MEDITERRANEAN STRATEGY FOR THE SUSTAINABLE DEVELOPMENT

Water use efficiency

Synthesis

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Water use efficiency

I. Preamble

As part of its activities for the year 2008 monitoring the Mediterranean Strategy for Sustainable Development (MSSD), the Regional Activity Center of the Blue Plan has launched a work plan to further the collection of the basic data needed to calculate the water efficiency index (MSSD priority indicator WAT_P01), to provide countries with methodological support for feeding this indicator, to assess what progress has been made by each country in terms water savings and to identify what are the priority actions needed to improve water use efficiency, particularly under the national strategies to that end.

In accordance with the terms of reference, this activity is articulated around two axes:

Completing the questionnaire on the water efficiency index (total and by sector), providing all the details required under the various headings.

- Producing a summary (ten to fifteen pages) to present:

  - The priority actions to be introduced in the country in order to improve the collection of basic data and the production of the efficiency index's various components, accompanied by a cost evaluation for such actions;

  - The national efficiency improvement objectives (sectoral and total) with deadlines for achieving them;

  - Policies and measures adopted, projects implemented (or to be implemented) towards improving sectoral efficiency, with the estimated cost of the various actions and projects;

  - The performance indicators used to assess the effectiveness of these actions (volume of water saved, for example);

  - Potential financial savings to be made through the implementation of water demand management measures (Case study) as well as the used method.

Eight volunteer countries have responded to develop national reports on these topics: Bosnia Herzegovina, Cyprus, Lebanon, Malta, Morocco, Syria, Tunisia and Turkey. These studies were presented at an experts meeting (see Minutes of the meeting, Annex 1) held on November, 5th 2008 at the Blue Plan in Sophia Antipolis. This meeting has enabled all participants to exchange information, experiences and share the best practices developed in each country.

II. Context and objectives

In the Mediterranean rim countries, water resources are limited and unequally distributed in both space and time; Southern rim countries account for a mere 10% of the total. About 180 million persons are in water stress situation (less than 1000 m3 / capita / year) among which 60 millions in water scarcity situation (less than 500 m3 / capita / year) and Twenty million Mediterranean people are deprived of access to drinking water, particularly in the South and East.

Within a context of worsening shortage in part of the region and in view of the uncertainties brought about by climate change, the Blue Plan's work highlights the pressing need to adapt water management policies, to better manage the various water uses and to ensure more optimal and effective use of resources, if present and future needs of populations and development are to be satisfied.

Given the potential efficiency gains, both the Mediterranean Commission on Sustainable Development (MCSD) and the Mediterranean Strategy for Sustainable Development (MSSD) («water» chapter) have placed particular emphasis on the need for greater awareness of what volume of water is currently being lost or wasted and possible ways of making savings.

III. Water use efficiency in the Mediterranean

1. Water demand management: a major political issue in the Mediterranean

For the past ten years or so, water demand management (WDM), which comprises all measures intended to enhance the technical, social, economic, institutional and environmental efficiency of the various water uses, has been emerging as an issue central to water management in the Mediterranean.

Based on recognition of the fact that simply increasing supply, which had always been the traditional response to increased demand, had already (or was about to) reach its limits, and was running up against growing social, economic and ecological obstacles in virtually all the riparian states, back in 1997 the Mediterranean Commission on Sustainable Development concluded that WDM was "the route for achieving the most significant progress in Mediterranean water policies".

Various workshops held at regional level (Fréjus in 1997, Fiuggi in 2002, Zaragoza in 2007) led to water demand management gradually becoming recognized as a priority route towards achieving two of the objectives central to the sustainable development concept: moving on from non-viable modes of consumption and production on the one hand, and the protection and sustainable management of natural resources for the purpose of social and economic development on the other. They provided an opportunity to discuss the tools for implementing water demand management policies and showed how the most significant progress had been achieved through the progressive and consistent implementation of combinations of various tools (strategies, pricing and subsidies, institutional organisation).

The integrated management of water resources and demand was selected as the Mediterranean Strategy for Sustainable Development's first priority action area, adopted by all the riparian states and the European Community in 2005. Within this common "framework" strategy, one of the main objectives related to water management (cf. annex 2) is to build up WDM policies in order to stabilise demand through limiting loss and misuse and to increase the added value created per m3 of water used (i.e. enhancing efficiency).

The Contacting Parties to the Barcelona Convention adopted, in November 2005, the Mediterranean for Sustainable Development (MSSD). The first priority field of action of the Strategy is « improving integrated water resources and demand management », the key aims of this Strategy are i) stabilize water demand through the reduction of water losses and the wasteful use of water (a reduction in demand in the North and controlled increases in the South and the East) and increase the added value per cubic meter of water used, ii) promote the integrated management of watersheds, including surface and groundwater; and eco-systems, and foster depollution objectives, iii) Achieve the Millennium Development Goals concerning access to safe drinking water and sanitation, iv) promote participation, partnership, active cooperation and solidarity for the sustainable management of water, at local and national level.

1.1. The current issue: speedier integration of water demand management into water, environmental and development policy

The recommendations addressed by the Zaragoza workshop (2007) to the political decision makers so much their role as regards promotion of water demand management remains essential, stress the need for water demand management to be ranked as a national strategic priority, to promote and to coordinate its implementation, follow-up and evaluation under the various sectoral policies - agricultural, energy, tourism, environmental and land planning in particular.

The issue at stake today thus entails speeding up the integration of WDM into water, environmental and development policy and, where appropriate, assisting states in drawing up or improving their national sustainable development strategies and « efficiency plans » (or plans for the rational use of water resources), the principle of which was adopted at the Johannesburg Summit.

Indeed, whilst water demand in Mediterranean countries should increase by some 50 km^3 by 2025 to reach almost 330 km^3/yr, in other words a level which is hardly compatible with renewable resources, losses related to transport, leaks and misuse of the resource could well exceed 100 km^3/yr (Blue Plan scenario). That is why a better water demand management is of such great importance.

2. Is water use becoming more efficient in the Mediterranean?

2.1. Calculation Methodology of water use efficiency

The water efficiency index and its sectoral components are still difficult to be filled in by countries. The Blue Plan has therefore retained in its work plan to deepen, in each country, the collection and validation of items data required to calculate sectoral efficiencies (drinking water, agriculture, industry) and in total and provide methodological support to countries to improve the collection of basic data and the production of indicators.

2.1.1. Priority indicators of the chapter « water » of Mediterranean Strategy for Sustainable Development

Five priority indicators were adopted to follow regularly the progress realized by countries in water management:

Number	Indicator	Code
1	Index of water efficiency (total and per sector)	WAT_P01
2	Water demand (total and per sector), and compared to the GDP (total and per sector)	WAT_P02
3	Exploitation index of renewable natural resources	WAT_P03
4	Share of the population with access to an improved water source (total, urban, rural)	WAT_P04
5	Share of the population with access to an improved sanitation system (total, urban, rural)	WAT_P05

2.1.2. Water efficiency index (total & per sector)

Definition

This index measures progress in water savings through demand management, by reducing losses and wasteful use during transport and distribution. It covers total and sectoral efficiency: drinking water, agriculture and industry.

Sectoral efficiencies

    a)   Drinking water distribution efficiency

This is the share of drinking water produced, distributed, and paid by consumers (Cf. sheme 1).
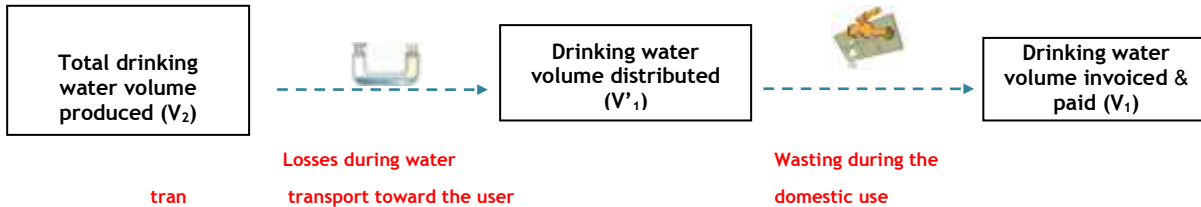
$$E_{pot} = V1 \ / \ V2 \text{ where}$$

- V1 = drinking water volume invoiced and paid by consumer in km^3/year

- V2 = total drinking water volume produced and distributed in km^3/year (drinking water demand)

The indicator measures both the physical efficiency of drinking water distribution networks (loss rates or yield) and economic efficiency, e.g., the capacity of network managers to cover costs through consumer payments.

Scheme 1 Distribution-consumption of drinking water

Total drinking water volume produced (V₂)		Drinking water volume distributed (V'₁)		Drinking water volume invoiced & paid (V₁)
	Losses during water transport toward the user		Wasting during the domestic use	

b) Irrigation water efficiency

The physical efficiency of irrigation water is the product of "network for irrigation water transport and distribution" efficiency by plot efficiency:

$$Eirr = E1 \times E2$$

– E1: efficiency of irrigation water transport and distribution networks, upstream from agricultural plots, measured as the ratio between water volumes actually distributed to plots (V3) and the total volume of water for irrigation (V4), upstream of networks, including losses in networks ;

$$E1 = V3/V4$$

– E2: plot irrigation efficiency is defined as the sum of efficiencies (per plot) of all irrigation modes (surface irrigation, sprinkler irrigation, micro-irrigation, others), weighted by the respective proportions of all local modes and estimated as the ratio between water volumes actually consumed by plants and volumes delivered to plots.

$$E2 = \sum_{1}^{n} \frac{Sm \times Em}{S}$$

– n   : number of irrigation modes used:
– Sm: surfaces irrigated using modes : m
– Em: method efficiency: m
– S   : total local irrigated surface according to different modes

Scheme 2 Distribution-consumption of irrigation water

Irrigation water demand (V₄)		Water distributed to plot (V₃)		Water consumed by plants
	Losses during water transport		Losses to plot	
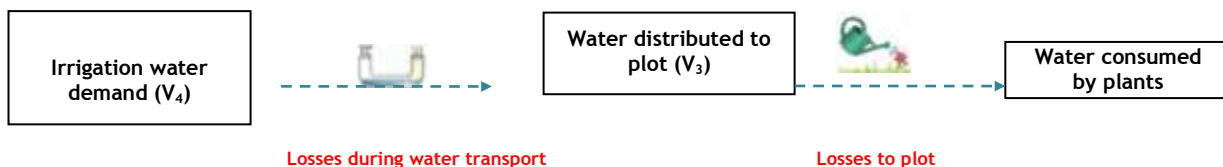
c) Water industrial efficiency

The volume of recycled industrial water (recycling index).

$$Eind = V5 / V6$$

– V5 = Recycled water volumes in km3/year.
– V6 = Gross volume consumed for industrial processes which is equal to the volume incoming for the first-time to the industrial plant + recycled volume in km^3/year.

Scheme 3 Distribution-consumption of industrial water

Recycled water volume
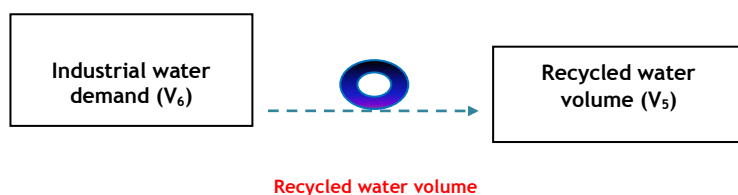
Total efficiency

Total physical efficiency of water consumption is defined as the sum of used water quantity ratios per sector (demand-losses) over sector demand, weighted by the share of sectoral requirements (drinking water, irrigation and industry).

$$E = \frac{(Epot \times Dpot + Eirr \times Dirr + Eind \times Dind)}{D}$$

D_{pot}: Domestic demand (drinking water), D_{irr}: irrigation water demand,

Dind: industrial water demand, D: total water demand

Water demand is defined as the sum of water volumes dedicated to satisfying needs (excluding « green[1] » water and « virtual[2] » water), including volumes losses in production, transport and consumption. This corresponds to the sum of water volumes abstracted, non-traditional water production (desalination and imports), and water reuse, minus export volumes.

Unit:

Percentage (%)

Precautions / Notes:

The economic efficiency of drinking water is dependent on invoicing modes (subscription, meters) and meter malfunction can yield biased results.

In situ measurements of actual average plot irrigation efficiency (E2) are more complex, in view of the difficulty in precisely assessing volumes consumed by plants, and in view of the high number of plots. Each country has national estimates of the average efficiency of all systems, based on pilot experiments. The value of E2 in fact highlights the distribution of irrigation per major modes of irrigation at national level (theoretical average efficiency estimated from 40 to 60% for surface irrigation from 70 to 80% for sprinkler irrigation and from 80 to 90% for localized irrigation).

2.2. Production & Collection mode of data for indicator calculating

The availability of basic data necessary of the calculation and production of various components of the efficiency index varies from country to country and by sector of use. Some data exist, notably the drinking water and agriculture, although some may be estimated, but they are scattered in different departments and collection well organized and well controlled has therefore become a

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[1] Green water is the transpiration which rises directly from precipitations; it is about rain agriculture, pastures, forests, etc.

[2] Virtual water corresponds to the volume of water consumed during the production of o good (not to be confused with the water content in this good). It is usually expressed in liters of water per kilo. For example, in Italy, approximately 2 400 liters of water is needed to produce one kilo of corn, 2 500 liters for one kg of rice and 21 000 liters for one kilo of Beef meat.

necessity. The collection and publication of these data are not made on a regular basis; they are rarely produced for statistical purposes, mostly for the management and design. In general, the problem of collecting data on water is due to the large number of institutions in charge of this resource or those who share the production of such data. The problem of collection is also due to the lack of an effective information system to rules which are clear and accepted by all stakeholders. Also, noting an insufficient funding. It is very difficult to ensure regular data collection and relevant and reliable information on the technical, economic and environmental progress and make available this information at any time to the various actors. The creation of a well-defined mechanism for the collection and dissemination could be the solution to make also the preparation and publication of data on water in general and the various components of efficiency index in particular, independent of operators, managers and contracting authorities. It will also highlight the problem of definitions and calculation methods that need to be harmonized and standardized.

Some countries such as Cyprus began to develop a data collection system more and more organized by inviting various stakeholders (Ministries, Offices, Statistics ...) to cooperate for reliable and regular dissemination of information.

So it is not a problem of data but rather a lack of organization and communication between different water actors.

The difficulties to inform the water efficiency indicator of industrial sector, reside in the absence of exhaustive and comprehensive statistics on the volume of water abstracted, used and recycled by the industry (permitting to approach the efficiency index in this sector).

2.3. Encouraging progress in different sectors of water use

The current performance of water use, despite some progress (Figure 1), are far to be satisfactory; losses and leakage of transport, lack of efficiency in irrigation and waste are estimated in the Mediterranean region, more 100 km^3/year, that's about 40% of the total water demand (280km^3/year) (*Table 1*).

Table 1 Losses of water abstracted for only the drinking water & irrigation (in km3/year)

Use sectors	Sub-regions			Total	
	North	East	South	km3/year	%
Irrigated Agriculture	25	24	46	95	87
Municipalities (drinking water)	7	4	3	14	13
Together	**32**	**28**	**49**	**109**	**100**

Source : Blue Plan 2007

That amounts to "potential" feasible water saving including at least one party could be mobilized by a more active policy of "water demands management".

Figure 1 Water efficiency (total & per sectors) in the Mediterranean countries
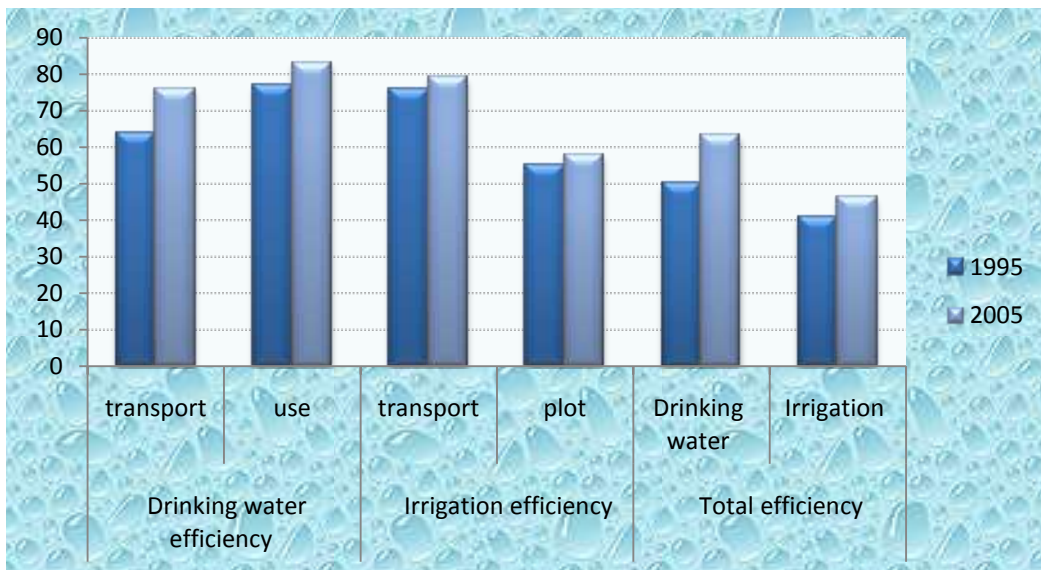
Source: Blue Plan

In 2005, total water use efficiency is believed to have been between 50 and 85% in the majority of Mediterranean states:

- Albania, Algeria, Bosnia-Herzegovina, Croatia, Egypt, Greece, Italy, Lebanon, Morocco, Montenegro, Palestinian Territories, Slovenia, Syria, Tunisia and Turkey are believed to have had 40-60% total water efficiency;

- France, Libya, Malta and Spain are believed to have had 60-75% total water efficiency;

- Cyprus and Israel are believed to have had total water use efficiency close to 84 and 81% respectively.

Between 1995 and 2005 virtually all states achieved encouraging progress in terms of their efficiency in the various water use sectors (figure 2). Water use efficiency rose from 40% to 50%, which is an improvement of 10%.

It should be noted that in order to face the financial needs of major programs of rehabilitation and replacement of old network or equipment of irrigation water-saving systems, the northern countries have benefited of aid from the EU, while the countries of South and East have established public-private partnerships and bilateral and multilateral cooperation.

Figure 2 Total water efficiency index in the Mediterranean countries
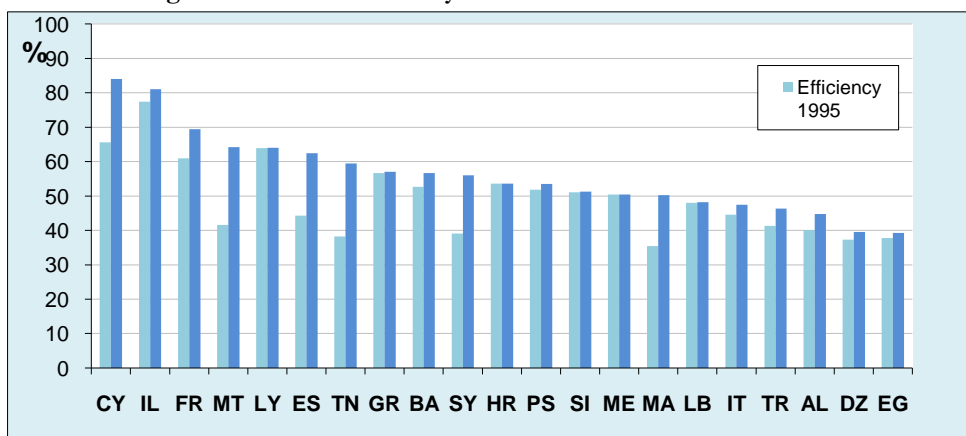
Source : Blue Plan

When the efficiency indexes for drinking water and water for irrigation purposes are compared per country, however, (in 2005), several situations emerge:

- In some countries, water efficiency in irrigation is much lower than for drinking water: Algeria, Egypt, Israel, Italy and Morocco.

- Water efficiency for drinking and irrigation water is more-or-less equal in the following countries: Croatia, France, Greece, Lebanon, Libya, Palestinian Territories and Spain.

- Albania, Bosnia-Herzegovina, Cyprus and Malta have greater irrigation than drinking water efficiency.

Figure 3 Total water efficiency index in drinking water & irrigation sectors
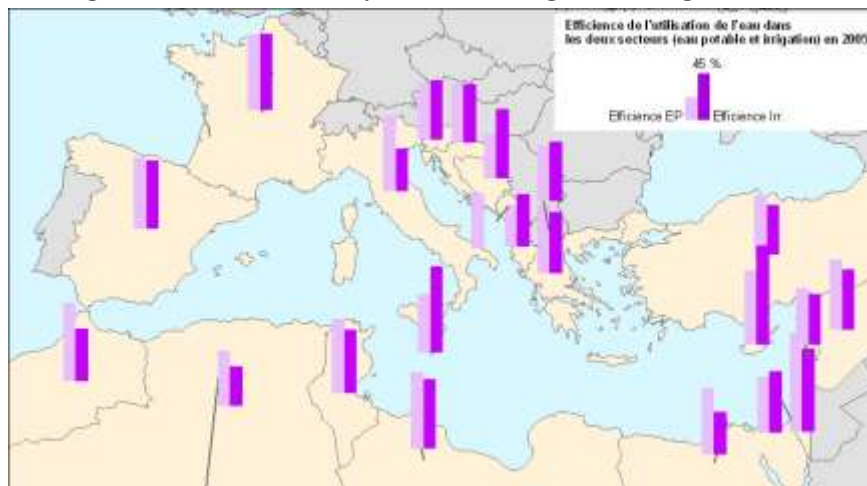
Source : Blue Plan

The water demands pressure level on the water resources can be seen in the way we practice agriculture (main consumer of water) and especially the irrigation in the plot. The losses by evaporation and infiltration in traditional irrigation are the highest. Depending on the techniques used, classic (surface irrigation) and modern (sprinkler and localized), water demands per hectare vary in the proportions of 1500 m^3 to 20000 m^3. The irrigation method is very variable with a dominant share (in area and more by volume) of surface irrigation. However, considerable efforts in equipment-saving water in recent years in most countries of South and East are recognized (Figure 4).

Figure 4 Irrigated areas with water-saving equipment
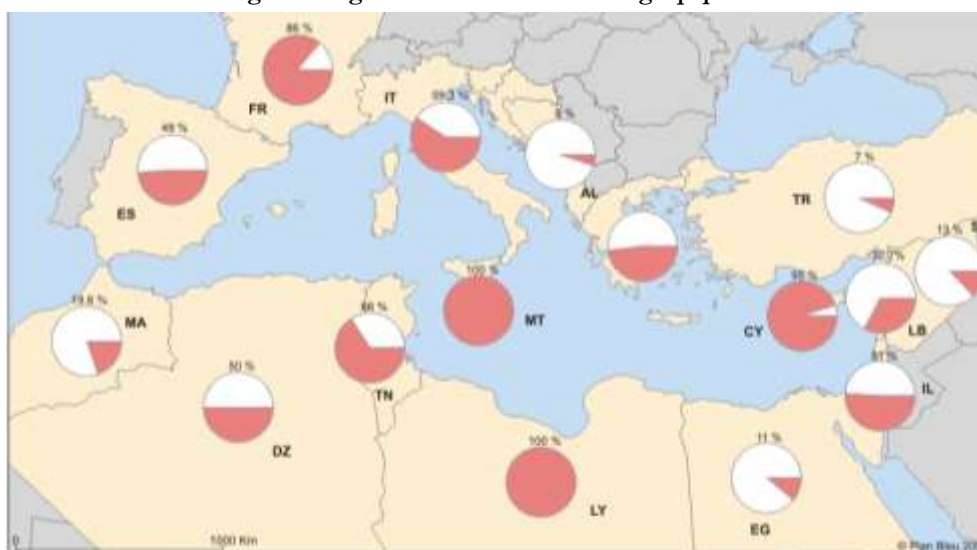
Source : Plan Bleu, Aquastat

2.4. The future: what efficiency improvement objectives exist in the Mediterranean?

2.4.1. The issue: to achieve regional objectives of improving efficiencies...

In its report entitled « *Mediterranean: the Blue Plan's environment and development outlook* » (2005), the Blue Plan endeavoured to evaluate the extent of water loss and «misuse » for each sector (losses which artificially inflate water demand in the various national planning documents) and on the basis of a set of ambitious albeit "feasible" hypotheses to estimate recoverable losses per sector and per Mediterranean basin sub-region (*table 2*). The feasible potential savings were thus estimated at around a quarter of current water demand, in other words 72km^3 for a total demand of 280 km3 for the Mediterranean states as a whole in 2005. In 2025 it would be about 85 km^3/yr for total water demand of some 330 km^3/yr (figure 4).

Table 2 Recoverable losses estimation per Mediterranean basin sub-region in 2000

Mediterranean basin Sub-region (countries)	Drinking water	Irrigation	Industries	Total
	Efficiencies improvement hypotheses			
	Networks efficiency raised to 85% and users efficiency raised to 90%	Networks efficiency raised to 90% and plot efficiency raised to 80%	Recycling generalized to 50%	
North	4,6	18,2	9,5	32,3
East	1,8	11,3	2,2	15,3
South	1,6	18,4	4,1	24,1
Total	**8,0**	**48,0**	**16,0**	**72,0**

Source: Blue Plan & J. Margat

Note: These losses are « recoverable» purely in terms of the techniques available, notwithstanding social difficulties and resistance.

Potential available savings are therefore by no means negligible in the Mediterranean. The main quantitative source lies in irrigated farming, where situations vary enormously. To the North, the losses stem from major networks, whilst to the South and East, plot-by-plot irrigation practices also come into play. In volume terms, potential savings in farming are five times higher than in the domestic sector. As for industry, it can make an effective contribution through recycling, as has been demonstrated by the French industrial experience. The drinking water sector would only release a tiny fraction of the total; it is, however, the most straightforward to mobilise to the South and North in the medium term, as well as the easiest to justify in economic terms, given the current cost of water.

Figure 5 Water demands per use sectors: potential saving by 2025
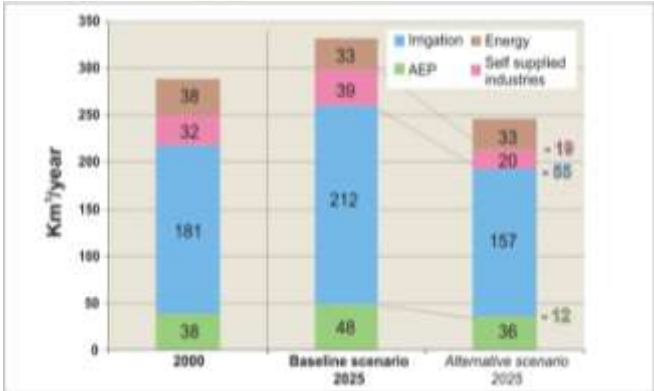
Source Blue Plan

2.4.2. ...to be declined in each Mediterranean country

The MSSD is a « framework » strategy which can inspire national sustainable development and sectoral strategies (or help in their updating). It is, however, up to each individual country to set its own efficiency improvement objectives. Efficiency plans (or plans for the rational use of water resources), the principle of which was adopted at the Johannesburg Summit, can be drawn up and implemented at various levels (country, watershed, expanse of water, city or irrigated area).

The various reports show encouraging progress in water use efficiency notably in drinking water and irrigation with a variety of situations. Some countries have adopted national policies and strategies and implementation of priority actions to improve sectoral efficiencies, while drawing national goals and priorities for the well-defined horizons (see Figure 6). Almost all countries have shown significant progress shown by performance indicators used to assess the effectiveness of these actions. This is to reduce losses during the water transport, sensibilize users to better water efficiency behaviours, equip irrigated areas by saving water systems and encourage maximum recycling water in the industry

Moreover, for the Mediterranean as a whole, it is still difficult to quantify the potential gains to be achieved through more efficient distribution between the various uses (improving « inter-sectoral efficiency »), from three points of view- economic, social and environmental. These gains can only be evaluated locally by "cost-benefit" studies into different options, including the cost and benefit of environmental and social externalities. This type of study is rarely undertaken, particularly on optimisation and allocation according to various qualities. Some Mediterranean countries are starting to make their allocation choices using optimisation criteria such as « more added value per drop ». This has prompted considerable gains in technical efficiency or water savings, but these decisions still take very little account of the social and environmental impact

Figure 6 National goals for improving water use efficiency

Cyprus

Source Iacovides,2008

Lebanon

Source Comair, 2008

Morocco

Source Belghiti, 2008

Syria

Source Al-Azmeh, 2008

Tunisia

Source Louati, 2008

Total efficiency National goals fixed by 2025

Source Plan Bleu, 2008
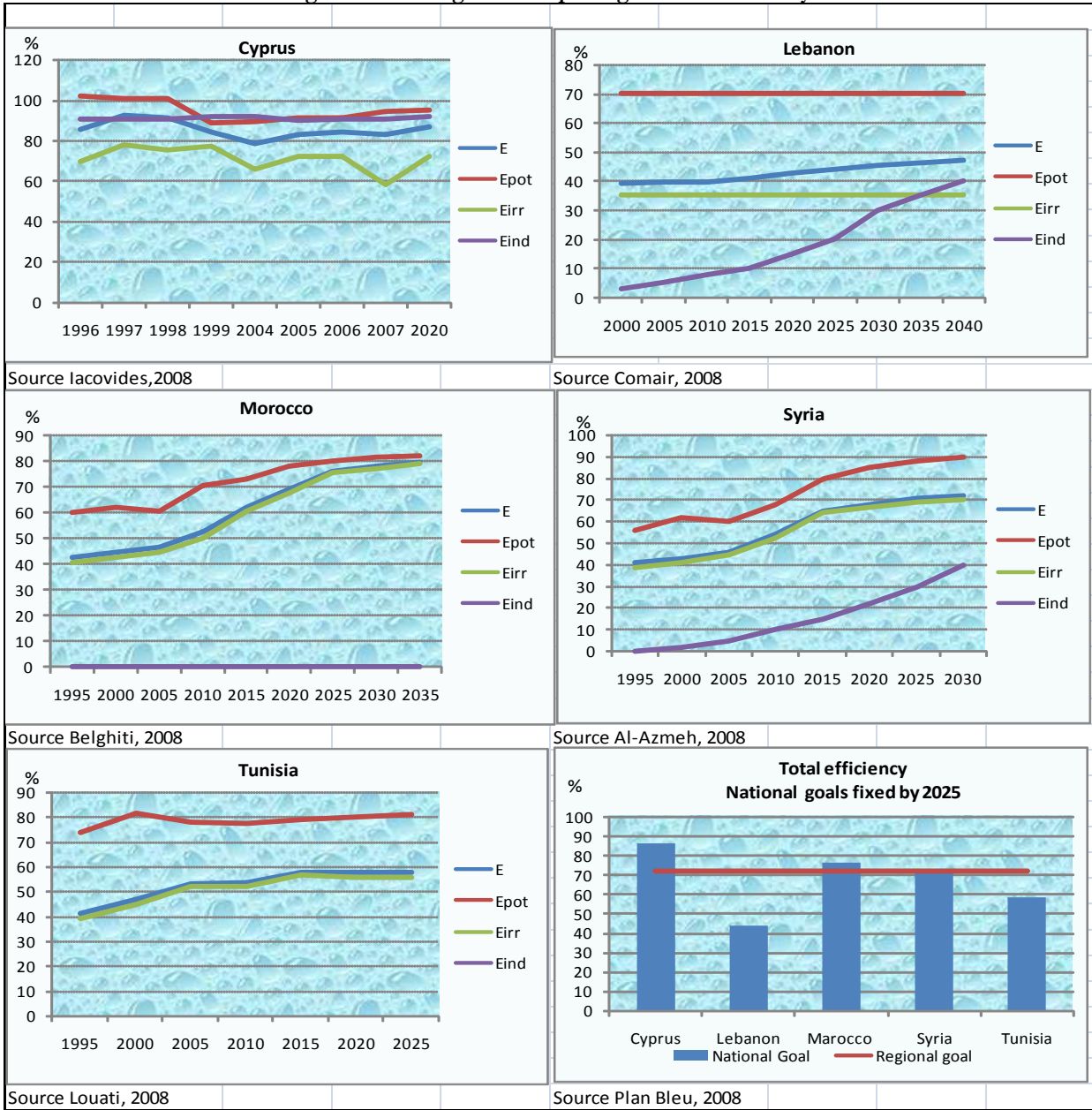
IV. Benchmarking of Mediterranean countries on components of the water efficiency index

1. Methodology followed

As regards methodology, it is intended to show the adaptability of multi-criteria analysis, as a process of decision support, the issues of sustainable development. The idea is to show that this methodology, usually applied to the fields of economy and management, is compatible with the follow-up to the MSSD. The measurement instrument proposed for this purpose is relevant. It helps to evaluate the convergence of a whole country to predefined profiles (examples of best practices) in learning, or to estimate their evolution from a comparative perspective.

Unlike the rating process developed only in the context of classification, assessment considered here is more intended to report on the progress in the water use efficiency. At term, the interest is to provide the Mediterranean countries a measurement tool adapted to their situations and to support the progresses made. Specifically, it aims to test the multi-criteria analysis on a particular context (progress made or not made on the water use efficiency), but also to identify the limitations in the development of profiles country.

In sum, a series of profiles have been defined so as to provide the landmarks that permit to progress towards sustainable development. The proposed Benchmarking consists in positioning elements (countries) compared to references (profiles) on an axis scale (categories), according to their situations in relation to the water efficiency indicator. It also makes a comparison between countries and evaluates their differences in terms of progress in relation to the profiles (with a threshold of indifference).

2. To define the reference profiles from efficiency objectives in the mediterranean

Based on The efficiency improvement hypotheses in the Blue Plan's alternative scenario in 2005 and up to 2025, the references at the top (*profile 1*) are respectively:

- Drinking water : rates of losses distribution to 15% & user leaks reduced to 10%.

- Irrigation : transport losses reduced to 10% & plot losses reduced to 20%.

As to the references at the bottom (*profile 2*), their definition was based on the report of the Blue Plan and the various national reports. Indeed, from the notes on the facing water stress and shortage in the Mediterranean[3], the situation is as follow:

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[3] Blue Plan, "Facing water stress and shortage in the Mediterranean", Blue Plan Notes, n°4, October 2006, pp.3-4.

The losses of water transport to the user is estimated at 30%, losses due to leaks at the user's are estimated at 20%, losses during water irrigation transport are estimated at 20% and irrigation efficiency in the plot is estimated at 60%.

The Mediterranean countries have been positioned around the two reference profiles based on their respective situations in the water use (*see table 3*).

Table 3 Determination of reference profiles with efficiency objectives (2005)

Efficience Eau Potable				Efficience Eau Irrigation				
Pertes transport / Demande eau potable (%)		Pertes usage / Demande eau usage (%)		Pertes transport / Demande eau irrigation (%)		Pertes parcelle / Demande eau parcelle (%)		
Pays	Donnée	Pays	Donnée	Pays	Donnée	Pays	Donnée	
Israël	5,00	Israël	5,00	Chypre	5,00	Chypre	5,00	
Italie	15,00	Libye	7,00	B&H	10,00	Israël	10,00	
Tunisie	15,00	Turquie	10,00	Croatie	10,00	Malte	13,00	
Profil 1	15,00	Profil 1	10,00	Profil 1	10,00	Profil 1	20,00	→ Profile 1 : Alternative scenario of Blue Plan
Maroc	16,00	Albanie	15,00	France	10,00	France	22,00	
Malte	18,00	France	15,00	Libye	10,00	Espagne	24,00	
Espagne	18,70	Maroc	15,00	Malte	10,00	Tunisie	28,00	
France	19,00	Chypre	15,00	Slovénie	10,00	Albanie	30,00	
Syrie	20,00	Italie	19,00	Israël	17,00	B&H	30,00	
Chypre	21,00	Algérie	20,00	Maroc	17,00	Grèce	30,00	
Grèce	22,00	B&H	20,00	Espagne	18,70	Libye	30,00	
Egypte	25,00	Croatie	20,00	Algérie	20,00	Syrie	31,00	
Libye	25,00	Egypte	20,00	Egypte	20,00	Croatie	40,00	
Profil 2	30,00	Profil 2	20,00	Profil 2	20,00	Profil 2	40,00	→ Profile 2 : Baseline scenario of Blue Plan
Croatie	33,00	Espagne	20,00	Grèce	20,00	Italie	40,00	
Liban	35,00	Grèce	20,00	Liban	20,00	Slovénie	40,00	
Slovénie	36,00	Liban	20,00	Syrie	20,00	Liban	42,00	
Algérie	37,50	Slovénie	20,00	Tunisie	20,00	Maroc	42,00	
Turquie	40,00	Syrie	20,00	Turquie	20,00	Turquie	44,00	
B&H	50,00	Tunisie	20,00	Albanie	32,00	Egypte	53,00	
Albanie	55,00	Malte	35,00	Italie	35,00	Algérie	55,00	

The targets selected by the Blue Plan in 2025 (and adopted by the riparian countries in the framework of the MSSD) are already achieved in 2005 by at least three countries in each component of the water use efficiency. This is very encouraging and consistent with the initial assumption, which stated that these references were feasible.

2.1. Performances of the Mediterranean countries in water use efficiency.

A classification based on the principles of multi-criteria analysis was proposed. Depending on their respective performances on the rate of water losses (5%), countries were compared to the two successive reference profiles previously fixed, then assigned to three predefined categories (*see table 4, right column*):

- Category 1 = high efficiency (low losses).
  Country ∈ Category 1 ⇒ Country Efficiency > Profile Efficiency 1 (±5%)

- Category 2 = Average efficiency (significant losses).
  Country ∈ Category 2 ⇒ Profile Efficiency 1 (±5%) < Efficiency Country < Profile Efficiency 2 (±5%)

- Category 3 = Low efficiency (heavy losses).

Country ∈ Category 3 ⇒ Country Efficiency < Profile Efficiency 2 (±5%)

The results of benchmarking have been used as a starting point for the determination of targets for total efficiency (including the efficiency of drinking water and irrigation water). A grid has helped to synthesize information on the situation in the countries and to outline their position in relation to objectives (*see table 4, left column*):

- Total efficiency ≥ 70% ⇒ High efficiency.

- 50% ≤ Total efficiency < 70% ⇒ Average efficiency.

- Total efficiency < 50% ⇒ Low efficiency.

The reading scale has been defined on top (max = 3) and bottom (min = 0). The profiles were normalized (profil1 = 2 and profil2 = 1). Depending on the number of positions over a profile that a country produces, it recorded a score (between 0 and 3). The more this score is high, the more the country has to improve its rank.

Table 4 Benchmarking of the Mediterranean countries related to the efficiency objectives (2005)
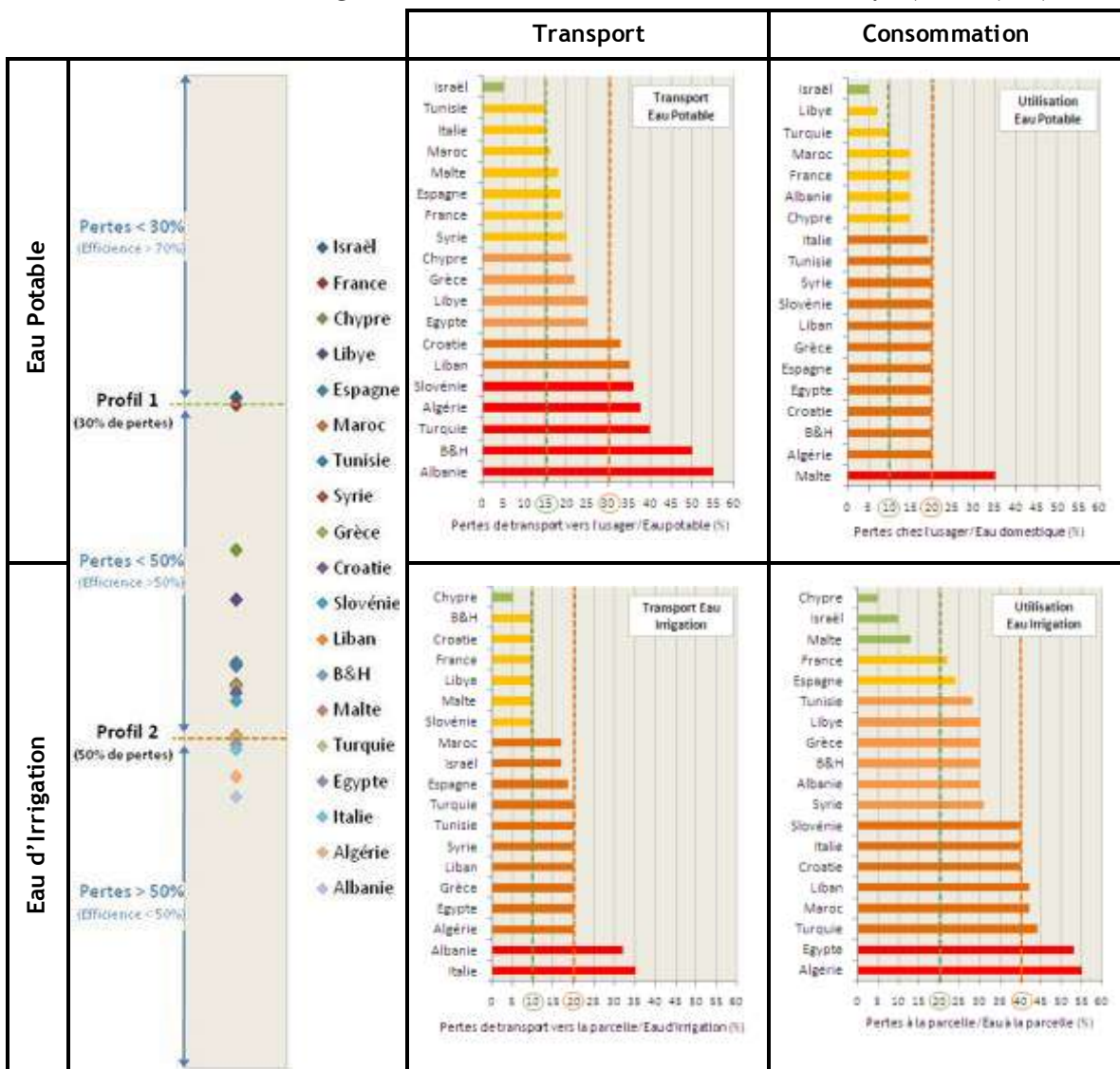
The results of benchmarking were extracted by country and represented in map form where the scores reflect the distances country-profiles, and their ranks give their position (*see Figure 7*).

Figure 7 Mediterranean performances on the component of water efficiency indices for drinking and irrigation water (benchmarking 1995-2005)

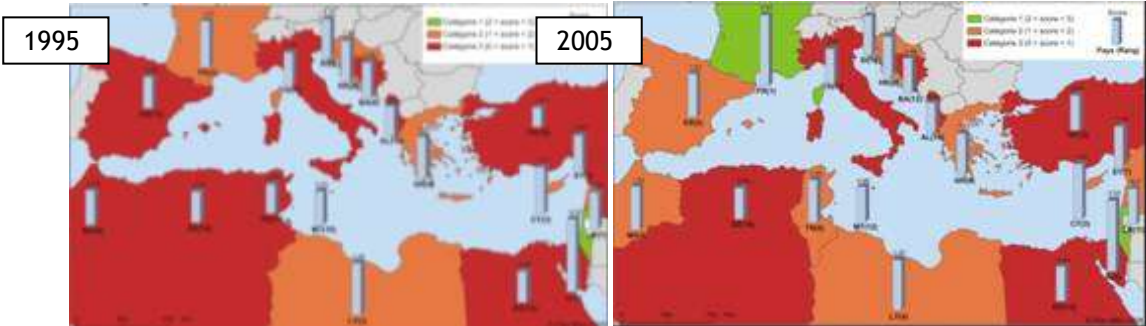Meanwhile, an attempt was made to identify a possible link between the irrigated areas and irrigation water efficiency integrating efficiency of transport and distribution and irrigation efficiency in the plot. From a sample composed of 19 Mediterranean countries for the year 2005, a trend curve was drawn. The slope is negative and shows that the more the irrigated areas are equipped with surface irrigation mode the lower is the water efficiency (*see figure 7*). It shows also that as irrigated areas increase, there is a decrease of the water use efficiency. It can be explained by the fact that in the Mediterranean, the dominant mode of area is the surface irrigation. It generates more waste and is inefficient compared to modes sprinkling and drip irrigation (*see figure 8*).

Figure 8 Correlation between the share of surface irrigation mode and the irrigation efficiency index in the Mediterranean (2005)

Figure 9 Correlation between the irrigated surfaces and the irrigation efficiency index in the Mediterranean (2005)
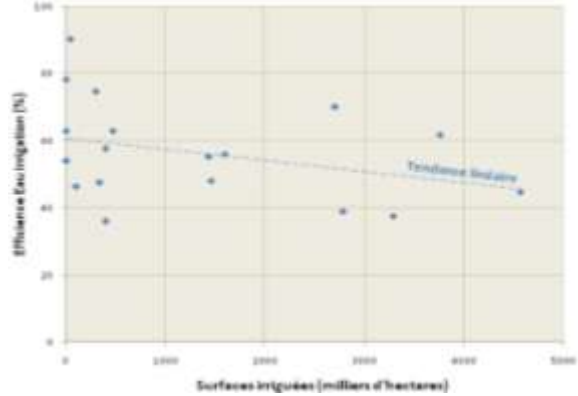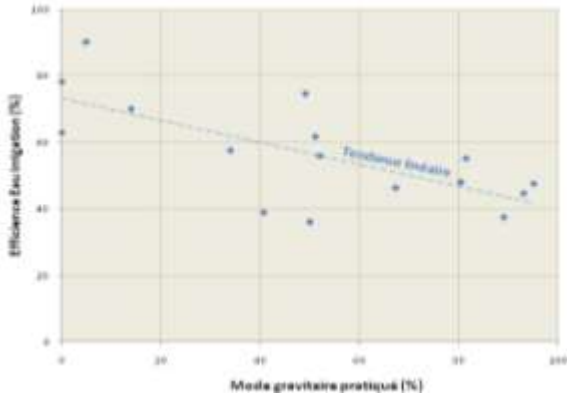
It should be noted that the item data it should be noted that all sources of item data used to calculate the indices of water use efficiency in different sectors are grouped in Table No. 14 in the references.

V. Conclusion

The assumptions of improved sectoral water efficiencies at the regional level and by 2025 included in the alternative scenario of the Blue Plan, were adopted by the rim countries of the Mediterranean as "desirable goals." These targets based on the constituents of the total efficiency can be grouped into the one and same target, namely, bringing the total efficiency to 70% in the Mediterranean. This number is "feasible" since it comes from the actual performances of the countries. However, although concerns about water demand management are becoming ever more widespread, this issue is rarely reflected in terms of targeted and quantified objectives in official national water planning documents. Indeed, only a handful of Mediterranean states have to date set national targets for improving efficiency (sectoral and total) and the dates for reaching them.

The implementation of the policies of improving water use efficiency can only be gradual, carried by the indispensable policy reforms posting clear water demand management objectives in all policies – particularly in agricultural ones – and generating the means for implementation, based on the development of sustainable efficiency plans and financial mechanisms.

In this context, the regional cooperation can play an important role in the transfer of know-how and capacity building, exchange of experience, sharing of best practices and financing of projects notably in the South and East countries. The public-private partnership will also have a positive effect on the use of economic (subsidies, pricing ...) and technical (rehabilitation of water transport networks, leakage detection ...) instruments to optimize the allocation of available resources.

The Work on the efficiencies, to be effectively pursued and strengthened, calls for a common language. This means improving the data collection systems, which do not have a role that is only academic, but are real tools for decision support. The research on the use of unconventional resources should not be overlooked.

The cost of improving efficiency is at the same time social, cultural and economical. It would be interesting if the decision-makers know both the cost of the non-action and, more especially, of the action.

In order to support Mediterranean states in drawing up « efficiency plans », in its future work the Blue Plan intends to identify a limited number of countries where national pilot studies could be conducted in order to glean further information on improving data collection, calculating water use efficiency, the cost of improving efficiency and what financial savings could be achieved through water demand management measures.

VI. Case Study

1. Bosnia and Herzegovina

1.1. Projects in water supply sector

1.2. USAID Program ˝Assistance to Water Utilities in B&H˝

This program is one of a series of USAID-funded programs for water utility strengthening that began in 1999. The objective of program was to strengthen the capability of water utilities in providing satisfactory water and wastewater services to their customers in a business-like manner, i.e., to become efficient and financially self-sustaining.

The first phase of this program included a detailed field diagnosis of conditions in selected ten water utilities considered as representative. Weaknesses were recognized in three aspects of their functioning: Legislative, Technical and Financial.

Second phase of program started in March 2002, under the project "Assistance to Water Utilities in B&H - Pilot Water Utilities Doboj, Orašje, Konjic, Tuzla˝, aiming at eliminate weaknesses recognized in the first phase.

Overall objective of this project was to strengthen the institutional and financial sustainability and operational efficiency of selected water utilities, to make them self-sustainable public companies and to qualify them for commercial credits from the World Bank and/or other lenders.

Project covered legal, technical and financial components and in accordance to that, the different activities and tools were implemented in order to improve water utility's management and operation.

Achieved results completely confirmed that the overall project objective was met in the areas of increasing water utilities' revenues, development of effective metering programs, full understanding and further reducing unaccounted-for-water losses, development of networks mapping and GIS, development of effective accounting and budgeting systems, establishment of more realistic tariff rates.

1.3. Training program supported by USAID - Unaccounted for water reduction and water demand management training

The objective of the training was to provide skills and knowledge to participants for development of Water Demand Management and Unaccounted for Water (UFW) Reduction Programs for their own utilities. Target for B&H water utilities was to reach a UFW level of 30%, which is believed to be reasonable and achievable for the incoming period. The training program included topics like water

demand management concept, water audit procedure, organization in water utilities relevant to UFW reduction, efficient metering and methods for testing big water meters in place, leak detection methods, mapping or setting proper tariffs.

1.4. Projects on measurement, detection and reduction of leaks in water supply networks in BiH

- Flow measurement, detection and reduction of leaks in water installations in Distribution Centre "Merkur" – Konjic. Before this project, leaks in the installations were 122 m3/day, but after measurement and leak detection activities, they reduced to 28 m3/day, year 2006;

- Flow measurement, detection and reduction of leaks in water installations in 16 Distribution Centers of "Amko Commerce" – Sarajevo. Before this project, leaks in the installations were 144 m3/day, but after measurement and leak detection activities, they reduced to 55 m3/day, year 2005;

- Flow measurement, detection and reduction of leaks in water installations in companies "Mill and Bakery" – Ljubače Tuzla. Before this project, leaks in the installations were 244 m3/day, but after measurement and leak detection activities, they reduced to 117 m3/day, year 2004;

- Flow measurement, detection and reduction of leaks in water installations on the territory of Neum Municipality. Before the project, leaks in the installations were 1028 m3/day, but after measurement and leak detection activities, they reduced to 517 m3/day, year 2004;

- Flow measurement, detection and reduction of leaks within International Airport Sarajevo. Before the project, leaks in the installations were 305 m3/day, but after measurement and leak detection activities, they reduced to 47 m3/day, year 2004;

- Flow measurement, detection and reduction of leaks in water installations on the territory of Sokolac Municipality. Before the project, leaks in the installations were 122 m3/day, but after measurement and leak detection activities, they reduced to 89 m3/day, year 2004;

- Flow measurement, detection and reduction of leaks in water installations in Civil Engineering Company "Tehnograd GMT" – Tuzla. Before the project, leaks in the installations were 276 m3/day, but after measurement and leak detection activities, they reduced to 142 m3/day, year 2003;

- Flow measurement, detection and reduction of leaks in water installations in Civil Engineering Company "Pijace" – Tuzla. Before the project, leaks in the installations were 562 m3/day, but after measurement and leak detection activities, they reduced to 96 m3/day, year 2003;

1.5. Projects in irrigation sector

1.6. WB Small Scale Commercial Agricultural Development Project

Within the World Bank Project «Small Scale Commercial Agricultural Development Project" possibilities were analyzed for self-sustainability of irrigation system. Two pilot sites were selected, Ljubuški filed region in FBH and Trebinje filed region in RS. Project analyzed present state within the pilots, from the point of management, institutional, legal, technical and financial aspect that was

relevant for irrigation system. It was estimated that present level of agricultural land use in pilots was 10-30% in Ljubuški and 30-50% in Trebinje. Water intakes were from natural streams, and rate of abstracted water quantities was unknown. Present practice regarding institutional arrangements, management, maintenance, collection rate and financing in both regions is partly implemented according to existing laws as in FBiH as in RS. Practically, those systems were mainly used and managed by individual farmers, mostly without any supervision. During the war and after, within municipalities Ljubuški and Trebinje, there were no collection of water charges from users so system stayed without any income needed for maintenance or capital investments. Based on analysis of the current condition, this study gave following recommendations related to institutional and financial arrangements, which would gradually provide self-sustainable functioning of this activity:

- Institutional proposals - Establishment of Water User Association for irrigation (WUA). These associations represent an adequate organizational form of expressing and achieving interests, but also taking over the responsibility of users of irrigation system and/or land reclamation system. Thus, and adequate and efficient management would be assured, as well as maintenance, financing and implementation of other activities necessary for self-sustainable functioning of irrigation system.

- Financial recommendations - Theoretical basis and methodology for setting the water prices has been suggested, as well as phase introduction of water prices based on suggested methodology. In the first phase (2-3 years) should be maintained the way of determining the price of water as it was before the war, i.e. fixed charge should be paid by the size of surface under irrigation system (regardless if it is currently irrigated or not) + variable part which would be paid by the quantity of delivered water. This variable part would be estimated/measured on the main water intakes, and the quantity of delivered water charged proportional to irrigated land surface. In the next phase, after the fulfilment of necessary conditions during the first phase, method of setting the water price would be applied, based on real costs generated by users, taking into account quantities of consumed water, electricity and type of crop on the land.

1.7. Projects in industrial sector

Since the industrial production has been increasingly developing in the last few years, it will result in increasing of the water consumption. For that reason it is necessary to introduce timely measures that will be in accordance with IWRM (Integrated Water Resource Management) and WDM for this field. According to this, it is necessary to involve public/private partnership in sector, apply targeted subsidies/tax benefits for water-saving systems, establish depollution funds, provide awareness raising campaigns and training of managers, etc.

One of the possible measures that should be taken is introduction of cleaner production, i.e. application of BEP (best environmental practices) in industry facilities. On one hand, these measures can contribute to significant BOD5 reduction, and on the other hand, bring economic profit, i.e. savings of raw material, water and energy-generating products in these industries. Cleaner production in B&H industries is introduced into national policy and strategy as a tool for accomplishing environmentally sustainable industrial development. Its application in industrial facilities in B&H is based, by adoption of set of environmental laws in B&H (FB&H and RS, in 2003), on EU directive for integral pollution prevention and control (IPPC).

Application of cleaner production is not a usual practice in B&H industries. First activities in this field were made during 2002, through implementation of project "Capacity building of cleaner production in B&H" – EC LIFE Third Countries Program. Project was implemented by nongovernmental organization "Center for Environmentally Sustainable Development" with

technical assistance of MAP regional Center for cleaner production from Barcelona, Spain and Croatian Center for cleaner production from Zagreb. Project was implemented in 9 industrial facilities in B&H where cleaner production measures were applied. It is calculated that implementing CP in industries, water savings and reduction of wastewaters varies between 24 to 81%, with average of 60%.

Another project which is currently being implemented is "Capacity Building in Integrated Pollution Prevention and Control in Bosnia and Herzegovina" (IPPC – BiH). The timeframe of this project's implementation is 2006-2008. The overall objectives of this project are:

- To minimize adverse impacts on human health and the environment as a result of industrial activity in Bosnia and Herzegovina;

- Strengthening the implementation of integrated environmental prevention and pollution control in B&H;

- Promoting the use of Best Available Techniques (BAT) in industrial sector;

- Strengthening of the implementation of Law on Environmental Protection.

Of course one of the BATs is reuse of water in industry, which is part of this project as well. Due to the fact that the project is still ongoing, results of the project are unavailable.

2. Cyprus

2.1. The Water Board of Lemesos[4]

A case study for the control of leakages in a domestic water distribution network is presented here below showing the methodology and approach followed and the results achieved:

The network of the Water Board of Lemesos, on the south coast of the island of Cyprus, is over 50 years of age and serves approximately 170,000 residents through approximately 64,000 consumer meters in an area of 70 km2. The annual volume of potable water distributed through the network of pipes, of approximate length 795km, is about 13.7x106 m3 and of value €7.0 million.

The Water Board of Lemesos has maintained records of its operational activities since 1963, which include production of water from sources, distribution through district meters and consumption from consumer meters. A Supervisory Control and Data Acquisition (SCADA) telemetry system is connected to meter readings of water sources.

The Water Board established[5] a "water audit" system and has over the years developed its infrastructure in such a way so as to be able to account efficiently and accurately for all water produced or "lost" or "non-revenue water" (Figure 10). Reduction and control of water loss was achieved through the application of a holistic strategy integral part of which is the establishment of a strategy for pipe break incidents ("pipe breaks policy").

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[4] S. Christodoulou, C. Charalambous, A. Adamou " Managing the "Repair or Replace" dilemma on Water Leakages"
[5] B. Charalambous (2005) Experiences in DMA redesign at the Water Board of Lemesos, Cyprus
http://www.findmoreleaks.com/downloads/Experiences%20in%20DMA%20redesign%20at%20the%20WBL.pdf

A water audit for the year 2003 using the International Water Association (IWA) 'best practice' water balance and terminology is shown in Table 5 for the whole of the Water Board's supply system.

Figure 10 Non revenue water
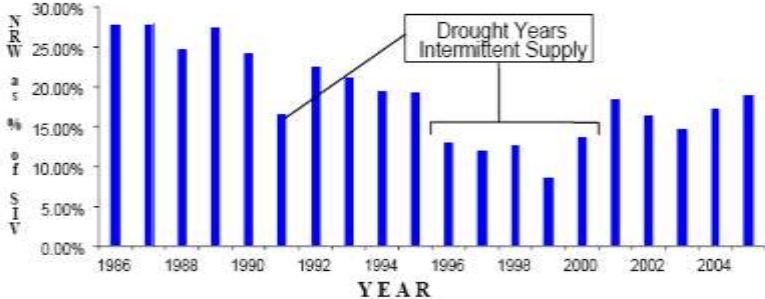
In addition to the reported bursts, the Water Board of Lemesos through its strategy for active leakage control maintains records of unreported bursts located by means of acoustic leak localizers. Typical results[6] are shown in Table 6. Details of all such breaks are maintained and included in the analysis, together with the reported bursts.

In late 1980 the Water Board embarked on a detailed program of leakage management. The efforts made and importance placed by the Water Board for proper leakage management is reflected in the reduction of the non-revenue water over the years, from 25% of total water produced in 1987 to about 16% in 2002, as shown Table 7.

Table 5 Water Balance (m³) for the year 2003

System Input Volume 11.985.560 100,00%	Authorised Consumption 10.276.626 85,74%	Billed Authorised Consumption 10.216.698 85,24%	Billed metered consumption (including water exported) 10.216.698 85,24%	Revenue water 10.216.698 85,24%
			Billed unmetered consumption Zero	
		Unbilled Authorised Consumption 59.928 0,50%	Unbilled metered consumption Zero	Non-revenue water 1.768.862 14,76%
			Unbilled unmetered consumption 59.928 0,50%	
	Water Losses 1.708.934 14,26%	Apparent Losses 299.639 2,50%	Unauthorised use 59.928 0,50%	
			Metering inaccuracies 239.711 2,00%	
		Real Losses 1.409.295 11,76%	Real losses on raw water mains and at the treatment works Zero	
			Leakage on transmission and/or distribution mains 80.458 0,67%	
			Leakage and overflows at transmission and/or distribution storage tanks 11.986 0,10%	
			Leakage on service connections up to the metering point 268.913 2,24%	
			Detectable Losses 1.047.938 8,74%	

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[6] C. N. Charalambous (2003) EFFECTIVE WATER UTILITY MANAGEMENT (Conference on "Integrated Water Management, Policy Aspects 19-21 June 2003 ARI), Water Board of Lemesos

Table 6 Unreported bursts – identified and repaired

Type of pipe	Number of bursts		Percentage per type	
	1999	2002	1999	2002
20mm MDPE	7	7	39%	44%
32mm MDPE	9	8		
100mm AC mains	10	10	61%	56%
150mm AC mains	12	9		
200mm AC mains	3	0		
TOTAL	41	34	100%	100%
Estimated water saved	140,000 m³	110,000 m³		
Worth of water saved	US$ 45,000	US$ 35,000		

The Water Losses from the system are made up of Apparent Losses and Real Losses. These losses together with the Unbilled Authorised Consumption comprise the Non-Revenue Water (NRW).

The Apparent Losses, consist of two main components: (i) metering inaccuracies (2% of billed metered consumption), and (ii) Unauthorised Consumption (0.5% of billed metered consumption).

The Real Water Losses, or "physical losses", is the annual volumes of water lost from the system through all types of leaks and overflows from reservoirs and from bursts in mains and service connections up to the point of customer metering, all within the District Metered Areas or DMAs.

The water meter management program, in which some 6000 meters are replaced annually, includes:

- Periodical checking and replacement if necessary of all source, storage and DMA meters,
- Use of high accuracy domestic meters.
- Meter reading and billing error minimization with the use of portable meter reader recorders.

The DMA redesign and the application of pressure reduction has produced favourable results with both background leakage and locatable losses being reduced by approximately 38%. Furthermore the frequency of reported leaks was reduced by approximately 41%. The overall pressure reduction for the fifteen DMAs was of the order of 32%.

The target of the Water Board of Lemesos is to reduce the Non Revenue Water to about 8% of the system input volume, which is considered to be the economic level of leakage. The Water Board demand forecasts indicate an increase of approximately 30% by the year 2020 and the leakage reduction will go some way towards offsetting this increase in demand as well as a provide considerable cost saving.

Table 7 Non-revenue water expressed as a % of water production

YEAR	Water Losses (%)	YEAR	Water Losses (%)	YEAR	Water Losses (%)
1985	22	1991	16	1997	12
1986	27	1992	23	1998	13
1987	27	1993	21	1999	8
1988	25	1994	19	2000	14
1989	27	1995	19	2001	18
1990	24	1996	13	2002	16

3. Liban

3.1. Stratégie quinquennale du Litani

En 1993, le nouveau conseil d'administration de l'ONL a établi un programme de travail étalé sur 5 ans et destiné à l'exécution des composantes des plans directeurs du Litani. Ce programme comporte trois étapes :

1) Programme de redressement d'urgence

2) Plans à court et moyen terme

3) Stratégie à long terme pour l'irrigation et l'adduction d'eau potable.

3.2. Programme de redressement d'urgence

Durant la guerre, les installations du Litani ont souffert de grands dégâts spécialement après les invasions israéliennes. Un plan d'urgence a été établi pour remettre à jour les anciennes études non achevées des grands projets d'infrastructures et la réhabilitation des dommages occasionnés aux équipements et aux aménagements hydrauliques.

Ce plan d'urgence concerne principalement la réhabilitation et la modernisation des entités suivantes :

- Bureaux administratifs et bâtiments techniques ;

- L'infrastructure hydro-électrique des installations du barrage de Qaraoun, et les stations de productions hydro-électriques de Markaba, Awali et Joun ;

- Le projet d'irrigation de Qasmieh-Ras el-Aïn ;

- Le projet d'irrigation du sud de la Békaa, incluant :

  - la mise à jour de l'étude de faisabilité de la rive droite et des régions Nord (12 888 ha)

  - la réhabilitation des périmètres amonts, l'achèvement des travaux des réseaux et l'installation de 2 000 hectares sur la rive gauche

  - la réhabilitation et la rectification du cours d'eau du Litani entre le lac de Qaraoun et le pont de Aamiq (14,5 km).

- Le périmètre de recherche situé à l'aval du barrage de Qaraoun.

- Le projet pilote d'irrigation de Saïda-Jezzine.

- Les équipements hydrométriques, les stations météorologiques et leurs logiciels.

- L'étude de faisabilité et le plan directeur pour l'adduction de l'eau des régions de l'Iklim el - Kharroub et du sud du Liban, à partir de la côte 600 m.

- Les études détaillées pour la seconde phase du barrage de Bisri.

- La mise à jour et l'achèvement des études du projet du Canal 800.

3.3. Plans à court et moyen terme

Ces plans sont destinés à la réhabilitation et la modernisation des projets suivants :

- Le périmètre d'irrigation de Qasmieh-Ras el-Aïn ainsi que les infrastructures auxiliaires qui sont :
    - Le réservoir de prise d'eau de Zrariyeh, avec une route d'accès de 5 km.
    - Un barrage et un réservoir de stockage à l'aval du Litani, pour irriguer les périmètres des terres situées en dessous de la côte l00 m, et aussi pour améliorer l'irrigation de 2 000 hectares situés entre la côte l00 m et le canal d'adduction existant.
    - Des canaux de drainage des eaux, les prises et les canaux d'irrigation secondaires.
- L'exécution de ces projets a été accomplie récemment par un financement de la Banque mondiale.
- Les travaux comprennent l'aménagement des berges du cours d'eau situées sur une longueur de 12,5 km.
- Les études de faisabilité et le plan directeur pour les régions de l'Iklim el- Kharroub et du sud du Liban, du réservoir d'Anan, le tunnel de Joun et le Canal 800 (mai 1996).
- L'achèvement en mai 1996 du réseau d'irrigation pour le projet pilote de Saïda-Jezzine (700 ha).
- L'augmentation de la capacité de stockage du réservoir d'Anan dont le but est de favoriser la production énergétique, durant les heures de pointe, dans les stations hydro-électriques de Awali et de Joun. Deux alternatives ont été considérées :
    - L'élévation du niveau de débordement de 0,65 m pour accroître la capacité du réservoir de 25 000 m3.
    - En plus de la première alternative, l'exécution du côté est, d'un réservoir de stockage d'une capacité de 70 000 m3 afin que le total du stockage supplémentaire atteigne 95 000 m3.
    - L'équipement de 15 000 hectares à partir du Canal 800.
    - L'équipement de 6 000 hectares à partir du barrage de Khardali.
    a) L'adduction supplémentaire en eau potable pour les villages situés dans la région du Liban-Sud.
    b) La relance des études et des investigations géologiques pour l'exécution du barrage de Khardali ainsi que la préparation des documents du cahier de charge pour son adjudication.
    c) L'aménagement des périmètres situés en aval du barrage de Qaraoun.
    d) La préservation du lac de Qaraoun de la pollution urbaine, agricole et industrielle.
    e) L'équipement des secteurs situés du côté de la rive gauche dans le cadre du projet d'irrigation du sud de la Békaa (6 700 ha).
    f) Les études détaillées pour l'exécution du barrage de Bisri qui est destiné à alimenter la ville de Beyrouth en eau potable.

3.4. Stratégie à long terme pour l'irrigation et l'adduction d'eau

Cette stratégie comprend tous les travaux mentionnés dans les plans directeurs et qui nécessitent des étapes d'exécution de plus de cinq ans. Ces projets sont les suivants :

- L'exécution du barrage de Khardali.
- L'achèvement du projet d'irrigation de la Békaa (12 888 ha).
- L'achèvement du drainage de 5 000 hectares dans la Békaa.
- L'exécution du projet d'irrigation du Sud-Liban qui comprend un périmètre d'environ 30 000 hectares.

4. Malte

4.1. Distribution of water saving devices in houses

Measure Code	QUAN_1	Full name of measure	Distribution of water saving devices in houses
Type of measure	Supplementary	*WFD measure Type* (see WFD Annex VI)	Water demand management
Sector(s) concerned	Households	Geographic focus/area	Malta and Gozo
Description of the measure	The measure consists in distributing to each **households** a set of domestic water saving devices in houses, on the basis of a preliminary communication / information campaigns, and demonstration pilot projects in public buildings. Those water saving devices are designed to be fitted on existing appliances. They include aerators, discharge limitation devices and pressure reductors (for taps and shower) + equipment for flushes (plastic volumes to be added in the toilet reservoirs)[7]. The measure will be implemented in two steps : Step 1: Pilot projects ex: Water savings in government housing estates and building (one per local council) Step 2: Communication / information campaign with distribution of water saving devices		
Target population for the measure	*Description* of individual units targeted by the measure	All Malta residences (188.360). Given that many households spend part of the year in their secondary residences, the devices will be distributed per residence. Whilst the cost of distributing devices should be based on the number of residence, the effectiveness should be based on the number of households	
	Criteria relevant to the identification of the total number of units/total population that can be targeted by the measure		
	Sources of data for quantification of the total number of units/total population	NSO data on residences	

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[7] A similar action has been implemented in Italy

Implementation	Current rate of implementation of the measure		Minimal number.
	Expected rate of implementation of the measure by 2015 (baseline)		Adoption rate is supposed to increase by 5% by 2015 (9418 residences)
	Expected adoption rate with the measure		The devices will be distributed in all residences. It is expected that only 50% of the beneficiaries will actually install them. With the measure, the rate of adoption will reach 50% (additional 84762 residences)
Cost of measure	Direct costs	Investment	The cost of the devices distributed is estimated at 2.3 Eur/residence. The cost from installation during phase 1 concerning public buildings is estimated to 35,000Eur. Total for residences= 450,000Eur. The measure will be accompanied by a horizontal public information campaign (across all proposed measures) Total cost= 485,000Eur
		Equip. lifetime	5 years
		Recurring costs	nil
	Administrative costs		
	Costs of accompanying & organisational measures		A information campaign targeting the entire population of Malta will the required. Given that this campaign is envisaged as part of the WFD implementation process, its costs are not included here.
	Indirect costs (and benefits):		Saving of water bills for households (volume saved * 0,37 Eur/m^3)= 190,000Eur Saving of government subsidies (2.19Eur per m^3) = 1,000,000Eur (assuming consumption at the first block of the tarriff system)
	Energy use and related air pollution (kwh, CO2 emission)		nil
	Other (non water related) environmental costs		
	Sources of information		
Effectiveness	Unit of effectiveness (e.g. m3 saved or reduction in kg of N)		m^3/year
	Expected effect per targeted unit		Water saving is estimated at 15% of water used in taps, showers and toilet flushes) ie 6 m^3/year
	Additional expected effect resulting from measure implementation by 2015 (baseline)		5% of the household install it spontaneously before 2015 = 9418 households. Total water saved = 9418*6 m^3 * 46% (share of groundwater abstraction in tap water) = 25 994m^3
	Remaining potential effect (with measure)		84762*6 m^3 * 46% (share of groundwater abstraction in tap water) **233 943 m^3/year**
	Sources of information		

5. Maroc

5.1. Approche économique de la gestion de la demande en eau d'irrigation

5.1.1. Comparaison du coût du m³ d'eau économisé par rapport au coût de développement de nouvelles ressources en eau

Cet indicateur, qui permet d'évaluer l'opportunité d'investir en économie d'eau par rapport à des solutions alternatives de développement de nouvelles ressources en eau, sera analysé à travers la comparaison des coûts d'investissement requis pour l'économie de l'eau, tels qu'ils découlent des besoins en investissements du programme envisagé, avec ceux qui seraient nécessaires à la mobilisation des ressources en eau supplémentaires. Les coûts de mobilisation de nouvelles ressources en eau, sont approchés par les coûts de développement de nouvelles ressources en eau par bassin versant (Ressource à mobiliser par les barrages projetés dans les différents bassins hydrauliques concernés par le programme d'économie d'eau).

Le tableau suivant présente les éléments de cette comparaison :

Table 8 Comparaison du coût du m³ d'eau à économiser ou à mobiliser

Zone	Economie d'eau			Coût de développement de ressources en eau (en Dh/m3) (2)	Rapport (1/2)
	Volume d'eau économisé actualisé (en 10^6 m³)	Coût des investissements actualisés (en 10^6 Dh)	Coût du m³ d'eau économisé (en Dh/m³) (1)		
Moulouya	594	957	1,61	1,86	0,86
Loukkos	297	309	1,04	1,01	1,03
Tadla	198	160	0,80	1,37	0,58
Haouz	594	640	1,08	1,42	0,76
Souss-Massa	693	735	1,06	2,60	0,41
Gharb (Beht)	396	447	1,13	3,30	0,34
Hors ORMVA	792	799	1,0	1,14	0,88
Total	3.564	4.047	1,14	1,20	0,95

Du point de vue de l'opportunité de l'investissement à consentir par la collectivité nationale, les résultats de cette analyse laissent apparaître un avantage en faveur de l'économie d'eau pour l'ensemble des zones du programme, à l'exception de la zone du Loukkos où le coût de développement de nouvelles ressources avoisine le coût de l'économie de l'eau.

5.1.2. Rapport avantages/coûts du programme

Pour l'évaluation de cet indicateur, les hypothèses suivantes sont retenues pour l'estimation des avantages procurés par le programme :

- Les volumes d'eau économisés avec l'adoption de l'irrigation localisée, seront valorisés par les cultures par l'amélioration de la couverture des besoins en eau des plantations et du maraîchage. Cette hypothèse se justifie par la situation de déficit en eau que connaissent les différentes zones du programme (à l'exception de la zone du Loukkos) ;

- Les économies d'eau que dégagerait le programme seraient valorisées à travers l'amélioration des rendements des cultures maraîchères et arboricoles. Les gains de productivité attendus sont estimés à (i) 40% pour le maraîchage et (ii) 20% pour les plantations (dont la moitié est supposée imputable à la technique d'irrigation et l'autre moitié à l'amélioration des dotations en eau qui, sans l'économie de l'eau, seraient réduites en raison des pénuries d'eau chroniques que connaissent les zones du programme ;

Les bénéfices du programme sont estimés sur la base des valeurs ajoutées additionnelles générées par l'amélioration des productivités permise par la conversion à l'irrigation localisée.

Sur la base de ces hypothèses les productions additionnelles escomptées en année de croisière du programme s'élèveraient à près de 630.000 tonnes par an de fruits et légumes et les valeurs ajoutées additionnelles générées sont estimées à 650 millions de Dirhams par an, ventilées comme suit :

Table 9 Valeur ajoutée additionnelle générée par les gains de productivité

ZONE	Superficie	Productivité actuelle	Gain de productivité	Production additionnelle	Prix moyen	Valeur ajoutée additionnelle	
						en Dh/ha/an	globale
	ha	t/ha	t/ha	en tonne	Dh/t		10^6 Dh/an
Total	114 500			632 240			649
Plantations	85 250	21	4,14	344 800	1600	6 040	515
Maraîchage	29 250	23	9,20	287 440	1400	4 600	134

Sur la base des valeurs ajoutées additionnelles et des coûts d'investissement du programme tels que présentés ci-dessus, actualisés sur une période de 50 ans, pour tenir compte de la durée d'amortissement des investissements, le rapport avantages/coûts du programme se présente comme suit :

Table 10 Comparaison des coûts / avantages du programme

ZONE	Valeur ajoutée actualisée en 106 Dh	Investissements actualisés en 106 Dh	Rapport bénéfices/coûts
Moulouya	1.000	957	1,04
Loukkos	424	309	1,37
Tadla	256	160	1,60
Haouz	672	640	1,05
Souss/Massa	1.472	735	2,00
Gharb (Beht)	480	447	1,07
Hors ORMVA	880	799	1,10
Total	**5.184**	**4.047**	**1,28**

Il ressort de ces éléments d'évaluation que le programme dégage, dans son ensemble, des bénéfices supérieurs de près de 30% aux coûts des investissements. L'économie d'eau et la gestion de la demande en eau sont économiquement profitables à la collectivité nationale.

5.1.3. Avantages pour l'agriculteur

Pour les agriculteurs, les avantages du programme d'économie de l'eau peuvent être appréciés à travers l'impact des projets sur la marge brute des cultures et par conséquent sur les revenus agricoles.

Les marges brutes additionnelles permises par le programme, comparées aux amortissements des investissements que les agriculteurs seront appelés à consentir pour l'adoption de l'irrigation localisée, permettent de juger de l'intérêt du projet pour les agriculteurs.

Les marges brutes additionnelles à l'hectare que dégageraient le programme s'élèvent en moyenne à près de 6.000 et 4.600 DH/Ha/an respectivement pour les plantations et le maraîchage. La comparaison des valeurs ajoutées additionnelles avec les annuités des prêts à contracter par les agriculteurs, en cas de prise en charge de la totalité des investissements, s'établissent comme suit :

Table 11 Comparaison des marges brutes des cultures avec et sans projet

ZONE	Marge brute en Dh/ha/an			Annuité (*)	Rapport
	sans projet	avec projet	Additionnelle	en Dh/ha/an	marge/annuité
Plantations	12 620	18 660	6 040	5 400	1,12
Maraîchage	15 790	20 390	4 600	4 880	0,94

(*)Sur la base d'un prêts bancaire sur 10 ans au taux d'intérêt de 10%

Il se dégage des éléments développés ci-dessus que, dans le cas où l'agriculteur prend en charge la totalité de l'investissement requis pour la conversion à l'irrigation localisée, les marges brutes additionnelles dégagées par le programme couvrent à peine les charges financières que l'agriculteur aura à débourser pour le financement des investissements.

Si l'on considère, en plus de l'effort d'investissement, les risques inhérents aux projets d'irrigation localisée en tant qu'innovation technique pour l'agriculteur, ceci explique le peu d'attractivité que présentent ces projets pour les agriculteurs en l'absence d'incitations financières conséquentes de l'Etat.

6. Syria

6.1. Efficiency improvement in process

Drawing curves of sectoral and total efficiencies over the whole period under consideration (as obtained in section 3 of this report) will clearly show the past-present-future continuous overwhelming effect in Syria of irrigation efficiency on the total efficiency, and the marginal effect of drinking and industrial efficiencies:

Figure 11 Sectoral and Total Water Use Efficieencies 1995-2030
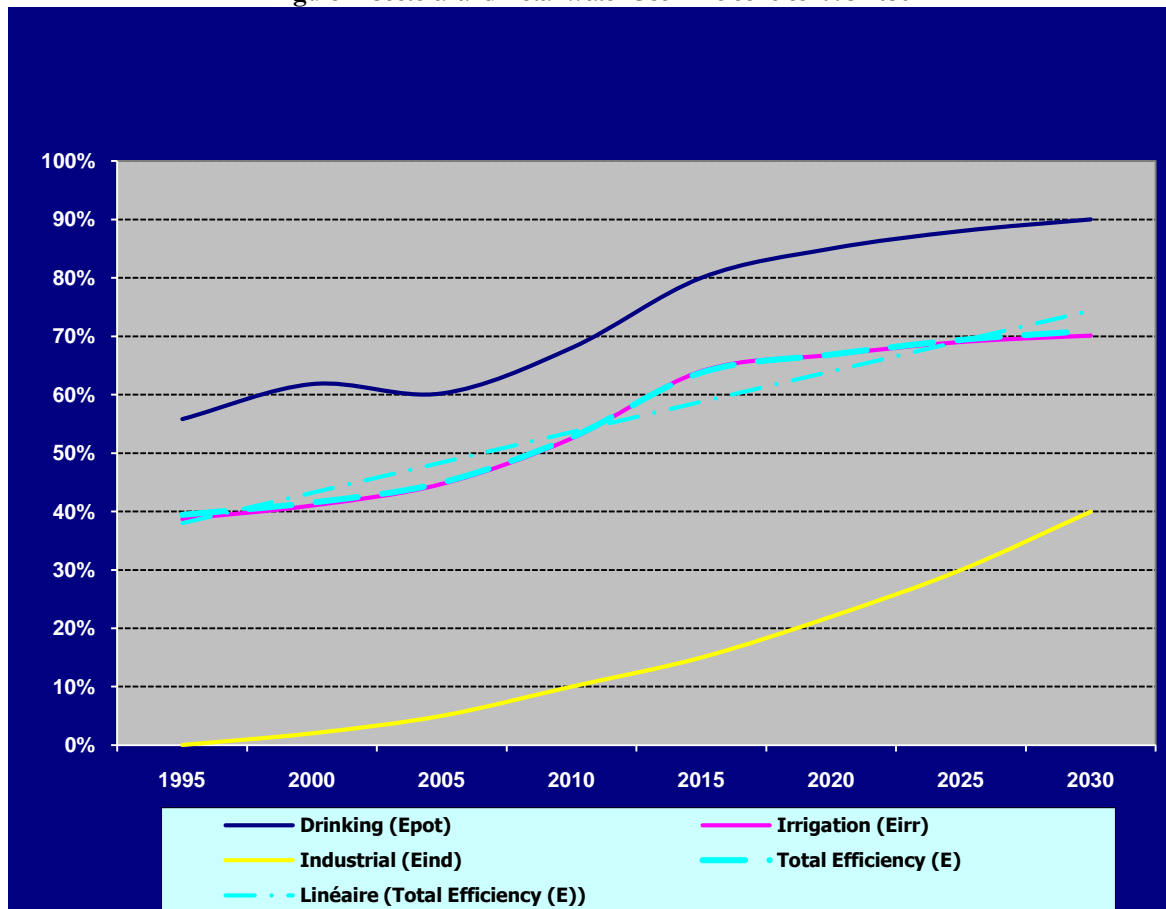
Thus, examining efficiency improvement process means, overwhelmingly, examining the process of rationalizing irrigation uses, the title of which in Syria is the National Program for Conversion to Modern Irrigation (February, 2005).

At planning level, the Program starts from the year 2004 status quo of conventional surface irrigated areas, classifying them according to water source (groundwater wells, rivers and springs, or public irrigation projects), then reclassify each into sub-classes according to the desired mode of irrigation appropriate to land features and planted crops, and then estimate the total cost of conversion by multiplying the area of each sub-class by an averaged cost for converting 1 ha to the desired irrigation mode. The total cost obtained by this method was 43.6 milliard Syrian Liras (equivalent to about 700 million Euros at 2004 exchange rate) distributed as follows:

- 12.7 milliard for converting 160,820 ha sourcing ex wells to localized mode
- 15.2 milliard for converting 434,808 ha sourcing ex wells to sprinkler mode
- 0.35 milliard for converting 50,000 ha sourcing ex Euphrates river to modified surface mode
- 6.3 milliard for converting 86,459 ha sourcing ex rivers/springs to localized
- 3.0 milliard for converting 85,950 ha sourcing ex rivers/springs to sprinkler
- 0.7 milliard for converting 100,000 ha sourcing ex public projects to modified surface mode
- 2.4 milliard for converting 53,106 ha sourcing ex public projects to localized
- 2.9 milliard for converting 83,344 ha sourcing ex public projects to sprinkler.

This estimated monetary cost of the Program, that to be spent over a period of implementation of 10 years or 2 successive 5-year national development plans, was allocated (along with an extra inflation reserve) by establishing a special fund, feed by public treasury, General Union of Peasants, and international donors, the function of which is to loan peasants medium-term and interest-free loans to be used in converting the a/m conventionally irrigated properties to the a/m water-saving irrigation modes.

Apart from funding issues, the Program tackles a variety of legal, organizational, land property and technical dimensions that supposed to smooth and boost its implementation.

The main objective of the program is not saving water to use the savings as water resource for further expansion in irrigated areas, though this could be the case in some hydrological basins or sub-basins in the country. Indeed the objective is to safeguard groundwater reservoirs from depletion, the risk that became of utmost concern in the last two decades.

The following chart compares the expansion occurred between 1990 and 2006 in irrigated areas from groundwater wells and irrigated areas from surface water sources including rivers, springs and public irrigation projects, showing clearly the huge expansion in total (215%), and the greater expansion occurred account groundwater wells (235%) compared to the one occurred account surface sources (196%):

Figure 12 Irrigated areas as per source of water
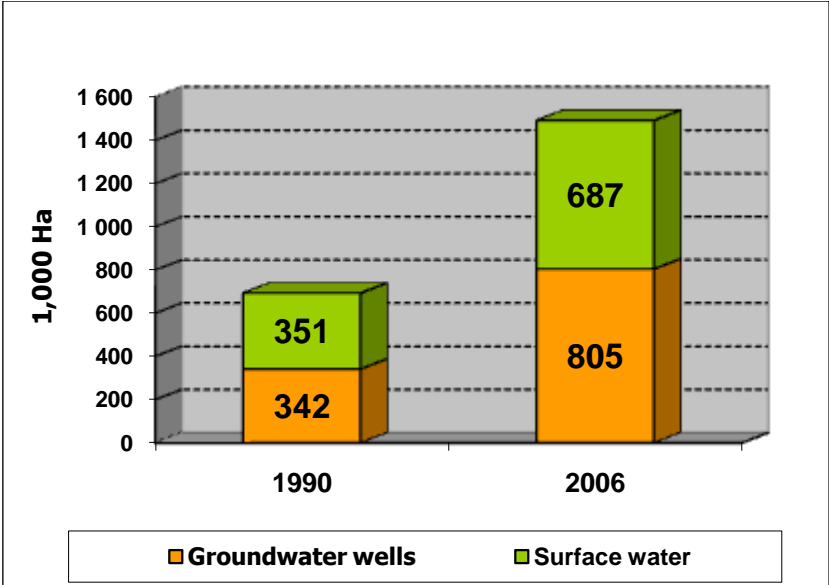
Source of data: the National Basic Prospective Report "Towards a Vision for Development Prospects - Syria 2025" (Damascus, 2007)

Consequently, the yearly extraction, countrywide, from groundwater reservoirs has exceeded by far the groundwater renewal rate. According to the National Basic Prospective Report "Towards a Vision for Development Prospects - Syria 2025" (Damascus, 2007), the current extraction has exceeded 8.5 km3/year against an average of 2.7 km3/year considered extractible without permanent negative effects on natural springs' flows. Here is the great challenge stands in front of the National Program for Conversion to Modern Irrigation, in particular, and the whole water demand management of the country towards improving water use efficiency, in general.

## 6.2. Water Demand Management; a must to Syria rather than a choice

The Water Strategy of the Syrian Arab Republic, adopted by the Government in March 2003, has clearly prioritized water resources allocation for potential conflicting uses as follows:

- 1st priority: potable (household) water

- 2nd priority: industry, including tourism

- 3rd priority: modern irrigated agriculture

Thus, in view of total water shortage already suffered in some hydrological basins of the country, particularly in Damascus area (Barada & Al-Awaj basin) and the far north-east region (Al-Khabour basin), and the shrinking surplus in the other basins, along with the continuing increase of potable and industrial demands pursuant to population growth, increasing coverage with piped water services, and industrialization, a realistic reaction to such a worsening situation is to restructure the allocation of water resources among sectors, enabling a room for sufficing the increasing household and industrial demands by decreasing agriculture share of water, mainly through irrigation rationalization tools.

The following chart shows the structure of water allocation in the near past, then how may change until 2030 if the prospects detailed in section 3 of this report (which involve the scenario of successful implementation of the National Program for Conversion to Modern Irrigation) are realized:

Figure 13 Sectoral Demand as Percentages from Total Water Demand
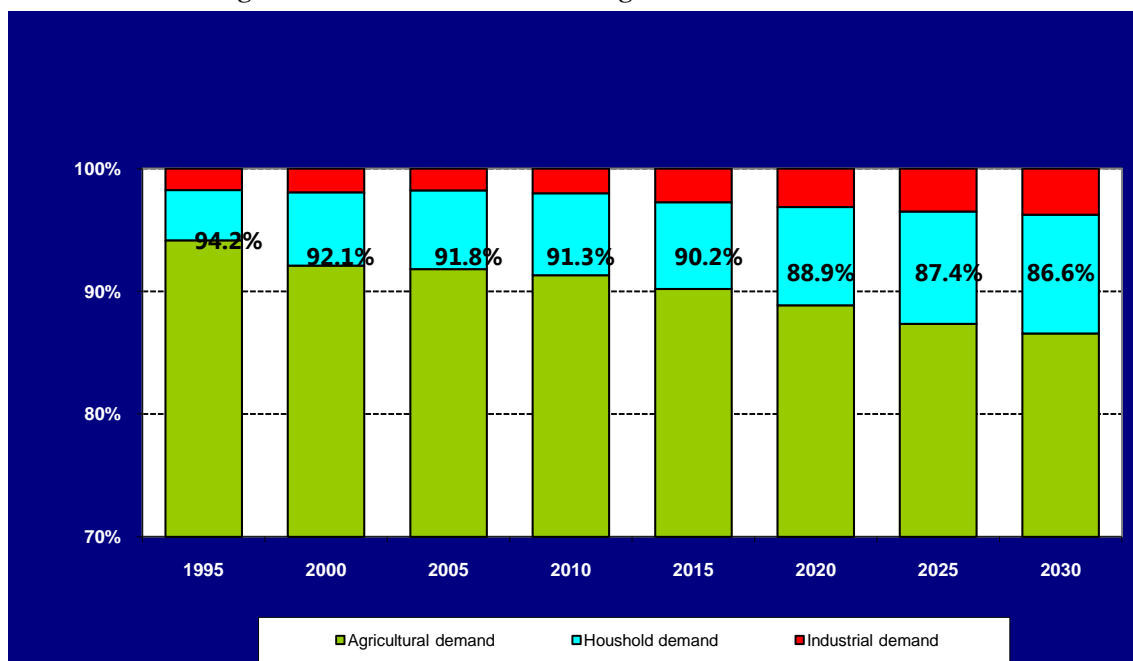
Anyhow, the matter could not be reduced to just a process aiming at reallocating water resources. It is also (and mainly) a vital matter of saving unrenewable resources from depletion since a huge volume of water (about 5.3 Km^3) would be annually saved in the agriculture sector according to the prospects obtained in this report, from 18.565 Km^3/year irrigation demand in 2005 down to 13.260 Km^3/year in 2030. The question with this 5.3 Km^3 is not a slack cost comparison between two alternatives;

- securing it under water supply management framework

- or saving it under water demand management framework.

The question is rather the absolute long-term physical unavailability of this quantity of water. Certainly there is no exaggeration if the question of sustainable use of the limited water resources of Syria is considered the most crucial question amongst the wide variety of sustainable development questions arising in front of the country. The water question is anticipated to acquire increasing importance in the light of the rapidly increasing population and the consequent increasing economic pressures on water demand added to increasing scarcity of water in result of accumulated and continuing depletion and pollution of water resources, all against a likely decrease of precipitation and renewable water resources due to anticipated adverse climatic changes in the east-Mediterranean region as a result of the global warming phenomenon.

Anyhow, with excluding the following two contradictory factors:

1) the anticipated decrease of renewable water resources due to climatic changes (since this factor is still unquantifiable), and;

2) a possible increase of resources that might result from adding major new resources to the national water balance, either conventional (e.g. utilizing Syria's share from the Tigris, bordering Syria territories along 44 km. this share is currently agreed with Iraq at about 1.25 km^3/year to be utilized for converting some 150,000 ha in the far north-east region from wells to networks), or unconventional resources (e.g. by costly seawater or saline groundwater desalinization),

the following multi-purpose chart will show, over the whole period under consideration in this report (1995-2030);

- the sectoral and total water demand trends (as per the results obtained in section 3 of this report), against country's average renewable water resources of about 16 km3/year (as obtainable from various national water reports and studies, including Syria's current share from the Euphrates about 6.6 km3/year as agreed with Turkey and Iraq,), and;

- compare water demand trends to;

  - population growth trends (Central Bureau of Statistics, Statistical Abstracts 1996, 2001 & 2006 for past years, and average projections reported in the 1st National Population Report, 2008, for upcoming years), and;

  - economic growth trends expressed as the national Gross Domestic Product at market price and constant prices of the year 2000 (Central Bureau of Statistics, Statistical Abstract 2006 table 9/16 for past years, and the prospects reported in the National Basic Prospective Report "Towards a Vision for Development Prospects - Syria 2025", Damascus 2007, for upcoming years), converted to Euros applying a constant exchange rate 72.5 Syrian Liras per Euro (2008 average exchange rate):

Figure 14 Water demand against average renewable water resources (km3/year), compared to population and economic growth
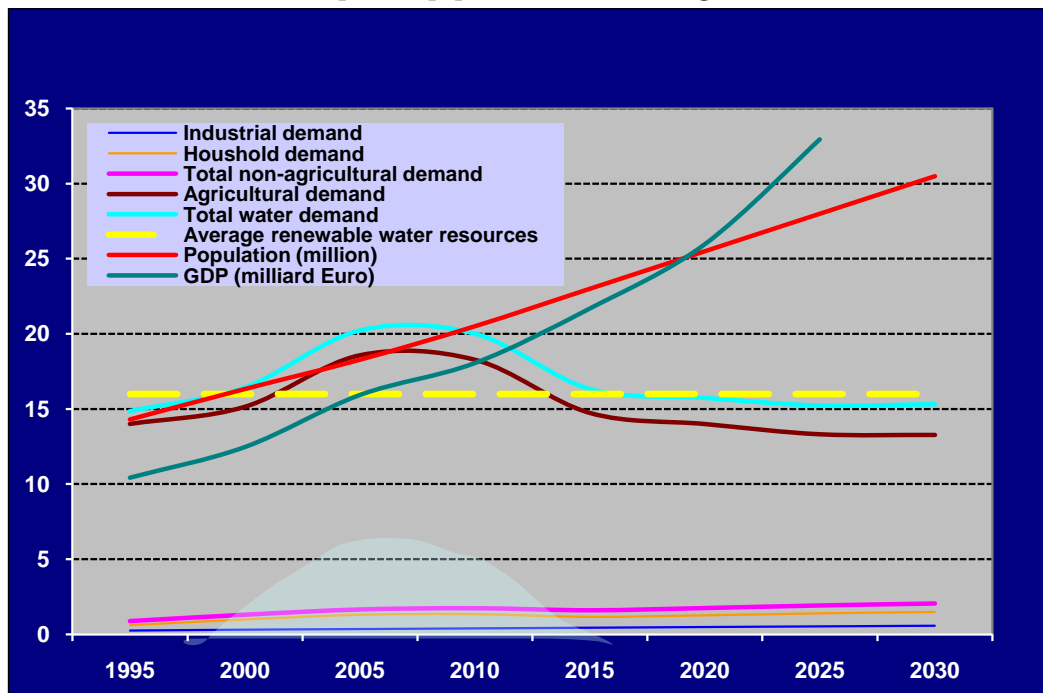
The most important points that could be concluded from above chart are:

1) The non-agricultural water demand (industrial + household) steadily increase with population and economic growth.

2) The agricultural water demand has dramatically increased over the last ten years. This is mainly attributed to the expansion in irrigated areas that sourcing water either ex dams (public irrigation projects) or ex groundwater by drilling licensed or unlicensed wells.

3) The curve of agricultural water demand has most probably reached its peak now years and expected to turn down now on. However, this trend is still uncertain enough since largely dependent on the level of success in implementing the National Program for Conversion to Modern Irrigation.

4) Seizing the overwhelming share of water uses, the agricultural sector is well shaping the curve of total water demand, up and down.

5) Sometime during the 2nd half of 1990s, following the dramatic increase in agricultural water demand, the national water uses have exceeded in value the national renewable water resources. Obviously the shortage is being compensated from reserve stock, i.e. extracting unrenewable groundwater, resulting into lower-flow or even dry-out of many natural springs and significant sink-down of groundwater levels in many hydrological basins in the country, causing increasing economic losses including high costs for wells' deepening and increasing consumption of power for pumping.

6) The current shortage gap between the national water uses and resources (represented by the light-coloured area in the chart) is expected to shrink down, then eliminate sometime during the 2nd half of 2010s, pursuant to the prospected progress in improving sectoral water uses efficiencies and particularly in implementing the National Program for Conversion to Modern Irrigation.

7) Accordingly, the national water balance could be expected to re-equalize, and even gaining some positive margin, then after. In a general term this is translated into prospected halt of depleting unrenewable stock of groundwater, however this is at national level and will not be to equal extents for all hydrological basins of the country.

8) It is noticeable from the chart that there was over the period 1995-2005 a type of parallelism between the growth of total water demand and the growth of population and GDP. As appears from the chart this is attributed mainly not to the growth of potable and industrial water demands but to agricultural demand due to horizontal expansion in irrigated farming as to satisfy the increasing foodstuff needs and to improve the status of national foodstuff self-sufficiency and security. Unfavourably, this type of expansion has reached to a point where foodstuff security started to threat the water security of the country, a matter that may badly return on foodstuff security itself.

9) But with the prospected improvement of water uses efficiencies, particularly in agriculture through the National Program for Conversion to Modern Irrigation, it appears from the future trends in the chart that the Syrian Arab Republic has a very good opportunity to "detach" (say; de-parallelize) the growth of total water demand from the growth of population and GDP. Nevertheless, this may not adversely affect the national foodstuff security and self-sufficiency if accompanied with a "vertical expansion" in agriculture, i.e. raising the productivity through increasing the yields of land unit and water unit in agrarian practice. In fact the results of the national researches and pilot experiences in this domain have proved enough that the conversion to sprinkler, localized and modified surface irrigation modes is accompanied for all major national crops not only by high water savings (higher water unit yields) but also higher land unit yields.

In few words, the sustainability of human wellbeing, economic growth and social development in the Syrian Arab Republic became increasingly dependent on a meaningful water saving through raising water uses efficiency and strict application of the approach and rules of Water Demand Management, otherwise the country will be facing a critical water crises in a not too far future.

7. Tunisie

7.1. Objectifs de l'économie de l'eau et de l'amélioration de l'efficience

L'Administration de l'eau en Tunisie a adopté à partir de 1995 un Programme National d'Economie d'Eau en Irrigation (PNEEI) dont les objectifs primordiaux visent à :

- rationaliser l'utilisation de l'eau dans tous les domaines, et essentiellement pour les réseaux d'eau potable et d'irrigation,

- assurer une meilleure valorisation économique de celle-ci, et

- maintenir la demande en eau à un niveau compatible avec les ressources disponibles, réputées insuffisantes afin de garantir la durabilité des ressources.

L'objectif cible, fixé par la réalisation des différents programmes, est d'atteindre une efficience globale dans le domaine de l'agriculture irriguée avoisinant le taux de 85% au niveau de la distribution et une efficience globale dans le domaine de la desserte en eau potable en 2025 de 80%.

Le Programme National d'Economie d'Eau en Irrigation avait en particulier prévu l'équipement en systèmes d'économie d'eau de 90% des 400.000 ha de périmètres irrigués à l'horizon 2006 et l'amélioration de l'efficience des irrigations à un niveau de 75% au minimum à fin 2006.

La superficie équipée en moyens d'économie d'eau (irrigation gravitaire améliorée, par aspersion et localisée) couvrait en juin 2006, près de 310.000 ha représentant 75% de la superficie totale irriguée. La cadence de réalisation a été de 15.000 à 25.000 ha par an.
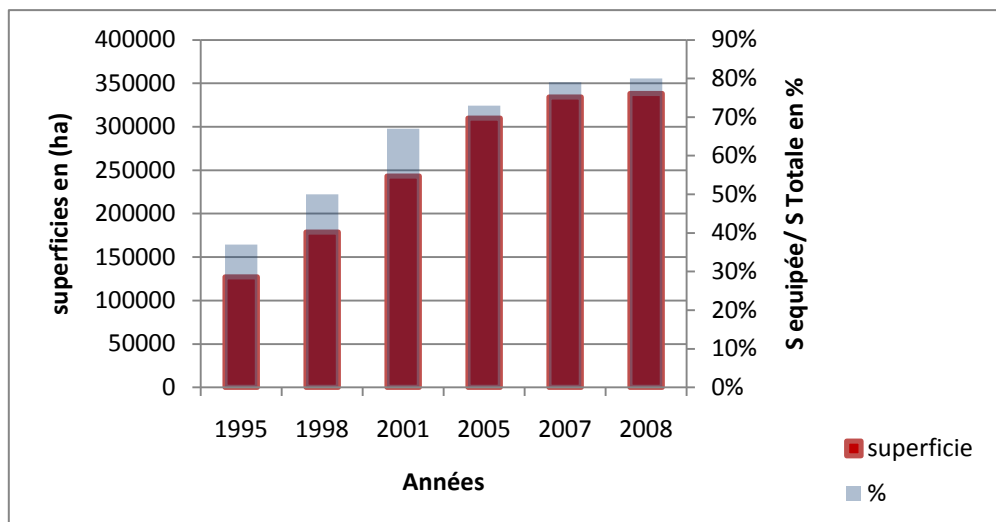
La répartition selon la technique d'irrigation se présente actuellement comme suit :

- 98.000 ha en irrigation localisée (soit 21,6% de la superficie totale irrigable),

- 106.000 ha en irrigation par aspersion (soit 26,7%), et

- 106.000 ha en irrigation gravitaire améliorée (soit 25%).

L'irrigation localisée représente actuellement près de 25% de la superficie totale irrigable alors qu'elle ne représentait que 3% en 1995.

Des plans d'action régionaux ont été mis en place par les Commissariats régionaux de développement Agricole en vue d'atteindre l'objectif de 100% de la superficie irriguée des périmètres irrigués en 2009.

La Société Nationale de l'Exploitation et de distribution des eaux (SONEDE), en tant qu'opérateur chargé de produire et de distribuer l'eau potable, a mis en place une stratégie visant une utilisation judicieuse de l'eau aussi bien au niveau des ouvrages et des réseaux publics qu'au niveau des réseaux privés

Le développement de l'économie de l'eau au niveau national a dû en outre bénéficié d'actions tous azimuts dans le but :

- d'approfondir la connaissance en techniques appropriées pour une utilisation optimale de l'eau,

- d'assurer une meilleure maîtrise de la part des services régionaux des techniques et des méthodes d'économie d'eau en irrigation, adaptées aux conditions du milieu,

- d'inciter les exploitants à adopter les techniques et les méthodes d'économie d'eau,

- de mettre à la disposition des citoyens les connaissances et l'appui technique nécessaires à une telle conversion.

- d'étendre rapidement l'introduction des techniques d'économie de l'eau à la parcelle ; et de transférer les périmètres publics irrigués (PPI) aux groupements de développement agricole (GDA) dans des conditions d'exploitation adéquates.

7.2. Les mesures entreprises et les politiques adoptées

7.2.1. Mesures réglementaires

L'économie de l'eau a connu en Tunisie un élan considérable, favorisé par des décisions politiques depuis 1995, par l'augmentation du taux des subventions relatives à l'économie d'eau en irrigation, de sorte à permettre une augmentation du taux de subventions de 30% à 40, 50 et 60% des investissements selon les différentes catégories d'agriculteurs.

Des textes de lois relatifs à l'incitation aux investissements, le cadre législatif et réglementaire relatif à la promotion des investissements et à la rationalisation de la gestion de l'eau ont fait l'objet de plusieurs réformes favorisées par l'intérêt politique accordé au secteur de l'eau en général et à l'économie de l'eau en particulier.

En effet, le code des eaux, promulgué en 1975, et notamment ses articles (12, 15, 16, 86, 102, 106, 90 et 96) relatifs aux ressources, aux aménagements, à la tarification, à la réutilisation et à l'économie de l'eau, a été modifié et complété par de nouvelles lois en 1987, 1988 et 2001.

Les textes et les lois relatifs à l'incitation aux investissements ont été revues et améliorées à maintes reprises (Loi du 6 Aout 1982 complétée et amendée par les lois de du 23 juin 1984 et du 2 Avril 1988 et particulièrement la loi relative au code unique d'investissement du 27 Décembre 1993). Cette dernière concerne essentiellement la réduction des droits de douanes au taux de 10%, la suspension de la taxe sur la valeur ajoutée (TVA) et des droits de consommation dus à l'importation des biens d'équipement n'ayant pas de similaires fabriqués localement, et la suspension de la TVA sur es équipements agricoles fabriqués localement.

L'acquisition des équipements d'économie d'eau a bénéficié de plusieurs avantages fiscaux prévus par l'article 30 du code d'incitations aux investissements. Les équipements bénéficiant de ces avantages ont fait l'objet de listes parues par décrets en 1995 et 1998

7.2.2. Mesures techniques

Des actions importantes portant sur l'amélioration de l'efficience des réseaux collectifs d'irrigation et de l'eau potable ont été programmées. Les principaux sont résumés comme suit :

- Le projet d'économie d'eau dans les périmètres de petite et moyenne hydraulique de la Tunisie Centrale qui vise la réhabilitation ; la modernisation du réseau public; et l'économie d'eau à la parcelle d'une part et le transfert de la gestion de ces entités aux groupements d'intérêt collectif (GIC). Il concerne une superficie de 11.000 ha de périmètres irrigués et a un coût de 24 MD.

- Le projet d'amélioration des périmètres irrigués dans les Oasis du Sud qui concerne 23.000 ha dans les Gouvernorats du sud Tunisien et consiste essentiellement en :

  - L'étanchéisation des canaux en terre par la réalisation de canaux en béton ou la mise en place de conduites enterrées en PVC, et

  - La mise en place d'un réseau de drainage permettant l'évacuation des eaux excédentaires et le lessivage des sels.

- Le projet de modernisation des anciens périmètres irrigués de la Basse Ballée de la Mejerda, en cours de réalisation, qui vise à moderniser une première tranche de 4 300 ha de l'ancien périmètre de la Basse Vallée de la Medjerda, sur une superficie totale de 27000 ha.

  Le programme d'économie d'eau au niveau des ouvrages et des réseaux publics d'eau potable est constitué de plusieurs composantes, tels que l'installation de nouveaux moyens de comptage et de régulation, la recherche des fuites, la rénovation des conduites et des branchements vétustes et compteurs et la régulation de la pression dans les réseaux.

- Le comptage des volumes d'eau produits et distribués occupe une place importante dans le programme des économies de l'eau. Cette action vise essentiellement à doter tous les systèmes hydrauliques de moyens de comptages appropriés et de bien quadriller les réseaux moyennant l'installation de compteurs de zones. Ce qui assurera une bonne orientation des opérations de recherche des fuites. En 2007, tous les réservoirs de distribution d'eau potable sont équipés par des compteurs ou des débitmètres.

Trois actions principales ont été menées dans le domaine du comptage :

La première consiste au changement des compteurs bloqués dans le but de réduire voire d'éliminer le recours à la facturation au prorata.

Année	2004	2005	2006	2007
Nombre de compteurs changés	41134	37586	34267	51082

La seconde action concerne le changement des compteurs vétustes (hors classe et classe B)

Année	2004	2005	2006	2007
Nombre de compteurs hors classe changés	71232	40727	16349	9611

La troisième action concerne le redimensionnement des compteurs.

Année	2004	2005	2006	2007
Nombre de compteurs redimensionnés	1419	1671	578	316

- La régulation au niveau des systèmes d'eau consiste à équiper les systèmes d'alimentation en eau potable (gravitaires et par refoulement) par des moyens de régulation appropriés (obturateurs, robinets à flotteur, vannes hydro-altimétriques, lignes pilotes, radios,...) afin d'éliminer les pertes d'eau par trop-plein.

Année	2004	2005	2006	2007
Nombre de compteurs redimensionnés	1419	1671	578	316

- Le taux d'équipement de tous les systèmes (gravitaire et par refoulement) par des moyens de **régulation appropriés a atteint 96,6% en 2007. En effet, outre les opérations d'entretien préventif,** 35 nouveaux équipements de régulation ont été installés en 2007.

  Il est prévu d'équiper tous les systèmes d'alimentation en eau potable par un moyen de régulation approprié.

- La réhabilitation des branchements et des réseaux est axée essentiellement sur le changement des branchements vétustes et le changement des conduites vétustes;

  Les branchements vétustes constituent une source importante de fuites. La SONEDE a engagé depuis 1998 une action de recensement de ces branchements (329000) et a planifié leur remplacement sur 10 ans.

  Actuellement le nombre de branchements vétustes s'élève à 127600 après avoir changé 11209 en 2007.

  Le taux des abonnés desservis par un branchement vétuste est passé de 24% en 1998 à 6% en 2007.

- Les opérations de recherches des fuites sont effectuées soit par corrélation soit par la méthode acoustique. Ces opérations sont menées en partie par les moyens propres disponibles selon un programme préétabli. Elles sont aussi effectuées en recourant à la sous-traitance.

  Durant l'année 2007, le linéaire du réseau de distribution inspecté a atteint 8300Km.

  Le nombre de fuites et casses détectées a atteint 2011 soit une fuite ou une casse tous les 3,3 Km.

  En outre, 1650 Km ont été inspectés en recourant à la sous-traitance pour détecter et réparer 91 fuites et casses soit environ une fuite tous les 18 Km.

7.2.3. Mesures institutionnelles

Des comités régionaux de suivi-évaluation du programme d'économie d'eau ont été créés en Mars 1992 au niveau des administrations régionales (CRDA(s)), à l'occasion du lancement du projet de formation et de vulgarisation de l'économie de l'eau en irrigation, et des stratégies régionales et un système de suivi-évaluation des activités de l'économie de l'eau au niveau national ont été instaurés depuis 1993.

Après le transfert de la gestion de tous les systèmes d'alimentation en eau potable et d'irrigation dans les périmètres publics irrigués sur forages, le programme de promotion des Groupements d'Intérêt Collectif (GIC) a été étendu, depuis 1998, aux périmètres publics irrigués à partir des grands barrages (GPPI) qui couvrent une superficie totale de 124000 ha en 2001 répartis sur une dizaine des gouvernorats et ce en vue de rompre avec la "dualité" existante dans la gestion des périmètres publics irrigués; à savoir une gestion associative pour les périmètres sur forages et une gestion publique pour les grands périmètres irrigués à partir des grands barrages (GPPI). Ainsi, grâce aux efforts déployés par les services régionaux, 50000 ha des PPIIGB ont été transférés aux GIC avant 2001, soit 40% de la superficie totale des PPIIGB en Tunisie et 25 000 ha ont été aussi passés sous gestion communautaire pendant la période (2001-2005).

Les périmètres publics irrigués à partir des grands barrages transférés aux GIC à la fin de l'année 2005 couvrent 75000 ha soit 53% de l'ensemble des GPPI en Tunisie (141 000 ha en 2005).

Le projet PISEAU (Projet d'Investissement du secteur de l'eau) qui a démarré en 2001, vise à appuyer les efforts des services régionaux dans le domaine du transfert de la gestion des GPPI aux GDA et ce à travers le financement de 10 projets d'assistance technique dans 8 gouvernorats du pays

pour transférer 31000 ha des PPIIGB aux GDA et pour renforcer les capacités des GDA crées déjà dans des GPPI (16000 ha).

C'est aussi dans ce contexte d'économie d'eau dans les Périmètres de Petite et Moyenne Hydraulique de la Tunisie qu'un projet d'assistance technique aux GDA dans les périmètres irrigués sur forages a été mis en œuvre.

Ce projet d'une durée 7 ans a touché une soixantaine des GDA (1999-2006) avec un coût d'environ un million d'euros.

De même, pour renforcer les capacités techniques des services régionaux et des GDA d'Alimentation en Eau potable, deux projets d'assistance technique ont été mis en œuvre : le premier a touché a démarré en 1997 et se poursuit jusqu'à l'année 2008 et il a touché environ 800 GIC d'AEP répartis dans huit gouvernorats, et le deuxième d'une durée de cinq ans (2006-2010), vise à renforcer des capacités techniques de 160 GIC d'AEP répartis dans dix sept autres Gouvernorats.

7.3. Approche économique utilisée

Le système de suivi-évaluation de l'économie de l'eau ainsi qu'une enquête de terrain, réalisée en 2001 sur certains indicateurs technico–économiques de développement, ont permis de réaliser une évaluation à mi-parcours du Programme National d'Economie d'Eau et de confirmer particulièrement son efficacité et sa rentabilité économique à l'échelle de l'exploitation agricole (DGGR/DGPDIA, 2001).

Les résultats de l'évaluation effectuée attestent particulièrement, du degré élevé de dynamisme atteint par les différents acteurs de développement, ayant amené à une augmentation considérable de la superficie équipée en systèmes d'économie d'eau. Les programmes de vulgarisation, utilisant différentes méthodes de communication et de vulgarisation de masse ont largement contribué à l'économie de l'eau en irrigation.

L'évolution de l'efficience mesurée dans le domaine de l'irrigation depuis 1994 jusqu'à 2007 et celle projetée jusqu'à 20025 est représentée au graphique ci après :

Figure 15 Efficience des réseaux d'irrigation
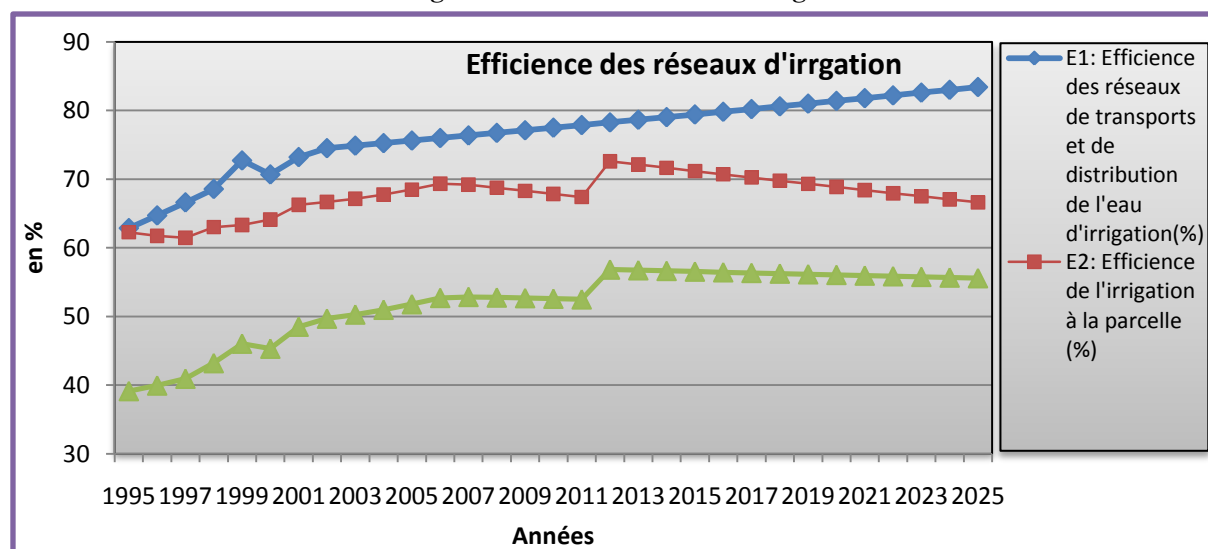
7.3.1. La consommation en eau avant et après économie d'eau

A l'échelle nationale, pour les cultures de tomate et de pomme de terre , l'économie en eau en moyenne est respectivement de l'ordre de 16% et de 14% en passant d'une consommation moyenne de 7275 m3/ha/an à 6100 m3/ha/an pour la tomate et de 4763m3/ha/an à 4075 m3/ha/an pour la pomme de terre. Pour l'arboriculture elle est de 9%.

Dans l'étude menée en 2001, bien que les résultats ne sont pas très significatifs (enquête non représentative) une meilleure rationalisation de l'utilisation de l'eau d'irrigation a été notée ayant abouti à une meilleure rentabilité à l'échelle de l'exploitation et par conséquent à une meilleure valorisation de l'eau.

7.3.2. Marges brutes

En adaptant un système d'irrigation efficient, avec le paquet technologique approprié, l'exploitant agricole obtient des bénéfices additionnels pouvant dépasser le double de ce qu'il obtenait avec un système d'irrigation traditionnel. Ainsi, à l'échelle nationale, le bénéfice additionnel est de 97% pour les cultures maraîchères et de 35% pour l'arboriculture.

7.3.3. Le recouvrement des investissements relatifs à l'équipement en matériel d'économie d'eau : (ou couverture des charges additionnelles par les bénéfices additionnels)

Sans tenir compte des subventions, les taux de recouvrement se présentent comme suit :

- 350% pour les cultures maraîchères,
- 325% pour l'arboriculture fruitière, et
- 109% pour les grandes cultures, soit 278% à l'échelle du pays.

7.3.4. Le délai de retour des investissements en économie d'eau (ou période pour le recouvrement total des investissements)

Délai de retour = Investissement / (Marge brute 2 - Marge brute 1) en tenant compte de l'investissement global (sans subvention), le recouvrement de l'investissement relatif à l'économie de l'eau serait atteint à la deuxième année, soit :

- 1,5 année pour les cultures maraîchères,
- 2 années pour l'arboriculture fruitière, et
- 1,7 année en moyenne.

    En tenant compte de l'investissement réalisé par l'agriculteur et des subventions, le délai de retour est de 1 année pour toutes les cultures étudiées.

7.3.5. Résultats de l'évaluation des performances des GDA d'eau à la fin de l'année 2006

Le nombre total des GDA d'eau a atteint 2809 GIC dont 1610 GDA d'AEP, 1064 GDA d'irrigation et 124 GDA mixtes.

La superficie totale des périmètres publics irrigués (PPI) mis en exploitation a atteint 226 214 ha et les surfaces transférées aux GDA sont réparties comme suit :

Table 12 Répartition du transfert des PPI aux GDA en 2006

Type PI	PPI/barrage (ha)	PPI/forage (ha)	Oasis (ha)	EUT (ha)	Total (ha)
S-totale (ha)	140881	47387	29783	8163	226214
S-transférée (ha)	105750	44821	29783	2837	183190
%	75%	95%	100%	35%	100%

7.3.6. Evolution des groupements de développement agricole

Le transfert de la gestion des périmètres irrigués pour des groupements de développement agricole a évolué comme suit :
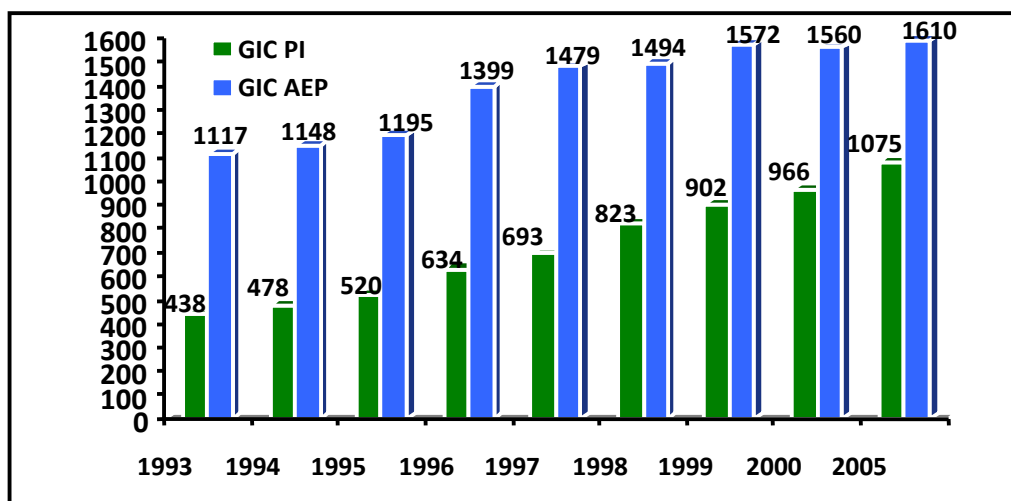
7.3.7. Indicateurs de performance pour l'eau potable

Dans le cadre de l'amélioration continue de ses méthodes de gestion et de ses outils de pilotage, la SONEDE a mis en place en 2007 un comité de pilotage et cinq comités opérationnels afin d'identifier et d'élaborer un ensemble d'indicateurs de performance relatifs aux activités touchant au personnel, aux équipements, à l'exploitation, à la qualité des services et aux finances. Le comité opérationnel d'exploitation a examiné les différents rendements des réseaux existants (Rg, Ra, Rd) et a proposé de retenir les rendements suivants et ce après validation par le comité de pilotage :

• Le rendement sur réseau de distribution (Rd) :

$$Rd = \frac{VC}{VD} * 100 = \frac{VC\,f + VCn\,f}{VD} * 100$$

• Le rendement sur réseau d'adduction (Ra) :

$$Ra = \frac{VD + Vsa + Vss + Vsm}{VP + Vss + Vsm} * 100$$

• Le rendement global

$$Rg = \frac{VC + Vsm + Vss + Vsa}{VES} * 100$$

- Le rendement sur réseau de transfert (nouveau concept)

$$Rt = \frac{VES + Vaic - Vst}{VINT} * 100$$

Les rendements des réseaux

Le rendement global des réseaux a atteint 77,3% en 2007 avec des rendements de 83,4% sur les réseaux de distribution et de 92,2% sur les réseaux d'adduction.

Le rendement du réseau global est passé de 78,2% en 2006 à 77,3% en 2007, soit une baisse de 0,9 point. Cette baisse est la résultante des régressions du rendement des réseaux d'adduction de 0,5 point (92,2% en 2007 et 92,7% en 2006) et du rendement des réseaux de distribution de 0,6 point (83,4% en 2007 contre 84% en 2006).

Par ailleurs, pour apprécier l'efficience des réseaux de transfert, on calcule le rendement sur réseaux de transfert (Rt).

En 2007, ce rendement a atteint 99,5% comparé à un rendement de 92,2% au niveau des réseaux d'adduction et de 83,4% au niveau des réseaux de distribution.

Le rendement du réseau de distribution (Rd)

Le rendement du réseau de distribution (Rd) est le rapport en pourcentage entre le volume consommé (VC) et le volume distribué (VD). Le volume (VC) en 2007 a atteint 348,1 Mm3 répartie en 345,2 Mm3 volume consommé non facturé (VCnf : 0,8%) constitué par la consommation des bouches d'incendies les dégrèvements, le rinçage et la vidange des ouvrages de distribution.

Le rendement à l'échelle de la distribution dans les réseaux d'eau potable en 2007 est de 83,4%, tout en présentant des variations d'une région à une autre (de 70% à Médenine au sud jusqu'à 89,3% au grand Sousse).

Figure 16 Efficience des réseaux d'eau potable
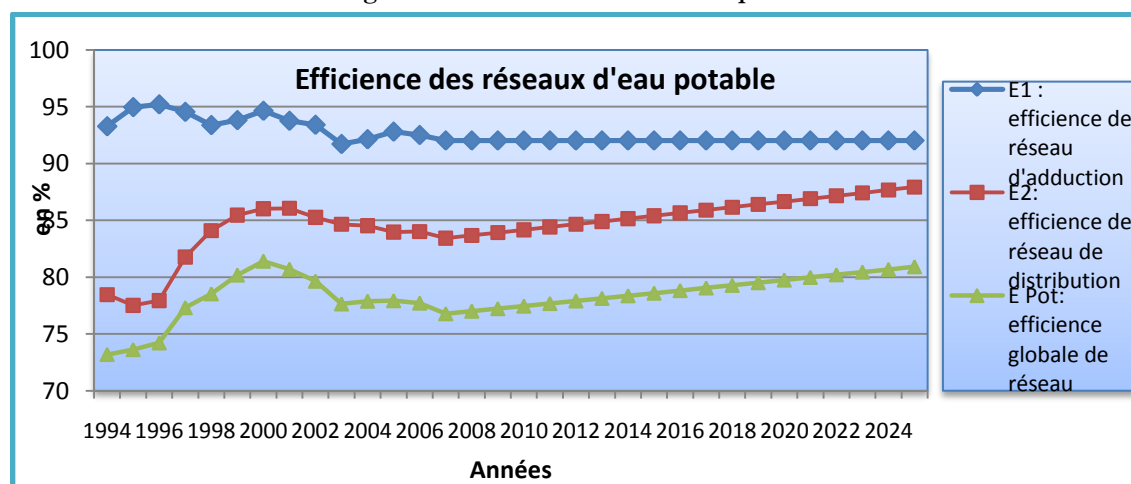
Une étude économique et financière élaborée par les service de la SONEDE évaluant les économies d'eau escomptées dans le domaine de l'exploitation es réseaux d'eau potable par la réalisation de différentes actions, à savoir la réhabilitation et la rénovation des réseaux, la mise en place des équipements économiseurs d'eau, l'installation de compteurs divisionnaires et la réalisation des actions de sensibilisation, a abouti aux résultats suivants :

L'économie de l'eau escomptée est de 25% au minimum ;

L'évaluation de l'économie escomptée sur cette base est comme suit :

Désignation	Avant application des actions	Après application des actions	Economie d'eau (m3)
Consommation (m3/an)	3 600	2 700	900
Consommation (DT/an)	7 100	5 300	1 800

Le délai de récupération est de trois ans et neuf mois.

7.4. Conclusion

Le défi de l'avenir pour la Tunisie sera, inévitablement, le développement de ses capacités à préserver et à valoriser ses faibles ressources beaucoup plus que de rechercher d'en créer de nouvelles.

Les économies substantielles à réaliser à l'avenir devront provenir essentiellement des secteurs d'usages importants de l'eau, entre autre l'agriculture qui utilise prés de 80% des ressources mobilisées

Dans cette perspective future de pénuries aggravées par l'apparition plus fréquente des épisodes de sécheresse d'une part et des changements climatiques d'autre part, la gestion de l'eau devra intégrer de plus en plus les aspects relatifs à l'amélioration du fonctionnement des infrastructures hydrauliques et de maitriser les technologies adaptées afin d'optimiser l'utilisation des ressources existantes.

Outre l'amélioration directe de l'efficacité technique de l'utilisation de l'eau en irrigation, la création de nouveaux périmètres d'irrigation mérite d'être examinée avec plus de rigueur dans le cadre d'une stratégie macro économique.

Outre les considérations techniques, la mise en place d'une stratégie de gestion de l'eau axée sur la demande, plaidera en faveur d'une réadaptation adéquate des instruments institutionnels du secteur de l'eau.

8. Turkey

8.1. The wastewater treatment

Many municipalities located in coastal areas of Turkey still discharge their wastewaters untreated to the sea mainly via deep sea discharges which is against both local environmental regulations and, being an EU accession country, EU environmental acquis. The main reason for this violation of environmental regulations is the financial constraints of the municipalities involved. Central governmental support is limited, political concerns play key roles in municipal decision making as well as overestimation of socio-economic difficulties, especially about the tariff affordability of the low-income groups which reduce willingness-to-charge the full cost recovery tariffs in accordance with the "polluter pays" principle by the elected Mayors and the members of the Municipal Councils.

Disposing urban wastewater collected via deep-sea outfalls has been selected as the most economical solution by the governments in Turkey and applied by İller Bankası (Bank of Provinces which provides technical, financial and implementation support to Turkish municipalities for local infrastructure development) so far. However, to be able to comply with the EU environmental acquis the central government has decided to declare all seas (Black Sea, Marmara, Aegean and Mediterranean) as sensitive areas which will require application of advanced wastewater treatment processes including nitrogen and phosphorus removal by all coastal municipalities in Turkey. This will be a big challenge for the protection of the marine environment which, at the same time, necessitates implementation of operationally and financially sustainable measures.

The financial impact of implementing advanced wastewater treatment technologies on the municipalities and, especially on the households to which incremental costs would be reflected as tariff increases to ensure full cost recovery, have been analyzed by making use of the real-life examples of three medium-sized Turkish municipalities discharging their wastewaters untreated to the sea. Figure 17 shows the location of the municipalities :

1) Ordu Central District Municipality of Ordu Province discharging directly to the Black Sea;

2) Çarşamba District Municipality of Samsun Province discharging to Kızılırmak River flowing to the Black Sea (1 km upstream) ;

Ceyhan District Municipality of Adana Province discharging to Ceyhan River flowing to the Mediterranean (25 km upstream).

**Figure 17 Location of the municipalities**

The NRW is above 50% which is typical for Turkey. The highest NRW among the case studies belongs to Ceyhan Municipality, with 62.4% as shown in Table 13 and Figure 18 below, due to major leaks and cracks in the main transmission line.

Table 13 Non-revenue water (%) (Burak and Mat, 2008)

Municipalities	2004	2005	2006	2007
ORDU	49.5%	49.2%	46.2%	46.1%
CEYHAN	62.5%	64.6%	62.0%	62.4%
ÇARŞAMBA	55.3%	54.0%	53.2%	52.4%
AVERAGE	55.7%	56.0%	53.6%	53.6

Figure 18 Non-revenue water trend in case study areas (Burak and Mat, 2008)
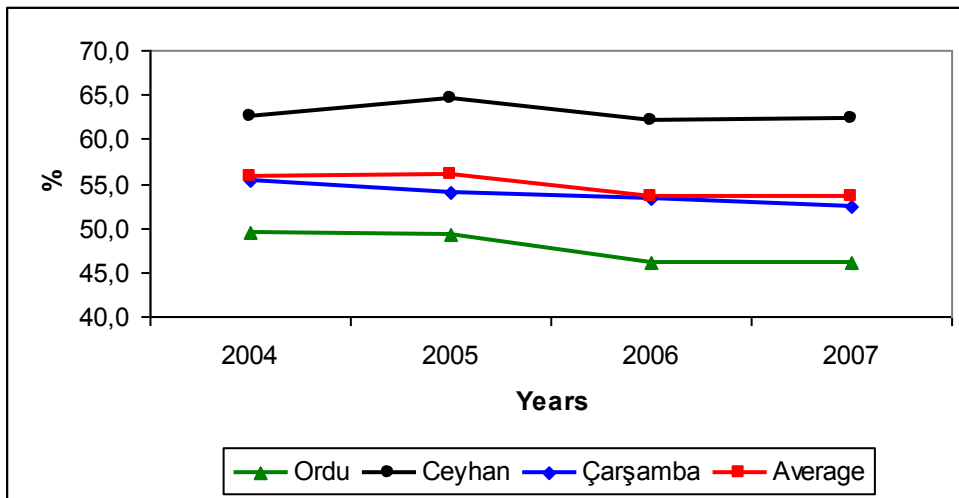
8.2. Project title: Tarsus municipality (TASKI) consulting services for management assistance and training/complementary measures

Overall Project Value: 737,915 Euro

Start – End Dates: December 2000 / August 2005

Partners: Deutsche Abwasser Reinigungs-gesellschaft (DAR) (Germany) / Berliner Wasser Betriebe (BWB) (Germany)

Project Description:

- Enable Tarsus Municipality's Water and Sewerage Operating Enterprise (TASKI) to implement a large scale Water/Wastewater Project co-financed by German Development Bank (KfW) and European Investment Bank (EIB) by improving its institutional capacity

- Advise the management in organizational and conceptual matters

- Support the construction department during the implementation of the project

- Advise and train the accounting staff of TASKI in their new commercial and accounting tasks, develop the accounting system, introduce a financial management information system

- Qualify the key staff for wastewater treatment plant management

  Support the development of an effective environmental control system including drafting of a polluter register and internal regulations and control routines for monitoring industrial polluters.

8.3. The cost of municipal services project

The Government of the Republic of Turkey has received a loan from the International Bank for Reconstruction and Development (IBRD-World Bank) towards the cost of Municipal Services Project with the objective of improving and rehabilitating water supply, sewerage, storm water, solid waste and treatment works of selected municipalities in Turkey. The general management of this extensive project is carried out by the Management Unit established within the organizational structure of Iller Bank. A portion of this loan is allocated to the Mersin Water Supply and Sewerage Administration (MESKI) towards the cost of the services of Mersin Drinking Water Rehabilitation Project. The scope of the Project covers specifically MESKI Water Network Rehabilitation. To improve the existing 67% of Non-Revenue-Water (NRW) level of MESKİ, the training program focuses on three main topics as: 1)Recording, records keeping and documentation; 2) NRW management; 3) Operation and maintenance. (WB, 2008).

8.4. Textile wastewater minimization and reuse

Project Summary: Harmonization Study with EU IPPC Directive in the Textile Industry

BAT Application

Project duration: 15.10.2005 - 15.01.2008

Objective: Application of best available techniques as requested by the IPPC Directive, application of alternative treatment technologies in the selected textile factory, cost estimate and analysis of replicability in the textile industry.

Scope of works: Wastewater caracterization study, pollution control and minimization, treatability studies have been conducted. In line with these studies, significant decrease in water volume was relized. Advanced technologies like ozonization and membrane filtration were applied mainly to dye process and mixed wastewater for reuse purpose.

8.5. Project title: land-use, environmental concerns and optimization of water demand management in the Gebze industrial area

Project Duration: 10/01/2004-10/06/2006

Objective:The objective of this project is to determine the total water demand of the industrial premises located in the industrial areas of Gebze, Dilovası and Çayırova, estimate the water demand variation and source of utilization (municipal network, groundwater or tanker) in accordance with the capacity utilization rate changes of the industries and to identify the potential of environmental stress generated by these activities both on fresh water resources and the marine environment.

During the field study, after having obtained the required authorization by the institutions concerned, pre-scheduled appointments were made with the nominated staff by the companies and face to face interviews were carried out with a structured questionnaire. Out of 686, 229 representative companies were sampled. In addition to this study, fifty large companies were analyzed separately within the sample of 98 which are determined as 'large-size' companies by the Industrial Chamber of Commerce of Kocaeli. All the data collected are statistically analyzed by using the 'Quantum' computer program and the detailed statistical output results were obtained. Tabulated findings are presented and commented in the 'Evaluation' chapter of the report.

The total water consumption of these 50 companies is computed and the related industrial categorization according to the 'Water Pollution Control Regulations' of the 'Environment Act' is made.

The operational practices of the existing wastewater treatment plants run by the industries, the pollution potential in the 'Dilderesi Creek' and the shoreline of the study area, are assessed at six representative stations. The analyses were carried out with a HACH DR- 2400 spectrophotometer and also at the laboratory of the Institute of Marine Sciences and Management.

As in other previous studies carried out for the environment of Izmit and Izmit Bay, the findings of the field survey at the industries and analyses of the samples have proven that the study area is subject to a severe environmental stress both with regard to fresh water resources and also with regard to the pollution of the receiving media. Overexploitation of the freshwater resources and industrial pollution of the marine environment are the two most important problems of the study area.

In the light of the present and previous studies, it is recommended that an integrated environmental study covering the identification of industrial pollution at source should be initiated with regular monitoring so as to start installing an industrial pollution abatement program on a voluntary agreement basis by the industrial premises.

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Table 14 : data sources on water use efficiency

Countries	References
Spain	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/EUROSTAT 2006 / Rapport national Saragosse 2007
France	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/IFEN 2006 (RNDE)
Italy	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/WRI 2005 / « Stato dell Ambiente 2001 » (minst dell Ambiente et della Tutela del Territoris, 2001) / A. Massaruto « Agricult. Water Ressources & Water Policies in Italy » 2001 / Rapport national Saragosse 2007
Malta	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/EUROSTAT-Environm Statistic 2006 / Rapport national Saragosse 2007
Slovenia	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/EUROSTAT 2006
Croatia	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/Statike information 2002
Bosnia-Herzegovina	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/Statisticki Yearbook 2001/ J. Margat, rapport PAM 158, 2004/ Rapport national Saragosse 2007/ Rapport national Sophia Antipolis 2008
Albania	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/ WRI 2005/AQUASTAT 2005
Greece	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/ WRI 2005/ AQUASTAT 2005
Cyprus	FAO-AQUASTAT 1997/Eurostat, Statist-. Service-Environmental Statist 2000/Etude IME, Lkhrouf, 2001/ Rapport national Saragosse 2007/ Rapport national Sophia Antipolis 2008
Turkey	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/ Turk Stat-EUROSTAT 2006/ WRI 2005/ Rapport national Saragosse 2007/ Rapport national Sophia Antipolis 2008
Syria	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/WRI 2005/ AQUASTAT 2005/ Rapport national Saragosse 2007/ Rapport national Sophia Antipolis 2008
Lebanon	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/WRI 2005/ AQUASTAT 2005/ Rapport national Sophia Antipolis 2008
Israel	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/ Water Commission 2002/WRI 2005/ Rapport national Saragosse 2007
Egypt	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/ EUROSTAT Compendiums 2003 et 2006/ J. Margat, rapport PAM 158, 2004/:WRI 2005/ FAO 2005
Libya	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/ WRI 2005/ FAO 2005
Tunisia	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/WRI 2005/ EUROSTAT Compendium 2006/ Rapport national Saragosse 2007/ Rapport national Sophia Antipolis 2008
Algeria	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/WRI 2005/ONS-EUROSTAT Compendium 2006
Morocco	FAO-AQUASTAT 1997/Etude IME, Lkhrouf, 2001/ Rapport national Saragosse 2007/ Rapport national Sophia Antipolis 2008

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