

*Report*

# Water-conscious development and the prevention of water misuse and wastage in the Eastern Mediterranean Region

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**SUMMARY** Many countries of the World Health Organization Eastern Mediterranean Region suffer from severe water shortage, primarily as a result of population growth. The problem will undoubtedly worsen in the future with possibly drastic consequences. This paper outlines the current situation in the Region and the possible impact of water scarcity on health and the environment. Water conservation in agricultural, commercial and domestic areas is discussed from the perspective of water-conscious development and possible strategies are proposed.

## Introduction

The severity of water scarcity in many countries of the Eastern Mediterranean Region of the World Health Organization (WHO) has started to assume an apocalyptic dimension. Of the 23 countries of the Region, 10 consume more than 100% of their annual renewable fresh water resources [1]. To illustrate the severe water shortage in the Middle East and North Africa (MENA) region, a part of a press release of the World Bank in March 1996 is cited as saying, "Although many areas in the world face water scarcity problems, the MENA region has the most severe situation. With about 5 percent of the world's population, it has less than 1 percent of the world's re-

newable freshwater" [2]. It goes on to say, "One of the most extreme examples of the water crisis looming in the Middle East and North Africa is Gaza, where each Palestinian now has access to less than 15 gallons of water per day, compared to 800 gallons of water for each American." With the Region having a very rapid population growth, the problem of water scarcity becomes even more critical. It is estimated that because of the population growth and increase in water demand, as a regional average, there will be a drop of almost 50% in annual per capita renewable water between 1995 and 2025 in the countries of the Middle East and North Africa [3].

An exceptionally high percentage of the available water in the WHO Eastern Medi-

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terranean Region is being used for agriculture [2]. At the same time, pollution from domestic, industrial and agricultural sources is degrading the quality of these same water resources. If the present economic activities continue, and agricultural practices are not radically up-dated, the future water shortages will surpass crisis proportion and may produce severe social, economic and political disruption and cause conflicts, or even wars.

The purpose of this paper is: 1) to examine water conservation in the WHO Eastern Mediterranean Region from an economic development perspective and 2) to assess development patterns and the need for integrated regional collaboration. The paper also looks at the need for more aggressive water conservation measures and policies as part of overall water resources management for preventing misuse, minimizing wastage and optimizing the benefits from the available water resources.

## Population

In 1995, the total population of the Region was estimated to be 454 million. This was almost 8% of the world population, which was estimated to be 5.61 billion. The average population growth rates in most countries of the Region are high. In 1990, out of 24 countries in the world with average annual population growth rates above 3.5%, 12 were in the WHO Eastern Mediterranean Region. The 12 countries constituted 59% of the total population of the Region [4]. Approximately 45% of the total population of the Region was under 15 years old [4]. Fortunately, successful family planning practices have reduced the figure to 9 countries [5]. Table 1 shows the population patterns of the countries of the Region. As can be seen, the Region is experiencing rapid

population growth in its cities [6]. Table 2 shows data for growth of some cities [4].

## Water resources and water use patterns

### Water resources

Most countries of the Region are located in arid zones and a large part of the Region is one of the driest areas of the world. The total renewable water resources of all countries of the Region are estimated to be 566 km<sup>3</sup> per year. This amount is approximately 1.4% of the total renewable fresh water in the world, which is estimated to be 40 000 km<sup>3</sup> per year. To illustrate the water poverty of the Region, the per capita renewable water resources in the world is almost 7000 m<sup>3</sup> per year [1]. In the countries of the WHO Eastern Mediterranean Region, the average per capita renewable water is 1427 m<sup>3</sup> per year. This figure indicates that the average person in other parts of the world has almost 5 times more water than a person in the WHO Eastern Mediterranean Region.

The availability of 2000 m<sup>3</sup> of renewable fresh water per person per year is considered the threshold for water shortage. If the availability is below 2000 m<sup>3</sup> per person per year, then the area is considered a water-poor area. An availability of less than 1000 m<sup>3</sup> per person per year is considered extreme water poverty. Table 3 shows that in 10 countries of the Region, the renewable fresh water availability is in the bottom range of extreme water poverty. The average renewable water resources per person per year have declined rapidly since 1960, as the population has rapidly increased in the Region. Table 4 depicts the decline in renewable water supply from 1960 to 2020 [1,6]. The reason for the decline is primarily due to population growth.

**Table 1 Population pattern of countries of the World Health Organization Eastern Mediterranean Region**

Country	1960	1970	1980	1990	2000	2010	2020
<i>Total population (000s)</i>							
Afghanistan	10 775	13 623	16 063	16 557	26 608	32 765	38 440
Bahrain	156	220	347	515	682	823	937
Cyprus	573	615	629	701	765	826	882
Djibouti	80	167	300	406	552	747	966
Egypt	25 922	33 053	41 520	54 059	66 710	78 456	89 025
Islamic Republic of Iran	20 301	28 397	38 900	56 585	74 460	94 691	113 550
Iraq	6 847	8 356	13 291	18 820	26 339	35 323	45 080
Jordan	1 695	2 299	2 923	4 270	6 329	8 941	11 728
Kuwait	278	744	1 375	2 090	2 782	3 451	4 072
Lebanon	1 857	2 469	2 669	2 965	3 603	4 170	4 691
Libyan Arab Jamahiriya	1 349	1 986	3 043	4 544	6 500	8 977	11 571
Morocco	11 626	15 310	19 382	25 139	31 366	36 977	41 953
Oman	505	654	984	1 468	2 057	2 882	3 835
Pakistan	49 955	65 706	85 299	122 666	162 467	205 472	248 112
Qatar	45	111	229	367	499	632	783
Saudi Arabia	4 075	5 745	9 372	14 131	20 686	29 551	39 667
Somalia	2 935	3 668	5 352	7 555	9 803	13 247	17 086
Sudan	11 165	13 859	18 681	25 195	33 610	44 007	54 618
Syrian Arab Republic	4 561	6 258	8 800	12 501	17 611	23 646	29 518
Tunisia	4 221	5 127	6 384	8 169	9 821	11 273	12 625
United Arab Emirates	90	223	1 015	1 588	1 950	2 286	2 578
Republic of Yemen	5 247	6 332	7 856	10 508	14 575	20 124	26 521
<b>Total</b>	<b>164 258</b>	<b>215 922</b>	<b>284 414</b>	<b>390 899</b>	<b>519 775</b>	<b>659 267</b>	<b>798 238</b>
<i>Urban population (000s)</i>							
Afghanistan	861	1 503	2 512	3 598	7 737	12 117	17 290
Bahrain	123	172	279	427	582	720	838
Cyprus	204	251	291	370	457	545	629
Djibouti	40	104	221	328	465	648	858
Egypt	9 815	13 951	18 561	26 381	36 547	48 352	60 211
Islamic Republic of Iran	6 828	11 648	19 088	31 066	45 487	63 515	82 108
Iraq	2 937	5 254	8 819	14 034	20 890	29 184	38 491
Jordan	724	1 162	1 756	2 908	4 684	6 989	9 577
Kuwait	201	579	1 240	1 998	2 704	3 368	3 989
Lebanon	735	1 466	2 016	2 483	3 135	3 713	4 257
Libyan Arab Jamahiriya	307	712	1 723	3 189	4 948	7 178	9 622
Morocco	3 409	5 300	8 000	12 180	17 488	23 110	28 690
Oman	18	33	72	156	311	602	1 067
Pakistan	11 042	16 354	23 936	39 229	61 438	93 294	131 709
Qatar	33	89	197	329	455	585	734
Saudi Arabia	1 211	2 796	6 265	10 926	16 924	25 033	34 562
Somalia	508	832	1 594	2 748	4 347	6 900	10 117
Sudan	1 150	2 271	3 688	5 548	8 902	14 758	22 674

**Table 1 Population pattern of countries of the World Health Organization Eastern Mediterranean Region (concluded)**

Country	1960	1970	1980	1990	2000	2010	2020
Syrian Arab Republic	1 077	2 713	4 174	6 479	10 115	15 065	20 494
Tunisia	1 521	2 229	3 334	4 439	5 755	7 274	8 854
United Arab Emirates	36	94	824	1 235	1 517	1 837	2 153
Republic of Yemen	475	845	1 602	3 079	5 466	9 093	13 953
Total	43 855	70 358	110 190	173 130	260 354	373 880	502 877
<i>Rural population (000s)</i>							
Afghanistan	9 914	12 120	13 551	12 959	18 871	20 648	21 150
Bahrain	33	48	68	88	100	102	98
Cyprus	369	364	338	331	308	281	253
Djibouti	40	63	79	78	87	99	108
Egypt	16 107	19 102	22 959	27 678	30 163	30 104	28 814
Islamic Republic of Iran	13 474	16 749	19 184	25 519	28 974	31 176	31 442
Iraq	3 910	4 102	4 472	4 886	5 449	6 139	6 589
Jordan	971	1 137	1 166	1 361	1 645	1 952	2 150
Kuwait	77	165	135	92	78	83	83
Lebanon	1 122	1 003	653	482	469	457	434
Libyan Arab Jamahiriya	1 042	1 274	1 320	1 356	1 552	1 800	1 949
Morocco	8 217	10 010	11 382	12 959	13 878	13 866	13 263
Oman	487	621	912	1 312	1 746	2 279	2 787
Pakistan	38 913	49 352	61 363	83 437	101 029	112 178	116 403
Qatar	12	22	32	39	43	46	49
Saudi Arabia	2 864	2 949	3 107	3 206	3 762	4 518	5 105
Somalia	2 427	2 896	3 803	4 807	5 457	6 347	6 969
Sudan	10 015	11 588	14 993	19 647	24 708	29 249	31 944
Syrian Arab Republic	2 884	3 545	4 626	6 022	7 496	8 581	9 023
Tunisia	2 699	-	3 050	3 730	4 066	3 999	3 771
United Arab Emirates	54	129	191	353	433	448	425
Republic of Yemen	4 772	5 487	6 254	7 429	9 109	11 031	12 568
Total	120 403	145 564	173 638	217 771	259 423	285 383	295 377

Source: [6]

**Water use patterns**

Table 5 shows the pattern of water use for the countries of the Region [1]. The table clearly shows that almost all of the available water is used for agriculture, often poor productive agriculture [1]. The present water use for agriculture is above 90% in 10 countries, between 70% and

90% in 8 countries, and between 55% and 70% in 4 countries; these latter are small countries that have virtually no agriculture production.

The present water use for domestic purposes is high in 9 countries (Bahrain, Cyprus, Djibouti, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Qatar and the

**Table 2 Population growth in some major cities of the World Health Organization Eastern Mediterranean Region, 1960 and 1990**

City	Population (millions)	
	1960	1990
Aleppo	0.5	1.7
Alexandria	1.3	3.7
Baghdad	0.4	4.0
Cairo	3.0	9.0
Casablanca	0.6	3.2
Damascus	0.5	2.0
Karachi	5.1	7.7
Lahore	1.4	4.1
Riyadh	0.3	2.0
Teheran	2.0	6.6

Source: [4]

An annual population increase rate of between 3.2% and 0.5%

United Arab Emirates). Djibouti's and the Republic of Yemen's water use is between 3 m<sup>3</sup> per person per year and 17 m<sup>3</sup> per person per year. All of these countries (with the exception of Cyprus and Lebanon) suffer from severe shortage of natural water resources.

Table 6 shows the pattern of water use in the Region compared with the world as a whole and the regions of Europe and North/Central America.

## Health and water scarcity

Health is the complete state of physical, mental and spiritual well-being (WHO's definition). In addition to absence of disease, there should be a supportive physical, economic and social environment to facilitate achieving the state of well-being and

**Table 3 Annual renewable water resources in arid countries of the World Health Organization Eastern Mediterranean Region, 1995**

Country	Internal renewable water resources per inhabitant (m <sup>3</sup> /year)	Actual renewable water resources per inhabitant (m <sup>3</sup> /year)
Kuwait	0	13
Bahrain	7	206
United Arab Emirates	79	79
Qatar	93	96
Libyan Arab Jamahiriya	111	111
Jordan	124	161
Saudi Arabia	134	134
Republic of Yemen	283	283
Tunisia	396	463
Oman	455	455

Source: [1]

full potential for health. Water scarcity has a profound direct and indirect adverse impact on human health. It can result in people not having access to adequate water for domestic use and for maintaining hygiene standards. Water scarcity further increases the risk of water contamination and reduces the capacity of agricultural, industrial and commercial sectors to grow, thus inhibiting economic growth. Without a minimal level of economic standing, a person's health and well-being are compromised.

The WHO Eastern Mediterranean Region is experiencing rapid urbanization with serious health and environmental consequences. One of the major factors contributing to the migration of rural people is

**Table 4 Total actual renewable water resources in countries of the World Health Organization Eastern Mediterranean Region**

Country	Total actual renewable water resources ( $\times 10^6$ m <sup>3</sup> )	Total actual renewable water resources per inhabitant (m <sup>3</sup> )		
		1960	1995	2020
Afghanistan	65 000	6 032	3 227	1 691
Bahrain	116	744	206	124
Cyprus	900	1 571	1 213	1 020
Djibouti	300	3 750	520	311
Egypt	58 300	2 249	926	655
Islamic Republic of Iran	137 510	6 774	2 044	1 211
Iraq	75 420	11 015	3 688	1 673
Jordan	890	519	161	75
Kuwait	20	72	13	5
Lebanon	4 407	2 373	1 465	939
Libyan Arab Jamahiriya	600	445	111	52
Morocco	30 000	2 580	1 110	715
Oman	985	1 950	455	257
Pakistan	418 270	8 595	2 968	1 731
Qatar	53	1 178	96	68
Saudi Arabia	2 400	589	134	61
Somalia	15 740	5 363	1 702	921
Sudan	88 500	7 927	3 150	1 620
Syrian Arab Republic	26 260	5 758	1 791	890
Tunisia	4 120	976	463	326
United Arab Emirates	150	1 667	79	58
Republic of Yemen	4 100	781	283	155

Source: [1]

the inability to expand agricultural land to absorb the increased rural population. Water scarcity is one of the main reasons that agricultural land has not been farmed in the rural areas. Because of this situation, rural migrants, who are usually poor farmers, go to cities in search of jobs and survival. They

generally end up in slum areas of the city and join the ranks of the urban poor. Housing and environmental services in urban poor areas are usually in a substandard state and consequently the health status of people in these areas is precarious.

Table 5 Pattern of water use in countries of the World Health Organization Eastern Mediterranean Region

Country	Year	Annual water withdrawal					Industrial use (%)	Domestic use (%)	Agriculture use (%)	Domestic use (%)	Industrial use (%)
		Total withdrawal (m <sup>3</sup> /person)	Agriculture use (m <sup>3</sup> /person)	Domestic use (m <sup>3</sup> /person)	Industrial use (m <sup>3</sup> /person)	Agriculture use (%)					
A'ghanistan	1987	1702	1685	17	0	99	1	0			
Bahrain	1991	465	250	181	24	56	39	5			
Cyprus	1993	331	246	80	7	74	24	2			
Djibouti	1985	20	17	3	0	87	13	0			
Egypt	1993	913	785	55	73	86	6	8			
Islamic Republic of Iran	1993	1091	1004	65	22	92	6	2			
Iraq	1990	2367	2178	71	118	92	3	5			
Jordan	1993	246	185	54	7	75	22	3			
Kuwait	1994	348	209	132	7	60	37	2			
Lebanon	1994	444	302	124	18	68	28	4			
Libyan Arab Jamahiriya	1994	880	766	97	17	87	11	2			
Morocco	1991	436	401	22	13	92	5	3			
Oman	1991	728	684	29	15	94	5	2			
Pakistan	1991	1277	1239	26	12	97	2	1			
Qatar	1994	528	391	121	16	74	23	3			
Saudi Arabia	1992	1040	936	94	10	90	9	1			
Somalia	1987	99	96	3	0	97	3	0			
Sudan	1995	633	601	26	6	95	4	1			
Syrian Arab Republic	1993	1017	956	41	20	94	4	2			
Tunisia	1990	382	340	34	8	89	9	2			
United Arab Emirates	1995	1107	742	265	100	67	24	9			
Republic of Yemen	1990	251	231	17	3	92	7	1			

Source: [1]

## Water conservation

Water conservation is not only about saving water and reducing wastage, it is also about improving the quality of life and the environment, among other things. Because of the severe water scarcity in the WHO Eastern Mediterranean Region, water conservation has come to be regarded as a means of saving more water to provide for the urgent water requirements of agriculture, industry, and domestic and commercial activities. The drive for immediate and rapid economic growth is so intense that, in reality, concern for future availability of water does not enter the development equation. However, by the year 2020, the average per capita renewable fresh water in the Region will be around 700–800 m<sup>3</sup> per year (not considering Afghanistan, Islamic Republic of Iran and Pakistan). This figure is well below the extreme water poverty level of 1000 m<sup>3</sup> per person per year. With this in mind, one wonders whether there will be enough water to support the current pattern of development activities. Therefore, there is a clear and urgent need to question the existing development patterns and to call for a change in this policy. We recommend that countries of the WHO Eastern Mediterranean Region move from development for rapid economic growth to *water-conscious* development for *sustainable economic growth*.

With this in mind and in the context of the WHO Eastern Mediterranean Region, water conservation will be examined further from the stance of water-conscious development, as an integral part of water resources management, and from the aspects of health and environment.

### Water-conscious development

#### *Existing problems and status*

The pattern of water use in the Region (Table 5) indicates that a large percentage of

water is used for agriculture. This is not surprising as the Region has a low average rainfall and crops have to be irrigated. Hence more water is needed to irrigate the crops as compared with other regions that have more rainfall. However, one of the main causes of high water consumption is the limited use of water-saving irrigation techniques and the planting and growing of crops or cattle raising that need large amounts of water. For example, beef production is particularly water intensive. To produce 1 kg of beef, 100 000 kg of water are needed [7].

Despite all of its attempts to raise much of its own food, the Region continues to be a net food importer because of the lack of adequate rainfall and modern agricultural techniques. Table 7 shows the contribution of agriculture to the gross domestic product of the countries of the Region and the percentage of water withdrawal for agriculture production.

#### *Strategies*

It is not easy to apply a water-conscious development approach in a short time. The economic, social, administrative and, above all, political dimensions of such a change are so large that much more deliberation and effort is needed to address them. That notwithstanding, the future critical water shortage in the Region calls for an urgent focused debate on the subject.

The following are a few conceptual strategies which could be addressed:

- regional and subregional integrated agricultural collaboration for food security;
- comprehensive review of existing agriculture, urban development, and industrial and commercial sectors within a water-conscious approach;
- development of a framework for a water-conscious development approach by

**Table 6 Pattern of water use in various regions of the world, 1993**

Region	Per capita water use (m <sup>3</sup> /year)		
	Agriculture	Domestic	Industry
World	444	52	148
EMR	876	38	23
Europe	235	92	385
North/Central America	912	167	782

EMR = Eastern Mediterranean Region

major development sectors receptive to the concept;

- water-friendly urban development allowing the building of efficient water supply systems and facilitating wastewater collection, treatment and reuse;
- development of industries not requiring much water;
- development of links between population policies and family planning and key sectors.

**Table 7 Agriculture data for countries of the World Health Organization Eastern Mediterranean Region**

Country	Contribution of agriculture to GDP (%)	Labour force in agriculture (%)	Water withdrawal for agriculture (%)
Afghanistan	46	67	99
Bahrain	1	2	56
Cyprus	5.4	11.6	74
Djibouti	3	-	87
Egypt	17	38	86
Islamic Republic of Iran	21	29	92
Iraq	5	20	92
Jordan	6	10	75
Kuwait	1	1	60
Lebanon	8.8	35	68
Libyan Arab Jamahiriya	5	13	87
Morocco	14.3	47	92
Oman	3.3	37	94
Pakistan	26	48	97
Qatar	1.1	-	74
Saudi Arabia	8.8	5.5	90
Somalia	65	70	97
Sudan	37.1	80	95
Syrian Arab Republic	28	22.5	94
Tunisia	16	33	89
United Arab Emirates	2	9	67
Republic of Yemen	20	62	92

Source: [1]

GDP - gross domestic product

## Water conservation as an integral part of water resources management

### *Elements and status*

Water resources management is a classic approach to water conservation. It involves preventing misuse of water, minimizing wastage and optimizing the benefits of water resources. The efficient use of municipal water supplies for industrial, commercial and domestic purposes is an important element. Similarly, prevention of water pollution, wastage in water distribution systems, collection and reuse of wastewater are also included.

In this context, the status of water conservation in the Region is a mix of good effort and no effort at all. In relation to municipal and domestic use, the problem of leakage in distribution lines, which is sometimes above the 50% mark, is severe. In many countries, proper metering of water and pricing are not exercised and water wastage is common.

In addition, the percentage of the population having access to a sewerage system is estimated to be less than 50% for urban areas [4]. Hence, most wastewater is not collected, treated and reused. The use of treated wastewater is becoming quite widespread in the member countries of the Gulf Cooperation Council, especially Bahrain, and in Jordan and Cyprus, and to some extent in Tunisia.

### *Municipal and domestic water conservation strategies*

Some strategies for municipal water conservation are:

- detecting and repairing leakage in the distribution systems;
- metering water consumption and charging higher rates above a certain amount of usage per month (rising block tariffs);
- encouraging the use of water-saving devices through legislation and building codes, and lowering taxes on water-saving devices;
- connecting sewerage rates with water rates;
- implementing public education and awareness programmes.

To encourage domestic water conservation, the water utility should educate consumers to apply at the household level the three golden rules: reduce, repair and retrofit. *Reduce* is to cut out unnecessary water use, such as taking long showers. *Repair* is to stop water leaks in the home. One drop per second wastes 10 000 L per year. *Retrofit* means adapting or replacing older, less efficient fixtures or appliances with water-saving devices available on the market.

Based on these three rules, there are many ways and means to save water around the house, both indoors and outdoors. Many of these tips and checklists are available on the Internet [8].

### *Commercial and industrial water conservation strategies*

This category includes private and public institutions, shops, various tourism facilities and industries. Conservation measures include the following strategies.

- There should be comprehensive metering of all commercial, institutional and industrial water consumption. The tariff structure for these users should reflect complete cost recovery of capital investment and operation and maintenance of water supply facilities.
- Water auditing should be applied and education campaigns implemented within the commercial, industrial and institutional facilities to reduce water consumption.

- Water consumption should be minimized by increasing efficient water use, introducing multiple uses of water, applying alternative technologies and by directing recycling in industrial and commercial enterprises.
- The reuse of treated wastewater in industrial applications, such as cooling towers, should be encouraged [3].

### Health and environmental aspects of water conservation

#### *Status*

In the WHO Eastern Mediterranean Region, there is a substantial degree of surface water and, to a lesser extent, groundwater pollution. In many cities, the municipal and industrial wastewater is not properly treated. It contaminates the receiving streams and in some cases ground aquifers. Also, coastal waters are often contaminated as a result of industrial and municipal discharges. These conditions may lead to the spread of infectious diseases and contaminate seafood and seawater used for desalination [4].

As water scarcity becomes more acute in the Region, water will have to be recycled and reused more frequently in the future. The recycling will increase the chance of water being polluted. Also, because of the impending water shortage, water supply systems will only be able to provide water to customers on an intermittent basis. Naturally, this will increase the chance of water supply contamination. Already in many cities and rural communities, intermittent water supplies are common. As the water

scarcity increases, intermittent water supply will increase even more. In addition, a water supply system that leaks and whose pipe joints are not watertight is in danger of being polluted by contaminated groundwater outside the pipes. This is a particular hazard when sewer pipes are laid close to water supply lines. The problem of cross-connection between water and sewer pipes has been cited as the cause of outbreaks of cholera, hepatitis, typhoid and other water-borne diseases in some cities in the Region [9].

Lastly, the reuse of treated wastewater for agriculture (which is an excellent way to conserve water) will surely increase. Such an increase may bring with it additional potential health risks.

#### *Strategies*

To cope with the above-mentioned situation, the following strategies are suggested.

- Identify major polluters and devise ways to clean them up and then strictly control their discharges.
- Levy a heavy pollution charge on municipalities and industries that contaminate water bodies.
- Improve and strictly observe the monitoring of water quality.
- Strengthen the monitoring and reinforcement of health measures and control the reuse of wastewater.
- Improve the quality of piping and watertight distribution systems.

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