MEDITERRANEAN STRATEGY FOR SUSTAINABLE DEVELOPMENT

WATER USE EFFICIENCY

NATIONAL STUDY OF SYRIA

Plan Bleu
Regional Activity Centre

Sophia Antipolis
November 2008

MEDITERRANEAN STRATEGY FOR SUSTAINABLE DEVELOPMENT

WATER EFFICIENCY INDEX CALCULATION

Plan Bleu

Regional Activities Centre
Sophia-Antipolis

Country:	**Syrian Arab Republic**
Date:	**24/07/2008**
Name of the Person having filled this questionnaire:	**Housney Al-Azmeh**
Organization/function:	**Expert Service Provider**
Address:	**1st floor Al-Samman bldg., Kourjieh Haddad Street, Ain El-Kersh quarter, Damascus, Syria.**
Tel:	**+963(011) 2313372**
Fax:	**+963(011) 2313372**
e-mail:	halazmeh@scs-net.org

LIST OF CONTENTS

1. CONTEXT

1.1. Improvement of water use efficiency in the Mediterranean

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. Potential achievable savings were thus estimated at around a quarter of current water demand, in other words 70 km^3 for a total demand of 282 km^3 for the Mediterranean states as a whole in 2000. In 2025 it would be about 85 km^3/yr (for total water demand of some 330 km^3/yr).

Sub-regions of Mediterranean basin (Countries)	Drinking water Networks efficiency raised to 85% and users efficiency raised to 90%	Irrigation Networks efficiency raised to 90% and plot efficiency raised to 80%	Industries Recycling generalized to 50%	Total
North	4,4	15,7	9,5	29,6
East	1,8	12,2	2,2	16,2
South	2,5	17,9	4,1	24,5
Total	8,7	45,8	15,8	70,3

Estimate recoverable losses by Mediterranean sub-regions in 2000
Source: Blue Plan, J. Margat

Note: They are the "recoverable losses" from the only point of view of the techniques available, without prejudging social resistances and difficulties.

It was retained the "desirable objectives" following as regards improving water physical efficiencies at regional level and by 2025 (These "desirable" objectives correspond to the efficiency improvement hypotheses in the Blue Plan's alternative scenario):

- For drinking water in the Municipalities: rates of distribution losses reduced to 15% and user leaks reduced to 10%;
- For irrigation: transport and distribution losses reduced to 10% and raised irrigation plot efficiency to 80%;
- For industry: recycling generalized to 50%.

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, basin, tables, city or irrigated area).

1.2. Priority indicators of water chapter of Mediterranean Strategy for Sustainable Development

The Contracting Parties to the Barcelona Convention adopted, in November 2005, the Mediterranean Strategy for Sustainable Development (MSSD). The first priority field of action of the Strategy is "integrated water resources and demand management", the key aims of which are:

- Strengthening of WDM policies to stabilize water demand by reducing losses and wasteful use, and increasing the added value per m^3 of water used (efficiencies improvement);
- to promote the integrated management of catchment's areas including underground and surface water, ecosystems and depollution objectives;
- Access to drinking water and sanitation to deliver the "Millennium Development Goals";
- to promote participation, partnership, and co-operation.

5 priority indicators adopted to regularly follow the progress made by the countries in terms of water management, namely:

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. WATER EFFICIENCY INDEX (TOTAL AND PER SECTOR)

2.1. 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).

1. <u>Sectoral efficiencies</u>

a. Drinking water efficiency

This is the share of drinking water produced, distributed, and paid by consumers.

Epot = V1 / V2 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.

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 x 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

c. Water industrial efficiency

The volume of recycled industrial water (recycling index)

$$Eind = V5 / V6$$

V5 = Recycled water volumes in km^3/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.

2. <u>Total efficiency</u>

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).

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

Dpot: domestic demand (drinking water),
Dirr: 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" water(1) and "virtual" water(2)), 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.

[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 litres of water per kilo. For example, in Italy, approximately 2 400 litres of water is needed to produce one kilo of corn, 2 500 litres for one kg of rice and 21 000 litres for one kilo of Beef meat.

2.2. Unit:

Percentage (%)

2.3. 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).

3. DETERMINATION OF EFFICIENCIES

3.1. Drinking water

3.1.1. Drinking water invoiced and paid by consumer

Drinking water volume invoiced and paid by consumer (V1) (km^3/year)			
Year		Values	Source
1995		0.340	1
2000		0.608	2
2005		0.781	3
2010	1st Scenario	0.954	4
	2nd Scenario	0.864	5
	Average	0.909	6
2015		0.925	7
2020		1.071	8
2025		1.226	9
2030		1.336	10

3.1.2. Drinking water produced and distributed

Total drinking water volume produced and distributed (V2) (km^3/year)			
Year		Values	Source
1995		0.609	1
2000		0.984	2
2005		1.298	3
2010	1st Scenario	1.612	11
	2nd Scenario	1.259	12
	3rd Scenario	1.140	13
	Average	1.337	14
2015		1.156	15
2020		1.260	16
2025		1.393	17
2030		1.484	18

3.1.3. Drinking water efficiency

Drinking water efficiency (Epot = V1 / V2 in %)		
Year	Values	Source
1995	55.8%	Expert's calculation
2000	61.8%	
2005	60.2%	
2010	68.0%	Expert's prospects
2015	80.0%	Set target
2020	85.0%	Expert's prospects
2025	88.0%	
2030	90.0%	

3.1.4. Sources and Remarks - Drinking water section

1) Central Bureau of Statistics, Statistical Abstract 1996, table 8/5

2) Central Bureau of Statistics, Statistical Abstract 2001, table 8/5

3) Central Bureau of Statistics, Statistical Abstract 2006, table 8/5

4) Proposed by the expert as a simple linear extension of the increase in drinking water volume invoiced and paid by consumer as recorded for the preceding period 2000-2005;

$$V1_{2010\ 1^{st}\ scenario} = V1_{2005} + (V1_{2005} - V1_{2000})$$

5) Proposed by the expert on basis of the following data/assumptions:

- The average population projection for the year 2010 (20.5 millions) which is the one-decimal rounded average of the high and low projections reported in the 1st National Population Report, 2008
- The anticipated urban/rural composition of population in the year 2010 (54.5% urban / 45.5% rural), calculated from 2007 composition (53.5% urban / 46.5% rural) and the current average urbanization rate (0.33% per annum, or 1% every 3 years). Both as reported in the 1st National Population Report, 2008
- Coverage with drinking water supply in the year 2010 for residents of urban and rural areas (99% urban and 93% rural), as targeted by the 10th 5-year national development plan (2006-2010)
- The current average consumption (invoiced and paid) 120 l/day per individual served with piped drinking water (from available statistics)

With the application of the following formula;

$$V1_{2010\ 2^{nd}\ scenario} = 20.5\ [(0.545*0.99) + (0.455*0.93)] \times 0.120 \times 365 \times 10^{-3}$$

6) The average of the two scenarios for V1 in 2010 is assessed by the expert to be more reasonable and likely realizable, thus would be the input for use in computing the Water Efficiency Index.

7) Proposed by the expert on basis of the following data/assumptions:

- The average population projection for the year 2015 (23.0 millions) which is the one-decimal rounded average of the high and low projections reported in the 1st National Population Report, 2008
- Coverage with drinking water supply in the year 2015 to reach 91.8% of whole population, as targeted by the 2nd National Report on Millennium Goals, September 2005
- A continued average consumption (invoiced and paid) 120 l/day per individual served with piped drinking water

With the application of the following formula;

$$V1_{2015} = 23.0 \times 0.918 \times 0.120 \times 365 \times 10^{-3}$$

8) Proposed by the expert on basis of the following data/assumptions:

- The average population projection for the year 2020 (25.5 millions) which is the one-decimal rounded average of the high and low projections reported in the 1st National Population Report, 2008

- Coverage with drinking water supply in the year 2020 to reach 95.9% of whole population, which is the average of targeted coverage of years 2015 and 2025 (91.8 and 100% respectively)
- A continued average consumption (invoiced and paid) 120 l/day per individual served with piped drinking water

With the application of the following formula;

$$V1_{2020} = 25.5 \times 0.959 \times 0.120 \times 365 \times 10^{-3}$$

9) Proposed by the expert on basis of the following data/assumptions:

- The average population projection for the year 2025 (28.0 millions) which is the one-decimal rounded average of the high and low projections reported in the 1st National Population Report, 2008
- The targeted full coverage with piped drinking water service for all urban and rural residents
- A continued average consumption (invoiced and paid) 120 l/day per individual

With the application of the following formula;

$$V1_{2025} = 28.0 \times 0.120 \times 365 \times 10^{-3}$$

10) Proposed by the expert on basis of the following data/assumptions:

- A population projection for the year 2030 (30.5 millions) as proposed by the expert on basis of continuing growth in population size at the average of about 0.5 million/year till the year 2035 at least
- A continued full coverage with piped drinking water service for all urban and rural residents
- A continued average consumption (invoiced and paid) 120 l/day per individual

With the application of the following formula;

$$V1_{2030} = 30.5 \times 0.120 \times 365 \times 10^{-3}$$

11) Proposed by the expert as a simple linear extension of the increase in Total drinking water volume produced and distributed as recorded for the preceding period 2000-2005;

$$V2_{2010\ 1^{st}\ scenario} = V2_{2005} + (V2_{2005} - V2_{2000})$$

12) Proposed by the expert on basis of the following data/assumptions:

- The results of the 1st Scenario for (V1) calculation (the previous table).
- The targeted reduction of water losses (sum of physical and administrative losses) as set in the 10th 5-year development plan (2006-2010), i.e. to reach average losses 22% for urban areas and 27% for rural areas
- An anticipated 2010 urban/rural composition of piped drinking water beneficiaries; 56% urban and 44% rural. Calculated from anticipated urban/rural composition of population in the same year (54.5% urban / 45.5% rural), and targeted coverage with piped drinking water supply in the year 2010 for residents of urban and rural areas (99% urban and 93% rural, please refer to the 3rd point of above source No.5), by use of following formulas;
  - Urban beneficiaries % = $100 (0.545*0.99) / [(0.545*0.99) + (0.455*0.93)]$

- Rural beneficiaries % = 100 (0.455∗0.93) / [(0.545∗0.99) + (0.455∗0.93)]

With the application of the following formula;

$$V2_{2010\ 2^{nd}\ scenario} = V1_{2010\ 1^{st}\ scenario} / \{1- [(0.56*0.22) + (0.44*0.27)]\}$$

13) Proposed by the expert on basis the following data/assumptions:

- The results of the 2nd Scenario for (V1) calculation (the previous table).
- The targeted reduction of water losses (sum of physical and administrative losses) as set in the 10th 5-year development plan (2006-2010), i.e. to reach average losses 22% for urban areas and 27% for rural areas
- An anticipated 2010 urban/rural composition of piped drinking water beneficiaries; 56% urban and 44% rural (as explained in the previous source)

With the application of the following formula;

$$V2_{2010\ 3^{rd}\ scenario} = V1_{2010\ 2^{nd}\ scenario} / \{1- [(0.56*0.22) + (0.44*0.27)]\}$$

14) The average of the three scenarios for V2 in 2010 is assessed by the expert to be more reasonable and likely realizable, thus would be the input for use in computing the Water Efficiency Index.

15) Proposed by the expert on basis of government's targeted efficiency 80%:

$$V2_{2015} = V1_{2015} \times 100/80$$

16) Proposed by the expert on basis of a higher target efficiency 85% for 2020:

$$V2_{2020} = V1_{2020} \times 100/85$$

This efficiency is prospected taking into consideration the following trends:

- The increasing pressures on potable water in result of Syria's high population growth, and;
- The increasing scarcity of potable water in result of accumulated and continuing depletion and pollution of its resources, added to the anticipated decrease of renewable water resources in general due to anticipated adverse climatic changes in the east-Mediterranean region as a result of the global warming phenomenon

A matter which will most likely bring the drinking water to become a national critical and first priority issue, forcing anticipatively the government to seek higher attainable target for drinking water efficiency by that time.

Worthy to indicate that the realization of 85% target efficiency in 2020 is dependent on the achievement of 80% in 2015

This judgment falls under futurity concepts and rules, and presented here for prospective purposes only, without any assumption of a planning role.

17) Proposed by the expert on basis of a higher target efficiency 88% for 2025:

$$V2_{2025} = V1_{2025} \times 100/88$$

While the trends described in the preceding remark (source 16) are prospected to continue and magnify, forcing the government to seek higher and higher targets for drinking water efficiency, the technical (and perhaps socio-cultural) limitations will most

probably prevent attaining the same improvement of efficiency as proposed for the preceding quinquennium 2016-2020 (5%). For the period 2021-2025 a 3% attainment is prospected by the expert to be a reasonable (though hardly attainable) target.
Worthy to indicate that the realization of 88% target efficiency in 2025 is dependent on the achievement of 85% in 2020
This judgment falls under futurity concepts and rules, and presented here for prospective purposes only, without any assumption of a planning role.

18) Proposed by the expert on basis of a higher target efficiency 90% for 2030:

$$V2_{2030} = V1_{2030} \times 100/90$$

While the trends described in the preceding remark (source 16) are prospected to continue and magnify in the quinquennium 2026-2030 (perhaps except of some improvement with regards to pollution of drinking water resources in result of prospected increasing enforcement of pollution prevention measures), the shrinking margins for improvement of efficiency, with a relatively low organizational and technical capacities which anticipated to continue in a way or another, will make it extremely difficult for drinking water providers to attain further 2 points of efficiency (from proposed 88% in 2025 to proposed 90% in 2030) comparing to 5 and 3 points as proposed for the preceding two quinquenniums 2016-2020 and 2021-2025 respectively. However such attainment is prospected by the expert to be a reasonable target for the government at that time, being forced by increasing severity and high priority of drinking water issue in the country.
Worthy to indicate that the realization of 90% target efficiency in 2030 is dependent on the achievement of 88% in 2025
This judgment falls under futurity concepts and rules, and presented here for prospective purposes only, without any assumption of a planning role.

3.2. Irrigation water

3.2.1. Transport and distribution networks

3.2.1.1. Water distribution to plots (upstream of plots)

Volumes actually distributed to plots (V3) (km^3/year)

Year		Values	Source
1995		12.043	19
2000		13.188	20
2005		16.616	21
2010	1st Scenario	17.796	22
	2nd Scenario	14.837	23
	Average	16.317	24
2015		13.192	25
2020		12.573	26
2025		12.000	27
2030		12.000	28

3.2.1.2. Total water for irrigation (upstream of networks)

Total volume of water for irrigation, including losses in networks (V4) (km^3/year)		
Year	Values	Source
1995	13.992	33
2000	15.137	34
2005	18.565	35
2010	18.266	36
2015	14.723	37
2020	13.986	
2025	13.304	
2030	13.260	

3.2.1.3. Transport and distribution efficiency

Transport and distribution efficiency (E1 = V3 / V4 in %)		
Year	Values	Source
1995	86.1%	Expert's calculations
2000	87.1%	
2005	89.5%	
2010	89.3%	Expert's prospects
2015	89.6%	
2020	89.9%	
2025	90.2%	
2030	90.5%	

3.2.2. Plot irrigation efficiency

Irrigated surfaces in the country according to modes of irrigation (Sm in 1000 ha)				
Year	Value			Source
	Surface (Ssur)	Sprinkler (Sspr)	Localized (Sloc)	

1995		1,089	Negligible	Negligible	38
2000		1,123	58	30	39
2005		1,182	160	84	40
2010	1st Scenario	1,100	262	138	41
	2nd Scenario	681	554	265	42
	Average	890	408	202	43
2015		315	840	395	44
2020		215	928	437	45
2025		150	986	464	46
2030		150	986	464	47

Total surfaces irrigated in the country according to the whole modes (S in 1000 ha)		
Year	Values	Source
1995	1,089	38
2000	1,211	29
2005	1,426	30
2010	1,500	31
2015	1,550	49
2020	1,580	
2025	1,600	
2030	1,600	

For information theoretical efficiencies are as follows

Irrigation mode practiced	**Theoretical efficiency (%)**	**Efficiency measured or estimated in the country (%)**			
		Em	Year	Values	Source
Surface	40 - 60	Esur	1995-2005	45%	50
			2010	48%	51
			2015	54%	
			2020	58%	
			2025	64%	
			2030	65%	

Sprinkler	70 - 80	Espr	1995-2005	70%	52
			2010	71%	53
			2015	72%	
			2020	73%	
			2025	74%	
			2030	75%	
Localized	80 - 90	Eloc	1995-2005	80%	54
			2010	82%	55
			2015	84%	
			2020	85%	
			2025	86%	
			2030	87%	

Plot water use efficiency E2 = (Ssur*Esur+Sspr*Espr+Sloc*Eloc)/S (in %)		
Year	Values	Source
1995	45.0%	Expert's calculations
2000	47.1%	
2005	49.9%	
2010	58.8%	Expert's prospects
2015	71.4%	
2020	74.3%	
2025	76.5%	
2030	77.5%	

3.2.3. Water irrigation efficiency

Water irrigation efficiency (Eirr = E1 x E2 in %)		
Year	Values	Source
1995	38.7%	Expert's calculations
2000	41.0%	
2005	44.7%	