and other uses include a cost for water which is generally based on the amount of water used and on the corresponding energy loss. Therefore higher demands in water (for irrigation,...) result in higher costs.

Box 6.2 Indirect Impacts on Energy Production

Indirect drought impacts on hydroelectricity production

To satisfy other uses water may be taken from reservoirs at a time which is not the optimum one considered from the energy point of view (for example off-peak production instead of peak). As a consequence peak production has to be ensured by another production mean. If the lack of water is widely spread over the country, hydroelectricity has to be replaced by a water-independent peak production mean like gas turbine (leading to CO₂ emissions).

Indirect impact on electricity market

As electricity production is penalized by droughts, the equilibrium between production and consumption may be harder to reach. When that happens, electricity cost rises on the market.

Indirect impact electricity distribution

A second ultimate consequence of electricity production penalization could be power cuts in very severe conditions. For example in 2003, there was simultaneously a drought and very high temperatures (see paragraph examples below): the situation was very tense on the French network. However the power cuts which happened were due to underground temperature and not to droughts.

The box below details examples of the 2003 heat wave on the energy utility EDF.

Box 6.3 *Example of Impacts of 2003 Heat Wave on EDF*

The 2003 summer heat wave (first half of August): example of impacts on the national French utility EDF

The 2003 summer combined both a lack of water (few rain periods, high temperature since May) and a period of very high temperature (hottest summer in France since 150 years). It is the combination of both factors which lead to a crisis in France.

Concerning the electricity sector, the following difficulties were encountered in France during August 2003:

- Low level of water in the reservoirs (lakes,...) leading to a loss for hydroelectricity power of about 1000 MW for current flow and 600 MW for lake production,
- Loss of thermal electricity potential production power up to 16 000 MW due to the loss of a part of the cooling power of rivers (high water temperature and low river flows).

Nota 1: This loss of production capacity occurred while the energy needs were 5 to 10 % higher than usually at that period of the year due to high temperature (supplementary cooling needs).

Nota 2: The increase of temperature lead also to other problems (e.g. power cuts due to temperature around underground wires) out of the present scope.

As a consequence, electricity price rose up to 1000 €/MWh on the market on August, 10th.

EDF company reported for itself a cost of about 300 M€ (exceptional material and human resources' costs, electricity purchase on the market).

6.3 *TERRITORIES*

6.3.1 *Background*

During the years 1998-2000, Israel, Jordan and the Palestinian Territories suffered from a severe drought, the worst drought on record. Rainfall was 30% of average rainfall, with the impact most severe in 1999. This led to water quality deterioration, a drop in the groundwater levels and a decline in spring discharge. Water shortage became very acute and available supply fell short of meeting demands. This occurred against a backdrop of continuing water scarcity, with a water exploitation index of over 200% in the Palestinian Territories and over 100% in Israel and Jordan in 1998/99; the rainfall record in the winter was the minimum in the past 100 yearlong history of rainfall records. According to future scenarios of future population growth and development needs, which projects a doubling of the population in the next couple of decades, this water shortage is expected to intensify. The average population growth rate is estimated at 4%, which, means that the population is expected to double in the coming two decades. (Rabi et.al, 2003a).

6.3.2 *Economic Impacts*

The economic impact of the drought varied between the countries and territories, in all areas water restrictions for agriculture were implemented, with economic implications. In Israel water supply to domestic agriculture was cut by 25%. In the West Bank, already in economic strife, and where up to 95% of agriculture is rain fed and agriculture provides 30% of the employment and contributes to 30% of the GDP, the agricultural sector and consequently the economy were severely hit. Long term water restrictions and shortages have also acted as a constraint to the development of a strong and diversified economy.

6.3.3 *Social Impacts*

As mentioned, employment and earnings from agriculture were seriously impacted as a result of the drought, with the most severe impacts in the West Bank and Gaza.

Food security in the Palestinian Territories suffered as a result. Furthermore, in Jordan and the Palestinian Territories, water rationing became more severe than during regular times, during the summer of 1998 and the winter of 1999 the residents of Amman, Jordan's capital, received municipally supplies water only twice a week.

These shortages have their ramifications on human health, with a lack of access to safe potable water and sanitation leading to diarrhoeal illness and even mortality, which was already a problem in Jordan, and exacerbated by the drought.

6.3.4 Political Implications

The water shortages caused by the drought lead to disputes over water and tension within and between communities.

Further, in 1999, Israel announced that it would be unable to meet its allocation transfers to Jordan from the Sea of Galilee as it had committed to doing in the 1994 Israel-Jordan Peace Treaty, and this threatened the stability of peace between the countries; it caused personal outrage on the part of King Hussein of Jordan, and protests on the streets of Amman, until Israel eventually supplied the water.

The drought and consequent water shortages also exacerbated Palestinian-Israeli tension; agreement over water rights is one of the remaining stumbling blocks in the Israeli-Palestinian dispute and anti Israel sentiments were heightened among Palestinian communities, particularly in the West Bank where Palestinian exploitation of water sources is restricted by Israel. The economic crisis, exacerbated by the drought, worked to further impoverish and alienate Palestinians, increasing the popular appeal of militant factions and making dialogue more difficult.

6.3.5 Water Scarcity and Drought: a Source of Both Conflict and Cooperation in the Middle East

Water, a transboundary resource in the study region, has the potential for being an issue of serious dispute, and it is often stressed that water has been, and continues to be an integral part of Middle East conflicts, even if it is not their sole cause (Gleick 1993, Wolf 1995, Beaumont 2000, Medzini & Wolf 2004).

Agreements over water rights, not having been settled in the Interim Agreement, remain part of the dispute between the Israeli Government and the Palestinian Authority. A limited agreement was reached under the Oslo Accords allowing interim quantities of water to Palestinians, however it is far from satisfying needs (Wolf 2000a). Furthermore, tensions have escalated a number of times between Lebanon, Syria, and Israel over water (Wolf 2000a, Medzini & Wolf 2004). In the Jordan River Basin, violence broke out in the mid-1960s over an "all-Arab" plan to divert the river's headwaters, a pre-emptive move to thwart Israel's intention to extract water for irrigation from the Sea of Galilee (Postel & Wolf 2001). In a similar unfolding of events, hostilities broke out between Egypt and Sudan in the late 1950s over Egypt's planned construction of the Aswan High Dam (Postel & Wolf 2001). As recently as 2002, Lebanese plans to divert Wazzani River waters which flow into Israel was branded by Israel a pretext for war (Blanford 2002). In most countries in the study area, water represents a significant part of continuing territorial disputes between the countries (Wolf 2000a, Postel & Wolf 2001, Medzini & Wolf 2004).

Nevertheless, the transboundary nature of water resources does provide the opportunity for cooperative efforts between countries and authorities, and can indeed catalyze those (Daibes 2004, Tropp & Jagerskog 2006). Moreover, it seems not to be strategically rational, hydrographically effective, nor economically feasible to go to war over water, and shared interests along a waterway have the potential to outweigh water's conflict-inducing characteristics (Wolf 2000b). Cooperation over water has already been a significant element of peace agreement efforts. Even during decades of tension in the Jordan basin, starting in the 1970s and occurring every two to three weeks, Jordanian and Israeli water officials held secret negotiations to discuss water quotas for each side. These unofficial meetings were held at the confluence of the Jordan and Yarmouk Rivers, and branded the 'Picnic Table Talks' (Lowi 1993, Berland 2000). Eventually Jordan and Israel signed a peace treaty including a water sharing provision; reputed "one of the most creative water treaties on record" the treaty has Jordan storing winter runoff in the only major surface reservoir in the region, the Sea of Galilee, even though that lake happens to be in Israel and includes Israel leasing from Jordan in 50-year increments wells and agricultural land on which it has come to rely (Israel Jordan Peace Treaty 1994, Postel & Wolf 2001, Medzini & Wolf 2004). The water relationship between the Israeli Government and the Palestinian Authority, although disputed and awaiting comprehensive settlement as part of a permanent peace agreement, includes a cooperative body, the Joint Water Committee (Interim Agreement, Annex III Art. 40, schedule 8). The Joint Water Committee is a permanent, consensus based organization, headed by an equal number of Palestinian and Israeli water authority representatives. The establishment and maintenance of the Joint Water Committee represent significant achievements of regional cooperation and hydropolitics, particularly in light of its continued operation throughout the years of the intifada, where most other formal cooperation between Israel and the Palestinian Authority had ceased (Selby 2006). However, following the establishment of the Hamas government in the Palestinian Authority, the Joint Water Committee too ceased to meet (Nagar, personal communications, 2007).

Water availability, access and rights are highly charged issues in the Middle East. A fall in water availability will most certainly be an exacerbating factor in political tensions, with the potential to increase political volatility in the area.

7.1 DEMAND SIDE MANAGEMENT

7.1.1 Water Demand Management: a Major Policy Challenge

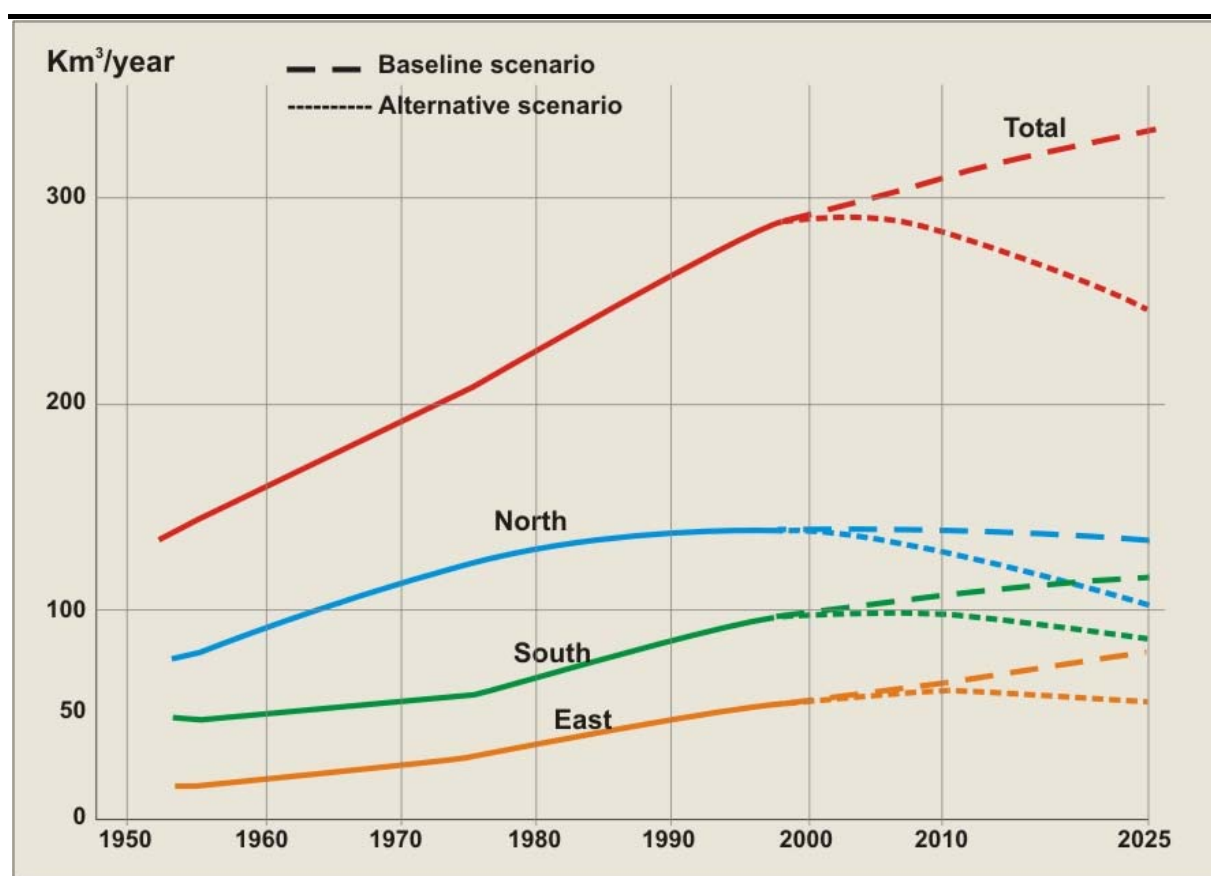
The Mediterranean region groups together 60 % of the world water-poor population (with less than 1000 m³ water/inhabitant/year), the resources are already overexploited in many places and the growing water demand is going to remain very high with the rise in the demographic rate in the South and the East, the development of tourism, industry and irrigated land. Climate change, with its already significant impact and the expected impact over the medium term on water resources and the irregularity of precipitations, represent a supplementary constraint that adds to the validity of this observation.

Beyond the improvements to resource management, there is a huge amount of possible progress in water demand ⁽¹⁾ management. Demand management includes all actions and organisational systems intended to expand technological, social, economic, institutional and environmental efficiencies in the various uses of water. This means making water consumption doubly efficient by increasing the effectiveness with which water needs are met and water is allocated to various uses. Different technical, economic and social approaches were thus presented in the first Mediterranean Water Scarcity and Drought Report (September 2007).

While the Mediterranean countries' demand should increase by about 50 km³ by 2025 to reach about 330 km³, i.e. a level that is not easily compatible with the renewable resources, transport losses, leaks, misuse could be greater than 120 km³ per year. Thus, there is considerable room for progress since, according to Plan Bleu, improved water demand management (WDM) would make it possible to save 25% of water demand, i.e. approximately 85 km³/year in 2025 (*Figure 7.1*).

(1) The water demand is the addition of water withdrawals, the imported water and unconventional production (desalination, reuse, etc).

Figure 7.1 Total Water Demand, Baseline and Alternative Scenarios (Entire Countries)



Source: Plan Bleu (2005)

The main quantitative potential concerns irrigation farming with a great diversity of situations. In the Northern countries there are the major network losses while in the South and East irrigation practices in a parcellary manner are also in question. The possible savings in the farming sector are five time higher in volume than in the domestic sector. Industry can contribute effectively through recycling (which the European Water Framework Directive should promote). The potable water sector would free only a small fraction of the total, yet it is easier to mobilise in the mid-term in the South and the North and easier to justify economically given the present price of water.

Thus for certain countries, a strong commitment on this way could avoid predictable water demand crises and even cancel certain investments that are heavy in costs and impact while making it possible to meet needs and go along with demographic transition.

The benefits would also be social by contributing to a rise of farming income, job creation (for the maintenance and the current management of infrastructures) and access to water for the poor (by reducing the supply costs).

The benefits would also be environmental by reducing or stabilising withdrawals from ecosystems and resources and by leading to the decrease in necessary supplying infrastructures number. This objective is, however, seldom the first in the WDM processes, and quite often the water savings made are re-used at once, so much so that the total demand is not reduced, quite the contrary. Careful management does not necessarily mean allocating more water to nature, unless this goal is clearly sought.

Benefits could also be seen in energy savings. Considering that it takes nearly 1 kWh to produce, treat and distribute 1 cu. m of water, potable water savings would on their own, by 2025, represent nearly 8 billion kWh.

These global estimates, based on concrete experiences carried out in certain countries (*Box 7.1*) show that current trends can be inverted.

Box 7.1 Water Saving Policies in Tunisia and Morocco

Tunisia has implemented a national water-saving strategy for irrigation, which includes the creation of user associations, pricing aimed at progressive cost recovery, targeted financial instruments for water-efficient farming equipment, and support to farmer revenues. Since 1996, this policy has stabilized irrigation water demand despite agricultural development, and the needs of both the tourism sector (a source of foreign currency) and cities (a source of social stability) have been assured.

In Morocco, increasing water demand in Rabat-Casablanca has been slowed down noticeably during the past fifteen years despite high urban growth. Improved water management (reduction of leaks, progressive pricing, systematic metering, major public awareness campaign) has deferred or perhaps completely avoided some costly investments (dams, transfer canals) initially planned in the 1980 Master Plan, while satisfying the needs. These investments, which are difficult to finance without extra debts, may prove to be unnecessary in the long term.

Sources: Hamdane (Fiuggi workshop, 2002), DGH Rabat (2002)

The WDM issues vary according to the country. In the Northern-rim countries, rather better endowed in water and with decreasing demand, it is the resource's qualitative aspects that prevail, not to mention the interest in maintaining, even restoring, ecosystems and simultaneously lowering the water supply costs. For the Southern & Eastern Mediterranean countries, with the squeeze coming from finite water resources and strongly increasing demand, it is the "quantitative" issue that prevails.

Taking into account the possible gains in efficiency, the Mediterranean Commission on Sustainable Development (MCSD) had already concluded in 1997 that WDM should be considered as « the way that will permit the most progress out of the Mediterranean water policies ».

The Fiuggi workshop on “Advances of Water Demand Management in the Mediterranean” (2002) demonstrated notably that the most significant progress obtained was a result of a combination of tools (institutional, legislative, economic, awareness-raising, technical tools) implemented progressively and continuously.

The Contracting Parties to the Barcelona Convention adopted in November 2005 the « Mediterranean Strategy for Sustainable Development » (MSSD). The first priority field of the Strategy is improving integrated water resources and demand management with, for principal objectives:

- To stabilize water demand through the reduction of water losses and the wasteful use of water and increase the added value per cubic metre of water used,
- To promote the integrated management of watersheds, including surface and groundwater; and eco-systems, and foster depollution objectives,
- To achieve the Millennium Development Goals concerning access to safe drinking water and sanitation,

- To promote participation, partnership, active cooperation and solidarity for the sustainable management of water, at local and national level.

Currently, the stake is to accelerate the integration of WDM in the water, environment and development policies (notably in the urban and agricultural policies) and to help, if need be, the countries to design or improve their National Strategies for Sustainable Development and « efficiency plans », the principle of which was decided on at the Johannesburg Summit. Better integration of the objectives of sustainability in the cooperation and development assistance policies is also both desired and essential.

7.1.2 Monitoring Progress and Promotion of Water Demand Management Policies

Too few Mediterranean Countries Officially Commit Themselves

Despite their immense potential, these issues are not yet well seen in their full light in the Mediterranean countries. Even if WDM seems to be a winning plan from many sustainable development points of view, it still runs up against much resistance which must be analysed in order to be overcome.

Many private and local initiatives combine for better WDM, but they are generally insufficient for mobilising the vast savings potential that quite often require a very voluntarism public contribution. More and more Mediterranean countries, often among the most water-poor, such as Israel, Malta, Cyprus, Spain, Tunisia and Morocco, commit to it. They provide themselves with official national WDM strategies, announcing quantified goals combining players' economic, technical and institutional tools with the mobilisation of players with the refurbishing of networks, the promotion of economical irrigation techniques, progressive pricing, bolstering water policies and raising the awareness of users. A certain devolution process in water management (at local level such as the catchment areas), the growing participation by users or the redefining of the State's role are changes observed that are favourable to the emergence of such strategies. The Tunisian example is probably one of the most advanced in this field with the implementation of institutions officially named for WDM and tangible results on demand.

Nevertheless, a few cases notwithstanding, too few Mediterranean countries have formally committed themselves to the WDM path; efforts have mostly remained concentrated on mobilising new resources. Although the WDM is an increasingly shared concern, it only rarely is included in official goals of water planning management and even more rarely in terms of targeted and quantified objectives. Few and far between are the Mediterranean countries endowed with specific institutions for managing demand or who define an environmental demand. In this regard, the Johannesburg Framework Directive on water and objectives might constitute a reform engine in numerous Mediterranean countries.

Main Achievements and Gaps

The national reports on « Monitoring progress and promotion of water demand management policies » carried out by different countries ⁽¹⁾ in view of the 3rd regional workshop on Water Demand Management in the Mediterranean (Zaragoza, March 2007) made it possible to highlight the reality of the progress made since the Fiuggi workshop (2002) in matter of taking into account WDM in the water policies and certain sectoral policies (cf. examples in part 7.1.3). It has emerged that strategy documents, legislative texts or national law

(1) Bosnia & Herzegovina, Cyprus, Egypt, France, Italy, Malta, Morocco, Spain, Syria, Tunisia and Turkey.

increasingly refer to the WDM and, this, either explicitly or, still too often, in an implicit way. It should be recalled that the 1st of the 8 recommendations made at the Fiuggi forum called upon Mediterranean countries to define, adopt and implement national strategies and institutional mechanisms for WDM ⁽¹⁾.

The Mediterranean countries must, however, face new challenges. Underscoring the difficulty of meeting an increasing water demand in a context of insufficiency, rarefaction, if not overexploitation, of water resources (likely to be exacerbated under the effect of climate change), as well as of alarming deterioration of water quality, the national experts at the same time reminded of the factors having motivated, sometimes in an early manner, the implementation of WDM measures in their country ⁽²⁾ and outlined the main obstacles still hindering a concrete implementation of WDM policies and strategies. These obstacles and hindrances are of various sorts: institutional constraints (scattering of responsibilities and lack of coordination between ministries involved in the management of water resources), lack of integration of the various policies (water and sectoral policies), absence of a legal framework, lax control, inadequate water pricing, lack of public awareness of the need for water saving, lack of involvement of the users in water resources planning and management, lack of qualified staff in charge of water management, lack of financial capacity of the States, which impedes the implementation of the national plans for an integrated management of water resources and water demand (implementation remaining dependent on national budget prioritisation), etc.

Box 7.2 Main Impediments to Implementing the WDM Approach in Syria

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- Lack of coordination between the ministries involved in the management of water resources,
 - Existence of contradictory policies: the policy of assistance to the farmers towards the purchase of modern irrigation systems is, for instance, not coordinated with the pricing of irrigation water (rates according to irrigated area, not to the quantity consumed, thus not conducive to water saving),
 - Lack of staff qualification (as regards the technical and administrative aspects),

Wastage of drinking water due to a lack of awareness among the citizens - as a result of low water price - about the importance of and need to preserve this scarce resource.

Source: Abed Rabboh, Report on water demand management in Syria, Zaragoza workshop (Plan Bleu, 2007)

Several countries have availed themselves of the various tools at their disposal (technical, legislative and legal, institutional, economic, planning and concerted action, training and awareness-raising.) in order to make headway in the field of the WDM, or are wishing to further develop these tools. The relevance and efficiency of the economic tools, still insufficiently used though playing a key role in matter of aligning the policies with WDM requirements, were particularly underscored. Specific reference was made to incentive economic mechanisms encouraging agricultural water saving (decoupling of the EU agricultural support from production, agro-environmental measures and cross-compliance, rate setting and quota systems), establishment of water accounts as a strategic tool for inter-use reallocation (on national level or on catchment area level), cost-effectiveness analysis and economic analysis of the various water uses. The pricing issue, though remaining a very

(1) National governments were also invited to support the adoption of WDM by local organisations (creating the political and administrative conditions necessary to the emergence of water citizenship) and to publish and implement the MCSD's work and recommendations (organising inter-ministerial meetings and ensuring that the results are made known to the major organisations involved in the water sector)

(2) For instance: In Cyprus, early implementation of WDM strategies; in France: implementation, as early as the 60's of the principal of water management by basin and development of the notion of WDM by usage, pursuant to the Water Law of 1992.

sensitive issue in all Mediterranean countries, has emerged as one of the priorities of WDM strategies.

It is indeed necessary to manage to achieve a gradual cost recovery (the EU Water Framework Directive requires full recovery of the water costs) while seeing to social equity. In this regard, the need to address with users' associations the issue of the water price, to help the various users to install water saving systems (*Box 7.3*) rather than subsidizing the water price, to assign a price to all the water resources of the country (both surface water and groundwater) and to implement a special rate for re-used water was underscored. The need to use planning and concerted action tools, allowing the definition of objectives that are common to and appropriated by all the stakeholders, was also particularly emphasized, and several innovative and positive examples were mentioned ⁽¹⁾ (*Box 7.4*). These planning and concerted action tools need to be developed on various territorial levels (national, regional and local).

Box 7.3 Subsidies for Water Conservation: the Case of Cyprus

Well drilling for garden irrigation (€680): Subsidy for well drilling for home gardens for households connected to the water distribution networks of all municipalities and villages (subject to well permit and inspection of site after permit and before drilling).

Connection of well with lavatories (from €200 to €680 depending on the number of connections): The subsidy covers connection of wells with home lavatories, schools, offices, shops, institutes etc connected with distribution networks of all municipalities and villages for the purpose of conserving drinking water (estimated up to 28%) that is used for lavatories (subject to application, inspection and provision of technical advice by WDD).

Installation of a system for the recycling of grey water (€1.700 for each household and 40% of the cost for the installation of such a system with a maximum amount of €6.800 for the rest of the cases): The subsidy covers installation of a system for the treatment of grey water and its reuse in lavatories and garden irrigation of a household, school, playing grounds, gyms, hotels, industries etc., connected with distribution networks of all municipalities and villages. Grey water is the water that comes from bathtubs, shower, wash-basins, cloth-washing machines, water from vegetable and fruit washing. The saving of water is expected to be about 33% (subject to application, inspection and provision of technical advice by WDD).

Installation of hot water circulating pumps in households, offices, shops, etc. for immediate supply of hot water (€170) (subject to application, inspection and provision of technical advice by WDD).

Source: Water Development Department (www.moa.gov.cy/wdd), Subsidies, (2008)

Box 7.4 Examples of Planning and Participatory Tools Implemented in France

The implementing of the 1992 Water Law led to the drawing up of a guiding scheme for planning and managing water at the basin level (Schéma Directeur d'Aménagement et de Gestion des Eaux, SDAGE) defining the directions of the management and planning of the basin for a period of 10 to 15 years. In the sub-basins, the scheme for planning and managing water (Schéma d'Aménagement et de Gestion des Eaux, SAGE), supported by local bodies, is the tool for managing and protecting water uses and resources.

The River Drôme « SAGE » (initiated in 1992), led by all the water users, made it possible to implement a global framework limiting water demand for agricultural purposes by the freezing of irrigated land, to supply water from the Rhone in the downstream part, to respect an instream flow and to develop a network for measuring the stream flow in real time to keep the managers informed.

Source: Faby, Nion, Report on water demand management in France, Zaragoza workshop (Plan Bleu, 2007)

(1) Concerted management with agricultural users within collective entities, development and water management schemes allowing the design of tools to arbitrate conflicting uses on the level of a sub-catchment area (France), water saving charters in the tourist sector signed by certain hotel-owners' groups etc

For the EU Member States, it has emerged that the WFD has had a particularly decisive effect on accelerating the adoption of WDM in the water policies (via mainstreaming the principles of management on catchment area level and of involvement of the various users in the planning, development of approaches to environment protection in order to achieve the objectives set by the Directive - of which observance of a proper ecological state of the water bodies -, requirement to reach full recovery of water costs, etc). The WFD thus proves to contribute some new "know-how" which could be inspiring to EU neighbouring countries.

The Southern and Eastern Mediterranean countries have underscored, on the other hand, the need for boosting international co-operation and scaling up development aid in support of the implementation of WDM strategies and approaches.

The exchange of views between the participants of the regional workshop "Water Demand Management in the Mediterranean, progress and policies" (Zaragoza, March 2007) has, in the end, highlighted the need, for all decision-makers:

- to improve knowledge of the water resource and, for this purpose, to have reliable, comparable and regularly updated information,
- to take into account such global developments as climate change and, in particular, to update the prospective scenarios related to water resources, water demand and potential water saving by integrating the climate change factor,
- to connect the water issue with that of energy.

7.1.3 Factoring Water Demand Management into Sectoral and Water Policies

This part focuses on the main conclusions and recommendations of the Zaragoza workshop thematic groups (2007).

Factoring Water Demand Management into the Agriculture Sector

Agriculture is the main water-consuming sector and accounts for more than 60% of total water demand (all Mediterranean countries included) and for more than 80% of the Southern and Eastern countries' water demand. It is expected to remain the main water user in volume, for water resource to satisfy irrigation requirements. According to FAO, irrigated surfaces could increase by 38% in the South and by 58% in the East by 2030.

According to the Blue Plan alternative scenario (based on improved water demand management), irrigated agriculture represents the largest potential for volume savings, with nearly 65% of total water potential savings identified in the Mediterranean by 2025 (transport losses reduced by 50% down to 10%, irrigation water efficiency increased from 60% to 80%). In most arid and semi-arid countries of the Mediterranean, irrigation water efficiency is very poor below 45%. In this regard, significant challenges remain in the areas of technological, managerial and policy innovation and adaptation, human resources development, information transfer and social environmental considerations.

Box 7.5 *Increasing Irrigation Water Efficiency*

Increasing irrigation water productivity is one of the issues where most activities during the running of the RAP-WRM project concentrated on. Evidently, achieving greater water productivity to resolve the water crisis is feasible in the developing countries of the region, where water productivity is far below potential. According to the cooperative networking survey, taking the cereal grains as an example, the range in water productivity in dry biomass produced is between 0.2 and 1.5 kilogram per cubic meter (IWMI, 2000). If a country's demand for grains grows by 50%, one way to match this rise is to increase water productivity by 50% (Hamdy et al., 2000).

How to achieve such increase in the water productivity? This was intensively searched in the WASIA (Water Saving in Irrigated Agriculture) research programme. The research findings pointed out that the key principles for improving water productivity at field farm and basin level, which apply regardless of whether the crop is grown under rain-fed or irrigated conditions, are:

- i) Increase the marketable yield of the crop per each unit of water transpired;
- ii) Reduce all outflows (e.g. drainage, seepage and percolation), including evaporative outflows other than the crop stomatal transpiration;
- iii) And increase the effective use of rainfall, stored water and water of marginal quality.

The first principle relates to the need to increase crop yields or values. The second one aims at decreasing all "losses" except crop transpiration. The third one aims at making use of alternative water resources. The second and third principles should be considered parts of basin-wide integrated water resources management for water productivity improvement. These three principles apply at all scales, from plant to field and agro-ecological levels. However, options and practices associated with these principles require different approaches and technologies at different spatial scales.

Within each of these broad strategies, more detailed measures can be identified. The choice of strategies for increasing water productivity will be guided by economic and social factors. Existing water rights will often constrain choices, especially when there are options of reallocation. In such cases, the basis of water rights may need to be reconsidered. Local availability of water will be an important consideration dictating an improvement strategy. In choosing among various strategies, cost-effectiveness is a central consideration.

Source: Hamdy (2006), Synthesis of the main outputs of the Regional Action Programme on Water Resources Management (1998-2003), Zaragoza workshop (Plan Bleu, 2007)

Different political instruments can be used to promote WDM in the agriculture sector:

- The subsidies for agriculture, notably for equipment in modern irrigation systems (% of the cost of the equipment) ;
- Agro-environmental aid;
- The conditions for agricultural aid;
- Changes in tariffs for agricultural water;
- imposing of quotas in the context of the water policies;
- The creation of agricultural organisations and associations with the aim of managing water demand;
- Awareness-raising campaigns;
- Investment in research and development, technical progress and popularising this;
- Progress in the training of engineers and farmers (with modules on water demand management)
- making of rules, obligation to have equipment with water meters
- The adopting and implementing of water strategies and instruments when creating new irrigation perimeters, etc.

Key messages of the papers presented at the Zaragoza workshop on WDM (2007) and of the discussion having followed the presentations can be summarized in four main points:

- Concerning the integration of the objectives of WDM into the agricultural policies: it is important to integrate environmental issues in the sectoral policies, in general, and in the agricultural policy, in particular. This process requires new tools for monitoring and evaluating the effectiveness of such integration in order to overcome the existing difficulties: limited availability of the data, the complexity of the policy tools, and the problem of the scale.
- Concerning institutional aspects and capacity building: a stronger regional partnership is needed to support dissemination initiatives and sharing knowledge on water demand management. It is important to continuously monitor the implementation and effectiveness of the Institutional Reforms adopted in many Mediterranean countries.

The new information technologies can contribute to improve WDM at basin level. Their effectiveness can be higher if participative and endogenous processes are implemented to build innovative tools of water management (cf. *Box 7.6*).

- Concerning the use of appropriate tariff rules: water tariff can have significant impact on the reduction of water consumptions and on a better water allocation.
- Concerning the improvement of participative water management: water users associations have to be further supported and solutions well adapted to the local context have to be implemented. (*Box 7.8*).

Box 7.6 Ador: Software for Water Management in Irrigation Districts in Spain

In the last decade irrigation districts in the Ebro Valley of Spain have started to use database applications to enhance their management operations. Such applications often put more emphasis on administrative issues than on water management issues. A new irrigation district management software called “Ador” has been designed to promote water traceability and demand management. Ador can be used in irrigation districts independently of the type of irrigation system (surface, sprinkler or trickle) and the type of irrigation distribution network (open channel or pressurised). It can even be used in irrigation districts combining different types of irrigation systems and different types of irrigation distribution networks. The goals are to manage detailed information about district water management and to promote better on-farm irrigation practices. Ador is currently used to enhance management of 62 irrigation districts accounting for some 173,000 hectares in the Ebro Valley. Ador has resulted in better water management in the irrigation districts. Water is now more traceable, and farmers receive bills indicating every dater diversion to their fields. The bills establish local water benchmarks (average water use) that farmers can use to evaluate their water use. In water scarce years, the establishment of water demand limitations has helped to avoid conflicts and to guarantee equity in the access to water. The key to the success of the Ador software is its participative nature. If it had not been for the close cooperation with the irrigation districts, administration and private companies, the software would have been just another research product without practical application.

Source: Playan, Caverro, Mantero, Slavador, Lecina, Zaragoza workshop (Plan Bleu, 2007)

Factoring water demand management into drinking and industrial water management, If agriculture represents the largest potential for volume savings, a further 22% in water savings potential can be expected from industry (recycling rate up to 50%) and another 13% from drinking water supply (transport losses and household leaks reduced by 50%, respectively down to 15% and 10%).

Different kinds of instruments can be used to promote WDM for domestic water (including for tourism) and for industrial water (including for energy):

Table 7.1 Type of instruments

Drinking Water	Industrial Water
Laws and other devices to promote water efficiency plans to be made by the local authorities or by those involved in tourism	Auditing systems
Inclusion of efficiency objectives in the terms of reference of the public and private partners	Voluntary measures
Auditing systems	Public/private partnerships
Mobilisation of technologies and investments for the improvement of networks	Targeted subsidies/tax benefits for water-saving systems,
Targeted subsidies/tax benefits for water-saving equipment, vi) progressive tariffs for urban water and for water for tourism	Depollution funds
Awareness-raising campaigns	Tariffs for water
Strengthening of the capacities of the cities, training of managers, Contracts between the states and towns and contracts between states and tour operators	Awareness-raising campaigns
Conditions of state aids to communities and tourist operators	Training of managers
Making of rules, fixing of quotas for water policies, widespread use of water metres	Making of rules, fixing of quotas for water policies, widespread use of water meters etc
Specific instruments implements for the managing of water for tourism etc.	

Key messages of the presentations and discussion of the Zaragoza workshop on WDM (2007), reaffirming the relevance of the recommendations proposed in Fiuggi, can be summarized as follows:

1) Concerning standards and regulatory aspects:

- Auditing procedures for the facilities and systematic control of withdrawals should be imposed.
- The regulations should also incite checking and measuring of individual consumption and even impose this.
- The implementing of stricter quality standards for the equipment used for storing or distributing water should be imposed, even if their application is progressive.
- « Water saving » labels should be attributed to the entities which are great water consumers, especially in the tourist sector, if these entities respect a list of specifications.
- The implementing of ISO 224 standards would help to create an institutional framework favourable to the setting up of a WDM policy.

2) Concerning the social and economic aspects:

- Water pricing is a very effective WDM tool. It should be adapted to the context of each country and reconcile the awareness of the real cost of water, the ability of citizens with low financial means to pay « basic » consumption and a real encouragement to save water (*Box 7.7*).

- The setting up of targeted subsidies aimed at permitting or encouraging action that is considered relevant for water saving or to develop equipment adapted to this policy.
- It is necessary to set up measures for awareness-raising about water savings in each sector of activity. If behaviour is to be altered in a sustainable way, it is essential to implement voluntary policies for education about water and the environment.
- The social and economic components are the key factors that contribute to solving the problems of urban and outlying areas. In this respect the example of the National Initiative for Human Development in Morocco has highlighted the fact that the joint mobilising of financial means and individual capacities has helped to meet the needs of low income populations.

3) Concerning the technical aspects: new technologies and new concepts:

This underscored the need to:

- Harness new information and communication technologies : Internet, advanced telephone technology, information and data management systems in all the fields contributing to demand management (knowledge of consumption and uses, customer communication, and so on),
- Take into account of new concepts that have now reached an interesting stage in terms of feasibility and credibility, such as the using of grey water, the storing of rainwater, the recycling of some types of water,
- Recourse to new equipment and materials designed to save water in homes and in the hotel and catering industry

Box 7.7 *Water Demand Management Tool, Staggered Rates: the Case of Drinking Water in Tunisia*

The Tunisian water pricing system has undergone, over the last three decades, several reforms that have led to establishing a markedly gradual and selective two-tier rate with a view to reconciling objectives of a social, financial and economic efficiency order.

A reform was conducted in 2005 with a view to simplifying the pricing system, promoting rational water use and fostering user solidarity (redistributing the subsidies granted to the social bracket, easing the pressure on large consumers, with a stepped up participation by intermediate brackets). The current pricing system remains gradual according to use (with 3 categories of use: i) domestic, public, commercial and industrial, ii) tourism (hotel facilities); iii) public water taps), as well as to water consumption bracket (5 water consumption brackets each of which corresponding to a rate).

The recourse to this pricing model has proven to be efficient as a water demand management tool, a demand that has been kept in check. Indeed, each consumer is thus led to remain within their habitual consumption bracket, any excess inducing a substantial increase in the water bill. Demand elasticity to water price variations does, nevertheless, vary according to use (with drinking water demand emerging as highly non elastic in the industry and tourism sectors) and, in the domestic sector, according to the consumption brackets (fairly high price elasticity for the highest consumption bracket, low elasticity for the lower brackets).

Source: Limam, Zaragoza workshop (Plan Bleu, 2007)

Box 7.8 ***Water Saving in the Industrial Sector in Morocco: Case of the Use of Flow Control Valves for Cleaning Operations in a Pork Butchery Plant in Mohammedia***

Current situation: The cleaning water of the factory shops comes from a well. The quantities used for cleaning based on classic hoses are excessive. The personnel is little sensitised.

Scope of the project: To equip the manual cleaning hoses with flow reduction heads and build awareness of the personnel as to the need to reduce water consumption.

Investment: 9 000 Dh (acquisition of 30 flow controls valves)

Expected gains: Saving 286 000 m³/year of water, that is 318 700 Dh/year
 Saving power energy: 26 000 kWh/year, that is 2,2 Toe/year
 Financial gain: 318 700 Dh/an

Return time-period: 1 month

Source: Oubalkace, Report on water demand management in Morocco, Zaragoza workshop (Plan Bleu, 2007)

Factoring Natural Water Needs for Ecosystems into Policies

As the limits required for preserving the natural ecosystems approaches, the existence of an "environmental demand" is being more and more admitted; it includes the water requirements for the operations of these ecosystems. Thus, some countries have included in their legislative arsenal the enforcement of a flow minimum in their rivers for the survival of species (France), or have included even more explicitly an environmental demand (Spain). Some examples of good practices can be put forward (*Box 7.9* and *Box 7.10*). But still the most common is that this demand is not quantified in balance sheets (supply and demand) and is considered more as a limitation on resource exploitation.

Box 7.9 ***Assessment of Ecosystem Water Needs for Water Resources Management at Catchment Level: The Case of Cheimaditida Lake, Greece***

The water level in Cheimaditida has decreased drastically the last decades, mainly due to over pumping for irrigation purposes, with adverse effects on the flora and fauna of the area. During winter and spring several conflicts arise between local farmers due to the rising of the lake's water level and the flooding of the adjacent agricultural land. Furthermore the appreciation of the conservation values of the lake by local people is low mainly due to lack of incentives for their active involvement in the management of the site. A LIFE NATURE project aiming at the conservation and management of Lake Cheimaditida coping with the above problems was carried out by the Prefecture of Florina (Directorate of Land Reclamation), EKBY etc. The hydroperiod of the lake was defined taking into account the needs of its biota. The maximum withdrawal of water volume for irrigation purposes was determined. Also following the above, the construction of a dyke for flood protection and expansion of wet grasslands to the NW side of the lake was proposed. Finally all the required studies for environmental interpretation in the catchment as well as for the design and construction of an Information-Visitor Centre close to Cheimaditida were elaborated.

Source: Papadimos, Zaragoza workshop (Plan Bleu, 2007)

Box 7.10 ***Factoring the Water Demand of Natural Ecosystems in any Water Resources Development Policy: Case of Ichkeul in Tunisia***

Like almost all lagoons around the Mediterranean basin, the lagoon-lakeside system of Ichkeul is under threat due to the socio-economic pressure exerted on it. The medium is indeed in the process of a drastic change induced mainly by the construction of dams upstream the catchment area (Joumine, Ghézala and Sejnane) which will lead to diverting a large volume of water initially flowing into the Ichkeul. This reduction of inflows will induce an imbalance of the water functioning of the lake-marsh system, with risks of increasing water salinity and gradual disappearance of the specific vegetation which feeds the water birds.

In order to address this mismatch between environment and development, several measures were decided in order to ensure conservation of Ichkeul:

Construction and operation of the lock-gate on wadi Tinja to the fresh water inflows and better manage the water exchanges with the Lake of Bizerte,

Updating the North and Far North Water Master Plan in order to integrate the National Park Ichkeul as a fully-fledged water consumer. The environmental demand of Ichkeul was met back in 2003 with the conveyance of 100 mm³ from dams in the vicinity (Sidi El Barrak, Sejnane),

Construction of the urban wastewater treatment plants of Mateur and Menzel Bourguiba in order to improve the quality of the water supply into the Ichkeul.

Source: Hamdane, Report on water demand management in Tunisia, Zaragoza workshop (Plan Bleu, 2007)

Key messages of the papers presented at the Zaragoza workshop on WDM (2007) can be summarized as follows:

- An integrated approach to water management is of great value for considering ecosystem needs. It is crucial not only to look at « water as a resource », but to understand the importance of water for complex ecological systems. Appropriate water quantity and quality must be provided to ecosystems for sustaining their functions, taking into account their natural dynamics.
- Different tools and methods for a better understanding of ecosystem functioning were mentioned: pressures analysis (as a starting point and linked to the WFD approach), functional analysis, economic instruments, risk analysis (e.g. in the context of climate change), Remote Sensing for understanding the evolution of vegetation in response to water level fluctuation, approaches from Ecohydrology as well as impact assessment studies.
- Scientific knowledge must be translated into clear management objectives adopted by the policy makers. The economic valuation of ecosystems (e.g. wetlands) and related services can be very useful to make the ecosystem needs considered as a priority.
- Local solutions utilizing local knowledge are needed for sustainable, integrated management and ecosystem protection.
- The importance of regional cooperation in the Mediterranean to improve the understanding of ecosystem functioning, as well as the adoption of methods and management tools integrating water needs for ecosystems, was stressed. The developed practical approaches in support of the WFD implementation in the EU member states (e.g. horizontal guidance document on wetlands) can be very helpful for water managers, also for countries that are not required to implement the WFD.

Factoring Water Demand Management into Water Policies

To ensure a well thought out and sustainable management of renewable and exploitable water resources, integrated water policies giving high and growing importance to water demand management should be implemented at the national, catchment areas and aquifers' levels. This implies:

- Ensuring better allocation to the various uses with a view to sustainable development taking into account the social, economic and environmental stakes,
- Ensuring the sustainable conservation of resources and ecosystems to answer the social and economic in situ water requirements (without abstraction): recreational activities, fishing and aquaculture, that could in some cases represent considerable stakes in terms of development),
- Avoiding going towards high cost water supply policies, including massive recourse to industrial desalination (with its foreseeable consequences in terms of energy costs, pollution and an artificial coastline).

Box 7.11 Water Saving and Managing Consumption. The Experience of Gironde (France)

In the Gironde (a sub-division of France), half of the water needs, all uses included, and all of the drinking water needs are met by deep underground water resources that are overexploited locally.

The solutions proposed in the nineties to reduce this type of water withdrawals were only based on the creation of new production and recycling facilities for an investment of about €150,000,000.

The water planning and management scheme (SAGE), approved in 2003, and favoured another strategy consisting in controlling water demand before increasing the water supply by creating new facilities.

The statutory document, the SAGE, is based on technical, awareness-raising and economic tools to aid the public operators (the state and government bodies), the economic stakeholders and the general public.

After less than 3 years of implementation, the first results demonstrate the efficiency of the idea and confirm the interest of the operation to economise water and control consumption, even if water savings are dispersed and widespread, requiring a specific methodological approach.

Source: Jeudi de Grissac, Zaragoza workshop (Plan Bleu, 2007)

Key messages of the papers presented at the Zaragoza workshop on WDM (2007) can be summarized as follows:

- There is an absolute need to combine various tools to implement integrated WDM policies. The importance of the economic approach has to be reiterated (paramount importance of water pricing and the instating of fees to encourage water saving and ensure solidarity of the users of the resource, valorisation of the economic dimension of the involvement of women in water management, cost-effectiveness and cost-advantages analyses for the choice of measures fostering the enhancement of environment quality and of WDM), as well as that of the tools of concerted action bringing together the public operators (State, communities), the economic life stakeholders and the general public.
- The importance of the set up of collective entities and of participatory management (agricultural users' associations, domestic users' associations) and the need to promote, in particular, the involvement of women, who are the main users and responsible over the water resources, in the decision-making and planning processes.

- The WDM principles need to be available on the various territorial levels. The purpose is to particularly promote ownership and implementation of WDM approaches by the local stakeholders (water services, local management on catchment area level).
- The operating costs to ensure the missions of information and coaching of a policy of water saving and control over consumption are high. The implementation of WDM approaches assumes, in view of the significant number of stakeholders to be mobilized, the availability of dedicated means to inform, sensitise, educate, persuade, and allow the sharing of experiences;
- The climate change factor, making it even more crucial to implement WDM measures, needs to be mainstreamed in the water resources planning and management.

Table 7.2 Recommendations of the Zaragoza Workshop Thematic Groups (March 2007)

Factoring WDM into the agriculture sector	Factoring WDM into drinking and industrial water management
Increase water demand management actions in Mediterranean Agriculture by taking into account: technical aspects (new technologies and innovation) and governance aspects (decentralisation, users participation, education, training)	Take an initiative to adapt ISO/TC 224 standards (service activities relating to drinking water supply systems and wastewater systems) to the Mediterranean context,
Integrate a more sustainable WDM into national policies (by clearly identifying priorities and responsibilities) and regional sectoral policy (agricultural, educational, energy) considering the local conditions (i.e.: food security for non EU countries),	Take an initiative to ensure better coordination among donors, as well as the complementary nature of their strategies, in the financing of WDM actions,
Go on the way of « decoupling » agriculture support from production as an effective tool to achieve positive environmental effects,	Raise the education component to the rank of the other WDM instruments and commit water service managers to devoting sufficient financial and human means to this education,
Support the dissemination and sharing of experiences (both among different countries and within the same country) of WDM policies actions in all Mediterranean countries. Ensure an interface between science and policy,	Besides applying techniques that have been known for a long time, such as the reusing of waste water, it is recommended to systematically search for what type of support the new technologies could contribute to global WDM policies.
Monitor the achievements of the different policies in terms of WDM by identifying appropriate and shared/recognized indicators.	

Table 7.3

Factoring natural water needs for ecosystems into policies	Factoring WDM into water policies
To promote the factoring of the natural water needs of ecosystems via an integrated water resources management approach on (sub) catchment area scale,	Integrate water demand management into the water and sectoral policies, on different territorial scales. The WDM policies will be based on the widest complementary of the available mechanisms (laws, planning and local action instruments, water police, actions at user levels, water pricing, information, education and awareness-raising actions, technical and technological measures, etc.) ;
To develop the scientific tools and methods necessary for a comprehensive understanding of the functioning of the ecosystems and to translate this scientific knowledge into management objectives listed in the planning documents. This requires, in addition, to take into account the specificities (not only the natural, but also the socio-economic and geopolitical, specificities) of the region and of the Mediterranean countries,	Involve local stakeholders in the WDM processes: set up an institutional framework making it possible to empower local stakeholders and help them to appropriate the WDM procedures;
To develop the economic approaches and mechanisms likely to promote recognition of the services rendered by the ecosystems and, hence, the sustainable management of these ecosystems,	Develop the economic approach of WDM (water accounts, water pricing that in particular integrates mechanisms in order to reach a progressive recovery of costs whilst at the same time ensuring social equity, cost-benefit analyses, etc.). The methods and tools for the economic analysis of the Water Framework Directive could serve as inspiration for neighbouring countries when implementing their WDM policies.
To foster the participation of the local players right at the outset of the first phases of the water resources planning and management processes, and this, in order to facilitate recognition and integration of the environmental water demand.	Integrate the « climate change » factor in the water resource management strategies in general, and WDM in particular.

7.2 *SUPPLY SIDE ACTIONS*

7.2.1 *Introduction*

In regions where all prevention measures have been implemented according to the water hierarchy (from water saving to water pricing policy and alternative solutions) and taking due account of the cost-benefit dimension, and where demand still exceeds water availability, additional water supply infrastructure can in some circumstances be identified as a possible other way of mitigating the impacts of severe drought or water scarcity.

There are several possible ways of developing additional water infrastructures, such as storage of surface or ground waters, water transfers, or use of alternative sources.

The constructions of new water supply dams and water transfers are subject to Mediterranean countries legislation. Interruption or transfers of stream flow inevitably change the status of water bodies and as such are subject to specific and strict criteria. In addition, large projects often provoke social and political conflict between donors and receiving basins, which calls their sustainability into question.

Alternative options like desalination or waste water re-use are increasingly considered as potential solutions across Mediterranean countries.

Water supply strategies to meet these demands vary according to the different situations in the different Mediterranean countries. The forecasts of demand growth are highest in the generally water-poor countries. On the other hand, demand seems to have stabilized in most of the water-richer countries, where efforts are directed more at reducing some disparities between regions or ensuring the quantity and quality of water supplies. According to the baseline scenario, there would be across the whole region a continuation of large construction programmes for securing supply, the extraction of a larger share of renewable natural resources or, in countries with more limited natural resources, ‘producing’ water from so called ‘unconventional’ sources such as sea-water desalination and the re-use of wastewater.

An important inventory of the various solutions for supply actions has been done in the “technical report on water scarcity and drought management in the Mediterranean and Water Framework Directive” The Blue Plan’s report "A Sustainable Future for the Mediterranean: The Blue Plan's Environment and Development Outlook" edited by Guillaume BENOIT and Aline COMEAU, in 2005, gave a tour of the various solutions. The remainder of this chapter is an excerpt from this book.

“Water demand in the Mediterranean catchment basins of very many countries is already more than twice the regular natural renewable resource and could not be met without such structures.

This is the case for Spain, France, Syria, Israel, Egypt, Libya, Tunisia, Algeria and Morocco.

7.2.2 *Examples of Dams and Water Transfer Projects in the Mediterranean*

The Mediterranean peoples have always developed a high degree of know-how in managing the scarcity of water and much ingenuity in building such structures. The last century was typified by growing activity in countries in contracting such work, which became increasingly larger in scale. More than 500 large scale dams were built during the last century in the Mediterranean catchment basin, providing a total of more than 230km³ of storage.

The box and figure below present different examples of dams and water transfer projects in the Mediterranean and the main water transfers in the region.

Box 7.12 *Dams and Water Transfer Projects in the Mediterranean*

In Spain the national hydrological plan, adopted in 2002, set out a programme of 119 new dams, storing 2.5km³, linked to the project of transferring water from the northern rivers, mainly the Ebre (1km³ per year at first, then 3.35km³ per year in the long term) to the Mediterranean coastal basins. Catalonia studied the feasibility of transferring water from the Rhone River in France to Barcelona. This project launched a major debate about questions of water demand management as opposed to supply management. One of the main criticisms of the project concerned the lack of studies dealing with evaluation of future water demand by Barcelona and socioeconomic and environmental analysis of the different possible options for meeting or changing demand. These criticisms led to the cancellation of the transfer project from the Ebre. The region Barcelona finally decided to retain desalination.

In Greece, the project to develop the Acheloos River to enable the transfer of 1.1 to 1.3km³ of water per year to Thessaly includes 4 dams.

In Turkey, the 'GAP' (SE Anatolia Project) in the upper basins of the Tigris and the Euphrates will contain 22 dams in its final stage, storing 60km³ of water (including 48km³ by the already completed Ataturk Dam).

In Cyprus, ten additional dams are planned (1999) for storing 85hm³ (hectometre) and regulating 25hm³ per year.

In Syria several dams are under construction or are planned in the Mediterranean Basin (Oronte and coastal basins) and the Steppe Basin in the master plans.

In Egypt the extension of the use of Nile water outside its basin, already begun by the Peace Canal (towards the northern Sinai) and the Tuska Canal (towards the Kharga oasis and the 'New Valley'), will be continued and completed by increasing the use of the Nubian aquifer (non-renewable resources). From an optimistic point of view, this extension relies on the discharge gains that would result from loss-reducing improvements in the Nile Basin in Southern Sudan (the Jonglei Canal, already begun), with a predicted proportional share for Egypt of about 4km³ per year in the initial phase, and from 9 to 10km³ in the long term.

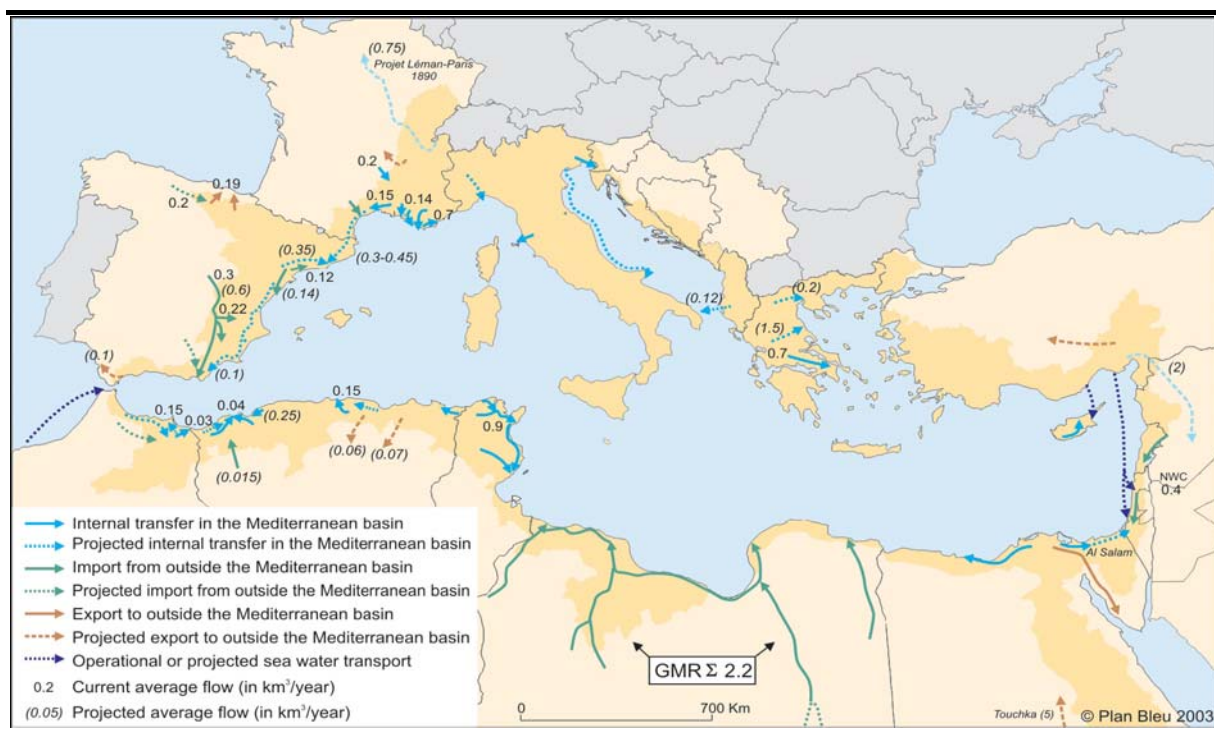
In Libya, the already advanced project of transferring water taken from the Saharan fossil aquifers ('GMR') will carry 2.2km³ of water per year to the coastal areas in its final phase by 2007.

In Tunisia, it is planned to fully use by 2010 the exploitable water resources (4.03km³ per year on average) by exploiting 0.835km³ per year more than in 1995, of which 0.67km³ will be of surface water, by increasing the storage capacity of dams to 1.9km³ (from 1.48 in 2000).

In Algeria, the national water plan projects to exploit an additional 5.4km³ between now and 2020, of which 3.1km³ will be from surface waters, in particular by building 50 additional dams.

In Morocco, the building plan foresees the construction of 60 major dams between now and 2020, controlling 14km³ per year, plus some 100 small or medium-sized dams (2 to 3 per year), and an increase in the exploitation of underground water to 3km³ per year.

Figure 7.2 Main water transfers in the Mediterranean region



To limit their dependence on ‘unsustainable’ withdrawals, countries faced by a limit to their exploitable natural resources (mostly group 1 countries: Libya, Malta, Israel, Syria, Spain and Cyprus) are committed to developing water production from alternatives sources as listed below.

7.2.3 Examples of Other Supply Side Actions

Successive Water-Recycling or Sea-Water Desalination

Recycling agricultural drainage water currently represents about 12.6km³ per year at the Mediterranean level, mostly in Egypt, making it possible to meet annual demands (73km³ per year) that are greater than the average annual natural resources (57km³ per year) by recycling the same water for several successive irrigations. Such recycling could double between 1990 and 2025 (an increase of 8km³ per year between 2000 and 2025). However, it does not come without major public health problems since the drains are very often used for waste (in the Nile delta, for example, where market gardens are irrigated by water of doubtful quality). Moreover, there is a serious risk of soil salination, since drainage water concentrates salts.

Re-using Wastewater is also being Developed for Irrigation

It represents about 1.1km³ in the entire Mediterranean Basin (Spain, Israel, Cyprus, Egypt and Tunisia). In Cyprus, the quantities re-used could triple or quadruple between now and 2010. In Egypt re-use could increase by a factor of ten. In Israel this potential is being intensively explored. However, the development of wastewater re-use at the basin level may remain technically and economically limited by the volume of wastewater produced, the places of discharge (usually far from places of re-use), and the need to store it and provide preliminary treatment before re-use, as otherwise the risks for animal and human health or soil contamination are significant. The potential for wastewater re-use may reach a total of 5.7km³

in the NV catchment areas by 2025, or 3 per cent of total demand in the baseline scenario (from less than 1 per cent in 2000).

The industrial production of freshwater through desalination of sea water or brackish water is another and growing non-conventional resource. Total production in the entire Mediterranean Basin (Spain, Malta, Cyprus, Syria, Israel, Egypt, Libya and Tunisia) approached 0.4km³ per year in 2000. However, in spite of a regular reduction in costs and its particular adaptability to meeting the needs of islands and tourists, its development remains limited (0.1 per cent of the 360km³ per year of exploitable natural resources in the basin and 0.2 per cent of total demand). It is reserved for domestic or industrial uses.

Desalination represents a large fraction of supply in only a few countries (Malta and Libya). In Malta all additional demand can only be met by desalinated water. The impacts of desalination on the cost of supply, energy consumption and the local environment must also be remembered, even if these should be put into perspective at the Basin level, given the small volumes involved compared with those of conventional water. The direct use of brackish water for industry or even agriculture is also being developed (in Israel, 166hm³ in 1999, and in Tunisia).

It may be possible to better manage water in an arid country like Tunisia with very scarce and vulnerable water resources.

The following options may enable progress towards more sustainable and integrated management:

Artificially Recharging the Water Tables

In arid areas, unlike in wetter climates, the immense regulatory capacity of the water tables could be better exploited by using water from dams when they are at their highest level for recharging water tables through infiltration (in infiltration zones or wadi beds), thus achieving underground water storage. The advantage of this is to transfer part of the irregular surface water (high water run-off) to regular water (in the aquifers), which is more easily exploitable. It would also make it possible to sustain dry weather flows and limit losses through evaporation. For example in Tunisia in 1996, 65 million m³ of water were transferred through the artificial refilling of aquifers. By 2030 this transfer is planned to reach 200 million m³.

Dividing up regulatory works upstream of catchment areas by creating many hillside lakes above big dams would help to limit the silting-up of reservoirs by reducing the erosive energy of run-off and reinforcing the effects of artificial water-table charging.

Interconnecting water networks would make it possible to re-establish regional balances and optimize resource allocation. A more balanced exploitation of aquifers with poor renewable resources could be achieved by matching withdrawals to practicable reductions in 'natural loss' (by evaporation in endoreic depressions), thus limiting withdrawals to achieve such a better balance. Depending on the situation, this strategy would be opposite to a more intensive exploitation of reserves (which would be more productive but unsustainable) or else could replace the final phase of such exploitation.

More active management of renewable-resource aquifers, making more use of their reserves when there is large capacity, could artificially amplify their natural 'regulatory reserve'.

Water soil and conservation: some steps (re-vegetation, cultivation practices, soil conservation, and biological processes) make it possible to increase storage capacity for rainwater via the ground and thus limit irrigation needs while also limiting erosion and the resulting silting-up of downstream reservoirs.”

8.1 INTRODUCTION

8.1.1 Concept and Classes of Public Participation

Public participation may be understood as the manner in which citizens, individually or collectively considered, may participate in public decision-making.

The Water Framework Directive distinguishes between «interested parties» and «users ». «Interested parties» are those members of civil society that consider themselves to be affected by public decision making. «Users», on the other hand, may be interpreted as people that use a determined product or make use of a public service. This is a wider concept than that expressed in Spanish water law, which identifies individuals who, through an administrative concession or other legitimate title, enjoy the use of public water.

Public participation is configured as means for channelling public will in the taking of politically-natured decision. This is especially so with regard to public law, in which the main aim of the Administration, to safeguard the general interest, could become unattainable should the public fail to have the possibility to contribute and collaborate in the decision making process, relegating interested groups to receivers of the approved regulation.

8.1.2 Public Participation in the Water Framework Directive (WFD)

The WFD considers participation as an obligatory activity for its correct implementation, with the aim of maintaining transparency throughout the entire process, informing of the results, encouraging consultations and implicating interested parties, especially in the process of the elaboration of river basin plans.

The WFD contemplates public participation more intensely than the countries implicated in the project.

The fourteenth Reasoning of the preamble establishes that “The success of this Directive relies on close cooperation and coherent action at Community, Member State and local level as well as on information, consultation and involvement of the public, including users”.

Of the provisions contained in the Water Framework Directive Frame and dedicated to public participation, three manifestations may be deduced: active participation, consultation, and information.

8.1.3 Public Participation in other International Frameworks

The box below details public participation clauses in international agreements and frameworks.

Box 8.1 Public Participation in International Frameworks

Rio Declaration on Environment and Development, Rio de Janeiro (1992):

“Principle 10:

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided”.

The Convention on the access to information, public participation in decision making processes and access to justice in environmental matters, Aarhus Convention (1998) (2).

Spain ratified this Convention in December 2004, entering in effect on 31st March 2005.

Citizen participation in communitary conception, the paradigm of which is to be found in the Aarhus Convention of 1998 (2) consists of three pillars: diffusion and access to environmental information, public participation in decision making with environmental effects and access to legal support in cases of breach of these rights of participation.

White Paper on European Governance (2001).

“The White Paper proposes opening up the policy-making process to get more people and organisations involved in shaping and delivering EU policy. It promotes greater openness, accountability and responsibility for all those involved. This should help people to see how Member States, by acting together within the Union, are able to tackle their concerns more effectively.” (European Governance. White Paper 25-07-2001. Summary)

II World Summit on Sustainable Development. Johannesburg Declaration on the Sustainable Development (2002):

Section 26: *“We recognize that sustainable development requires a long-term perspective and broad-based participation in policy formulation, decision-making and implementation at all levels. As social partners, we will continue to work for stable partnerships with all major groups, respecting the independent, important roles of each of them”.*

Source: Rio Declaration on Environment and Development, Rio de Janeiro (1992); The Convention on the access to information, public participation in decision making processes and access to justice in environmental matters, Aarhus Convention, White Paper on European Governance, II World Summit on Sustainable Development. Johannesburg Declaration on the Sustainable Development (2002)

8.2 CASE STUDY OF THE JUCAR RIVER BASIN AUTHORITY

8.2.1 Legal Framework

The Spanish Legal Code encourages public participation by means of the legitimacy that, at different levels, is established in relation to the individual’s right to inform him/her and to collaborate in the processes relative to the development of environmental regulations. The box below provides more information on the legal texts which include references to public participation.

Box 8.2 *Public Participation in Spanish Legal Texts*

The Revised Text of the Water Law (TRLA, 2001), was modified by article 129 of Law 62/2003, to incorporate the Directive 2000/60/CEE into Spanish Law.

With regard to public participation, the TRLA establishes, in article 41.3, that “under all circumstances, public participation is guaranteed in all planning processes, in all prior consultations and in the development, approval and revision of plans”.

Point 2 of this article makes reference to the procedure for the development and revision of river basin hydrologic plans, which must contemplate, in all circumstances, “the programming of timetables, work schedules, elements to be taken into account and preliminary drafts in order to facilitate suitable information and public consultation from the beginning of the process”.

Also, article 42 establishes that “river basin hydrological plans will obligatorily include a summary of the measures regarding public information and consultation, the results obtained and any consequent changes in the plan, as well as the points of contact and procedures for obtaining base documentation and the information required for public consultation”.

Finally, the Additional Twelfth Provision of the TRLA establishes the terms for public participation in relation to three documents: timetable and work schedule for the development of the plan, with indications regarding the consultation methods to be adopted in each case, a provisional relation of the water management measures, and examples of the hydrological river basin plan project.

Law 9/2006, 28th April, on the evaluation of the environmental effects of certain plans and programs, incorporates Directive 2001/42/CE of the European Parliament and the Council, 27th June 2001, regarding the evaluation of the environmental effects of certain plans and programs, into Spanish Law.

Law 27/2006, 18th July, regulates the rights of access to information, public participation and access to justice in relation to environmental matters incorporated into Spanish Law through two European Directives: **Directive 2003/4/CE, of the European Parliament and Council, 28th January 2003, on the public access to environmental information** (which repeals Council Directive 90/313/CEE), and the **Directive 2003/35/CE, of the European Parliament and the Council, 26th May 2003, which establishes measures for public participation in certain plans and programs related to the environment and which modifies, in relation to public participation and access to justice, the Directives 85/337/CEE and 96/61/CE.**

On the other hand, **Hydrologic Planning Regulation** approved by **Statutory Law 907/2007, 6th July (RPH, 2007)**, with the aim of complying with the mandates contained in the TRLA and **Directive 2000/60/CE**, as well as in Decision 2455/2001/CE.

The Hydrologic Planning Regulation establishes, in article 63, that, “the hydrological plan will contain to summary of the public information and consultation measures that have been applied during to the procedural process, the results and consequent changes made to the plan, in accordance with the articles 71 to 80, both inclusive”.

This is the first time the right of public participation has been introduced into the Hydrological Planning Schedule.

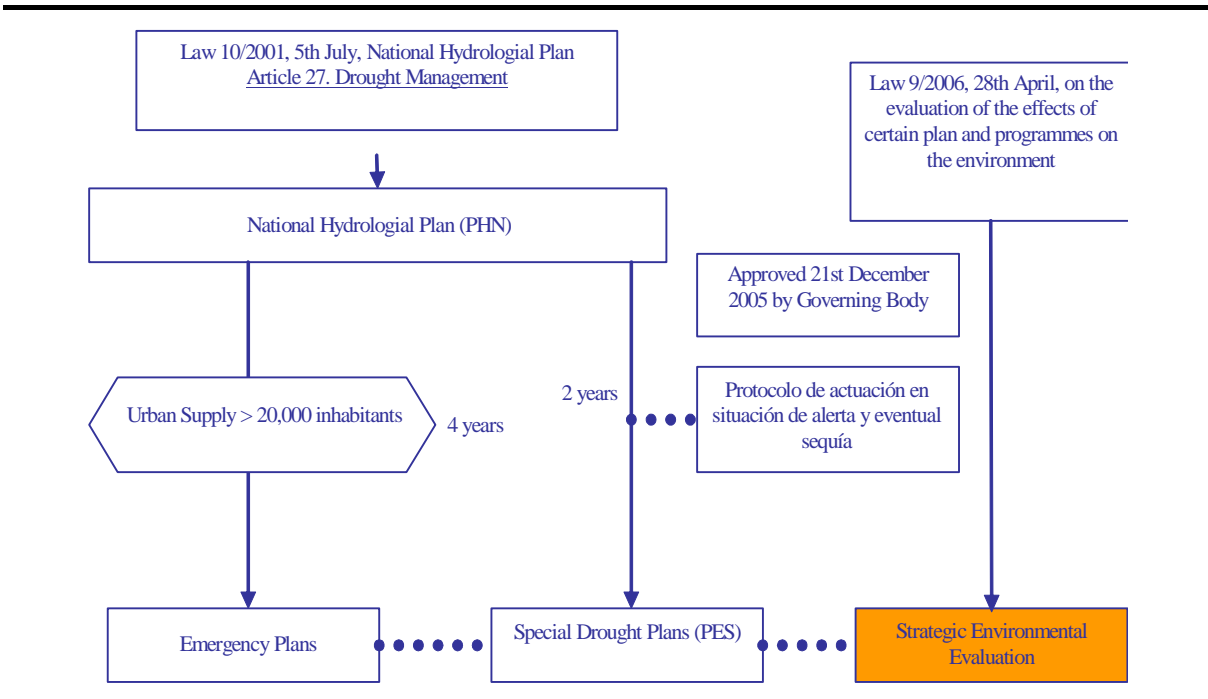
Source: Spanish legal texts

8.2.2 *Public Participation in the Special Alert and Temporary Drought Plan (PES, 2007)*

According to Law 10/2001, 5th July, the National Hydrological Plan (PHN, 2001), the River Basin Authorities must develop, within a maximum period of two years as of the entry into effect of the mentioned Law, the Special Alert and Temporary Drought Plans (PES, 2007), in which the operational regulations for the systems, as well as the measures to be applied in relation the uses of the Public Hydraulic Domain, are included.

This Plan, which has the general objective of minimising the environmental, economic and social impacts of the drought situations, is based on defining drought prevention and detection mechanisms, and establishing thresholds for determining the aggravation of drought situations. Additionally, it establishes a series of management measures for each of the defined scenarios, with the aim of reducing the impact of drought situations.

Figure 8.1 PES and EAE



Source: Hydrological Planning Department (CHJ)

On 14th December 2006, all the Special Drought Plans from the different Spanish River Basin Authorities were presented in the MMA. On 15th December 2006, the Jucar River Basin Authority's Special Drought Plan and Environmental Sustainability Report were presented in the CHJ to the different sectors of society.

The observations and allegations to both documents could be forwarded via a specially designed form available through the website, which was automatically sent to a database pertaining to the River Basin Authority –an automatic confirmation of reception was sent to the interested party -, through CHJ general registry or in the form established in article 38.4 of Law 30/1992, 26th November, Legal Regulations of the Public Administrations and the Common Administrative Procedure.

Once the period of public consultation had terminated, the observations and allegations received were dealt with and responded to by the River Basin Authority. Additionally, a report justifying the method in which the allegations and observations were taken into account in relation to the Plan was developed. This report corresponds with the present document.

8.2.3 Public Participation in Drought Management

The Permanent Drought Commission and the 2004/05 drought

The Permanent Drought Commission of Governing Body of the Jucar River Basin Authority is responsible for the discussion and approval of measures directed at the management and uses of the public hydraulic domain in times of drought within the Jucar River Basin. It is a collegial organisation in which the discussion and approval of agreements is carried out with the participation of environmental representatives.

The intense hydrologic drought that began in 2004/05 and that continues at the present time in the area covered by the Jucar River Basin required the introduction and continuation of a series of emergency activities aimed at mitigating the effects produced by the drought.

The Permanent Drought Commission approved the Procedural Plan for the Mitigation of Drought Effects on 13th February 2006, based on the Jucar River Basin Authority's Drought Protocols (preceding of present P.E.S, 2007), which contemplates a series of activities classified as:

- Environmental protection activities
- Management and control activities
- Water saving activities
- Activities for the generation of additional savings.

As a result of the persistent situation of water uncertainty in which the Jucar System is submerged, this Drought Effect Mitigation Plan continues in effect and the mentioned actions will be extended for as long as the situation persists.

Sources of Public Participation and Environmental Information

With the aim of facilitating the transparency of the processes associated to the development of the diverse plans and programmes and permitting the reception of suggestions and observations from interested parties, the Spanish Ministry of the Environment's website, <http://www.mma.es>, proves an area dedicated to public participation in users have access to an e-mail address in order to facilitate communications between the public and the organisations. All documents which, in accordance with the applicable legislation, require public participation are also published.

Equally, it offers connections to the different dependant Hydrographic Confederations from the Ministry of the Environment (ex-. www.chj.mma.es); In the same manner, the site offers links to the different River Basin Authorities depend on the Ministry of the Environment (i.e. www.chj.mma.es); links to Non-Governmental Organisations specialised in environmental matters, such as www.adena.es, National parks; Climatic change, General State Administration; Spanish Regional Environmental Organisations, European Union member state Environmental Ministries; State Societies; Environmental Education, etc.

9 DROUGHT RISK MANAGEMENT

9.1 INTRODUCTION

In light of the increasing droughts in past years and expected exacerbation of drought impacts in coming years, the priority should be to move from crisis management to drought risk management. It is better – and less costly – to prevent droughts as much as possible rather than to try to solve the problem once it has affected us.

The associated measures often result in comprehensive drought risk management plans with water stress area mapping, alert levels, warning systems, etc. For European countries, the WFD also provides flexibility to develop specific drought management plans in relevant river basins. A report specifying recommendations on how a drought management plan can be developed was set up last year by the EU Expert Network on water scarcity and drought. This report will be soon available on the website of the Commission (http://ec.europa.eu/environment/water/quantity/scarcity_en.htm) and can be particularly helpful to all Mediterranean countries.

9.2 RISK VERSUS CRISIS MANAGEMENT: THE CASE OF THE JÚCAR RIVER BASIN

9.2.1 Introduction

The hydrologic drought which began in the area of the Júcar River Basin Authority in 2004/05 and that persists up to the present day, needed the introduction and, given its special intensity and persistence, the continuation of a series of emergency measures to alleviate the effects of the drought.

As indicated in the Special Alert and Temporary Drought Plan in the Júcar Hydrographic Commission (PES), approved by the Ministry of Environment order 687/2007 of 21 March (CHJ, 2007), when one or several exploitation systems are in a pre-alert scenario, the Drought Management Office (OTS) will be constituted with the responsibility for monitoring the drought indicators in this phase. In the event the situation deteriorates further, and after passing through the alert scenario, when one or several exploitation systems are in an emergency situation, the Governing Board of the Júcar River Basin Authority will request the need for a National Decree declaring a drought situation and regulate the constitution of the Permanent Drought Commission.

In this fashion, at the end of October 2005, the Statutory Law 1265/2005 of 21 October 2005 was published in the Official Spanish Gazette. This measure adopted exceptional administrative measures for water resources management to correct the effects of the drought in the river basins of the Júcar, Segura and Tajo. It establishes in article 2 point 3 that in order to fulfil the functions defined by the law for each governing body, a permanent commission will be formed, delegated to the Júcar, for monitoring and management of the drought.

Due to the special intensity of the aforementioned drought, the Permanent Drought Commission approved the Procedure Plan, dated 13 February 2006, for mitigating of the effects of the drought, basing it upon the “Júcar River Basin Drought Protocol” (CHJ, 2005) (drawn for the Special Drought Plan approved 21 March 2007), which contemplates a series of actions of four types:

- Measures for environmental protection,
- administrative measures for managements and control,
- management measures of demand and supply, and
- measures for additional resource creation and alternative sources.

On account of the persistence of the drought in the Júcar system and its extension to the Turia system, this Procedure Plan for the mitigation of the effects of drought remain in effect, renewing the actions now under way for as long as said situation may continue.

The Drought Management Department (OTS), as the PES states, consists, mainly, in supporting to the Permanent Drought Commission, contributing information to the same, updating the different indicators, clarifying any consultation question that the members of the Commission may have, as well as in the development, application and monitoring of the Procedure Plan for the mitigation of the effects of drought approved in February 2006.

- To provide technical support for the constituted Permanent Commission in accordance with Statutory Law 1265/2005
- To analyse and define the Procedure Plan of mitigation of the effects of drought in the area of the Júcar River Basin Authority, fundamentally for the Júcar and Turia exploitation systems.
- To develop the necessary activities for the initial application, development and monitoring of the Procedure Plan for the mitigation of the effects of drought.
- To coordinate other technical assistance that may contribute to different aspects of the application and monitoring of this Procedure Plan.
- To issue periodic reports of the works carried out and the monitoring of the application of the Procedure Plan for the mitigation of the effects of drought.
- To publicly spread the considerations that the Permanent Commission considers opportune.
- To make field trips and hold meetings with users and other interested parties in order to obtain the most accurate compilation of information that may be needed.
- To issue a closing report of all the works carried out.

9.2.2 Drought Management Measures

The measures that have been applied during the drought were approved in the Procedure Plan approved 13 February 2006 by the Permanent Drought Commission, are presently included in the PES (CHJ, 2007) and grouped in four categories.

Water Environment Protection Measures

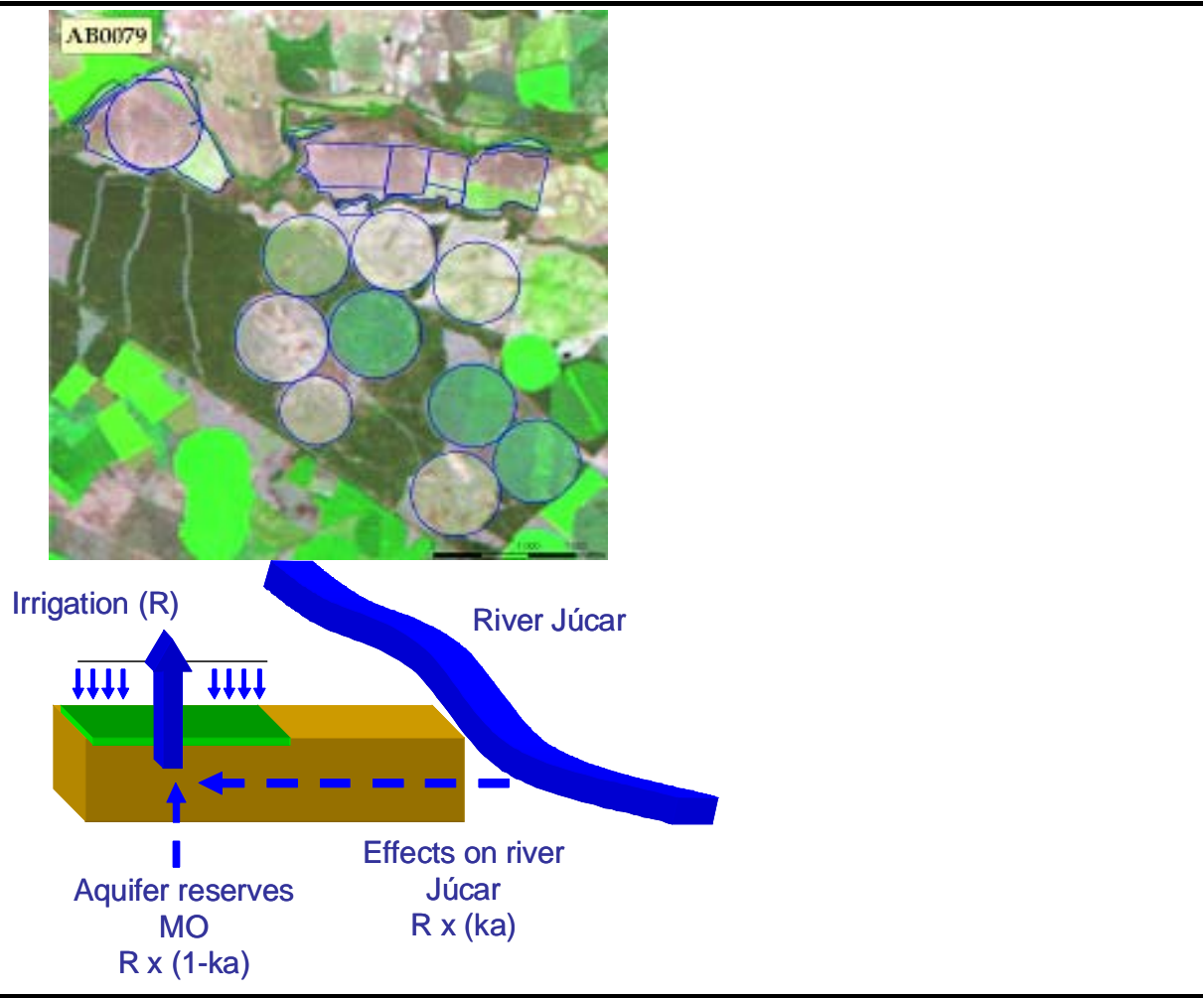
These measures have monitored the protection of the environment during this period of drought in which the water average was especially vulnerable, due to a reduction in the volumes of water in the reservoirs and the instream flow can produce a worsening in water quality or the aquatic ecosystems.

The management of water resources, and specifically the management of the reservoirs, have been carried out in a manner conditioned by maintenance of the ecologic basins at all times, with the intention of avoiding the drying of any section of the river.

- Monitoring the instream flow at the most serious trouble spots of the Júcar and Turia systems.

In the middle section of the Júcar River, the use of underground waters from the Mancha Oriental aquifer has reduced the contributions of water that source used to produce for the Júcar river, endangering the ecological flow of the middle section of the Júcar river in drought situations

Figure 9.1 *Irrigations Pivots with Underground Waters in the Surroundings of the Jucar River and its Effect on the River Itself*



For that reason, it has been one of the points of greater monitoring in the Júcar River, since the risk existed that it might dry out in some section between the Alarcón and Molinar reservoirs, specifically at Cuasiermas, where the river did dry up during the last drought of 1994-96.

The final section of the River Júcar presented a complex challenge, due to the high number of derivations and the incorporation of water contributions etc. It required the monitoring of water quantity as much as water quality, since the reduction in the in stream flows could result in a worsening of water quality.

The lower section of the Turia, poses an array of problems similar to that of the final section of the Júcar River, and also required monitoring quantity as much as quality of the water.

- Monitoring of places of special environmental value, as emphasised in the monitoring of the quantity and quality of water in the Albufera lake of Valencia, a wetland area included in the RAMSAR list of wetlands.

In the Albufera Lake, Valencia, improvement of the existing measurement networks was carried out, which allowed for the monitoring of water levels in the lake and evaluation of the water contributions it received at all times.

In addition, the monitoring of water quality in the lake was carried out, analyzing the influence of agricultural activities going on in the Nature Reserve itself or the surrounding areas.

- Other specific measures:

Water Rights Exchange Centre: In 2006 as well as 2007, similar Public Bids for the acquisition of water rights (OPAD) were offered for the middle section of the Júcar in the areas located over the Mancha Oriental aquifer, whose intention was to reduce the environmental affects that agricultural activities might produce on the water flow in the river.

Administrative, Management, and Control Measures

The measures of management and control have pursued, among other goals, the improvement and optimization of the water resource management and the quality control of waters and the Public Hydraulic Domain (DPH).

These measures are defined according to the following classification:

- Water quality and control of Public Hydraulic Domain.

An increase in the physical-chemical control has been carried out and reports on the trouble spots of the Júcar River during the current drought have been produced.

The controls will be carried out by using two automatic Mobile Water Quality Stations, equipped with multi-parameter probes and three analyzers able to control up to nine variables in fifteen-minute intervals, and to transmit the data to the Water Quality and Environmental Management Department of the Water Authority to be integrated into the corresponding databases and reports.

The analytical control of spills has been strengthened, and both monitoring of DPH use and the number of sanctions have increased. Modification of the conditions set forth in the refuse dumping authorisations, Statutory Law 1265/2005, including the possibility of closure for the charge of illegal spills in collaboration with SEPRONA.

- Control and monitoring of underground water sources.

The present situation of the water reserves in the Júcar river basin, as a result of the lack of rain at the head of the river together with reductions in surface supply, motivated by the continuity of the drought in the present hydrological year, determines that the usual irrigation demands cannot be met by using surface waters. In those cases where it is possible, it is necessary to resort to the use of underground waters by means of the introduction of so-called drought wells, that is to say, wells that are not usually used. In situations like the present one, the organization of the river basin in question authorises and sets the conditions for their use.

The authorizations of drought wells and drought re-pumping facilities in the current 2006-2007 hydrological year have been assigned, in order to increase the guarantee for the 2007 irrigation campaign.

The CHJ and IGME (Spanish Geological and Mining Institute) decided to sign a collaboration agreement to carry out specific tasks that would allow them to know the status of aquifers impacted by the drought alleviation operations. Specifically, it concerned the realisation of general diagnostic studies centred in evaluating the initial and final status of the aquifers as well as the range of actions that might arise based on the studies.

A periodic monitoring and control of variations in the piezometric level, the conductivity and the chlorides that have taken place in the aquifers has been carried out.

- Control and monitoring of surface water sources.

The permanent recognition of existing resources and the needs and demands of the users constitutes the first step towards guaranteeing supply and a sensible distribution. To achieve that, continuous monitoring of the variables that represent the collection of resources (the variable figure of water entering reservoirs) and of user supply (water gauge stations and extraordinary supplies) are carried out.

The daily representation of these variables, published on a weekly or monthly basis in an aggregate manner, allow us to know that the supply goals established at the beginning of the campaign are being fulfilled.

Water Demand and Savings Measures

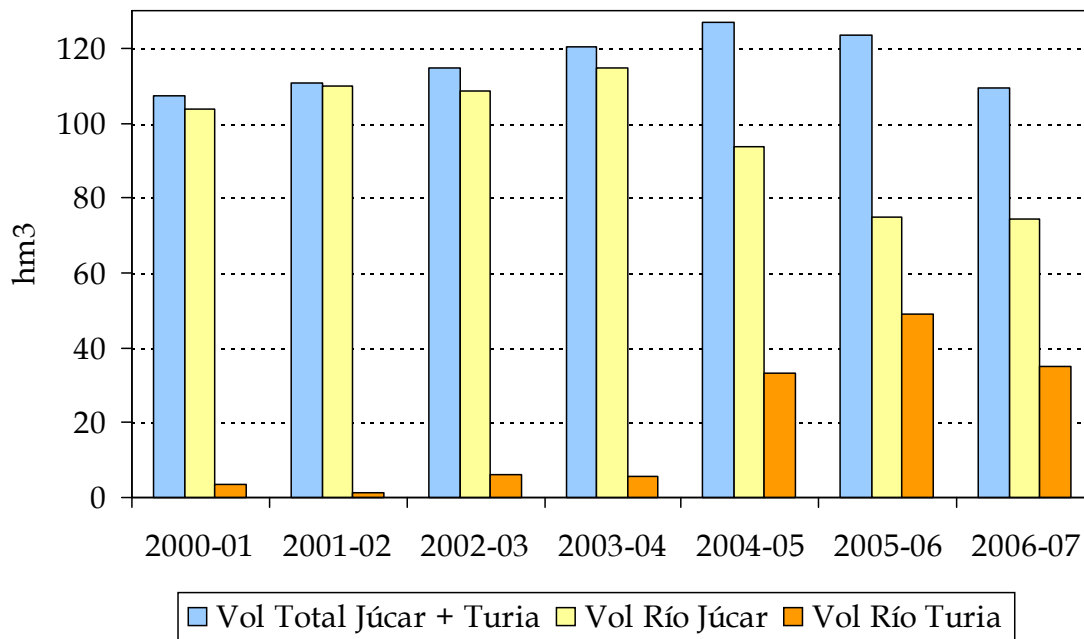
The saving measures applied to all the activities that we carry out imply the co-ordination of all our efforts in order to preserve a resource that is necessary for human life and economic development.

The following classifications are employed with regard to saving measures (development of measures for water saving in relation to urban and agricultural users):

- Savings in the urban supply

In order to communicate their findings to the Permanent Drought Commission, the OTS has regularly compiled a relation of supply data for the main urban zones that employ superficial water from the Júcar

Figure 9.2 Savings in the Urban Supply to the Metropolitan Area of Valencia. Information for the CPS



- Savings in the supply to agricultural zones

At the present time, agricultural savings constitute one of the preferred objectives in relation to the management of water resources, due in part to the high percentage of overall water use that they represent and the fact that the long-term savings that such measures facilitate justify the changes effect to otherwise unalterable uses and practices.

Additional Resource and Alternative Source Generation Measures

The measures regarding alternative sources and the generation of resources have been aimed at introducing and promoting the use of measures with the aim of reducing the pressure to which traditional sources are subjected, given that the increase in human activity and contamination have reduced their availability, causing loss in the quality of life and limiting productive activities and urban and rural development.

- Improvements in supply.

These activities have been developed through the use of wells in order to supply Albacete, the adapting of the Turia output to the levels required during drought situations in relation with the Valencia supply, the introduction of an emergency supply point in the River Turia to cover the supply to Sagunto, the introduction of emergency works for the supply to Minglanilla from the Contreras Reservoir (Cuenca), the emergency repair of the Sagunto supply deposits, improvement work related to the supply infrastructure.

- Reuse of treated water

The quality of the potentially reusable water of the EDAR has been analysed and the introduction of these measures has enabled the supply to the Vega de Valencia agricultural operations to be met, thus demonstrating the Valencia metropolitan area and irrigation communities are fully aware of the need to reuse and save water.

10 CLIMATE CHANGE

10.1 INTRODUCTION

We are already observing the effects of climate change across the globe. Freshwater resources have the potential to be strongly impacted by climate change. This means that beyond impacts on the water cycle and water ecosystems, the function and operation of existing water infrastructures will be affected. Therefore the expected impacts of climate change need to be taken into account as soon as possible in the definition and planning of any future water management measure in order to ensure the preservation of the water resources and avoid the building up of oversized infrastructures instead of the development of effective water demand management measures.

10.2 IMPACTS OF CLIMATE CHANGE IN JORDAN, ISRAEL AND THE PALESTINIAN TERRITORIES

10.2.1 Current observations and future predictions

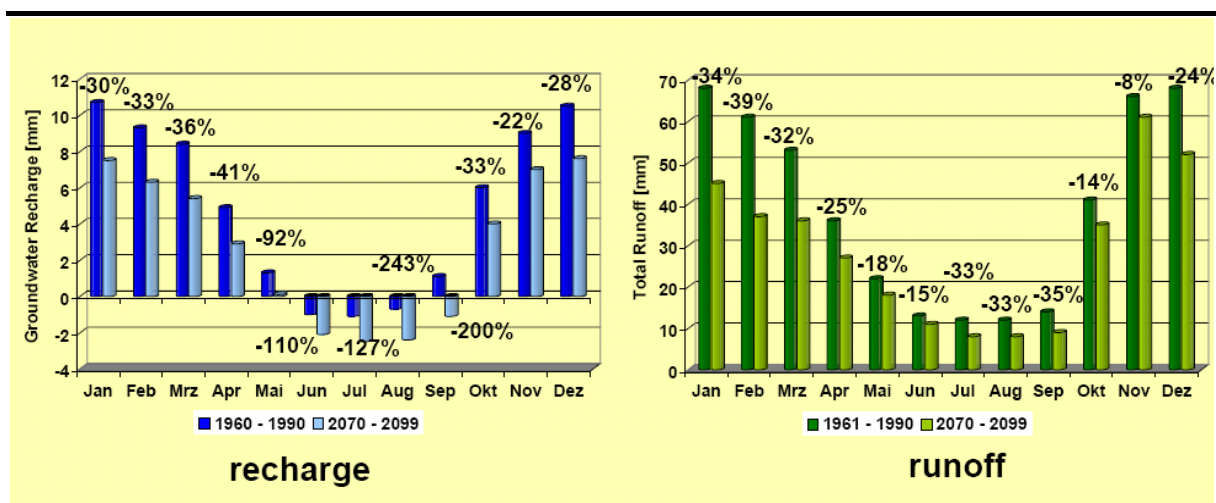
In a simulation conducted by Carmi et al in order to conduct a drought analysis in the West Bank and assesses the impact of climate change, it was observed that the possible increased rainfall intensity coupled with an increase in extreme events, and an overall reduction in precipitation will lead to increased soil erosion, runoff and salinization. This in turn will cause loss of biodiversity and increase desertification. Given that groundwater levels are shallow in the Iskandaroun catchment that was studied, the reduction in recharge and the increased salinization will deteriorate the water quality. Palestine already suffers from water shortage and if the available quantities are polluted the situation will be more critical and will likely cause a rise in the incidence of water borne diseases. The increased water stress will increase the likelihood for water resource conflicts in the region. This will also increase abstraction from groundwater and will deplete the storage, especially in the northwestern part of the West Bank, where agriculture is the main source of income and is dependant on groundwater.

Winter precipitation trends over the whole eastern Mediterranean showed an overall fall in rainfall between the years 1948-2000 period (Shamir 2004, Alpert et al. 2006a, Lozan et al. 2007). An exception to this was an area including Southern Israel and parts of Northern Egypt which experienced cooler winter temperatures and a moderate winter precipitation increase (Alpert 2004, Shamir 2004, Jacobeit et al. 2007). The rainfall distribution over the study area has also changed; the predominant decrease in average rainfall has been coupled with an increase in extreme daily rainfall, i.e. torrential rain (Alpert 2004, Alpert et al. 2006a, Lozan et al. 2007). Added to this, a significant increase was revealed in the index of maximum number of consecutively dry days (Kostopoulou & Jones 2005), indicating an observed trend towards a drier, more extreme and sporadical precipitation regime of torrential rain and dry spells.

Predictions covering the entire Mediterranean region suggest up to 35% rainfall reductions by 2071-2100 (Alpert et al. 2006b), reducing inland water flows and water yields. The IPCC projects, under an A1 scenario, a 4 to 27% average decrease in precipitation for the south eastern Mediterranean, with significant spatial and seasonal variation (Alley et al. 2007 IPCC WG1). Regional circulation models findings suggest even greater falls in precipitation, with a decrease in mean annual precipitation of up to 50% in the Jordan River Basin (Tielbörger

2006), caused by a decrease in Mediterranean cyclones (cyclonic, rain cloud forming low pressure systems) associated with a northern extension of sub tropical highs (Piero et al. 2006).

Figure 10.1 Hydro climatic Scenarios for the Jordan River Basin for the Coming Century



Source: Hoff & Tielbörger 2006

With a mere 1.5 °C warming, Mediterranean biomes are projected to shift 300 to 500 km northward and 300 to 600 m uphill due to precipitation changes. Biome refers to the ecology of a broad geographical area, characterized by the plants and animals of that area and maintained by its climatic conditions. In Israel, the desert biome of the Negev, comprising low, sparse vegetation may be expected to replace ecosystems of the denser, taller vegetated Mediterranean biome of the agriculturally productive north (Pe'er and Safrieli 2000).

Further, and following current trends, a tendency to a more extreme climate with more uneven rainfall distributions is projected (Alpert et al. 2006b). A 46% increase in 'significantly drier than normal' years is expected for the study area (Christensen et al. 2007), along with an exponential increase in drought probability- the return period of a drought in 2070, which is expected to occur once every 100 years under current climate conditions, is reduced to less than ten years in the eastern Mediterranean. This is coupled with a projected increase in the frequency of extreme precipitation events in line with current trends (Kasang & Kasper 2007). Increased rain intensity leading to reduced groundwater percolation, a shorter rainy season and increased rates of evapotranspiration of up to 10%, together with reduced precipitation are together projected to reduce the study region's water supply drastically. Pe'er and Safrieli (2000) conclude that Israel's total water supply could fall by up to 60% by the end of this century, a trend likely to be consistent across the region.

10.2.2 Impact of Predicted Climate Change on Water Scarcity and Drought, and Socio-economic and Political Implications

Across the region, climate change is predicted to reduce water availability severely, in places by up to 60% in the coming century. Water shortages are likely to worsen and in places become critical. Reductions in water availability are likely to have drastic effects on agriculture, economic diversity and productivity, lead to a loss in GDP, displace large numbers of people, and lead to food shortages.

In a number of places across the region, particularly in places where a majority of agriculture is rainfall dependant, and to a somewhat lesser extent spring fed such as the Palestinian Territories, the agricultural sector may be forced into a drastic adaptation, or otherwise face collapse. This is due to a combination of reduced rainfall, greater sporadicity in rainfall events, and increasing droughts. These factors are likely to aggravate economic and developmental challenges and increase poverty in the region.

While ocean-water desalination offers a means for alleviating some of the region's water problems, it is limited by space, coastline, and energy demand, and is financially viable only for domestic water supply.

An in-depth study of the political implications of climate change in the Middle East is beyond the scope of this report. Nevertheless it is worthy to note that climate change is likely to reduce the availability of basic resources, primarily water and food, in the region. Such water scarcity is likely to contribute to factors which will aggravate civil and international tensions, heighten anti-government sentiment, further alienate people, foster extremism and radical fundamentalism. Water scarcity exacerbated by climate change is thus also likely to threaten both existing and potential peace agreements, thus acting as a threat multiplier in this already turbulent region.

Some Recommendations

International, national and local efforts to curb greenhouse gas emissions need to be prioritized and enhanced with urgency in order to minimize future climate change and its impacts. Extensive adaptation measures need also to be adopted, including water conservation, increasing water use efficiency, and the possible resettlement of populations in areas particularly vulnerable to climate change. Drought contingency plans need to be developed and worked into planning and legislation at all levels, including peace agreements. Cooperative efforts need to be undertaken within and across countries to tackle the causes and effects of climate change and adapt to future climates with an approach that utilizes the challenge as a reason for cooperation rather than a trigger for conflict.

Some more specific recommendations on the local level include a complete rehabilitation of extremely inefficient water transport infrastructure such as that in Amman where up to 70% of water is lost in transport, and the sharing of water saving technologies, such as the Israeli drip irrigation system which can make significant water savings in agriculture and enhance its viability, particularly in the face of climate-change-affected water regimes.

11 VIRTUAL WATER

11.1 INTRODUCTION

Demand for the world's increasingly scarce water supply is rising rapidly, challenging its availability for food production and putting global food security at risk. Agriculture, upon which a burgeoning population depends for food, is competing with industrial, household, and environmental uses for this scarce water supply. Even as demand for water by all users grows, groundwater is being depleted, other water ecosystems are becoming polluted and degraded, and developing new sources of water is getting more costly.

There is an urgent need to develop appropriate concepts and tools to bridge water management practice and economic thinking.

The concept of Virtual Water was coined in London in about late 1994 some years after finding that the term 'embedded water' did not have much impact. The idea is derived from Israeli analysis by Gideon Fishelson et al in the late 1980s which pointed out that exporting Israeli water in water intensive crops did not make much sense.

11.2 VIRTUAL WATER PRINCIPLE

The principle of virtual water is really simple. Water is required for the production of food such as cereals, vegetables, meat and dairy products. The amount of water consumed in the production process of a product is called the 'virtual water' contained in the product (Allan, 1998). For example, to produce one kilogram of wheat we need about 1000 litres of water. For meat we need about five to ten times as much!

11.2.1 Virtual Water Trade

Virtual water trade as such is not new; it is as old as there is exchange of food. With the trade of goods especially food - there is a "virtual flow" of water from commodity exporting countries (food and manufactured goods) to the countries that import those commodities. It allows some countries to support other countries in their water needs. Instead of producing these goods themselves, the importing country can utilise this water for other purposes that else would have been necessary for its production. So, a water-scarce country can import products that require a lot of water for their production rather than producing them domestically and by doing so allow real water savings relieving the pressure on water resources.

Importing countries need not be water poor or water short to be receiver of this virtual flow. For example, the bananas and citrus are imported by Canada - the richest country in water, a down-streamer on the virtual flow of water that originates in Central America. In this environment of world trade, virtually all countries are down-streamers of virtual flow of water, and a great many of them are up-streamers, even those of high water shortage like Jordan or Gaza of which both also export food commodities (citrus, vegetables). With virtual water trade optimisation of the use of water as a scarce commodity in terms of environmental, social and economic value becomes possible.

Reversibly, water-rich countries could profit from their abundance of water resources by producing water-intensive products for export. Virtual water trade between nations and even continents could thus ideally be used as an instrument to improve global water use efficiency, to achieve water security in water-poor regions of the world and to alleviate the constraints on environment by using best suited production sites (Turton, 2000).

The estimates on present annual Virtual Water Trade range from 1,040 – 1,340 km³ depending on the perspective taken as water saver/importer or producer/exporter (Hoekstra ed., 2003). To put this in perspective, the total annual freshwater withdrawals (blue water) amount some 3.800 km³ of which 2000 km³ are consumed or for agriculture these values are respectively 2.500 km³ for withdrawals and 1.750 km³ for consumption (Cosgrove and Rijsberman, 2000). This means that an amount of 50-70% of the total consumed blue water is traded. However, a great amount of virtual water is green water. So, if we include the soil water (green water), then the virtual water trade amounts some 15% of the total water use on earth, including rainfed agriculture.

Trade in cereals and other crops amount to some 60% - 67%, animal products 23%– 26% and others 10-14%. Jordan is for 80-90 % dependent on virtual water imports.

The box below shows the water content for selected products.

Figure 11.1 Virtual Water Content for Selected Products

<i>Virtual water content for selected products</i>	
[m³/ton]	
<i>(Zimmer D., and D. Renault 2003)</i>	
Wheat	1,160
Rice	1,400
Soybean	2,750
Beef	13,500
Pork	4,600
Poultry	4,100
Eggs	2,700
Milk	790
VIRTUAL WATER CONTENT OF DIETS	
[M³/PERSON/DAY]	
<i>(D. RENAULT, W.W. WALLENDER, 2000)</i>	
Diet 0 (reference USA)	5.4
Diet 1 25% reduction animal product	4.6
Diet 2 poultry replaces 50% beef	4.8
Diet 3 vegetal products replaces 50% red meat	4.4
Diet 4 50% reduction of animal products	3.4
Diet 5 vegetarian	2.6
Diet 6 Survival	1.0

11.3 BLUE AND GREEN WATER

A differentiation of the origin of virtual water can be made in blue and green water. Blue water (groundwater, surface water) generally has many alternatives for its development and use because of the flexible access and its transportability. This is much less for green water (soil moisture in the unsaturated zone), which can only be taken up by local vegetation. Whatever the origin, the virtual water discussion should focus on water for which there is an alternative use and water for which there is not. Where the alternative uses for blue water are obvious and manageable (domestic water supply-agriculture-industry-environment), the possibilities for alternative uses for green water are not always that obvious. However, green water also has alternative uses (rainfed natural cover or any rainfed cultivated crop). This requires changes in crops or land use and will usually not importantly change the water balance in a quantitative sense but could make important differences in qualitative sense.

In many countries, pasture is not natural but the result of encroachment of population and farming systems on forests. The alternative for such pasture could be forest or plantation, which produces some other values - not necessarily food but conservation of bio-diversity, erosion control, or even commercial forest exploitation. There are cases though for which use there is no alternative, like a study made by FAO in Mauritania, showing that this arid country is exporting virtual water through the trade of goats, which are produced almost in a desert land taking advantage of little rain and small water streams on huge areas. Here there is apparently no alternative for this water use other than feeding goats.

The virtual water content of for example timber, coffee, tea, rubber, oil palm etc comes from rain. The economic benefits for these regions up in the hills are very important. This can not be considered as a waste of water given their value added (especially when processed) and foreign exchange contribution, not to mention economic support of many thousands of families. The change of this forest land into plantations will not have much effect on the water balance of the region - no water will be saved for other purposes elsewhere – but more on the environmental and economic situation of the region. It must not be forgotten that in the absence of these cultivations, the regions would have been covered with natural forests with rich biodiversity.

11.4 POLITICS OF VIRTUAL WATER

At the global level, virtual water trade has geopolitical implications: it induces dependencies between countries; it is influenced by and has implications on the world food prices as well as on the global trade negotiations and agreements on tariffs and trade. Indeed the issue of virtual water is related to that of globalization, which raises a concern among many politicians and the general public. This can be understood from the fact that increasing global trade implies increased interdependence of nations. This can be regarded either as a stimulant for co-operation or as a reason for potential conflict. Alternatives to the current trends and directions of economic globalization must be developed, tested and supported. Regional approaches are worthwhile to stimulate. The problem in the virtual water trade could be solved through special trade agreements among regions, common market countries, and even between countries of different commercial blocks (e.g. Mercosur & Europe).

Trade cannot take place only because of demand and supply - there is also the question of affordability as well as economic priorities of the importing countries. In Virtual water trade one has to consider the food import requirements of the water scarce countries and the willingness of water abundant countries to produce these products, if soil and climatic

conditions permit, at a price that is acceptable and affordable for the importing countries. Therefore, even if countries face water scarcity, they may consider the needs to produce the basic crops themselves priority, if they cannot afford to import products.

11.5 APPLICATION OF VIRTUAL WATER CONCEPT IN THE MEDITERRANEAN REGION

In the Mediterranean riparian countries, water resources are limited and unevenly apportioned over space and time. Southern rim countries are endowed with only 13% of total resources. The Mediterranean countries water demand having doubled up within the second half of the twentieth century is likely to further rise by about 50 Km³ by 2025 to reach 330 Km³/yr. the increasing scarcity of water resources in certain parts of the region is likely to exacerbate under the impacts of climate change.

Virtual water is an indicator that can highlight the various types of interaction between sectoral policies, especially the agricultural ones, and efficient water management. It highlights the connection between needs and food preferences on the one hand and agricultural policies in surplus-producing regions that influence the way water in the watersheds is used, on the other hand.

Indeed, water is a scarce resource in Mediterranean region and it is unevenly apportioned over space and time. In this context, The Plan Bleu for the environment and development in the Mediterranean proposed to study the relevance of the concept of virtual water (amount of water necessary for the production of a specific imported commodity) for an analysis of water management and distribution strategies and of its connection with the sectoral policies of the Mediterranean countries.

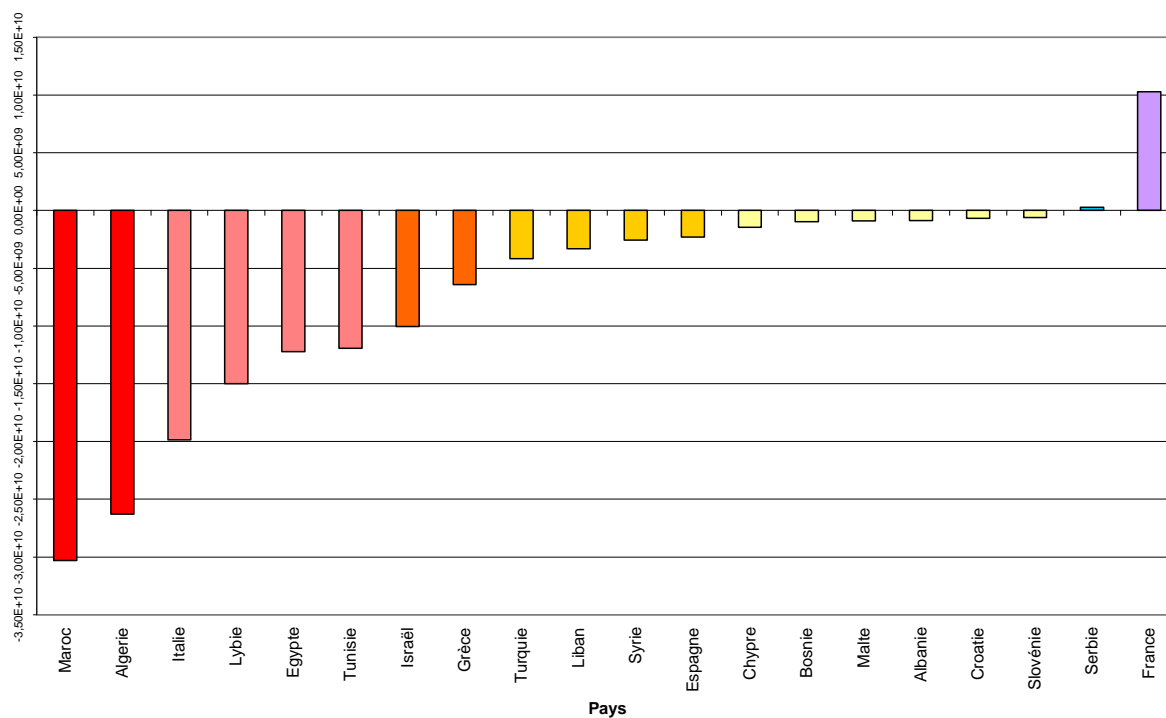
The results of the quantification of virtual water flows ⁽¹⁾ (*Figure 11.2*) highlight the importing nature of the Mediterranean region (considering the twenty-one rim countries). If we consider all the selected products, only France and Serbia-Montenegro are net virtual water exporters over the period 2000-2004. All the Southern and Eastern Mediterranean countries are net virtual water importers, with Libya being the largest net importer per inhabitant (2800 m³/inhabitant/year).

There is a stark contrast between the Northern and the Southern and Eastern Mediterranean countries regarding their virtual water exchange profiles. However, there are some exceptions (Syria, Spain, Italy)² by and large determined by factors that are not only physical, but are rather related to trade and food security policies impacting water uses and virtual water flows.

(1) The quantification focused on flows of virtual water associated with selected agricultural products accounting for 70% of the total virtual water volumes exchanged through agricultural products trade from and to the studied Mediterranean countries (wheat, barley, soya bean, olives, beef and specific crops such as dates). The contributions of blue water (irrigation water) and of green water (rainwater and soil water) have been calculated separately

(2) In Syria, a large-scale programme for the development of irrigation, together with an intensification of the use of groundwater, has resulted in a high growth of agricultural production and exports over the period 1990-2000. Spain and Italy are net virtual water importers, on the whole, while their water resources per inhabitant are fairly high and close to those of France. Spain is, however, the Mediterranean country that is the largest net exporter of virtual water linked to trade in bovine meat, a large part of this virtual water being generated by imports of grain for animal feed.

Figure 11.2 *Net balance of Virtual Water Exchanges related to international trade in grain, soya bean, olives, specific crop products and bovine meat, average over the period 2000-2004 (billion m³/year)*



Source: Fernandez & Thivet, Plan Bleu (2007)

Virtual water flows in the Mediterranean via exchanges of cereals are quantitatively significant, in particular when compared with the volumes of virtual water consumed for the national production of the countries studied, or with their water resources available. For the importing countries, these flows may involve "water saving" if they induce reallocations - whether productive or not - of the non mobilized resources. The transfers of virtual water also entail consequences for the exporting countries because their increased mobilization may generate tensions between the users and environmental degradation.

The transfers of virtual water are generally made in a disguised and often non conscious, manner insofar as they result from choices based on other issues (food safety, trade balance). The concept of virtual water thus proves to be an interesting tool for analysis inasmuch as it highlights the prevailing phenomena by giving orders of magnitude and calling for consideration, while its prescriptive value still remains to be proven.

An economic analysis, complementary to the agronomic analysis, should make it possible to address the objectives of the agricultural policies in terms of trade balance and food security, so as to then study their impacts on the management and distribution of water in the countries considered. It is indeed advisable to refocus the debate on the countries' food security strategies (strategies aimed at food self-sufficiency or relying on the international market), while taking into consideration the social dimension of agriculture. The harnessing of the concept of virtual water thus relates to the reforms of a macro-economic nature, to the debate on the distribution between rainfed crops and irrigated farming, as well as to issues pertaining in the integration of agriculture in the markets.

12 CONCLUSIONS AND RECOMMENDATIONS

The information presented in the report provides an initial assessment of the extent and impacts of water scarcity and droughts in the Mediterranean Region, thanks to countries' efforts in collecting data.

However, some data gaps remain (some countries not covered, major lacks of information). Additional work is therefore needed in order to deliver a comprehensive overview of the extent and impacts of water scarcity and droughts in the Mediterranean Region.

- Prior indicators could be set-up and agreed by the countries of the Mediterranean Region in order to ensure the collection of relevant and comparable data at national level and therefore reflect the true situation at river basin level.
- The impacts of climate change on the future evolution and extent of water scarcity and droughts need to be further assessed, as they will directly affect the water availability across the Mediterranean Region and are expected to exacerbate the water stress in already sensitive river basins.
- The economic, social and environmental impacts of the issues need to be better quantified. Impacts due to water scarcity and droughts have been hardly estimated so far.
- In the light of these shortcomings, the following next steps and deadlines are foreseen.

By the end of 2008

- Carry on the activity of the Mediterranean Working Group on water scarcity and droughts based on the following tasks:
- Further develop the sharing of good practices
- Start working towards the establishment of an effective Mediterranean drought information system by discussing the steps and (financial and human) resources needed
- Take into account the future results of research projects on the impacts of climate change on droughts

From 2009 onwards

The Med WG would:

- Prepare detailed Terms of Reference for a Mediterranean Drought Observatory, linked to the forthcoming EU Med Drought Observatory and the Mediterranean Water Information System
- This objective entails the following actions:
- Set-up a range of indicators related to the extent and impacts of these issues, agreed by the Mediterranean countries

- Organise the collection of information within the countries, according to the set indicators
- Ensure the dissemination by the Med Observatory of an annual in-depth assessment on basis of countries' information

The Water Directors of the Mediterranean countries will be regularly informed of the outcomes of the work.

ANNEX A: ACRONYMS

Acronyms	Meaning
AWC	Available Water Content
CHJ	Jucar River Basin Authority
CPS	Permanent Drought Commission
EEA	European Environment Agency
EC	European Commission
EU	European Union
EUWI	European Union Water Initiative
FAO	Food and Agriculture Organisation
GES	Good Ecological Status
IGME	Spanish Geological and Mining Institute
IPCC	Intergovernmental Panel on Climate Change
MCSD	Mediterranean Commission on Sustainable Development
MIMAM	Directorate General for Water of the Ministry of the Environment, 1995
MSSD	Mediterranean Strategy for Sustainable Development
NAP	National Action Plan
OTS	Drought Management Plan
PDSI	Palmer Drought Severity Index
PES	Temporary Drought Plans, 2007
PHDI	Palmer Hydrological Drought Severity Index
PHN	National Hydrological Plan, 2001
RAI	Rainfall Anomaly Index
RDI	Reconnaissance Drought Index
SPI	Standardized Precipitation Index
SWSI	Surface Water Supply Index
TRLA	The Revised Text of the Water Law, 2001
UNCCD	United Nations Convention for Combating Desertification
WDM	Water Demand Management
WEI	Water Exploitation Index
WFD	Water Framework Directive
WMO	World Meteorological Organisation
WS&D	Water Scarcity and Drought

ANNEX B: SOURCES

Chapter	Source
Chapter 3	Vlachos, 1982
Chapter 4	Gibbs e Maher, 1967 Palmer, 1965 Shafer and Dezman, 1982 McKee et al, 1993 Van Rooy,1965 Tsakiris et al., 2006 Yevjevich, 1967, 1983 Rossi et al., 1992 Cancelliere et al., 2004 Bergman et al., 1988
Chapter 5	Brooks & Mehmet,2000 Jagerskog 2003, Tropp & Jagerskog 2006 Allan, 2002 Phillips, 2004 Benoit & Comeau, 2005 Bou-Zeid & El-Fadel, 2002 Bucknall, 2007
Chapter 6	Rabi, A., Khaled, A. & Carmi, N, <i>Integrated Water Resources Management Under Complex Hydro-political Conditions – The Palestinian Case Study. In: Third World Water Forum, Kyoto, March 2003</i> Gleick, 1993 Wolf, 1995 Beaumont, 2000 Medzini & Wolf, 2004 Wolf, 2000 Postel & Wolf, 2001 Blanford, 2002 Daibes, 2004 Lowi, 1993 Berland, 2000 Selby, 2006
Chapter 7	Plan Bleu, 2005 Hamdane, Fiuggi workshop, 2002 DGH Rabat, 2002 Abed Rabboh, <i>Report on water demand management in Syria</i> ,2007 Water Development Department (www.moa.gov.cy/wdd), <i>Subsidies</i> , 2008 Faby, Nion, <i>Report on water demand management in France</i> , 2007 Hamdy <i>Synthesis of the main outputs of the Regional Action Programme on Water Resources Management (1998-2003)</i> , 2006 Playan, Caverro, Mantero, Slavador, Lecina,2006 Limam, 2007 Oubalkace, <i>Report on water demand management in Morocco</i> , 2007 Papadimos, 2007 Hamdane, <i>Report on water demand management in Tunisia</i> , 2007 Jeudi de Grissac, 2007 Benoit & Comeau, <i>A Sustainable Future for the Mediterranean: The Blue Plan's Environment and Development Outlook</i> , 2005 Margat, 2004
Chapter 8	<i>Jucar River Basin Authority Drought Protocol</i> , 2005
Chapter 10	Shamir, 2004, Alpert et al. ,2006 Lozan et al. ,2007 Alpert, 2004, Shamir, 2004, Jacobeit et al., 2007 Kostopoulou & Jones, 2005 Alley et al., 2007 IPCC Tielbörger, 2006 Piero et al., 2006 Hoff & ö Tielbörger, 2006 Pe'er and Safriel, 2000 Christensen et al. 2007

Chapter	Source
	Kasang & Kasper 2007
Chapter 11	Allan, 1998 Turton, 2000 Hoekstra ed., 2003 Cosgrove and Rijsberman, 2000 Fernandez & Thivet, Plan Bleu, 2007