Resources and Water Demand: Forecasts for the Future of Water in the Mediterranean

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An essential resource for humanity and for ecological balance, water is at the core of the problem of sustainable development. Its management in the Mediterranean area, where it is unequally distributed in time and space, is today characterised by non-sustainable forms of production and consumption, frequent failure to take into account the long term, and policies chiefly concerned with the water offer. Today these approaches are reaching their limit and are coming up against growing social, economic and ecological obstacles in almost all the Mediterranean countries.

Resources are already being overexploited in many places, and there will continue to be significant increasing water requirements as a result of the population growth in the South and East and with the development of tourism, industry and irrigated areas.

Within the context of a growing water shortage in part of the region, and in the light of the uncertainties arising from the climate change, the Mediterranean countries are now confronted with several challenges: sustainable management of limited resources, ensuring access to drinking water for the population groups who are not yet supplied, and raising the users' awareness of the importance of water-saving habits.

The first of these challenges means implementing water demand management policies able to reduce loss and inefficient use, managing the resource fairly and assuring its different uses are catered for. An increase in the water offer will also presumably be necessary to be organised through improved resource management (increasing the amount of potentially usable water and combating pollution) or through non-conventional forms of water supply (recycling of treated waste water and desalination of sea or brackish water). The second challenge involves putting the Millennium Development Goals into practice as regards access to drinking water and sanitation. The third calls for reinforcement of the partnerships between the users and the local water management organisations, together with water saving awareness-raising campaigns geared towards the former.

The work of the Blue Plan and the recommendations resulting from the regional workshop it organised in 2007 with its regional water sector partners highlight the pressing need for adaptation of water management policies, improved administration of the different uses and a more economical, efficient use of resources, in order to respond to the population's demand and the need for development in the present and future.

Water Resources in the Mediterranean Region

Fragile, Irregular Water Resources

The conventional renewable water resources – the so-called "natural" water resources – of the group of Mediterranean countries are globally estimated to be around 1,080 km^3 per year, for an average year.

The most important issue is the conspicuous unbalance in the geographical distribution of these resources:

- two thirds (2/3) are located in the North
- a quarter (1/4) are located in the East
- a tenth (1/10) are located in the South.

The group of 6 countries with the shortest supply (Cyprus, Israel, Libya, Malta, the Palestinian Territories and Tunisia) possesses less than 1% of the whole.
The Mediterranean is home to 60% of the world's "poor" with regard to water (those with less than 1,000 m^3 per inhabitant per year) and twenty million people currently without access to drinking water, particularly in the southern and eastern countries.
Overall, 28% of these resources, i.e. some 300 km^3 per year, cross the borders and are common to several countries, Mediterranean and others. The rate of dependence on external resources is particularly high in some of the countries: 97% in Egypt (the Nile), 55% in Israel (the Jordan, Mountain Aquifer), 47% in Croatia, and 43% in Syria (the Euphrates).
However, quantifying water resources by annual averages by no means presents a whole picture of the situation, and the gaps are more significant than the averages: with the Mediterranean climate, the annual amounts vary greatly according to wet and dry years; in 9 out of 10 years the minimum assured resources, corresponding to the amounts for a decennial dry year, can fall to a third or a quarter of the average. The variability differences between seasons and years, more marked in the southern and eastern regions, increase this contrast.
The resources should not merely be restricted to "blue waters," i.e. surface or ground water sources; the "green waters" proceeding directly from rainfall, with an average annual flow of up to 400 - 500 km^3 per year in the Mediterranean countries, should also be taken into account. These resources have a similarly unequal distribution: 65% in the North, 20% in the East, and 15% in the South. These figures explain the increase in the demand for irrigation water in the eastern and southern countries, often over 60% and reaching almost 90% in some countries.

Indicators to Illustrate Water Resource Evaluation

The competition indicator and the inverse ratio – the index of resources per inhabitant – are very sensitive to population variations and are in general an efficient expression of the relative wealth or scarcity of water in a country. These indicators are of practical use for comparisons on a national level, and particularly for forecasting purposes, as they rest on the only demographic variable, which is relatively easy to forecast. The figure for "natural" water resources per inhabitant is the first indicator able to define situations of "water stress" or "scarcity" (1,000-500 m^3 per head per year) and "structural shortage" (less than 500 m3 per year per head). The differences between countries and between interior regions or basins are even greater. For example, the natural resources per inhabitant in Montenegro (a Mediterranean record: over 25,000 m^3 per year) are 500 times greater than those of Gaza, the territory with the least resources!
This unbalance is further increased if we express water availability by calculating how many inhabitants need to share each million m^3 per year. This competition indicator varies from 40 inhabitants in Montenegro to 25,000 in Gaza!
This stress affecting water resources is even more important when we consider that not all of the natural renewable water resources are necessarily "usable." In practice, genuinely usable water resources represent around a half or a third of the renewable natural resources. This phenomenon is due to practical limitations (only a third of the whole consists of regular flows), and others of a socio-economic and environmental nature (particularly for the conservation of the aquatic eco-systems). The key figures in Table 4 sum up the contrasts between sub-regions.

TABLE 4 **Renewable and Usable Water Resources in the Mediterranean Region (2004)**

		Sub-regions			
		North (Europe)	East (Near East)	South (North Africa)	Overall
"Natural" Renewable Resources, "Blue Water"	**km^3 per year**	740	247	95	1,083
	%	68	23	9	100
(annual averages)[a]	**m^3 per inhabitant per year**	3,915	2,371	631	2,441
Average Competition Index	**No. of inhabitants per hm^3 per year of resources**	255	422	1,584	410
Usable Resources	**km^3 per year**	359	133	81	572
(annual averages)[b]	**m^3 per inhabitant per year**	1,899	1,279	536	1,289
In Comparison: Average "Green Water" in km^3 per Year[c]		300	100	70	470

Source: Blue Plan, 2007. a. Internal and external resources, calculated by sub-regions. Exchanges between bordering Mediterranean countries have not been counted twice; b. According to each country's particular criteria; c. Rainwater used and consumed (evapotranspired) by irrigated agriculture and pastureland.

Water Demand and Use in the Mediterranean

Total Water Demand

The approximately 281 km³ per year used by the inhabitants of the Mediterranean is also unequally distributed, less so between the North and the South-South-East than between consumer sectors. Irrigation greatly prevails in the South and the East: 81%, as opposed to the 64% on average for the region as a whole. As regards demand per inhabitant, while this seems quite similar on average per sub-region, it is much more contrasted when calculated by countries: it varies from over 1,000 m³ per year (Egypt) to under 100 m³ per year (West Bank, Montenegro, Croatia). There again, the variation in the relative weighting of irrigation explains most of the differences.

Like the resources, the demand calculated per basin is marked by significant unbalances: the record for demand per inhabitant is in Spain, in the Ebro basin: 3700 m³ per year in around 2000.

Water demand is not linked to levels of socio-economic development, and the most developed countries do not use more water than the "developing" countries; in fact the opposite is true. Compared with each dollar of agricultural added value, the annual amounts of water used for irrigation range from around 15 litres in Slovenia to over 3000 litres in Syria and in Egypt.

Water Demand for Agriculture

Analysis of per-sector demand shows that in most of the countries, the main user in terms of volume is still agriculture (irrigation), except in the eastern Adriatic countries and France.

The demand for irrigation water (Table 6) shows a diversity of situations. In the temperate countries, irrigation water withdrawals are not very significant (12% of the total for France). However, the dryer the climate is, the more agriculture needs to resort to irrigation (blue water) and the more its part of the total withdrawal increases. Values of around 80-90% of the total demand for blue water are registered in certain countries in the South and East. This fact highlights the importance of rainfed agriculture (green water), which is not properly exploited and should be valued in the semi-arid and arid countries. Improving the efficiency of rainfed agriculture through conservation of the water and the soils would lead to an increase in the soil's rain water storage capacity and would consequently limit the need for irrigation contribution, while at the same time reducing erosion and the consequent silting up of the reserves downstream.

TABLE 5 **Current Water Demand in the Mediterranean Countries**

		Sub-regions			
		North (Europe)	East (Near East)	South (North Africa)	Overall
Blue water demand (use) in km³ per year (2000-2005)	**Communities (drinking water)**	22.3	8.7	7.9	38.9
	Irrigated agriculture	57.7	47	76.6	181.3
	Industries not served	13.6	2.2	3.4	19.2
	Energy (cooling)	34.1	2.5	3.4	19.2
	TOTAL	127.7	60.4	92.8	280.9
Evaporation of reservoirs (approximate) in km³ per year		5	7	12	23
Sum total (rounded off) in km³ per year		133	67	105	304
2004 populations in millions of inhabitants		189	104	151	444
Average demand (of the 4 sectors) per inhabitant in m³ per year		676	580	618	633

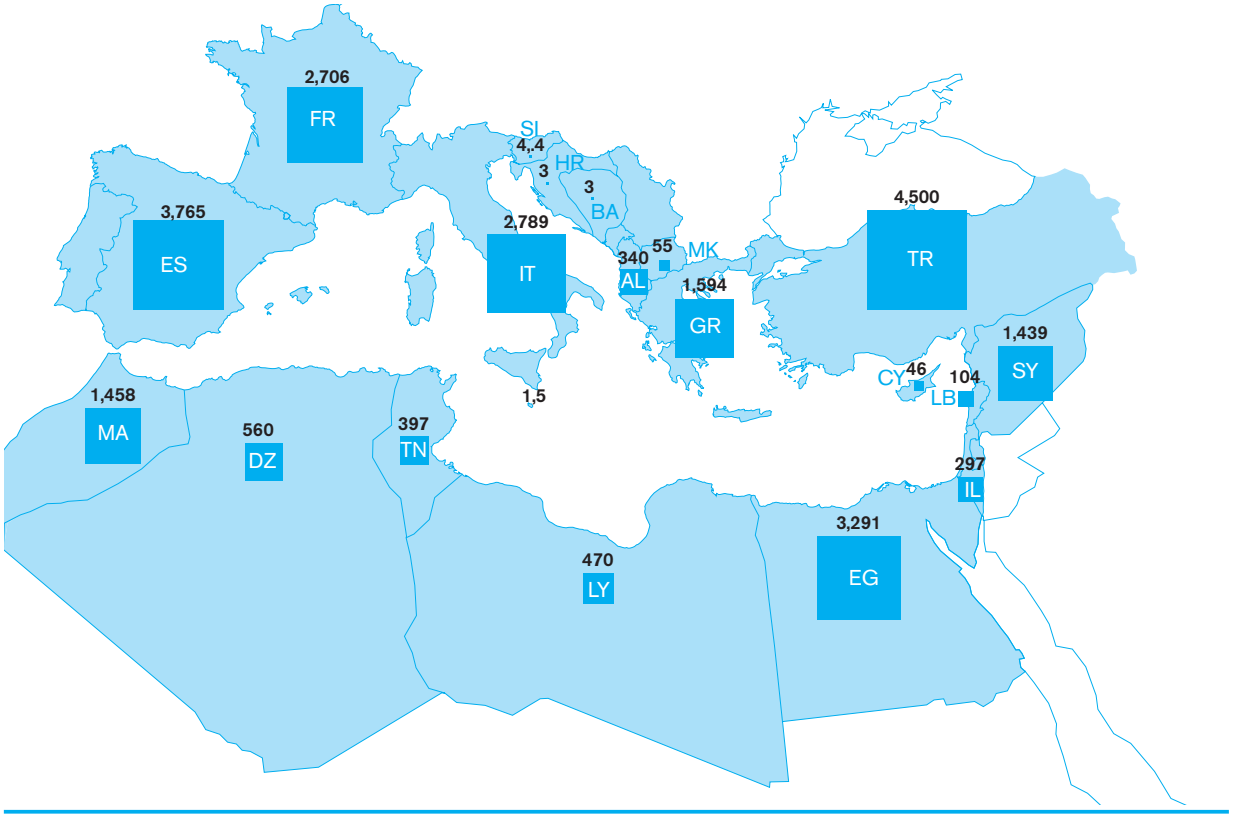
Source: Blue Plan, 2007. The key figures in table 5, in which we have considered it relevant to include the net consumption by evaporation of the dam reservoirs (the real supplementary evaporation resulting from the creation of reservoirs is calculated by the difference between the annual averages for potential evapotranspiration and real evapotranspiration applied to the air used); the total average flow for this in accordance with the world register of dams (ICOLD) should be around 20-25 km³ per year in the region as a whole.

TABLE 6 **Water Demand for Agriculture in the Mediterranean Countries**

	Sub-regions			
	North (Europe)	East (Near East)	South (North Africa)	Overall
Irrigated agriculture (blue water) in km³ per year	57.7	47	76.6	181.3
Demand for green water (rainfed agriculture) in km³ per year	276	101	70	447
Water demand for agriculture in km³ per year	**334**	**148**	**146**	**629**

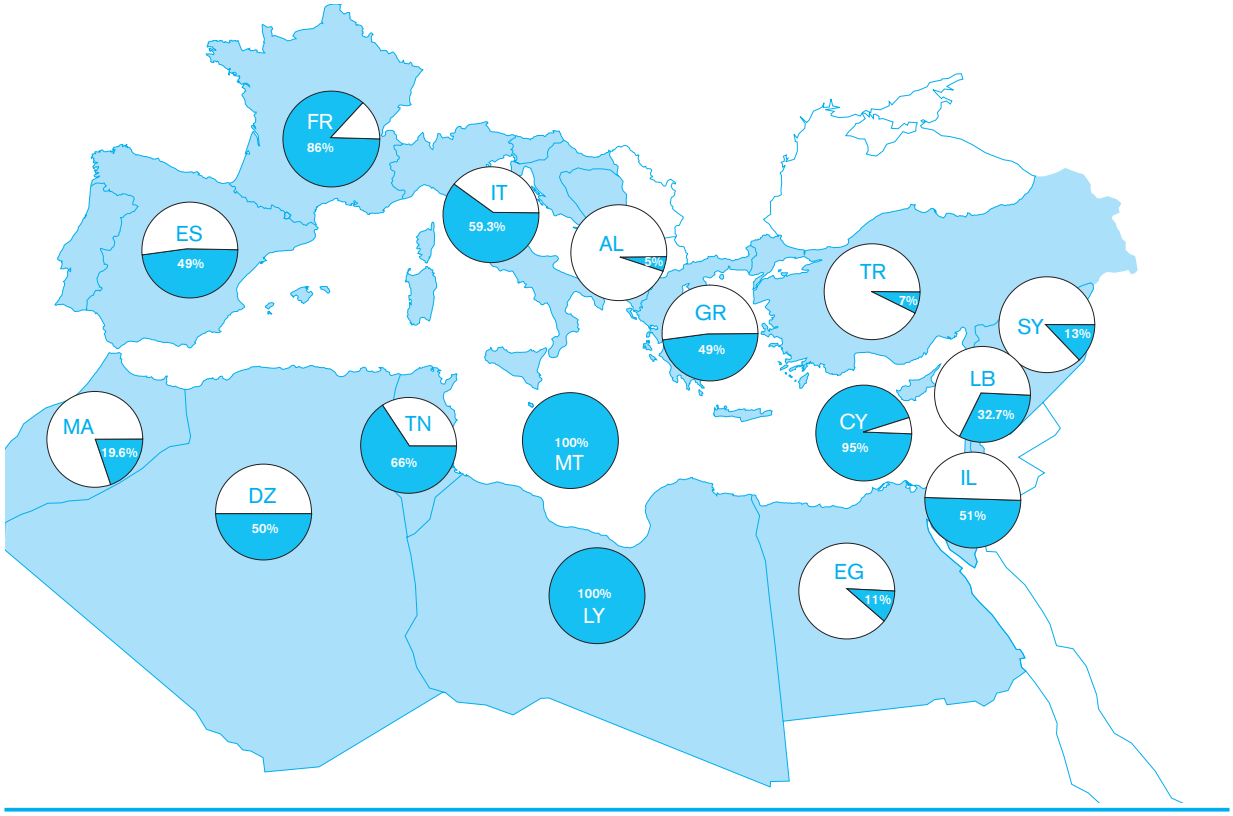
Source: Blue Plan, 2007

MAP 2 **Irrigated Surface Areas in the Mediterranean Countries (in 1000 ha)**



Source: Blue Plan, Aquastat, 2008

MAP 3 **Irrigated Surfaces Equipped with Water-Saving Equipment**



Source: Blue Plan, Aquastat, 2008

The irrigated surface areas in the Mediterranean countries and the irrigation water demand per irrigated hectare show that the proportions vary greatly from one country to another (Map 2). In 2007, around 182 billion m^3 of water was used for irrigating some 24 million hectares as compared with 11 million ha in 1961 (WWF, 2006), which represents an average water demand per hectare of around 7500 m^3.

The form in which irrigation is carried out is also very variable, the main part corresponding to gravity irrigation (in terms of surface area, and even more so in terms of volume). However, over the last few years considerable efforts have been remarked with regard to pressure networks such as sprinkling and localised irrigation in the most of the southern and eastern countries. Map 3 shows the amounts of water-saving equipment in the irrigated surface areas.

At least in theory, there is considerable room for progress, which may in fact involve irrigation output and the form of irrigation. As regards the latter, the consumption in m^3 per hectare per year varies greatly:

TABLE 7 **Variation in Consumption in m^3 per Hectare per Year**

	Consumption in m^3 per ha per year
Gravity irrigation	5,000 - 20,000
Sprinkler irrigation	1,500 - 5,000
Localised irrigation	1,000 - 3,000

Source: (FAO, 1999)

Even though the water transported to the plot in excess of the plants' requirements is reused in certain cases (irrigation by groundwater pumping or runoff), changing the form of irrigation can, more often than not, lead to significant water savings.

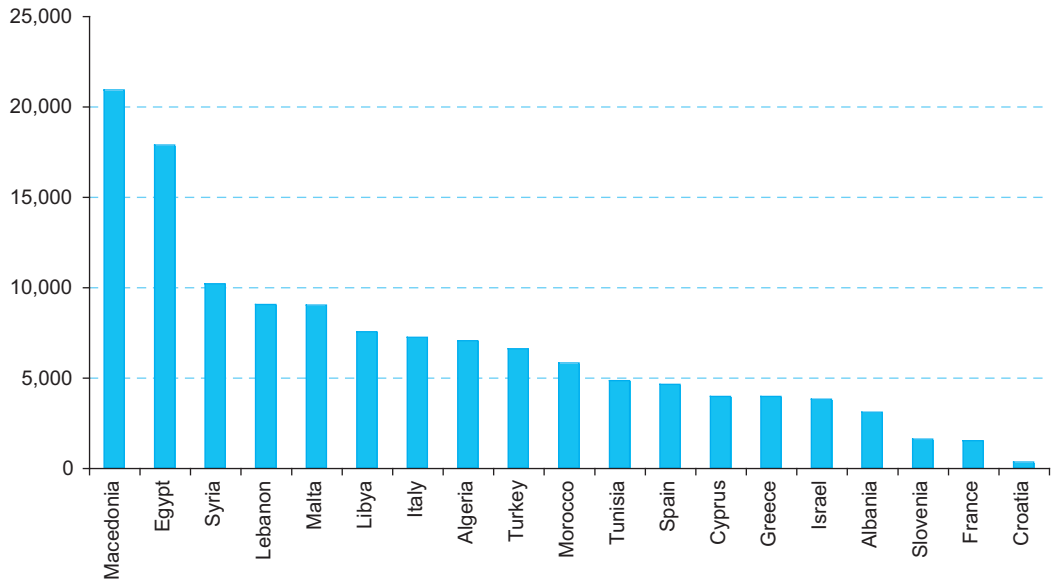
The degree of pressure exerted by the demand on the resources can be seen by the way in which agriculture, and particularly plot irrigation, is practised. The water consumption index per hectare calculated for the Mediterranean countries between 2000 and 2005 reveals a great diversity of situations (Chart 5):

- A 1st group of countries whose water consumption per hectare is between 5,000 and 20,000 m^3;
- A 2nd group of countries with a per-hectare water demand between 3,000 and 5,000 m^3;
- A 3rd group of countries whose water consumption per hectare is under 3,000 m^3.

Efficiency of Water Use

In spite of some encouraging progress (Chart 6), the current returns from water use are far from satisfactory; throughout the Mediterranean region, losses and leakages in transport, inefficient irrigation practices and squandering are estimated to be in excess of 100 km^3 per year, i.e. some 45% of the total water demand (281 km^3 per year) (Table 8). This is equivalent to a potential "pool" of considerable water savings, of which at least part could be mobilised by a more active "water demand management" policy (increased efficiency of water use).

CHART 5 **Demand for Irrigation Water per Irrigated Hectare**



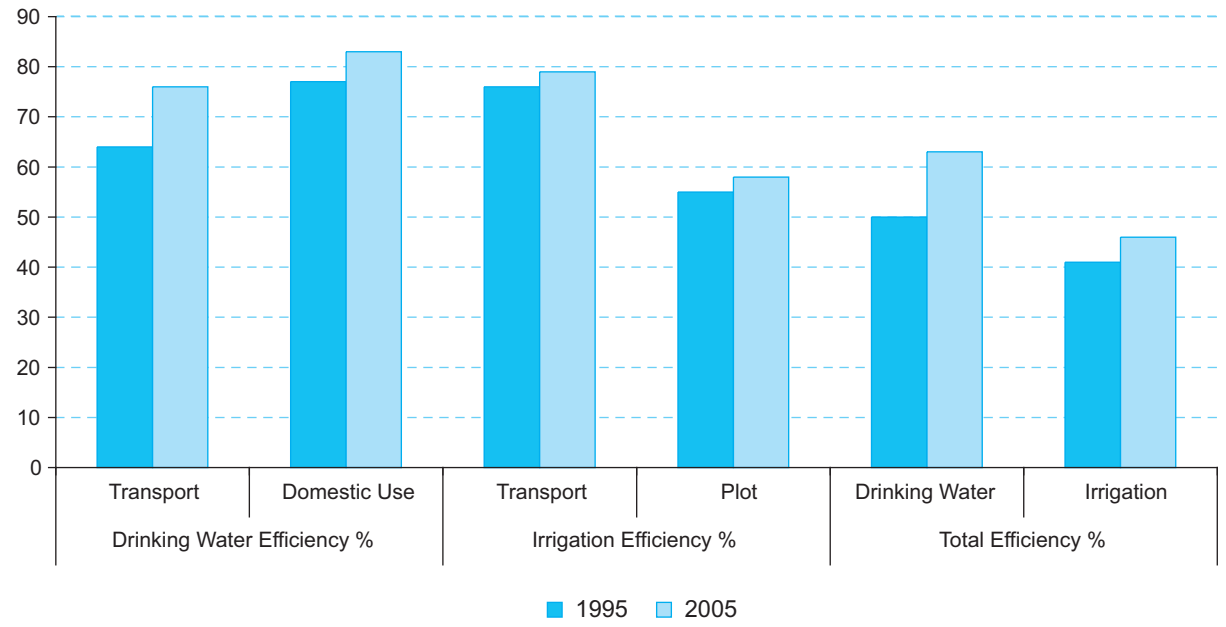
Source: Blue Plan, 2007

TABLE 8 **Current Losses and Inefficient Use of Water Withdrawn for the Drinking Water Distribution and Irrigation Sectors Only (in Km³ per year)**

	Sub-regions			Total	
Consumer sectors	**North**	**East**	**South**	**km³ per year**	**%**
Irrigated agriculture	25	24	46	95	87
Communities (drinking water)	7	4	3	14	13
Overall	**32**	**28**	**49**	**109**	**100**

Source: Blue Plan 2007, based on national sources.

CHART 6 **Efficiency of Water Use (Total and by Consumer Sectors) in the Mediterranean Countries**



Source: Blue Plan (data currently being validated).

Demand with Respect to Water Resources

Increasing Pressure on Water Resources

To evaluate the degree of water stress or shortage, these studies are based on two classic indicators (Table 9): on the one hand, renewable water resources (natural or usable) per inhabitant (M. Falkenmark, 1997), and on the other hand the use index for renewable natural resources (ratio of withdrawal to resources) each matched with revealing thresholds.

TABLE 9 **Thresholds for Water Stress and Scarcity Situations**

Situation	Average renewable natural resources (m3 per inhabitant per year)	Index of use of renewable natural resources (%)
Water stress, water shortage	500 - 1,000	50 - 100
Water scarcity	< 500	≥ 100

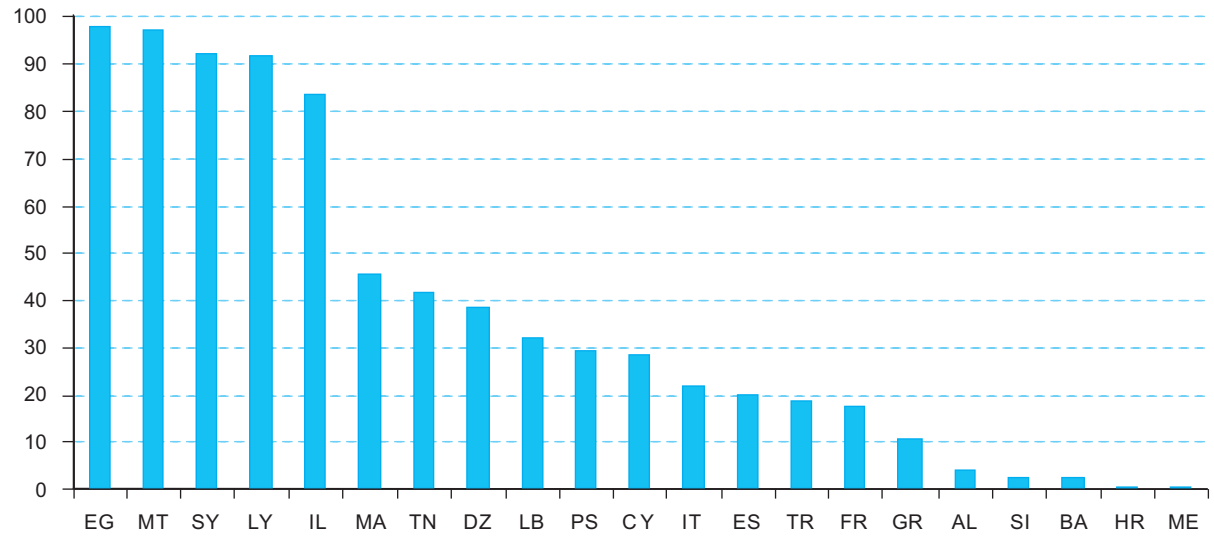
Source: Blue Plan, 2007

The average use indexes in each country suffering this pressure are a new indicator of situations of water stress (above 50%) or scarcity (approaching or even exceeding 100%), and are fairly well correlated with the resources per inhabitant.

In accordance with these criteria, all the southern and many of the eastern Mediterranean countries have currently surpassed the stress threshold, and six of them (Algeria, the Palestinian Territories, Israel, Libya, Malta and Tunisia) are in a scarcity situation.

The use indexes calculated by country have revealed three different situations (Chart 7): a first group of countries in which the ratio is under 25%, a second group of countries with a ratio of between 25 and 50%, and a third group of countries where water withdrawals approach or even exceed the limit level of renewable resources (ratio > 75%). These use indexes, calculated on a national level, may hide major disparities as regards the catchment area or on a local level, as is the case in certain countries in the North (Mediterranean Spain, southern Italy, etc.).

CHART 7 **Index of Use of Renewable Natural Resources (2000-2005) in %**



Source: Blue Plan 2007

The current pressure of water withdrawals – essential sources of water supply in most of the Mediterranean countries – are naturally highly unsymmetrical, as the demand is higher wherever there are less resources. Table 10 shows the average values for another pressure indicator (the index of final consumption of the renewable resources) and again highlights the differences between sub-regions, although the averages by countries are further contrasted.

At present, the total demand approaches or exceeds the renewable resources in several southern and eastern countries, where they are partially covered by the use of non-renewable or non-conventional resources: this is the case in Egypt, Gaza, Israel, Libya and Malta.

Developments Incompatible with Those of Water Availability

According to the forecasts made in the Blue Plan (baseline trend scenario), the water demand could be increased by a further 50 km³, reaching 332 km³ by 2025 (i.e. 18% of the current demand), with the South and the East shore countries at the root of this growth (Chart 8). Agriculture should remain the principal user of the water resources, in terms of volume, for satisfying irrigation requirements, particularly in the South and East of the basin. According to the FAO, irrigated surface areas could increase by 38% in the South and by 58% in the East by 2030, while the demand for agricultural water will only slightly increase or remain stable in the North.

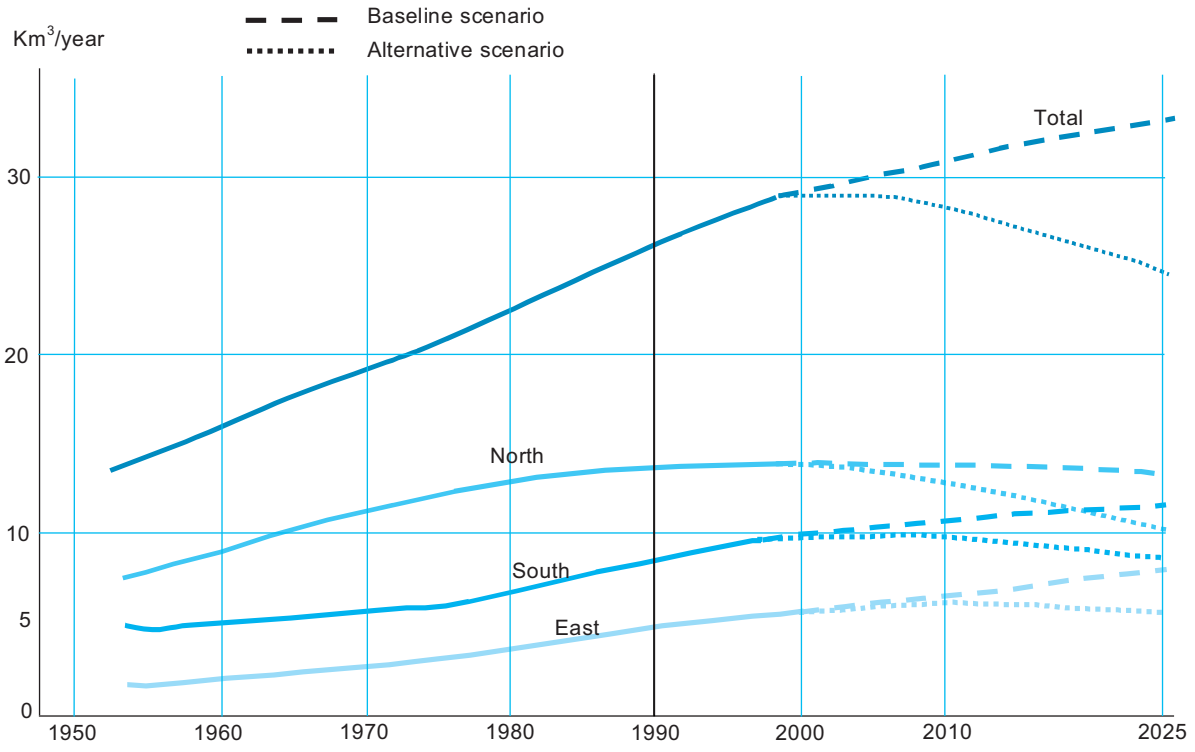
Given the essential nature of the drinking water supply, urban demand will undergo rapid, significant growth as regards allocation of resources and investment. In the southern and eastern Mediterranean countries, the urbanisation rate has in general exceeded 50% of the total population; it is increasing very rapidly and within twenty or thirty years is expected to reach the "ceiling" of 70-80% which the northern countries will soon have attained. Likewise, in the space of a generation, the population of the Mediterranean countries should increase by 10 million in the North and by 82 million in the South and East, reaching 535 million inhabitants by 2025.

TABLE 10 **Current Pressure on the Average Renewable Water Resources**

	Sub-regions			
	North	**East**	**South**	**Overall**
Current withdrawals in km³ per year[a]	128	61	72	261
Average use index (%)	16	26	76	23
Final consumption in km³ per year	276	101	70	447
Average final consumption index (%)	6	13	67	12

Source: Blue Plan, 2007.a. Withdrawals from renewable resources only. Withdrawals from non-renewable or "secondary" resources (water returns) and the resulting final consumptions are not taken into account here.

CHART 8 **Total Water Demand, Baseline and Alternative Scenarios (by Whole Countries)**



Source: Blue Plan, 2007

Furthermore, with some 300 million tourists in 2025 in the Mediterranean coastal regions, which will remain the world's top tourist destinations, tourism has the effect of increasing the demand for drinking water in the receiving areas: in luxury hotels it is 500-800 litres per person per day, much higher than that of the permanent residents. Golf courses consume as much water per hectare as well-irrigated areas do (7,000-10,000 m³ per hectare per year).

Industry, although it uses a lesser amount, is also set to increase its water consumption. This is the case for the Algerian paper pulp factories, for example, which are huge water consumers (just one factory consumes 30 million m³ per year, equivalent to a town of half a million inhabitants); and certain areas have significant projects for industrial development.

While it is difficult to quantify, the environmental demand – mainly used for the correct functioning of the ecosystems – could take on great importance. Certain countries have already included the earmarking of a minimum flow of the watercourses for species protection in their legislation (France), or have explicitly included environmental demand (Spain), and others could follow (Italy, Israel, Morocco, Tunisia, etc.).

The unequal tendencies towards growth in demand are expected to spread and worsen the unbalances, particularly in the South and the Near East. So, even if the water resources remained unchanged, the populations in a situation of water stress or scarcity could increase to 250 million by 2025 (i.e. 47%), from a total population of 535 million in the Mediterranean countries, according to forecasts made by the United Nations, and this would be even more so in the case of impoverishment of the conventional water resources. In 2050, all the countries in the South will be in a scarcity situation (Egypt and Morocco will have joined those already on the list).

Water scarcity situations are already the case in part of the Mediterranean region and they will inevitably spread and worsen in the twenty-first century, especially in the South and the East: the countries whose water resources are already the lowest per inhabitant and the most expensive to mobilise and distribute will experience the greatest increase in demand and will run the greatest risk of their resources becoming impoverished. This means considerable efforts will have to be made to adapt to the new Mediterranean contexts (economy, forms of development).

The margins for choice of water policies in the Mediterranean region are not huge, but they do exist. The poli-

cies should be modified towards a rebalance between the offer-orientated approach, which has long predominated, and an approach geared towards demand management.

Ideas for Saving a Quarter of the Water Demand

As water management is also a political issue, these trends cannot be ignored. They can be mitigated by policies especially geared towards improving the efficiency with which resources are used and further diminishing losses and inefficient use, particularly in irrigation, where the average efficiency of water use on a plot barely exceeds 60% and in some towns leakage is estimated to be as high as 40%.

The room for progress in this issue is considerable, as improved water demand management (the Blue Plan alternative scenario) would enable savings of a quarter of the demand, i.e. some 86 km³ per year by 2025 (Chart 8 and Chart 9).

Irrigated agriculture represents the greatest potential for savings in terms of volume, with almost 65% of the total water saving potential identified in the Mediterranean area (transport losses reduced to half, reaching 10%, efficiency in transporting irrigation water to the plots increased from 60% to 80%). The rest of the potential water savings involve industry, representing 22% (recycling rates reduced to 50%), and the supply of drinking water, with 13% (reduction by half in transport losses and leakage affecting users, reaching 15% and 10% respectively).

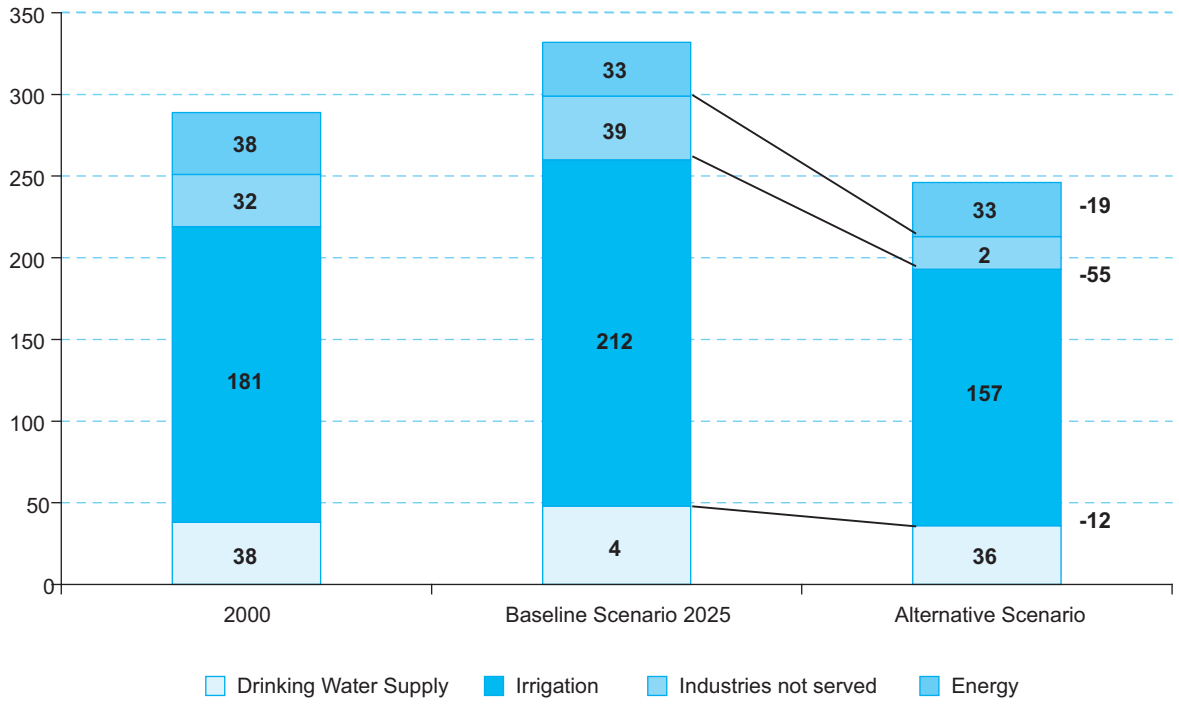
In the light of this optimistic perspective, theoretically generalised in all the Mediterranean countries, the total water demand could reach 246 km³ per year (102 km³ per year in the North and 144 km³ per year in the South and the Near East), which would be the overall equivalent of a reduction in the total demand of some 40 km³ per year with respect to 2005 (Chart 9).

Essential Reforms for Trend Improvement

The switch from a trend scenario to a more durable development scenario can only be made progressively, through essential reforms with the clear objective of integrated water resource management in all the policies – and in the agricultural policies particularly – and generating the means for it to be put into practice, basically establishing efficiency plans and sustainable financing systems.

Within this context, the question of financing investment in drinking water supplies and sanitation

CHART 9 **Demand by Consumer Sector, Baseline and Alternative Scenarios, Whole Countries**



Source: Blue Plan, 2007

(in the South and East), and the use of financial instruments – subsidies, pricing, etc. – to optimise allocation of available resources are vital for the future. The same applies to the reinforcement of management capacities, particularly on a local level. Regional cooperation, benefiting from a long-standing tradition in the water policy field in the Mediterranean area, is in a position to contribute to catalysing and accelerating the desired changes.

The recommendations of the regional workshop organised by the Blue Plan and its partners (see box), adopted by the Mediterranean Commission on Sustainable Development (May 2007) and later by the Mediterranean countries as a whole and the European Community at the 15th meeting of Contracting Parties to the Barcelona Convention (January 2008), are aimed at the political decision-makers, given the essential nature of their role in promotion of water demand management (WDM). They place particular stress on the need to raise WDM to the rank of a strategic national priority, to assure its promotion and to coordinate its definition, follow-up and evaluation within the policies of the different sectors, particularly those of agriculture, energy, tourism, the environment and land planning.

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SUMMARY OF THE ZARAGOZA WORKSHOP'S RECOMMENDATIONS FOR THE NATIONAL POLITICAL AUTHORITIES OF THE MEDITERRANEAN COUNTRIES

1. To make Water Demand Management a national strategic priority, in accordance with the MSSD's guidelines;
2. To ensure that the problems associated with WDM are correctly articulated with global environmental problems such as climate change or the conservation of biodiversity and the ecosystems;
3. To encourage mobilisation and empowerment of the various actors concerned with WDM;
4. To take all possible measures to raise public awareness of WDM;
5. On a two-yearly basis, to assess the progress made with regard to WDM, highlighting the reinforcement of WDM's consideration within the national water information systems;
6. To reinforce regional scientific and institutional cooperation to in order to encourage WDM.

Source: Recommendations of the workshop "Water demand management in the Mediterranean, progress and policies," (Zaragoza, 19th-21st March 2007)