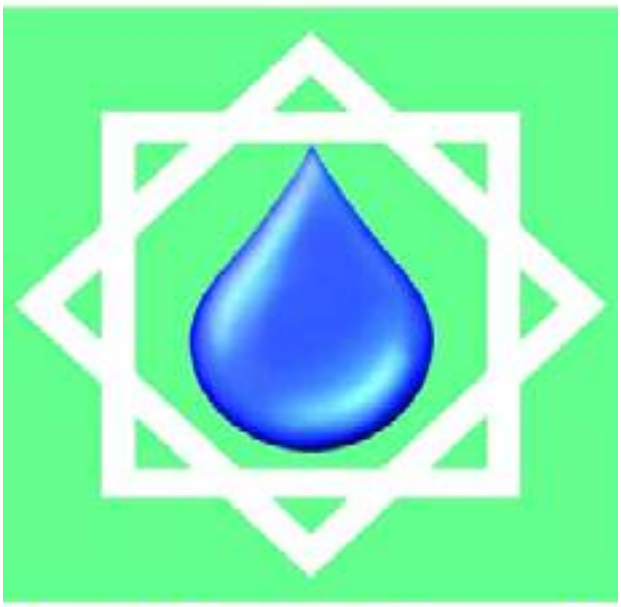
المجلس العربي للمياه



Arab Water Council

WARNING:

5th World Water Forum Secretariat
Libadiye Caddesi No:54
Küçükçamlıca-Üsküdar
34696 Istanbul/TURKEY
www.worldwaterforum5.org

Graphic Design
PAB Mimari Tasarım

Edit by
35 mm Studio Service

Printed by
Oluşur Basım

This publication has been printed on recyclable paper.

Distributed free of charge.

Acknowledgments

This document is prepared by a team comprising Drs. Bayoumi Attia (Advisor, Ministry of Water Resources and Irrigation "MWRI", Egypt), Abdin Saleh (Professor of Water Resources, University of Khartoum, Sudan), Khaled Abu-Zeid (Regional Water ResourcesProgram Manager, Center for Environment and Development for the Arab Region and Europe "CEDARE"), Hammou Laamrani (Project Manager, Water Demand Initiative in the Middle East and North Africa, International Development Research Center "IDRC"), Emad Adly (General Coordinator, Arab Network for Environment and Development "RAED"(, and Rachael McDonnell (Consultant, International Center for Bio-Saline Agriculture "ICBA", Dubai).

We appreciate background papers, reviews and valuable comments received from Drs. Munther Haddadin (former Minister of Water in Jordan), Atef Hamdy (Mediterranean Agronomic Institute of Bari-MAIB), Rachid Taibi (Algeria), Wael Khairy (Nile Water Sector, Egypt) and Engineer Munadhil Al-Mahdawi (Ministry of Water Resources, Iraq) for their valuable inputs, and Abdalla Abdelsalam Ahmed (Director General, UNESCO Chair in Water Resources, Sudan) and Hussam Fahmy (Director, the Nile Research Institute) for reviewing the document. In this regard, the input of the Economic Sector of the League of Arab State and the Arab Center for the Studies of Arid Zones & Dry Lands (ACSAD) is particularly appreciated. Thanks are due to the Senior Water Officials of the Arab States who reviewed and provided valuable comments on this document. Thanks are also due to Dr. Shaden Abdel-Gawad (President, National Water Research Center "NWRC", Egypt) and Ms. Claire Kfouri (Water Supply and Sanitation Specialist, Middle East and North Africa Region, the World Bank) who carried out overall review of the document.

The team would like to thank H.E. Dr. Mahmoud Abu-Zeid (Minister of Water Resources and Irrigation in Egypt, and President of the Arab Water Council "AWC") for his great support. The leadership and prominent coordination effort of Dr. Safwat Abdel-Dayem (Executive Director of the Arab Water Council and Regional Coordinator of the MENA/Arab Countries) in producing and editing the document is highly recognized and appreciated..

The team also appreciates and extends deep thanks to all organizations and institutions listed in the first chapter of this report who provided support to the Arab countries' regional process of the 5th World Water Forum. Special thanks are due to the Regional Office for the Near East of the Food and Agriculture Organization of the United Nations (FAO/RNE) and the World Bank for their valuable invaluable support for the production of this report.

The team also acknowledges with appreciation the role of Engineer Heba Yaken (Arab Water Council) in preparing the report, and the excellent linguistic, writing and editing abilities exemplified in this document by Mr. Kingsley Kurukulasuriya, Sri Lanka.

CONTENTS

MENA/ARAB COUNTRIES REGIONAL DOCUMENT

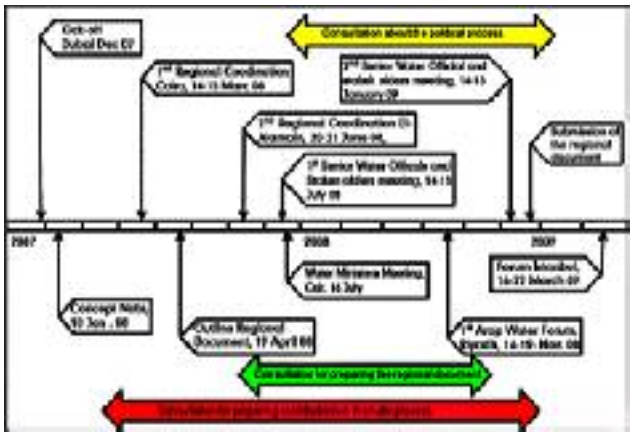
1

Background of the Regional Document

The main objective of this document is to serve as a reflection on the region's most challenging water issues causing divides within and beyond the water sector, the way in which they are assessed and a meta-analysis on the region's states' present and future responses to these challenges. The report also intends to provide a window of opportunity to share with the global water community, the expertise, and wisdom of water politicians, experts and practitioners in the region. Actual and potential opportunities in bridging the water divides within and beyond the region are compiled and are expected to lead to actions that could shift challenges into opportunities for better water outcomes and a secure future.

The regional preparatory process has been developed through a comprehensive regional consultation between all regional stakeholders (Figure 1.1). The kick-off of the regional process took place in Dubai on December 9, 2007, which mandated the Arab Water Council (AWC) to lead the regional preparatory process. It was followed by two regional coordination meetings the first of which took place in Cairo, 14-15 March 2008 and was attended by 85 participants from 17 countries and 35 organizations. At this meeting, consensus was reached on the priority regional issues to be addressed within the scope of the themes of the forum and their identified topics. The second coordination meeting took place in Alamain,20-21 June 2008 and was attended by 60 participants from 15 countries and 23 organizations. The main purpose of the meeting was to discuss the progress in initiating actions of the preparatory process and in building bridges between the regional and thematic processes

Figure 1.1 Meetings and events of the MENA/Arab countries regional process.



The regional process was endorsed by the Senior Water Officials from 22 countries at their first meeting organized by the League of the Arab States (LAS) in Cairo between 14-15 July 2008. This was supported at the highest level during the meeting of the Arab Water Ministers on 16 July 2008. A review of the preparatory process was the main agenda item of the 1st Arab Water Forum held in Riyadh, Saudi Arabia, 16-19 November 2008. It provided a platform for further deliberations and discussions on priority issues. Representatives of the Turkish Forum Secretariat and the World Water Council (WWC) attended the regional meetings and provided valuable inputs. A second meeting of the Senior Water Officials of the Arab States was held in Cairo, 14-15 January 2008 to review the final draft of the regional document. While preparing for the thematic contributions and the regional document continued, a number of side meetings were organized during the World Water Week in Stockholm, Sweden, 17-20 August 2008 and the 13th World Water Congress of IWRA at Montpellier, France, 1-4 September 2008. At all times consultation and deliberation continued electronically between the stakeholders.

This document is structured to emphasize the theme of "Bridging Divides" within and beyond the water sector in the Arab countries. Chapter 1 gives the background of the regional process and chapter 2 provides an overview of the water status in the region. The next five chapters describe the critical issues and overall strategies to bridge water divides at different levels in the following order:

- Chapter 4: Between the Present and the Future.
- Chapter 5: Between the Rich and the Poor.
- Chapter 6: Between the Arab Countries and Their Neighbors.
- Chapter 7: Between Knowledge and People.

Chapter 8 gives conclusions and key messages for future directions which emerged from the regional process. Two annexes are given at the end of the document. Annex I lists the main organizations and institutions that offer technical and financial support to water-related issues in the region while annex II provides a bibliography of relevant documents.

The institutions and organizations that participated in the development of the regional document are listed below in alphabetical order:

- Arab Center for the Studies of Arid Zones & Dry Lands (ACSAD)
- Arab Network for Environment and Development (READ)
- Arab Water Council (AWC)
- Center for Environment and Development for the Arab Region and Europe (CEDARE)
- Food and Agriculture Organization of the United Nations
- Regional office of the Near East (FAO-RNE)
- International Development Research Center (IDRC)
- League of Arab States (LAS)
- Mediterranean Agronomic Institute of Bari (MAIB)
- Ministry of Water Resources, Iraq
- National Water Research Center (NWRC), Egypt
- Nile Water Sector (NWS), Ministry of Water Resources and Irrigation, Egypt
- Palestinian Water Authority
- World Bank

2

Regional Overview

2.1 The Arab Region

Twenty two Arab states[1] extend geographically over the area situated between longitude 16.5° west and longitude 60° east and from the equator south to latitude 37.5° north. They are located between the sub-Saharan Africa in the south and the Mediterranean and Turkey in the north and between the Gulf and Iran in the east and the Atlantic in the west (Figure 2.1). Thus they are centrally located to bridge the four corners of the world. They all are members of the League of the Arab States (LAS) which politically binds these countries together. In the context of the regional process of the 5th World Water Forum this group of countries is categorized as one of three country groups and referred to in the Forums' documents as the "MENA/Arab Countries.[2]

Figure 2.1. Arab countries

Driven by severe aridity, water has played a dominant role in determining human activities, settlements, socioeconomic interactions and growth in the Arab countries more than in any other part of the world. The River Nile hosted one of the greatest early civilizations on earth and so did the Euphrates and Tigris rivers. The ancient Yemen civilization was closely tied to the availability of water resources, and its declination is historically related to the destruction of the ancient Maareb dam.

[1] Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates and Yemen.

[2] The regional contributions to the Forum are implemented though specific regional preparatory processes in four "continent-"based regions, namely Africa, the Americas, Asia-Pacific, Europe, as well as three specific subregions, namely In/Around Turkey, Mediterranean and MENA/Arab countries. This grouping is an initiative of the organizers of the 5th World Water Forum and should only be treated within this context.

2.2 Demographic and Economic Conditions

Currently, the total population of the Arab states stands at about 350 million (UNDP, 2008; World Bank, 2007a). The average annual rate of population growth is 2.6% although it varies from one country to another. The highest growth rate is 6.5 % in United Arab Emirates (UAE) and the lowest is 1.3 % in Lebanon. The urban proportion of the total population is 55% although it varies widely between states where it is more than 80% in Bahrain, Djibouti, Jordan, Kuwait, Lebanon, Libya and Saudi Arabia, and less than 40% in Comoros, Somalia and Yemen. The average Gross Domestic Product (GDP) in the Arab states is US$1,043 billion or US$1,915 billion in terms of the purchasing power parity (PPP). The corresponding per capita values are US$3,659 and US$6,716, respectively. However, the average hides the fact that the GDP/capita is too high in the oil states compared with the non-oil states. For non-oil states, the per capita varies between US$700 and US$1,800. The average Human Development Index (HGI) is 0.699 with 13 countries above this average. Although data on the Human Poverty Index value is rather scant, the average is 38%. Values less than 10% are depicted in Jordan, Lebanon, Qatar and UAE.

Women are playing an increasingly significant role in economic, social and political life in the Arab countries. The recent published figures (UNDP, 2008) indicate that the ratio of female to male adult literacy is higher than 0.9 in Bahrain, Jordan, Kuwait, Qatar and UAE. The minimum ratio of 0.47 is in Yemen. The percent of youth literacy rate of females aged 15-24 (1995-2005) varies from 99.8 in Kuwait to a minimum of 55.5 in Mauritania. In economic activities, the ratio of the percentage of females to males aged 15 and above varies between 85 in Kuwait and 22 in Saudi Arabia.

2.3 Water Resources in the Arab Region

2.3.1 A super arid region

The Arab region has a total area of about 14 million square kilometers out of which more than 87% is desert, with super aridity and poor vegetation cover dominating the region, as depicted from the land use distribution given in Figure 2.2.

The aridity condition is expressed by the scarcity of rainfall, except for narrow coastal strips in the Maghreb, East Mediterranean, South Sudan and Northern Iraq (Figure 2.3). The average amount of rain received by the Arab region is estimated at 2,148 km^3 per year, out of which about 50% occurs in Sudan. The average annual precipitation for the Arab nations varies considerably between 18 mm/yr in Egypt and 827 mm/yr in Lebanon, and averages at 156 mm/yr (FAO, 1997).

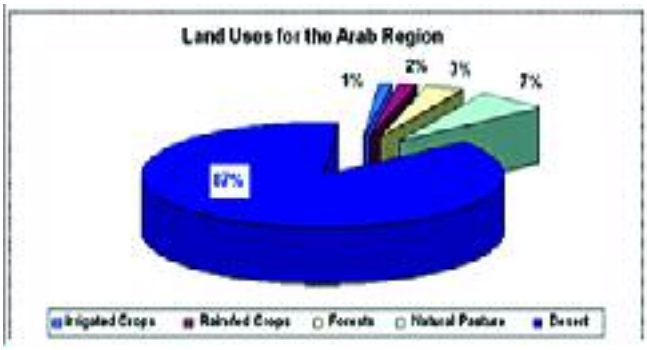


Figure 2.2. Distribution of major land uses for the Arab region.

Figure 2.3. Aridity expressed by the ratio of rainfall to evaporation.
Source: World Bank, 2007a.

2.3.2 Water supply and demand

Renewable water resources in the Arab region are estimated at around 335 km^3/yr and more than half of this amount originates outside the region and is mainly conveyed through international rivers. On the other hand, demands of a growing population and their economic and social development needs exceed 200 km^3/yr (about 60% of the renewable resources) and are rapidly escalating. In 1950, the average annual share of available renewable water resources (ARWR) per inhabitant exceeded 4,000 m^3/cap/yr for the Arab region. This share decreased dramatically to 1,312 m^3/cap/yr in 1995, to 1,233 m3/cap/yr in 1998 and is projected to drop to 547 m3/cap/yr by year 2050 due to excessive population growth (World Water Forum 2006; World Bank, 2007; UNDP 2008). The change in per capita share of

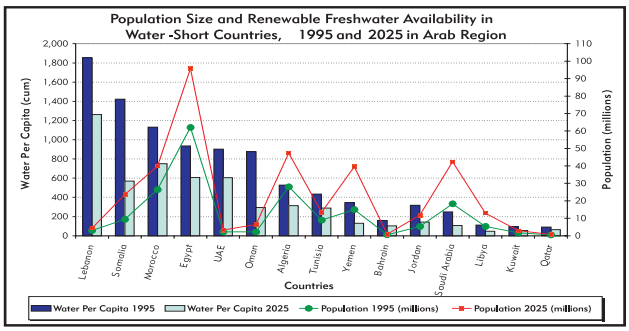


Figure 2.4. Changes in per capita share of renewable water resources and population between 1995 and 2025
(Source: Gardner-Outlaw & Engelman, 1997).

renewable water in water-short Arab countries between 1995 and the projection in 2025 is shown in Figure (2.4) against trends in population growth.

The agriculture sector is the prime water consumer at the regional level, with an annual average consumption of 83% of total water available. The remaining 17% is shared between domestic and industrial sectors at about 10% and 7%, respectively (Figure 2.5).

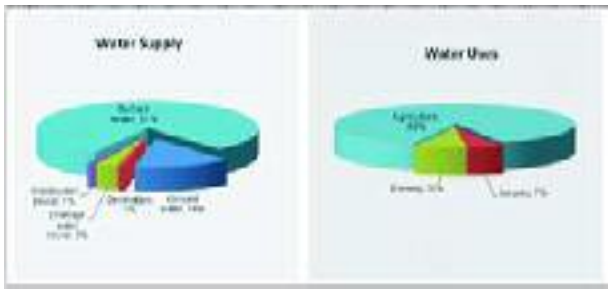


Figure 2.5 Water supply and uses in the Arab countries.

Agriculture is important mainly because it absorbs a large proportion of the labor force reaching 50% in Yemen for example between 2002 and 2003. However, the contribution of agriculture to the national GDP is significantly low ranging from less than 0.3% in GCC states (Kuwait and Qatar) to about 19.2 % in Syria[3] . Under existing conditions, it is unlikely that the expansion of irrigated agriculture can proceed without major water-shortage problems, a situation which is actually emerging in some Arab states.

Due to the scarcity of water resources in the region, a total of approximately 30 km^3/yr of nonconventional water supplies are being produced (FAO-Aquasta). Nonconventional water supplies have been widely adopted in the form of desalination plants (see chapter 3) for brackish and seawater, in addition to treated wastewater reuse programs and reuse of agricultural drainage water. Fossil groundwater has also been extensively tapped such as in the two major shared aquifer systems of North Africa, the Nubian Sandstone and the Northwestern Sahara fossil aquifers, which extend from Egypt to Mauritania for example. In the Arabian Peninsula, deep nonrenewable aquifers supply more than 80% of total freshwater use. Now, these aquifers are at risk, particularly in the Arabian Peninsula, as volumes withdrawn far exceed natural recharge resulting in a continuous decline in groundwater levels and quality deterioration due to seawater intrusion.

Reuse of drainage water is practiced on a very large scale in Egypt, where 5,000 million m^3 of agricultural drainage water (equivalent to 10% of the total water resources) are reused annually after mixing with freshwater. Reuse of drainage water is practiced on a more limited scale in Iraq, Saudi Arabia and Syria (World Water Form, 2006).

In the Arabian Peninsula (Gulf Cooperation Council [GCC] countries), and of the 0.918 km^3 of treated wastewater generated per annum, only about 0.4 km^3 are being tertiary-treated and used for the irrigation of non-edible and fodder crops as well as for landscaping. In Lebanon and Syria, about 0.2 km^3 of wastewater is used annually for irrigation purposes. However, recycled treated wastewater volumes are anticipated to increase to about 3 km^3/yr by the year 2020, to be used mainly as a substitute for groundwater in irrigation in GCC countries.

For more than 25 years, the GCC countries have been world leaders in the desalination of seawater and brackish water. Currently, they produce 3.4 billion m3 of desalinated water annually, which represents 56% of their consumption of domestic water uses. More desalination plants are under construction in the GCC countries and many long-term plans envisage relying more on desalination in the rest of the Arab countries (World Bank, 2007a; Zubari, 2008).

The prospect of water supply and sanitation in the Arab region is an area of extreme importance and relevance to the MDG's. The total domestic water supply is presently estimated at about 16.7 km^3 and is expected to rise to 27.6 km^3 in the year 2025, which means that about 11 km^3 or only 7% of the present consumption of water in the agriculture sector (146 km^3) would be needed to satisfy the growing domestic water needs over the coming 20 years.

Major progress was witnessed in many Arab countries in the areas of water supply and sanitation even before the implementation of the MDG's. This was mainly driven by the general developmental trend that started in the last decade (see chapter 5). The population which has access to an improved water source is about 86% of the total population. Some countries achieved 100% coverage of clean water supply but a few countries are lagging behind. On the sanitation side, an average of 71% of the total population has access to improved sanitation (UNDP, 2008; World Bank, 2007a).

Driven by fluctuation of river flows, years of extended drought and high floods, investments in water storage have protected people and their livelihoods across the Arab countries and have brought major economic benefits. Dam storages have provided drought protection, energy production and increased agricultural productivity from using the stored water for surface irrigation. Large scale dams have been built in Egypt, Iraq, Morocco, Sudan, and Syria. Medium and small scale dams are built across the region mainly for water harvesting and groundwater recharge. The total estimated dam capacity in the region is about 280 km3. The history of dam construction in the region is rich with important experiences in planning, construction and mitigating

the side effects of dam construction (World Bank, 2007a).

In addition, some countries with large populations in areas of water deficit in the Arab region have invested in inter-basin transfer. Perhaps the best known of these schemes is Libya's Great Man-Made River, which transfers fossil aquifer water from under the Sahara Desert in the south of the country to population centers in the north for domestic, industrial, and agricultural uses. At a capital cost of US$20 billion, it is one of the largest projects of its kind in the world, with capacity to deliver some 4.5 billion m^3/year when completed (Government of Libya 2005). Similarly, Morocco has developed important schemes to redistribute water resources through 13 inter-basin transfer systems, with a cumulative length of more than 1,100 km, capable of delivering a volume of 2.5 billion m^3/year (World Bank 2007a).

Rainwater harvesting is considered very crucial for rural development where water resources are severely depleted and the optimal use of precipitation is warranted. The challenge with this issue is to ensure that rainwater harvesting structures are managed in such a way that they are sustainable and provide equitable water share to the poor in remote areas. ACSAD as a regional organization has implemented several activities for supporting the countries of the region in their efforts to overcome the water crisis and ensure sustainable agricultural development . Among these efforts, projects water harvesting projects were implemented in Syria and Yemen.

As consumption has increased, environmental degradation has emerged, mainly in the form of water-quality deterioration, salinization and reduction of the yield of heavily exploited aquifers. The decline in water quality has, in part, been caused by problems related to the fast growth of cities in the region, insufficient and inefficient municipal and industrial wastewater treatment facilities, poor or nonexistent solid waste management, and weak pollution-control and abatement programs.

Agriculture near Tripoli, Libya

Aflaj supplied Al Ain area farmers with abundant irrigation water for 3,000 years (UAE).

[3] AOAD: 2006 Statistics http://www.aoad.org/ASSY27/Chap1/TAB(7).htm

[4] Droubi , A, I. Jnad, M Al Sibaii,: ACSAD activity in the field of water resources management and. The Arab Center for the Studies of Arid Zones and Dry Lands, Damascus. http://www.gwadi.org/allepo/RegionalDroubi.pdf

3

Bridging the Divides within Each Arab State

İmportant divides are usually found in water policy and management *within* nations which result from a complex mixture of drivers and tensions. Obviously, the basic building blocks of available quantities and quality of natural water resources influence this, but differences in economic capacity, and social and political systems greatly affect the adaptive responses of nations. This chapter will focus on four of the most pressing issues causing divides within and beyond the water sector in the Arab Region, namely water allocation, the role of various stakeholders in the decision-making process, the balancing act between supply and demand and the sources of finances.

3.1 The Allocation Challenge

The limited water availability in most Arab states and the basic tendency for demand to outstrip supply (discussed in detail in section 2.3 and in chapters 2 and 4) ensure challenges exist between the different water-using sectors. The balancing act for policy developers and managers has been to provide some water for all and a little more for some, depending on the priorities developed by governments. The necessary reallocation of water supplies from one sector to others has been argued for as a macro-economic necessity which would give results in gains in the aggregate wealth of a nation (Beaumont, 2000; Molle and Berkhoff, 2005). The implications of such moves go far beyond economics though, are highly contested and come with considerable potential political and social costs. This is especially so where there are strong advocacy groups for the different sectors. The major areas of allocation are explored below.

3.1.1 Water for food

For most, but not all, Arab countries, the largest water-use sector remains agriculture, accounting for over 83% of usage in some states (see chapter 2 and Figure 3.1)., Food security (discussed in detail in chapter 4) and the support of rural communities continue to be significant associated policy drivers. There is little rain-fed

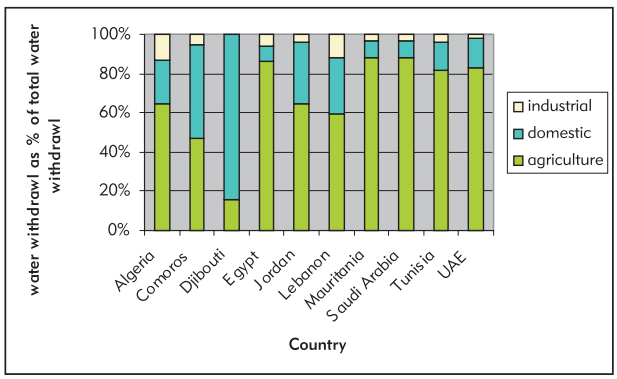


Figure 3.1.Water withdrawal for selected Arab states (average for period 1998-2002) FAO

agriculture in the region and soil water tends to be low, so river water, groundwater and increasingly marginal water (wastewater and brackish water) are the main sources used in irrigation. In some countries, even desalinated water is being used.

With the demand for municipal water and other water uses increasing, critics of the farming sector across the Arab region argue for the need to reallocate some of this large share, as irrigation is seen to be wasteful (Thivet and Blinda 2008). The inefficiencies of current irrigation practices have highlighted that too much of this input water (often up to 50%) is being lost through evaporation and leakage either from the supply networks or from the field plots. These figures have little improved over the last decade even given advances in technology and irrigation-practice understanding (Al-Weshah, 2000). However, in new agribusiness developments, particularly in the areas of chicken and egg production, and milk and meat production, water efficiency is much greater.

3.1.2 Water for people

The challenge of supplying safe drinking water to burgeoning populations in the Arab states is demanding ever more the attention of water policy makers and managers. Recent headlines highlighting the 19% increase in water and electricity consumption in Dubai in the last year resulting from a huge growth in the real estate market, and concomitant increases in migrants constitute one such example. Such trends have brought demands from urban water providers that more water should be reallocated to them to meet the needs of the population.

The driving force behind the rapid growth in many cities is increasingly endogenous with natural growth, with young urban populations being major contributors. It is also fed by intercity or rural to urban migration which is either decreasing (Egypt, Tunisia) or being maintained (Syria, Morocco 5% per annum) (Plan Bleu, 2008). Growth from migration is particularly pronounced in Arab countries experiencing, or near to, conflict zones such as Sudan or Jordan receiving influxes of refugees from both Palestine and Iraq.

The movements of people from rural (dispersed) to urban (concentrated) settlements bring difficulties to the city water suppliers in accessing a sufficient and relatively close raw resource to satisfy this growing demand. There are particular difficulties in areas of unregulated housing (Aleppo 40%, Cairo 58%, and Algeria/Morocco 30% of total urban population) where development is more haphazard and the populations often have to rely on tanker or standpipe supplies (Plan Bleu, 2008). Additional complexities come with unemployment and poverty within this urban population (42% of Egypt's poor live in urban areas, 25% of Beirut's population live below the poverty line) so that paying/charging for these new water services becomes difficult (Plan Bleu, 2008).

3.1.3 Water for energy

The generation of electricity is a key element of economic development. Water is an important part of the process whether in the actual generation (hydroelectric power) or in steam-driven turbines and cooling (fossil-fuel production). Hydroelectric power generation does contribute in a number of states and its relative importance is shown in Figure 3.2.

There are, of course, many difficulties with hydropower production in arid countries associated with maintaining flows sufficient to generate the electricity (Houri, 2006). Whilst hydropower generation does not abstract water from the river system, the allocation challenge within the country comes in balancing the timings of flow releases to produce energy. As electricity cannot be 'stored,' power generation has to link closely with demand cycles. The resulting releases of water through the turbines often

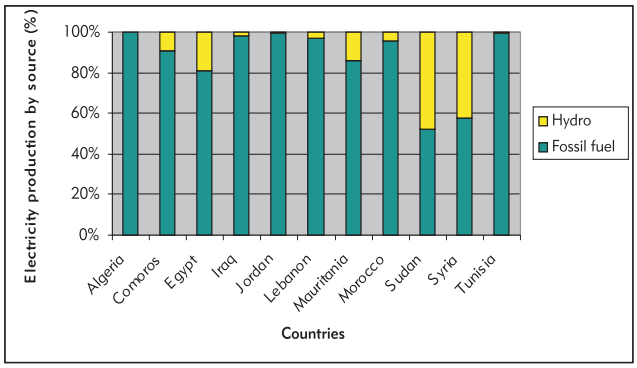


Figure 3.2. The relative contribution of electricity production source for selected Arab states. Source: CIA, 2003

do not synchronize with timings for water needs of other users. These release patterns will be at peak energy-demand times which are usually in the summer in the Arab states and at odds with natural patterns of flow coinciding with winter or equinox peaks in rainfall.

3.1.4 Water for nature

The natural landscape of the Arab states is as variable as those of their economic, social and political environments. The small mountainous, tropical islands of Comoros are a stark contrast with the vast sand seas of the Arabian Peninsula. Within these environments, there are distinct habitat groups reflecting these variations with freshwater ecosystems being found predominantly in the wadis, major rivers and oases of the region. The various

vertebrate and invertebrate communities that live in the wadis, waterholes, floodplains and estuaries are adapted to live in the 'boom and bust' (floods and droughts) of flows.The main rivers of the Arab countries originate outside of the region in much wetter climates. It is no surprise, given the general aridity of the region, that these may all be described as closed, that is, all their flow has already been allocated (Smakhtin, 2008). Dams and other engineering works have been built on all these rivers. Rivers have also been used as a means of waste disposal so that marked changes have resulted in both the magnitude, patterns and chemistry of flows which have in turn affected the ecology.

Lake environments are often the sites of deep tensions in the allocation challenge with human uses such as fishing, irrigation and waste disposal at odds with the ecological function of these systems. For example, the 'Four Sisters' lake in Egypt, Manzala, Burullos, Edku and Mariut provide a rich and vital habitat for estuarine and marine species. However, in recent years these lakes, particularly Lake Mariut, have been subject to increasing water pollution through direct discharges from agriculture, industry and urban centers. Water is also being diverted to support reclaimed land (Bush and Sabri, 2000).

In other freshwater system, water withdrawals from aquifers have had equally degrading impacts on environmental systems. Aquifer depletion and the subsequent declines in the water table below the root zone, or waterlogging and salinization have led to ecosystem degradation in many areas with the loss of both plant and animal species.

Courtesy Dr G. Lichtenthaeler (gtz, Yemen)

3.2 Between Stakeholders (the Participation and Trade-offs Challenge)

Development and management of water policy in many Arab states have traditionally been at the local level. Oasis communities in many areas continue to manage the allocation of water between individuals, and the quality is maintained through ownership responsibilities of the resource (Zekri et al., 2006). Tribal powers were (and still are in some Arab states) also important in influencing water-allocation decisions. With the big drive towards supply development in the twentieth century and central government's ability to fund investment programs, new institutional structures emerged to manage, in a more extensive way, the nation's water resources.

In recent years, these resulting structures have come to be viewed as ineffective and fragmented. The responsibilities for water have tended to lie in a number of different government departments, problems of bureaucracy and inefficiency have influenced decision making and action has been slow and nontransparent. These departments have also been found to be underfunded and understaffed, and lacked real operational authority (Ferragina et al, 2002). There have also been problems resulting from weak regulatory frameworks and enforcement leading to degradation of the resource, risks to public health and poor service delivery (chapter 5). In many Arab states, the private sector has also become directly involved with the production and delivery of potable water supplies and the management of wastewater.

Changes in water governance have also taken place in rural areas where poor experiences of large-scale irrigation management have prompted a number of Arab states to return to more local-based decision-making frameworks. Hamdy (2008) describes the growth in irrigation management transfer and participatory irrigation management programs throughout the globe. There are considerable differences in the irrigation water user associations (WUAs) with some 'modern' user associations taking financial responsibilities for works, operation and maintenances, whereas the term 'traditional associations' refers to groups where the O&M are the focus (FAO, 1986).

With these changes in water governance, there are obviously challenges involved in bringing together complex, multi-stakeholder affairs. The various actors have their own roles,

rights and responsibilities with often conflicting interests in water resources management (Laban, 2008). There are also differences in power and so influence within the resulting networks of governance stakeholders, and the ceding of these and responsibilities to decentralized organizations is often very difficult for government agencies. Whilst the changes in participation are relatively recent, some anecdotal reactions to date have included the strong resistance by governmental irrigation agencies towards irrigation management transfer to organized farmers. In some cases, members of irrigation staff do not believe (or think they cannot afford to believe) that farmers are capable of managing an irrigation system, even though there may already be successful farmer-managed irrigation systems in the country.

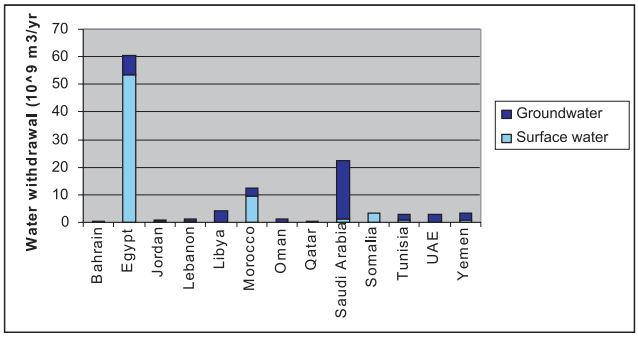
3.3 Between Supply and Demand (the Scarcity Challenge)

As stated, the Arab world is dominated by water scarcity. The natural aridity of over 85% of the area ensures balancing the supply/demand equation which involves complexities not found in more temperate climes. This lays down a particular difficult challenge to water policy developers and managers with the scarcity playing out a number of levels—scarcity of physical resource, scarcity of organizational capacity and scarcity of accountability for achieving sustainable outcomes (World Bank, 2007a).

3.3.1 The supply challenge

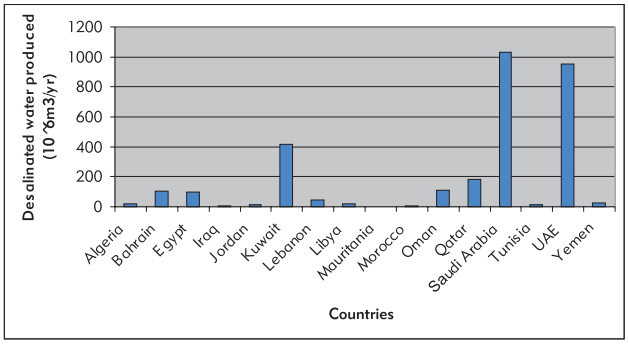
Given the low precipitation levels it is a little wonder that supply development has focused on the few surface water bodies available, predominantly exogeneic rivers and groundwater resources. The variation in available natural water resources means that many different sources have been developed and that their relative importance varies between states as Figure 3.3 shows.

Figure 3.3. Total water withdrawals from surface water and groundwater sources in some Arab states. Source: FAO Aquastat Database.



In the last two decades, major supply augmentation schemes involving dams, transfers and large-scale pumping have developed to supplement traditional supply resources. One of the most important developments has been the rapid increase in desalination capacity (see Figure 3.4). This has been particularly pronounced in the Gulf countries (chapter 2) where co-generation plants linking electricity and water generation are numerous and expanding. Desalinated water accounts in many of these states for over 90% of potable water supplies and in some areas is even being used in agriculture and landscaping.

Figure 3.4. Desalinated water production in Arab states. Source: FAO Aquastat Database.



In other moves, marginal water (namely wastewater and brackish water) is being increasingly recycled/used as a water supply resource, particularly for sectors such as agriculture, forestry and landscaping. One of the most developed examples is at Sulaibiya in Kuwait with the world's largest membrane-based water reuse plant which will convert 100 million gallons per day (MGD) into 85 MGD of high-quality water that will be used for agriculture (Gagne, 2006). Within the supply side, it is important to acknowledge the complexities and differences within countries, especially between regulated (tapped water) and unregulated (standpipes) settlements, and between rural and urban services. Rural water supply and sanitation have received the least investment support and where it is available, has often been linked to agricultural development. Problems of unequal access to water supplies remain a challenge even though the efforts under the MDG's have made a difference in Arab countries as a whole (AbuZeid and Elrawady, 2008b).

3.3.2 The demand challenge

The use side of the water balance equation seems to be one of relentless increase, and the complexities associated with human activities and drivers for economic growth make demand management ever more difficult. There are many demand complexities both within and between countries resulting from widely varying Gross Domestic Products (GDPs), the associated differences in living standards, and variations in economic-development priorities. There are thus marked differences in daily consumption per capita relative to the nominal rate of the World Health Organization (WHO) of 170 liters per capita per day. Jordanians' average supply is 90 liters per day whilst those living in the United Arab Emirates have one of the highest consumption rates in the world of over 550 liters per capita per day.

The demand challenge is arguably one of the most important problems to be tackled, and some of the allocation complexities have already been highlighted. Reducing consumption is imperative if future plans for economic development and the impact of changing natural environment are to be accommodated. In addition, the geopolitical problems of the region have highlighted the need for water security for individual nations and this is adding additional demand requirements.

The scarcity challenge to date has been predominantly met by increases in supply sources through engineering projects. Results of demand-side management to date have varied across the region. In the Rabat-Casablanca coastal area, success in demand management through leakage repairs, progressive pricing and public awareness have led to delays in investments in proposed new infrastructure (Figure 3.5)

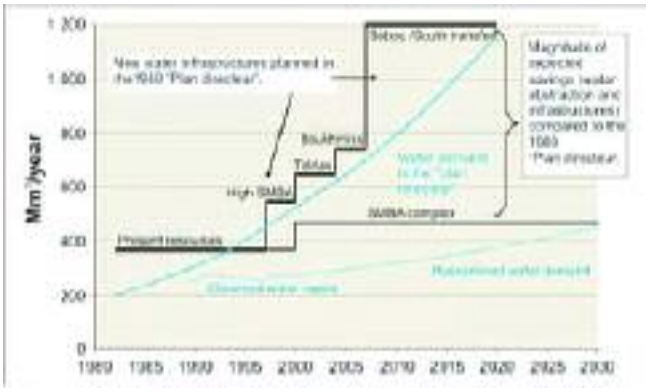


Figure 3.5. The delay in investment in infrastructure with demand management compared to Morocco's 1980 "Plan directeur". Source: Rabat, 2002.

Many policy changes are needed and are not without difficulties. For example, Molle et al. (2008) have shown that increasing water charges has not always delivered the returns expected in the Jordan Valley. Recent calls to increase the tariff difference between freshwater and wastewater to encourage greater use of this resource have failed to stimulate change so far (Abu-Madi et al., 2008).

The main challenge is to ensure that managing scarcity becomes a priority of both politicians and society. The past emphasis of securing new resources must be replaced with developing an awareness and greater sense of responsibility towards water use.

3.4 Between Public and Private Finance (the Financial Challenge)

One of the most important changes in Arab water service provision in the last decade has been the increasing role of the private sector. Private Sector Participation (PSP), which has also undergone in many other areas of industry and service provision in this region (Kauffmann and Wegner, 2007) has received a mixed response with many citizens happy with the increased quality, quantity and reliability of supplies, whilst others have been fearful of the loss of control of 'their' water and potential increases in prices.

The drivers to PSP are many and varied and include the inability of governments to raise adequate capital to finance, operate and maintain the required updates and development of water supply and sanitation infrastructure (Thompson, 2001). There has also been the belief that management and technical experience, structures and practices within the private sector would lead to more efficient provision than from government-run providers. A third motivator suggested has been linked to the difficulties government officials, subject to political processes, experience in raising tariffs to cover increasing costs.

The result has been that governments in, for example Abu Dhabi, Algeria, Jordan and Morocco have moved away from being the direct providers of water and sanitation services into a more strategic and regulatory position. Recent moves in Dubai, Lebanon and Saudi Arabia illustrate that PPP is developing under many different existing models of provision. In countries such as Tunisia, a centralized public-sector-funded system is in place, with moderate private-sector participation recently introduced in sanitation through service contracts and a build operate and transfer (BOT) contract in Tunis.

Private-sector financing is also increasingly playing a part in irrigation management development (World Bank, 2007b). The West Delta Water Conservation and Irrigation Rehabilitation Project in Egypt (Abdel-Dayem et al., 2008) is a recent example where, through finances raised through the private sector, it will develop a conveyance system to bring Nile water to an area suffering from groundwater depletion. This water will support

the activities of commercial farmers who in return, and following important reforms to the sector by the Government of Egypt, will pay for the full cost of the service including the cost of the system through volumetric charges. The Guerdane Project in southern Morocco is a similar example under implementation.

3.5 Actions and Policy Directions to Bridge the Divides within Each Arab State

Table 3.1 summarizes suggested directions to respond to the challenges discussed above in order to bridge the divides between water-use sectors, stakeholders, supply and demand, and the public-private finance.

3.6 Conclusions

To bridge the divides that result from the major challenges within nations to water resources management, a multi-sectoral, multi-stakeholder, multi-governance-level set of approaches is needed in the Arab world. The greatest need is not in new engineering schemes, but in the reform of current policies and practices that will meet these challenges over the next decades. Any such moves need to acknowledge the deeply political context of this, but there is evidence of a growing movement for change within leaders of the Arab world. The starting blocks of good governance need to be reinforced with the development of knowledge bases bases (chapter 7) to support informed decision making. It is from this position that the necessary policy and practice reforms and changes in priorities can be decided upon and enacted.

The Arab world has managed its water with efficiency and equity in the past, and whilst the scales and dynamics of today's challenges are large and fast, there are many examples of success that give hope for the future. Bridging those gaps and moving beyond engineering to an understanding of water through multiple lenses will ensure a bright new era in Arab water.

Table 3.1. Proposed ways to bridge the divide within nations.

Challenge identified	Proposed actions to bridge the divide
Allocation between sectors	○ Ensure coordination of land management with water management. ○ Set realistic water charges to ensure economic and social balance in the allocation debates. ○ Develop demand management strategies that involve policies, activities and new technologies to reduce rates based on unit of activity use. ○ Develop policies to support rural communities through targeted subsidies. ○ Encourage improvements in farming practices, and crop harvesting, collection and processing to ensure that water - efficient varieties are grown and the product quality is maintained during transport and sold at the best possible price. ○ Assess the role of virtual water and develop foreign policies that lead to food security.
	○ Ensure environmental flows and environmental services aiming at a more balanced view of the role of nature in the water-allocation debates. ○ Set stronger regulatory structures to support environmental and supply protection. ○ Integrate policies of water security with those of food security
Allocation between supply and demand	○ Control losses/inefficiencies from water transfer systems in both rural and urban settings. ○ Introduce economic and financial instruments that remove incentives for wasteful water use and/or reward demand management efficiencies. ○ Increase the actual efficacy of existing systems by addressing the problems of deteriorating infrastructure and poor service quality. ○ Reduce other unaccounted for water through metering and regulation. ○ Ensure the demand patterns are accurately understood through measures such as water metering in all sectors of water use. ○ Ensure a realistic value is given to water while ensuring the social dimension through appropriate means ○ Increase public awareness of the need to return to traditional cultural values for water conservation. ○ Ensure social equity, gender and public participation in demand management. ○ Ensure that managing scarcity becomes a priority for both politicians and society.
Allocation between stakeholders	○ Establish decentralized institutions supported by a transfer of funds to support activities and access to knowledge and capacity building. ○ Shift the role of government agencies from direct management organizations to support services and enforce regulations. ○ Provide strong political support and a developed enabling environment, which is needed to facilitate implementation.
Allocation between public and private finance	○ Create an enabling environment that encourages the private sector to invest in water infrastructure and water management. ○ Empower a regulator to ensure compliance to standards set for health, environment, pricing and service quality. ○ Ensure transparency in accounting and operations so that customers are able to see the economics and price structures. ○ Make information available and accessible to stakeholders. ○ Make contracts clear, balanced and transparent to protect various parties from the risks involved. ○ Support research to fully understand the implications of private finance in the Arab world.

4

Bridging the Divides between the Present and the Future

4.1 Introduction

Like many other parts of the world, the Arab region is witnessing a dramatic shift in priorities in recent years towards a more sustainable use of available resources. Irrigation, which was seen as an essential step towards the achievement of self-sufficiency in food production throughout the 1970s and 1980s, has been regarded in the late 1990s as a low-value use for water in comparison with municipal and industrial uses (chapter 3). As explained in previous chapters, many countries in the region are also beginning to include environmental flow in their national plans in order to protect and maintain the ecosystem while allowing effective recharge of the aquifer systems.

It is often assumed that since the Arab region has very scarce water resources, the impact of climate change would be negligible (IPCC, 1996). However, as noted earlier, since water resources in the region are under a heavy and increasing stress, any alteration in climate patterns that would increase temperatures and reduce rainfall would greatly exacerbate existing difficulties.

This chapter aims to describe the current conditions of both "water security" and "food security" in the Arab region and the key issues related to them. It then shows the future expectations, and briefly presents the potential impact of climate change on water resources management in the region. It concludes by recommending future policies, strategies and adaptation measures that could be undertaken to ensure food security and water adequacy in the region.

4.2 Present and Future Water Challenges

4.2.1 Water scarcity

The issue of water scarcity in the Arab region was highlighted in chapter 2 of this report. Not only is water scarce, but river flows are highly variable and difficult to manage. Many countries in the region are mining groundwater, which is a temporary and risky expedient. The region accounts for about 60% of the world's desalination capacity. But this option is restricted so far to the major oil-producing countries. Major water resources in the region are shared between countries lying both within and outside the region, all of which are subject to contentious riparian issues. Large aquifers underlie North Africa and the Arabian Peninsula but are costly to develop, and pose potential problems as agreement on abstractions by several countries is difficult to

achieve. Deteriorating water quality is also an increasingly serious issue in many areas due to a combination of low river flows, agricultural runoff, and uncontrolled or inadequate treatment of municipal and industrial effluent. Seawater intrusion into coastal aquifers is a critical issue in most locations.

Lack of water needed for the agriculture sector to ensure the food needs of the people is the main challenge facing the farming sector. This shows the strong relationship between Arab food security and water security as they have become the two sides of the same coin.

Taking into account the expected impacts of climate change by 2050 (through the combined effect of changes in precipitation and in evapotranspiration), the availability of renewable water resources will decrease while, at the same time, irrigation water withdrawals would need to increase, thus severely worsening the situation of water scarcity in the region.

4.2.2 Food security and water

The current global food security situation is highly unstable. Fluctuating energy prices, poor harvests, rising demand from a growing population, the use of biofuels and export bans have all increased prices, in some cases sparking riots and instability in a number of countries around the world and pushing millions of people in developing countries further into poverty and hunger (Defra, 2008).

Water shortages further exacerbate the problem as they reduce global food supply due to reductions in irrigated agricultural production representing 40% of the world's food demand. This results in sharp price increases and disruption of world grain markets, the brunt of which is felt by the poorest nations. Studies suggest that at least 20% more irrigation water will be needed by 2025 (FAO, 2006) to meet projected food demand. Falling investments in new dams and irrigation infrastructures, combined with unsustainable aquifer depletion rates, dim the prospects for substantially increased irrigation even if it is desirable. Furthermore, competition for water demand is also growing among other stakeholders, including those of industry, expanding urban centers and aquatic ecosystems.

Countries in the Arab region are not an exception. The region is characterized by high population growth rates, large and rapidly increasing food deficits, highly variable income levels both within and between countries, and limited natural resources, particularly arable land and water. Therefore, it is a must that countries in the region address and tackle these issues at national, regional and international levels.

4.2.3 Water productivity

According to projections, developing countries account for 75% of global irrigated land and are likely to expand their irrigated area until 2030 by 0.6%/yr, while the cropping intensity of irrigated land will increase from 1.27 to1.41 crops/ha/yr, and irrigation water use efficiency will increase slightly. Most of this expansion is projected to occur in already water-stressed areas, such as North Africa, South Asia and the Near East (FAO, 2008a). These estimates do not take into account climate change.

Irrigation water withdrawals in the Arab region could increase by some 29%, from the current 269 km^3/yr to 346 km3/yr in 2050 (Table 4.1). Withdrawals may even increase up to 366 km^3/yr if the impact of climate change in the region is considered. This increase is modest compared to the more than 50% increase projected in the harvested irrigated area. Most of this discrepancy will result from the expected improvement in the water requirement ratio, leading to a reduction in irrigation water withdrawal per irrigated hectare. On average, it is estimated that the ratio for the region was as high as 52% in 2003/05 and could increase to 66% by 2050.

		NE Africa	NW Africa	West Asia	Arabian Peninsula	Arab Region
Water Availability						
Precipitation	mm	308	102	225	78	177
Internal RWR	k m^3	37.8	48.1	176.2	6.5	268.5
Net incoming flows	k m^3	108.7	11	28.3	0	148
Total RWR	k m^3	146.5	59.1	204.5	6.5	416.5
Irrigation Water Withdrawal						
2003/05						
Water requirement ratio	%	57	55	48	50	52
Irrigation water withdrawal	km^3	98.4	22.2	126.2	21.7	268.5
(as % of RWR)	%	67	38	62	334	64
2030						
Water require ment ratio	%	62	60	57	58	59
Irrigation water withdrawal	km^3	125.1	29.1	160.1	21.5	338.6
(as % of RWR)	%	85	49	78	331	81
2050						
Water requirement ratio	%	69	64	65	64	66
Irrigation water withdrawal	km^3	130.2	30.1	164.7	21.7.	346.2
(as % of RWR)	%	89	51	81	334	83
2050 with climate change						
Water requirement ratio	%	71	67	64	65	68
Irrigation water withdrawal	km^3	137.5	74.1	33.8	22.6	365.8
as % of RWR	%	93	89	71	343	92

Table 4.1.Annual renewable water resources (RWR) and irrigation water requirements

Sources: FAO 2008b.

A better policy to improve agricultural production is to maximize water productivity. Two strategies can be followed to this end: 1) increase crop yield while maintaining a constant water use level (dealing with other agricultural inputs) and 2) reduce water consumption and maintain the yield level. In a water-scarce situation as in the Arab region, the most viable option is to increase the agricultural water productivity and not the agricultural land productivity.

An example for maximizing the water productivity is the Egyptian policy for providing irrigated lands with field tile drainage. Drainage has a significant role in soil improvement and crop yield. It is evident in the case of Egypt that drainage can control soil salinity and waterlogging and increase crop production by 10 to 30% according to crop type. Vast areas of the Arab agricultural land are suffering from desertification due to salinity and waterlogging; and yet, drainage coverage is lagging behind irrigation systems with the exception of Egypt.

The other example is the policy that aims at limiting areas cultivated by high-water-consuming crops such as rice and sugarcane. This policy is not implemented yet on rice cultivation areas due to the high market price of rice compared to other crops. The cropping pattern shift policy could be adjusted through the application of a system for financial incentives to encourage the farmers to cultivate less-water-consuming crops.

Most of the Arab countries have not developed all their cultivable land and there is still a margin in which investments can be made. This margin, in Sudan alone, exceeds the total potentially cultivable land in the rest of the Arab world. Reduction of the bias against investment in agriculture at the national and regional level can make a difference. For instance, Algeria and Iraq probably still have potential to expand agricultural areas (Algeria has 61% of potentially arable lands). Some have even gone beyond, indicating expansion in marginal lands (FAO, 2008).

4.2.4 Recurrent droughts

Due to its arid climate, most parts of the region experience frequent droughts. FAO identified Iraq, Jordan, Morocco and Syria as being most affected by drought (FAO, 2008a). Droughts cause a major reduction in agricultural output mainly in rain-fed areas and also in irrigated areas where inflow into reservoirs are reduced. Due to notable change in climate and hydrologic conditions in recent years, the region has experienced droughts of higher frequency and longer duration. These have seriously impacted development in several countries of the region, with severe repercussions for economic growth, food security and poverty alleviation. Furthermore, droughts affect the lives of the rural poor through decreased agricultural production, death of livestock and endangered environment as seen in loss of soil fertility, loss of species and the threat of extinction.

In the 1994/95 crop season, a drought season in Morocco, agricultural output was 45% lower than the previous year, a non-drought year. Rural landless or small landholders lost 100 million work days in agricultural employment. Drought in southern Somalia led to mass migration of the rural population to neighboring countries and to excessive groundwater abstraction if resources and means are available in other richer nations. As a response to drought, some governments in the region provided aid and relief to the most affected communities. In the least-developed countries in the region aid and relief programs were provided primarily by the international agencies. These countries are often not geared up to develop water infrastructure for water storage to mitigate the impact of drought.

4.2.5 Potential impacts of climate change on water resources

A recent IPCC report (2008) predicts that climate change over the next century will affect rainfall patterns, river flows and sea levels all over the world. Climate change impacts add to already difficult water management challenges in the Middle East and North Africa regions. For many Arab countries there is an expected precipitation decrease over the next century of 20% or more. This decrease would not linearly translate into a 20% reduction in river flows: river flows are "what is left" after local evaporation and transpiration through rain-fed vegetation. It can therefore be expected that runoff will decline faster than precipitation. In addition, although the implications for groundwater are poorly understood, the reduction in precipitation will lead to lower overall groundwater recharge rates—again by more than the decline in precipitation.

Climate change will impact several sectors of the economy and have worldwide ramifications. Agriculture and food security is threatened. Recent research indicates that even if basic adaptive measures are taken (such as changing crop types) global agricultural production will decline 3% by 2080. The demand for water generally increases with temperature—particularly crop water demand. Thus, while climate change is expected to reduce the supply of water, demand will be moving in the opposite direction. One study (Doll, 2002) has estimated that crop water demand will increase by 5-8% by 2070, with regional variations up to 15%. In addition, potential crop yields tend to fall at high temperatures, so the productivity of water in agriculture will fall (Kunzewicz et al, 2007; Cline, 2007).

Studies predicting the potential impacts of climate change on groundwater resources in the region showed that groundwater supplies will be at great risk from rising sea levels and reduced recharge as mentioned above. Higher sea levels would cause seawater intrusion leading to salinization of the region's groundwater aquifers close to coastlines. Excessive withdrawal from aquifers will further magnify the problem.

As more winter precipitation falls as rain instead of snow in Syria, Lebanon and parts of Iraq, water managers will have to balance the need to fill reservoirs for water supply and the need to maintain reservoir space for winter flood control. Additional storage needs to be developed to equalize variability with high economic and environmental costs. Diminished snowmelt (in Lebanon and Syria) flowing through dams will decrease the potential for hydropower production. Some countries in the region produce large amounts of hydropower and changes in runoff to the system could have a significant effect on the power output of these countries. One of the biggest river systems in the region, the Euphrates and Tigris, has a number of dams used for irrigation and water supply as well as for hydropower. To date, no studies have assessed the effect of climate change on these systems. However, if there is a reduction in total runoff as a result of climate change, the increased demand for agricultural and hydropower activities could place more pressure on water resources.

Egypt depends on the Nile for more than 95% of its water needs. The Nile is highly sensitive to climate variations and change. Impacts of climate change on the Nile flows are uncertain and will be probably large in either direction. On the other hand, it is virtually certain that demands are increasing without climate change. While large flow reductions may be very harmful to the sustenance of Egyptian agriculture, large increases may also change the system operation and may require bold decision-making. Till now, the Aswan High Dam has protected Egypt from both floods and droughts. Drought period of the 1980s created some preparedness to face droughts. This may not be enough under drastic climate change. The adaptive capacity of Egypt in general and its water resources system in particular, is economically and technologically constrained. Combining these factors together, it is beyond doubt that the water resources in Egypt are highly vulnerable to climate change and that adaptation should start soon.

Climate change leading to higher temperatures of cooling water will reduce the efficiency of the desalination process. High salinity resulting from evaporation of feed water in semi-enclosed seawater intakes might affect production capacity of desalination plants. The higher temperatures of near-shore seawater will increase biological content and algae blooms leading to the use of higher doses of chlorine at intakes to control bio-fouling.

The expected changes in precipitation, combined with rising temperature and reduced snow cover, will have impacts on water quality and quantity, requiring water managers to incorporate climate change in their planning and investment decisions.

4.3 Future Expectations and Meeting the Challenges

4.3.1 Water availability

To close the gap between water supply and demand in the Arab countries, from a resource perspective, it is necessary to reconsider their reliance on supply management to favor demand management policies. From the sustainable development perspective, the top priority for adaptation in the water sector would be the reduction in the vulnerabilities of people (particularly the poor and disadvantaged). The value of low- quality water use, particularly in agriculture, will continue to increase steadily over time. Desalination is projected to be one of the main future options to fill the gap between water supply and demand, especially in the energy-rich Gulf region.

Regi on	2,015	2,030	2,050
World average	2,950	3,040	3,130
Developing countries	2,860	2,960	3,070
sub-Saharan Africa	2,420	2,600	2,830
Near East / North Africa	3,080	3,130	3,190
Latin America and the Caribbean	2,990	3,120	3,200
South Asia	2,660	2,790	2,980
East Asia	3,110	3,190	3,230
Industrial countries	3,480	3,520	3,540
Transition countries	3,030	3,150	3,270

Table 4.2. Per capita food consumption (kcal/capita/day).

Source: FAO, 2006.

4.3.2 Food security

Table 4.2 shows the estimated per capita food consumption up to 2050. Again, it shows that countries in the Arab region will maintain the increase that they have already made in the last decades and will reach almost 3,200 kcal/capita/day which is close to the world average (FAO, 2006).

The Arab region is—for natural and environmental reasons—far from having enough water to grow sufficient basic food crops (mainly cereals) for its steadily growing population. The obsession

[5] One ton of wheat production requires approximately 1 000 m^3 of water, the importation of one million ton of wheat would correspond to the purchase of one billion m^3 of water from abroad.

of self-sufficiency at any cost that was predominant in the 1960s and 1970s is no longer rational or sustainable. In fact, since the early 1970s the region has been importing more and more food to meet its national need. The net deficit is covered through food import that is indeed importing its equivalent in water in condensed form known as "virtual water."[5] Several studies by FAO have shown food import in the Near East and North Africa region was equivalent to 83 billion m^3 of virtual water, or 11.9% of the region's annual renewable water resources. In fact, the same study has shown that for selected countries, the percentage was much higher: Algeria (87%), Egypt (31%), Jordan (398%), Libya (530%) and Saudi Arabia (580%). The increase of 5% of the virtual water import across the region shows that its role is likely to be part of strategic choices in the future to address the growing gap between nations' food production and their growing demand.

4.3.3 Adaptation measures to climate change

As discussed, and according to the FAO projections, developing countries account for 75% of global irrigated land and are likely to expand their irrigated area until 2030 by 0.6%/yr, while the cropping intensity of irrigated land will increase from 1.27 to 1.41 crops/ha/yr, and irrigation water-use efficiency will increase slightly. Most of this expansion is projected to occur in already water-stressed areas including the Middle East and North Africa Region (FAO, 2008a). These estimates do not take into account climate change.

The expected changes in precipitation, combined with rising temperature, will have impacts on water quality and quantity in the Arab countries, requiring water managers to incorporate climate change in their planning and investment decisions. There are several key policy challenges that have to be confronted for successfully adapting to climate change in respect to water. The first challenge concerns information and data collection and sharing. The adaptation strategy is another challenge, varying from one country to another based on the projected impact of climate change. The institutional capacity should be strong enough to undertake adaptive measures. One of the greatest policy challenges would be the financing of climate change adaptive measures. With imperfect information about the magnitude of climate change impact, the allocation of financial resource to construct expensive infrastructures will be a great challenge particularly for non-oil producing countries in the region.

The socioeconomic costs and possible benefits of climate change on the water sector in the Arab region are very difficult to determine. Costs would include the costs of damages (displacement due to extreme events, deterioration in water quality, erosion, loss of biodiversity, etc.) and the costs of adaptation to reduce or avoid damage (new dams and reservoirs, desalination plants, water treatment plants, pumping stations, dikes, etc.). With respect to water supplies and sanitation, the costs will be significant to accommodate high variability and to re-accustom the water and wastewater treatment infrastructures to cater for different water characteristics.

Climate change is a newly introduced driver in water resources management (WRM) in the Arab region. Therefore, adaptation strategies need to be embedded within existing national policies, and legislative and institutional frameworks. This means, difficult policy choices have to be made between additional capital investments or advocacy campaigns to promote behavioral changes.

Many countries in the region are already taking actions that will help them manage the challenges of climate change. The approach each has followed is specific to the context of the country. The main emphasis is on improving information, strengthening institutions and devising strategies for reducing the negative impact on vulnerable population groups. There are as well several regional initiatives in the making. Among these initiatives are the World Bank's Strategic Framework on Development and Climate Change in MENA, the NBI's Initiative to Address Climate Change Impacts and Adaptation in the Nile basin, and Arab-OECD countries' new initiatives to promote investment.

Even though countries in the Arab region may participate in the Clean Development Mechanism which accepts afforestation and reforestation as eligible activities, many areas in the region cannot grow forests. However, there are also large expanses of degraded land that could be reforested if grazing is controlled. Planted forests may help to counteract negative effects of climate change on natural forests and improve local water cycles. Some countries in the region such as Egypt, Kuwait, Oman, and UAE are building solid experience in afforestation and reclamation of desert areas, using treated sewage water for irrigation.

Implementation of climate change adaptation strategies within national water resources strategic plans will require interaction and horizontal coordination between multiple levels of government institutions and the involvement of stakeholders, civil societies, business sectors and the public. Countries in the region should tap international funds available now to promote strategies and implement actions for adaptation to variability and climate change.
Furthermore, The Arab Water Council in cooperation with the National Aeronautics and Space Administration (NASA), USAID and the World Bank recently initiated a joint collaborative effort

to provide proper understanding of the location, availability and quality of water resources, as well as the current and future uses of these resources. In addition to Space and Planetary Sciences, NASA studies the earth from space to advance scientific understanding and meet societal needs. Space-based remote sensing techniques developed by NASA now enable the routine collection of accurate water data. Such data can be easily turned into information through maps and graphs that allow stakeholders to be involved and water managers to take better, more informed decisions. The initiative aims at improving water managers' ability to monitor changes in water availability, including surface- and groundwater storage, river runoff, and related land use changes, provide a tool for predicting the regional hydrological impacts of climate change scenarios; and provide a platform for cooperation and data sharing among nations. A Land Data Assimilation System (LDAS) for the Arab region will be developed. This regionally specific LDAS would use NASA satellite data, surface observations from Arab countries, and publically available meteorological analyses to drive a suite of advanced land surface models, with the goal of providing optimal estimates of hydrological states and fluxes relevant to water resources.

4.4 Concluding Remarksand Recommendations

Several priority areas for actions on sustainability, food security and climate change adaptation can be highlighted as follows:

- Solutions to water scarcity problems require the consideration of cultural, educational, communication and scientific aspects. Given the increasing political recognition of the importance of water, it is in the area of sustainable freshwater management that a major contribution can be found to avoid or solve water-related problems, including future changes.

- Reuse of treated wastewater and agricultural drainage recycling constitutes an opportunity for specific food production in Arab countries. Egypt and Jordan have developed long experience in such practices. However, this has to be supplemented with the introduction of effective schemes to improve food quality and safety and strict quality standards and guidelines.

- More attention should be paid to the quality issues of water resources, especially with respect to the impact of wastewater reuse on public health, trade, tourism, etc., as more and more quantities of wastewater is being produced in rapidly growing urban areas around the region.

- Technical innovations and water-sector reforms need to be accompanied by reforms in the agriculture sector. Empirical evidence indicates that water-sector reforms in the absence of associated reforms in the agriculture sector will be unproductive and unsustainable.

- New techniques of molecular analysis and biotechnology offer promise as a means of improving food security and reducing pressures on the environment provided the perceived environmental threats from biotechnology itself are addressed.

- New funds need to be directed towards research and development (R&D) in the agriculture sector to achieve higher efficiency of water use at the farm level, considering that small percentage savings in agricultural water could make very large amounts of water available to the other sectors expecting higher economic returns.

- Greater integration with world markets will become essential; likewise, investments are needed in human capital, natural resources management, research and technological development. Countries in the region should also have more integration and complement each other to reach food security and minimize food imports from outside the region and maximize the use of their resources.

- To reasonably maintain economic balance between food import and export while conserving the scarce local water resources, emphasis should go to grow high-value cash crops of low water consumption.

- To meet regional challenges, planning for the future needs critical evaluation considering short-term gains versus long-term costs.

- Develop policies, legislations and activities in natural resources management that can lead to sustainable livelihood, mitigation and adaptations to climate change.

5

Bridging the Divide between the Rich and the Poor

Important divides are usually found in the relation between the rich and the poor in many respects and water is not an exception. These divides may be related to issues such as political economy influencing management of water resources and decision making, water governance, water rights, financial sustainability and social equity in the water sector. This part of the report will discuss those divides and identify the local experiences and opportunities for bridging those divides. It will also discuss the state of achieving the MDG's within Arab states.

5.1. The Political Economy and Water Governance Perspective

Water is by all means a key driver of macroeconomics and sectoral policies in the Arab region (Richards and Waterbury, 2008). In turn, the political economy of water shows that key drivers (political, environmental, and social) of water policy lie outside the sector (World Bank, 2007a). Agriculture policy, fiscal policy, food security and self-sufficiency, energy, global trade, urbanization and associated changes in demography and land management have ramifications in, and implications on, political choices determining water outcomes and are therefore the losers and winners.

5.1.1 Water policy reforms: Challenges and opportunities

The Arab region has much to be proud of in terms of water-sector reforms. Bold steps in the right direction are taking place across the region at different paces. There is a "slow" but steadily growing will to encourage stakeholders' participation; efforts of decentralization in decision making at different levels are progressing; and civil society's role is growing in the water sector. Water issues are moving from the technocentric domain to espouse the political economy perspective where the key driving forces of water reforms lie (Box 1).

Box 1. Agriculture, "self-sufficiency" and "food security" at any cost.

Over the past three decades, economic policies and generous subsidies in most of the GCC countries have supported the expansion of irrigated agriculture in an effort to achieve food security. Irrigation water is often used inefficiently without considering the economic opportunity cost for potable and urban/industrial purposes. Agriculture contributes less than 2% of GDP in GCC countries but it overexploits groundwater resources, most of which are nonrenewable fossil groundwater, resulting in their depletion and quality deterioration due to seawater intrusion and the up-flow of saltwater. No clear "exit strategy" exists to address the question of what happens when the water is gone (Al-Zubari, 2005)

In the Arab countries, what makes a water policy reform (and therefore its water outcomes) take shape or fail is neither simply the economic rationality nor socio-ecological needs (Box 1). The

principles and practices of water management are embedded in social, cultural and political institutions, which today are in flux and transition both regionally and nationally. The political environment forges water governance and sets the machinery of the political equilibrium, and societal processes that distribute roles and power of different interest groups, power networks and lobbies (Box 2).

Box 2. Pillars of the sustainable development in the Arab region,

Among six pillars of sustainable development structure in the Arab region listed by the Arab Organization for Agricultural Development (AOAD), the first is in the development of the political and economic environment. The strategy document reports that "at the political level, the Arab countries adopted, at the 2004 Arab Summit in Tunis, an important declaration pertaining to political reforms. It urged the Arab countries to carry out political reforms to develop their political systems in order to cope with contemporary life, by opening the way for a real democracy stemming from the Arab environment allowing wider space for freedom of expression, increasing people's participation in decision making, empowering women rights and activating their role in the society, and keeping human rights and maintaining human dignity, to attain rational governance."

Arab Organization for Agricultural Development, AOAD (League of Arab States), 2005.

5.1.2. Agriculture and population policy reforms

Agriculture in the Arab region remains by far the largest water consumer. It is also the less-productive user sector with generally low contribution to the GDP. It is also the sector with the lowest economic returns to water use in the region. As reported for Jordan (Shiffler, 1998), the economic returns to water use in industrial and urban domestic use are respectively 60 times and 6 times higher than irrigated agriculture. However, agriculture remains a large employer in rural areas with a strong social dimension that makes reforms slow and politically uncertain and even risky. This challenge is even magnified by the population growth and uncontrolled urbanization.

The contribution of the agriculture sector in the Gross National Income in the Arab countries in best case scenarios does not exceed an average of 30%. This ranges between a minimum of 1% in some GCC countries in the year 2002 (Zubari, 2008), to a maximum of 40% in the Sudan (Dabour, 2005). On the other hand, the proportion of workers in agriculture is about 30% excluding Mauritania, Sudan and Yemen. In fact, most studies indicate a decrease in the rate of employment in agriculture in recent years. In Egypt, the employment rate fell from 55% in 1965 to below 35% in 2000, in Syria, from 52% to 22% and in Jordan from 37% to below 10% (ACSAD, 1997; ESCWA, 2001).

[6] As defined by Swatuk L. A. (2008). A political economy of water in South Africa. Water alternatives 1. (1):24-47.

5.1.3. The challenge of cost recovery

Water economics has drawn increasing attention and several studies considering the importance of economic instruments in optimizing water productivity, improve efficiency and slow the steady increase in water demand. Water pricing mechanisms are varying between countries. The most recent and spectacular outcomes are highest cost recovery (O&M) in municipal water in two large cities in Morocco after the privatization of 30% water utilities in big cities.

In Tunisia, an eloquent example of the power of economic instruments is the stabilized agricultural demand while the added value of irrigated agriculture was steadily increasing as shown in Figure 5.1 (Hamdane, 2008).

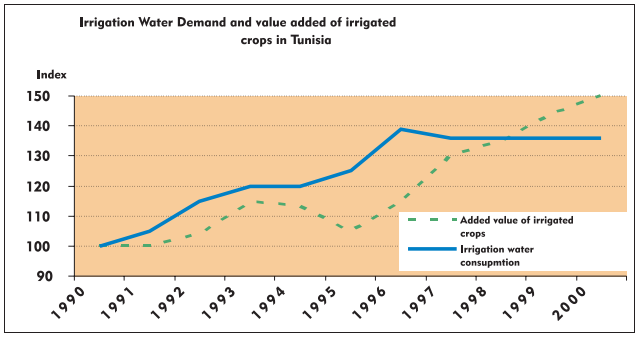


Figure 5.1. Irrigation demand management (stabilized) and added value of the irrigated agriculture in Tunisia (Hamdane, 2008).

Decentralization and farmers' participation in irrigation management, the progressive tariff block and its revision over time yielded significant improvements in efficiency and rational water use in urban areas. Economic incentives when adjusted to the local settings did curb the tendency in demand-side management without affecting the socio-economic benefits and livelihoods.

5.2. Bridging the Governance Gap

The overall governance in the Arab region is a development challenge (Figure 5.2). Water governance should be analyzed within this perspective.

Figure 5.2. Governance indicators in some MENA countries (World Bank, 2003).

5.2.1. The challenge of inclusiveness and transparency

Global changes and challenges have influenced the pace of policy reforms. Revised water policies, institutions, laws and strategies in Morocco (2005), Saudi Arabia (2003-2007) and Yemen (2003), have been implemented. However, the enforcement of laws through participatory regulation and transparency in decision making to ensure ownership and engagement of all stakeholders is yet a weak link in the chain of water policy reforms (InWent, 2008). As a result, the ranking of the Arab countries with regard to the "Corruption Perceptions Index 2007" underscores the gap yet to be bridged (Lambsdorff, 2007). Only few Arab countries are in the first quintile.

In the Arab region, at project and program level, evidence is showing success stories of public participation and effective governance in local water management (www.ar.empowers.info/2875; www.idrc.ca/wadimena). However, this does not transcend in a linear way into the national and regional level.

In many settings in the region, the rural poor with limited or no access to groundwater have been losers and it is only those who are rich enough to own and pump progressively deeper wells that have been able to reap the benefits.

Furthermore, there is growing evidence that gender inequities are being reduced in several Arab countries, but this remains a major setback as women often have limited power over the decision-making process and limited access to natural resources and are exposed to a host of health risks such as waterborne diseases.

5.2.2. The challenge of accountability

A 2007 World Bank report states that: "accountability to citizens and users of water services will be the key for allowing countries to act when opportunities arise and pass reforms that lead to real improvements in water resources and services." The report emphasizes, for instance, that management and governance of groundwater have direct macroeconomic externalities and values, such as a 1.5% reduction in GDP in Yemen are reported. Similarly, Jordan may have seen its GDP reduced by 2.1%, Egypt by 1.3%, Tunisia by 1.2% while Morocco has not yet experienced a significant impact.

There are bright spots taking place in some countries of the region. However, it is fair to say that while the overall political tendency is to open new exits for political systems to enhance their overall governance, this positive development has also translated into effective water governance though at a slower pace. A benchmarking analysis carried out by KfW-GTZ experts between 2005 and 2006 compiled quantitative and qualitative data on water management and governance in nine countries in the Arab region, namely; Algeria, Egypt, Jordan, Lebanon, Morocco, Palestine, Syria, Tunisia and Yemen. Results revealed that trends in accountability are small but in the right direction (Figure 5.3).

[7] A synthesis document of the three workshops hold by InWent on water governance in MENA in Sana'a, Cairo and Marrakech respectively in 2006; 2007 and 2008.

Integrated Water Resources Management (IWRM) as a discursive context in the Arab region is contributing to enhancing inclusion of public participation in water management at the local and regional level. The empowerment of water users associations (WUAs) in Egypt, Tunisia and Yemen (Groupement de Developpement Agricole), the dialogue and participation of stakeholder in water planning and management in Morocco (National Debate on water, basin authorities) and Sana'a basin and urban water supply and sanitation framework in Yemen, are all meaningful signals worth stronger political backup.

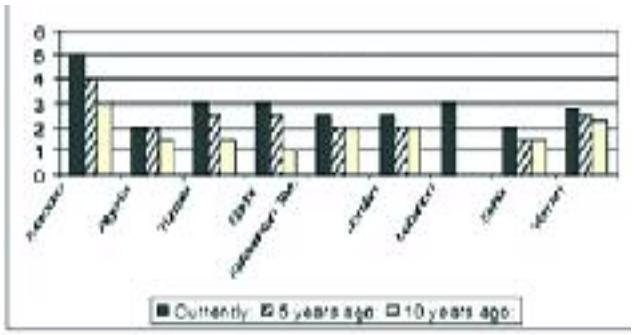


Figure 5.3. Accountability: Do different stakeholders possess influence on water service providers?

Involvement of private operators in both agricultural and municipal water and sanitation is yielding in terms of renovation of the network and quality of services, and ultimately the assumption of water saving holds reasonable as leakage and losses in municipal networks are significantly reduced. Today, Morocco's experience of privatizing 30% of its urban water and launching the privatization irrigation schemes in southern and northern Morocco are worth consideration. The cost recovery in Casablanca and Rabat has reached the highest rate in the region and water loss is reduced thanks to renovated municipal networks, reduced illegal connections, and increased accuracy in metering instruments and communication with users are all indicators of benefits of stakeholders' engagements.

5.2.3. The role of regional and international organizations

The role of national and regional organizations in spilling over the culture of participation and advocacy in the water sector is steadily growing. Emerging independent professional organizations are a strong backup to the transparency, access and use of data and information. The Arab Water Council has a leading role to play in promoting good governance. Regional networks operating in partnership with the council as is the case of "Réseau Arabe pour l'Environnement et le Developpement" or the Arab Network on Water Ethics are entry points to monitor and catalyze change in water governance through public awareness, advocacy, empowerment through knowledge and information. Recently, a professional organization gathering the Arab countries' Water Utilities Association ((http://www.acwua.org/index.php?id=7)) has emerged and has a role to play in building trust and confidence between different stakeholders through dialogue and transparency. The organization under the League of Arab States

(LAS) such as the Arab Organization for Agricultural Development, Arab Center for the Study of Arid Zones and Dry Lands (ACSAD) and Centre of Water studies and Arab Water Security (COWAWS) are also key players to consider in setting the strategic regional agenda to promote effective water governance.

There is a growing trend in capacity building on water governance led by both regional (e.g., Arab Water Council through the Arab Water Academy) and International organizations working in the region that is generating a critical mass of national and regional experts with the capacity to frame and implement adapted water governance strategies to bridge the governance gap in the region. World Bank, FAO, Inwent (Germany), WaDImena (IDRC-Canada), UNEP Plan Bleu and the Blue revolution initiative (USAID) are all engaged with the Arab Water Council (AWC) and in bilateral joint actions to promote water governance in the region through empowerment of regulatory and operator bodies, decentralization and encouraging public participation.

5.3 The Challenge of Financial Sustainability, Economic Incentives and Social Equity

Water rights refer to the right of a user to use water from a water source, which could be a river, pond, lake, stream or a groundwater source. The term "water equity" refers to the equity of water resources allocation for different users within the same sector and also among different sectors. The equity issue often takes international dimensions when it involves different riparian states that share a river basin (see chapter 6). Equity is a big quest, around which many questions should be answered, such as how the priorities are set, how water could be fairly allocated between different sectors, when equity is achieved, and whether the benefactors are free to trade their shares (AbuZeid, 2005). The answers to these questions would surely help in defining at least the outermost frame to water rights and equity and bridge the gap in opinions that have developed around these issues.

It is widely recognized in Arab countries, water is a public good. Water rights are privileges awarded to those who deserve them for a specific purpose. Trading these rights should not be against the public interest. Water pricing is different from water service charges (tariffs) where the cost of water services could be recovered. Profiting from water as a good may contradict the fact that water is a public property, and gives these privileges to the rich over the poor which makes it difficult to achieve social equity. In order to avoid profiting from water services as a disguised method to profit from water, effective regulatory arrangements should be enforced. Making profit from water services is acceptable as far as an adequate system of subsidies is in place to ensure that the needs of the poor are satisfied.

5.3.1 Who finances infrastructure?

Governments across the Arab world have financed much of the maj capital or trunk infrastructure. Water services are also financed through public finance, but these costs are recovered from users of those services. However, in the greater part of the region, the burden on public finance is high for both aspects, and public spending on water as a share of the GDP is significant for all countries (Figure 5.4). In addition, energy subsidies alter cost structures for pumping water. Groundwater-based irrigation has expanded beyond sustainable levels (particularly relevant for countries such as Saudi Arabia, UAE and Yemen). Estimates of costs to GDP because of excessive groundwater depletion in Jordan and Yemen are between 2% and 4% of GDP.

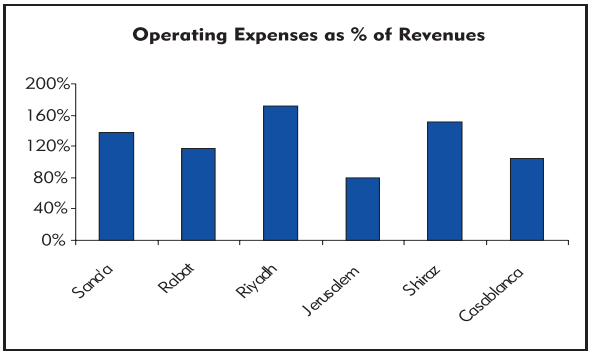


Figure 5.4. Public spending on water. Source: World Bank, 2007.

Government policies in the region require service providers to recover operating costs for water supply, sanitation, irrigation and drainage services. Investment costs for the 'trunk' infrastructure will be recovered from general revenues. With the exception of Morocco and Tunisia, most household/industrial service providers do not recover all operating costs even in the water-supply sector, (Figure 5.5). In the irrigation sector the situation is similar, with Morocco and Tunisia being the only two countries in the region that recover operating costs from water users. Financial sustainability therefore depends critically on government support, rather than payments from water users. Under these circumstances the pressure of maintaining and sustaining the water infrastructure imposes a heavy burden on national governments.

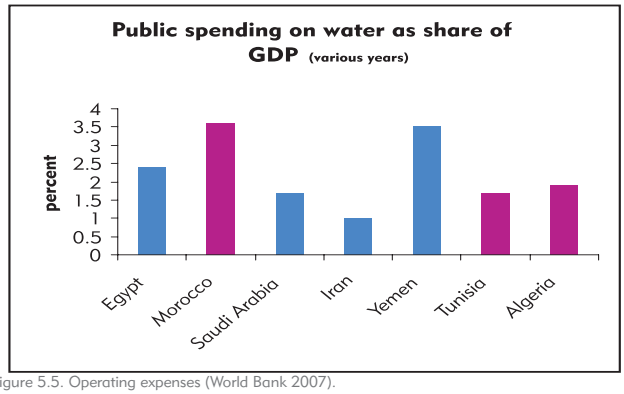


Figure 5.5. Operating expenses (World Bank 2007).

5.3.2. How do these financing arrangements affect incentives?

Existing financing arrangements are not conducive to efficiency in the delivery of water services. This is most visible in water and sanitation services, as indicated in Table 5.1. With the exception of Morocco and Tunisia, the other Arab countries have between 40 and 50% of the water not accounted for in terms of generating a cash flow. (World Bank 2007)

Country	Unaccounted for water (%)
Jordan	52
Egypt	50
Palestine	45
Lebanon	40
Algeria	40
Morocco	30
Tunisia	22

Table 5.1 Inefficiency in water service delivery)

Added to this, investments from the government have focused more on improving water supply to households and industries, and much of the wastewater is returned to the environment without adequate treatment, thereby polluting watercourses (both surface water and groundwater). World Bank estimates indicate that between 2 and 3% of the GDP is lost because of the environmental degradation that has taken place (Figure 5.6). One could conclude that excessive reliance on the government has led to disincentives among water-service providers to perform their duties efficiently. This is particularly significant for water supply and sanitation (which, on an average, use only 10 to 20% of a country's water resources, but about half of public investments in water infrastructure).

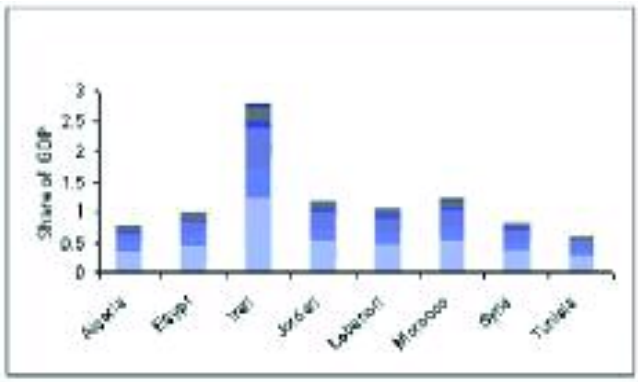


Figure 5.6. Cost of environmental degradation.
Source: World Bank (2007).

5.3.3. Are there any interesting illustrations of promoting social equity in the water sector?

Applying "Volumetric Cost Recovery" for irrigation and drinking water services may be reasonable measures for achieving equity. "Targeted Subsidies" are recommended where water services are charged. Charging for domestic water may be categorized by income or may be waived for individuals below a certain income limit or just waving the connection fees. It is up to governments to set the level of subsidy it can provide to its population.
Policy reforms in most Arab countries are directed at improving efficiency and increasing the voice of beneficiaries. Targeting government subsidies to low-income users has also been tested successfully. These initiatives are summarized below with examples from Egypt, Morocco and Yemen. In Egypt and Yemen, WUA's have played an important role in ensuring that services respond to farmer demands, particularly in terms of timely and equitable water delivery that meets cost requirements.

Farmer participation through cost-sharing leads to greater accountability. Their sense of ownership leads to their engaging in resolving local problems, particularly in terms of maintaining equity between upstream and downstream farmers. Beneficiary contributions to capital and O&M costs also relieve pressure on the national government budgets, while ensuring farmer participation in decision making and in selecting design options. Egyptian water law requires cost recovery from beneficiaries for construction of improvements. It also requires cost recovery from users of the construction improvements to the field pipe drainage system. Community participation has been encouraged, as in Yemen, to enhance the sense of ownership and responsibility.

On the water supply side, Morocco has embarked on an interesting pilot project to improve access of low-income communities. Starting in 2007, 12,300 low-income households have been connected to piped water and sanitation services in Casablanca, Meknes and Tangiers. Individual eligible households receive subsidized house connections, but pay the tariffs as any other customer.

5.4. Water MDGs in the Arab Region: Status, Challenges, and Opportunities

5.4.1. Status of MDG's in the Arab region

Achieving the MDGs' water targets needs further investments across the Arab world and are not necessarily feasible in all

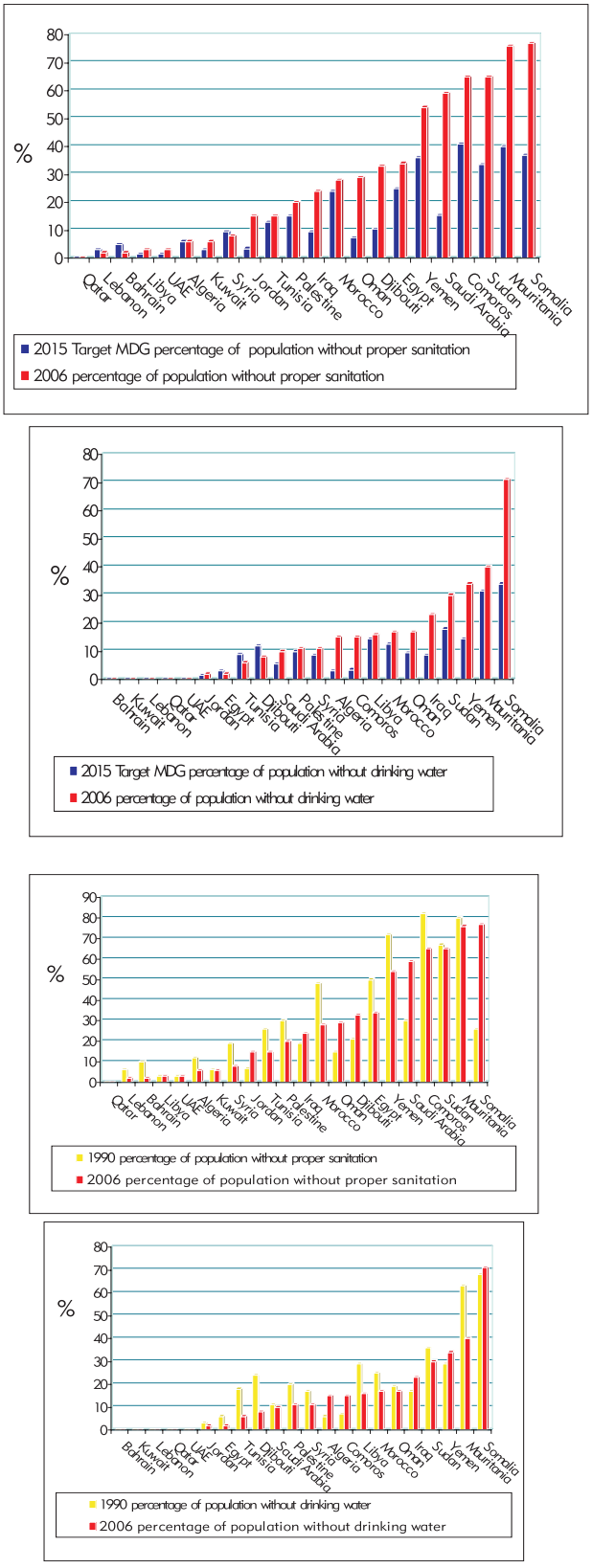


Figure 5.8. Percentage of population without drinking water (CEDARE, AWC, 2005; WHO/ UNICEF, 2008).

countries due to the high disparity in wealth within the Arab region. The percentages of population without access to drinking water and sanitation are shown in Figure 5.7, for the years 1990 (baseline for the MDG's) and 2006, respectively. Figure 5.8 shows the percentage population lacking drinking water and sanitation in 2006 compared with the MDG target for 2015. After achieving the MDG's targets, the population without access to drinking water in the Arab region in 2015 is expected to be 34 million. This value is close to that of 1990 which was 40 million. Meanwhile, the population not served with proper sanitation will be 109 million which is higher than the baseline of 94 million in 1990. The increase in the unserved population is attributed to the expected increase in population (AbuZeid and Elrawady, 2008).

5.4.2. Challenges

While there has been some progress in the recognition and implementation of the right to water, the same is not true for sanitation services. Declaring the year 2008 as International Year of Sanitation presents an opportunity to address the lack of attention paid to sanitation and hygiene in terms of human rights.

Reaching the MDG for water supply and sanitation requires a general improvement in water technology. Many Arab countries have a low water-technology base and rely on imported equipment. Moreover, the private sector is not efficiently filling the gap left by the relevant governmental entities. With many Arab countries suffering from techno-centric domain and trying to establish new communities far away from the population centroids, providing water and sanitation to these new communities would be a big challenge (RAED, 2008). Cost-effective and reliable technologies for wastewater treatment are needed to improve sanitation in rural areas and small communities. Several options have been tested and proven effective in Egypt and Jordan.

Informal settlements are another challenge, where slums are built without a permit outside big cities. This puts governments in a dilemma between, not extending drinking water services to illegal settlements as disincentive to violators to prevent informal settlements, and the right of people to access clean water. In many cases, governments yield for the latter choice and this problem remains to be solved within the overall development and poverty-reduction perspective.

5.4.3. Opportunities

Some of the Arab countries, namely North African countries, have initiated a sub-regional program for enhancing the achievement of the water MDGs through the establishment of the Regional Water MDGs' Monitoring and Evaluation Unit with national

task forces. The objective of the program is to advocate the importance of the MDG's, to raise awareness about methodology of assessing status and progress, evaluate the investment needed to achieve the MDGs, and identify gaps to mobilize the necessary financial resources to achieve the MDG's (CEDARE/N-AMCOW/AWF, 2008).

5.5 Conclusion and Recommendations

There are strong signals that the dynamics of water policy reforms in several Arab countries are moving in the right direction though the pace is slow considering the urgent action needed. The progress is even slower in terms of water-governance reform compared to water management.

The following highlights are drawn from an overview analysis:

- Some countries are ahead and others are responding at a slower pace. The benefits of bridging the water divide between the rich and the poor, between the power holders and the rights-holders are yielding socio-economic, environmental positive impacts in some countries. Hard political decisions are sometimes needed, but their long-term return is definitely a key step to ensure efficient, sustainable and equitable use of water resources in the Arab region.

- There is an urgent need to put water challenges in the perspective of development priorities of the nations. Issues that affect the water sector are not separated from reforms and challenges taking place in other development sectors. Often, they can be solved outside the sector. Solutions to water challenges need a cross-sectoral policy perspective (macroeconomic versus sectoral analysis).

- Sustain the political backup to water reforms and seize the opportunities provided by the global challenges and changes (global market and trade opportunities, climatic change, food, energy and financial crises) to implement hard decisions in terms of accountability, cost-recovery mechanisms and water-demand management.

- The role and type of agriculture and water allocation between sectors need to be revisited within the changing socio-economic development patterns of nations without compromising the issue of food security in the Arab countries.

- Solutions to water challenges in the Arab countries have a strong and overarching governance dimension that needs to be addressed as a priority in the water reforms and in the overall development agenda.

- Power relations and interests need to be part of the analysis of key determinants of water-policy cycle in the Arab region.
- Water governance has to be recognized as an equally important response to water challenges as any other technical or political response.

- Initiate a stepwise process towards institutionalization of mutual accountability between national and local government-users-regulators and operators. This effort should be at the heart of water reforms and not a sideline component.

- A common vision on water rights and equity should be clearly identified and agreed upon in the Arab region. Efficient regulatory and law enforcement mechanisms are absolutely important for preserving water rights.

- All stakeholders should be given a voice, not only to interested groups, powerful networks and lobbies, to ensure fair and transparent mechanisms that police the policy implementation and to allow participants find the most economically efficient and socially acceptable solutions.
- Participation needs to be part of the reform process through involvement of stakeholders in preparing new water policies and regulation and to gain their support before, during and after policy formulation. This also helps enforcing laws consistently and avoids bringing rules into force until the capacity exists to enforce them.

- Arab states should have reliable and up-to-date databases to reflect their current MDGs achievement status. The effort initiated by the Arab Water Council should be appreciated and given all necessary support.

- Many efforts have to be devoted to public awareness on many issues, including the importance of: (a) achieving MDG targets, (b) proper sanitation as a human right, and (c) bridging the gap between the rich and the poor and its positive impact on the whole community.

- For funding the necessary drinking and sanitation coverage, targeted subsides may be introduced where service charges are according to income classes. This creates some form of social integration where the rich cares for the needs of the poor.

- The same social integration concept may be expanded regionally and can be applied between different Arab countries, where wealthy countries and development banks contribute to an Arab Water MDG Fund that can finance achieving the Water MDG's in the less-fortunate Arab countries.

6

Bridging the Water Divide between the Arab States and Their Neighboring Countriesr

6.1 Introduction

As indicated in chapter 2, more than 60% of Arab surface water resources come from outside the Arab region. The rivers shared between Arab and non-Arab countries are the Nile; the Jordan, the Tigris, Euphrates and Shatt Al-Arab, the Senegal, and the Jubba and Shabele (Figure 6.1). At the same time, almost no two territorially contiguous countries in the Middle East and North Africa, and possibly further out, are void of sharing renewable or nonrenewable groundwater aquifers. Aquifers penetrate the sandstone rocks underneath the Egyptian, Libyan and Sudanese soils and some sections extend to the Chadian soil. Groundwater aquifers are also shared between Syria and Turkey (Haddadin, 2008). There are also fossil aquifers underlying the Arab countries of North Africa, which are shared with their neighbors to the south.

The water bodies shared with non-Arab countries have a common characteristic; almost none of them, have become the subject of a treaty between the Arab parties and their non-Arab neighbors to regulate the sharing and the management of the shared water body. This critical issue, if unsolved and inadequately addressed, will remain a potential area of delayed development, conflicts and cause of divides between the Arab states and their neighbors.

Moreover, some of the Arab water is under Israeli occupation in the Occupied Syrian Golan and the Occupied Palestinian Territories. Water in these territories is subject to exploitation by the occupying authorities depriving those countries from access to, and utilization of, their own national water resources. This is another critical issue which is among the root causes of the violation of the water rights of the Arab States.

It is not the intention of the regional document to present a comprehensive account of each shared water situation. This chapter will focus on what can be a basis for bridging the divides including some case studies to illustrate either promising success stories or potential risk of conflicts in managing international and transboundary water resources. Comprehensive review and assessment of the shared water resources issues in the region are described in a number of background reports (Hddadin, 2008; LAS, 2008a; NWS, 2008).

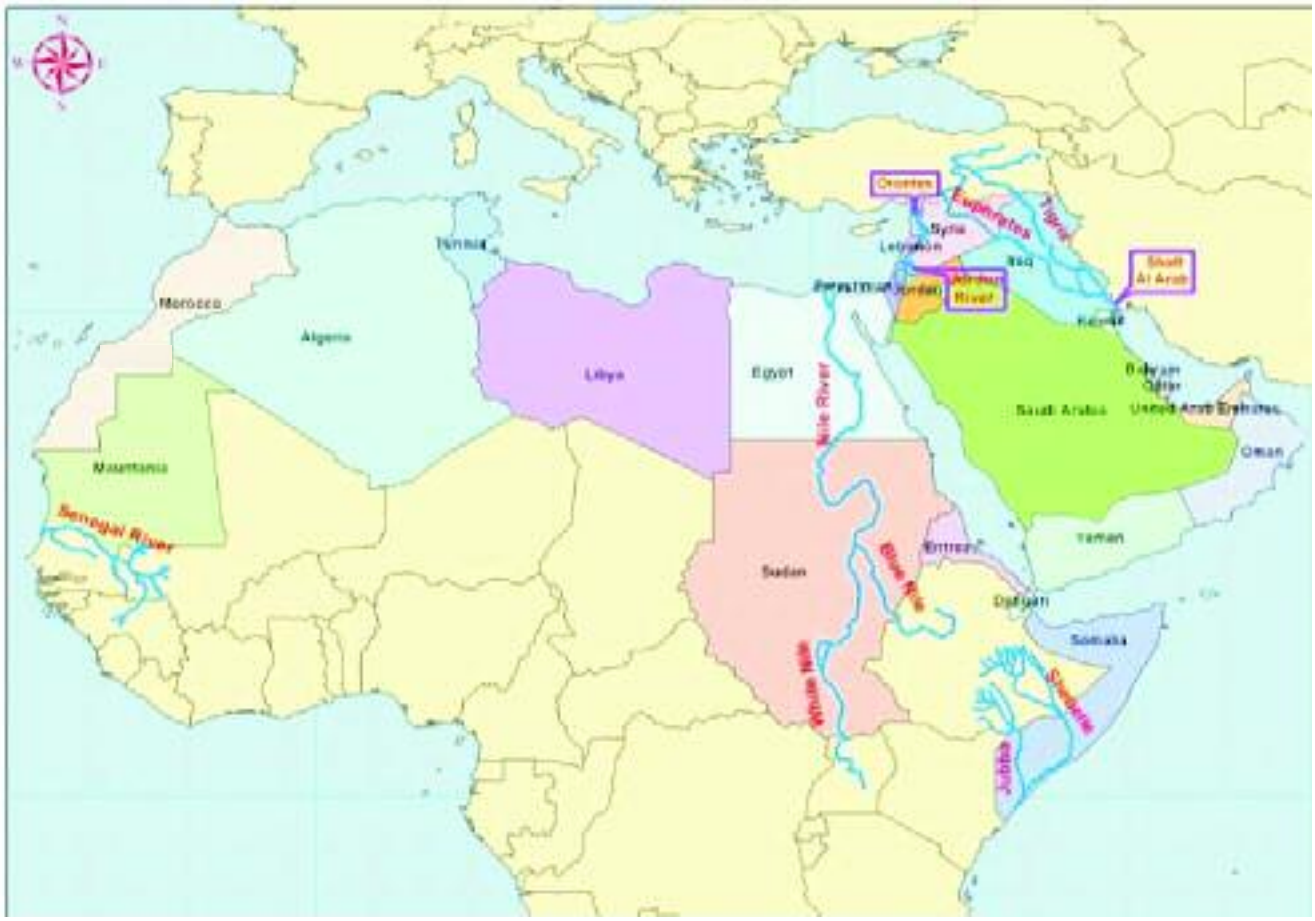


Figure 6.1. Shared between Arab and their non-Arab neighbor countries.

6.2 Legal and Institutional Framework

There is a set of principles which regulate the utilization of international rivers (LAS, 2008a). International customary law views such principles as being principles that must be respected. These principles include the following:

1. Whatever was agreed formerly by a riparian state should be respected.
2. Each state has the right to obtain the same share of water it used to obtain before.
3. Equitable distribution of the river water.
4. Obligation of not causing any harm to other riparian states.
5. Negotiations with riparian states if a state wishes to readjust its share of the river water through the construction of dams or diverting the river course.
6. Cooperation among riparian states for managing shared water resources and protecting the river environment.

The International Law Association approved in its meeting in Helsinki in 1966 what is now known as the "Helsinki Rules" on the Uses of the Waters of International Rivers. These rules are viewed as the cornerstone for the existing rules of International Law regarding international rivers. The Helsinki Rules promote the principle of "reasonable and equitable" sharing of the water of international rivers which in turn requires the implementation of the rule of "No–Harm."

Article Twelve of the Vienna Convention, 1978 offered a regulation for the treaties that were traditionally known for their "in-kind" nature. The Successor State, according to this Article, should abide by the treaties concluded by the Predecessor State directly relating to the region, including international river treaties. The International Court of Justice emphasized in one of its recent rulings concerning international rivers (the dispute between Hungary and Slovakia over the Gabcikovo-Nagymaros Project) the fact that regional treaties, including international river treaties (whether the water of such rivers is used for navigation or non-navigation uses) are binding treaties by virtue of the Succession of States. This implies that the Successor State inherits international treaties from the Predecessor State and cannot for any reason renounce those treaties.

The 1966 Helsinki Rules and the 1997 UN Convention had some differences in terminology, for example, the UN Convention pertains to water as "an international watercourse" as opposed to "an international drainage basin" in the Helsinki rules (AbuZeid, 2001).This created a difference in the interpretation of the articles among different countries. It is worth mentioning that the Arab countries had slightly different standpoints in terms of voting for the 1997 UN Convention. Out of 22 Arab countries, 15 voted in favor of the law, 6 did not vote for different reasons, and one country abstained from voting. The countries that voted in favor of the convention are: Algeria, Bahrain, Djibouti, Jordan, Kuwait, Libya, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, UAE, and Yemen. Egypt was the only Arab country that abstained from voting. Comoros, Lebanon and Mauritania were absent, while Iraq, Palestine and Somalia were not represented. It could be noticed that there was no general trend or common motive that can directly explain the reactions of Arab countries towards the 1997 UN Convention on the basis of the location of the countries in the river basin, whether it is upstream or downstream riparian (AbuZeid, 2001).

Legal systems governing shared surface water resources by Arab and non-Arab countries are partial and incomplete. The majority of shared river basins, if not all, suffer from the lack of comprehensive international agreements (LAS, 2008b).

Agreements between riparian states should be considered on a case by case basis. This is not only because the conditions of basins and aquifers largely differ in terms of the existing legal systems and institutional mechanisms but also because of the geographic, hydrologic, hydraulic and demographic characteristics of each basin or aquifer.

Undoubtedly, the existence of a legal framework approved by the riparian states is an indispensable and essential prerequisite for realizing stability, peace and sustainable development in the basin.

6.3 Case Studies

6.3.1 The River Nile

Bilateral agreements in the Nile basin started as early as the 1890s. These agreements and subsequent inter-country agreements on the river Nile have not produced a basin-wide institutional arrangement for its integrated development. However, they have acted as bases for launching a number of cooperation projects and programs including the HYDROMET in 1967, the UNDOGO in 1983, and TECHONILE in 1992 (NWS, 2008). The Nile Basin Initiative (NBI) was launched in 1998, as a partnership led by the riparian states of the river ile river with all Nile basin countries, except Eritrea, as members. The Initiative seeks "to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources." To transform the NBI vision into action, the NBI developed two complementary sets of programs: the Shared Vision Program (SVP) and the Subsidiary Action Programs (SAPs). The SVP, a US$130 million grant-funded program launched in 2003, is a multi-country, multi-sectoral program of collaborative action, exchange of experience, and trust and capacity building designed to build a strong foundation for regional cooperation. The Eastern Nile Subsidiary Action Program (ENSAP) is an investment program by the Governments of Egypt, Ethiopia and Sudan under the umbrella of the NBI. The Nile Equatorial Lakes Subsidiary Action Program (NELSAP) is a similar investment program under the umbrella of NBI where the participating countries are Burundi, Democratic Republic of Congo (DRC), Egypt, Kenya, Rwanda, Sudan, Tanzania, and Uganda. The objective of both programs is to achieve joint action on the ground to promote poverty alleviation, economic growth and reversal of environmental degradation.

Over the past decade, the NBI has built a transitional regional institution, including a Secretariat in Uganda; two sub-basin project development offices in Rwanda and Ethiopia, national offices in each country and advisory committees and technical working groups. To endow this organization with a permanent institutional and legal foundation, the Nile basin countries have been negotiating a Cooperative Framework Agreement (CFA). A final conclusion of the agreement is important to reflect the culmination of progress over the last decade and launch the NBI into more intensified joint development programs and a sustainable opportunity for cooperation.

6.3.2 The Jordan River

The dispute over the Jordan River is one of the significant elements of the Arab-Israeli Conflict. It was one of the reasons for the 1967 War and the Israeli occupation which aimed at destroying existing Arab projects to divert the watercourse of the Jordan River. To date this situation has hindered the conclusion of a comprehensive regional agreement among the Jordan River's riparian states.

The Peace Treaty between Israel and Jordan in 1994 included clauses related to water. In the Oslo Agreement between the Palestinian Authority and Israel, there is a vague reference to water which was considered as one of the issues to be negotiated at the final stage of negotiation with other substantial issues. However, there are two Arab states, Lebanon and Syria that remain until now far from any arrangements related to the Jordan River. Like Jordan and Palestine, territories of these two countries

are subject to Israeli occupation and illegal exploitation of the water resources of the Jordan River (see section 6.4).

6.3.3 The Tigris and EuphratesRrivers

Although there is no comprehensive international treaty concluded between Iraq, Syria and Turkey with regard to sharing the water resources of the Tigris and Euphrates Rivers, there were a number of agreements signed in the 1920's which address aspects of utilizing the water of the two rivers among these states. An Iraqi-Turkish Protocol to control the flow of water between the two states was concluded on 29 March 1946. In 1982, Iraq and Turkey agreed to establish a Joint Committee; its mandate included information exchange and technical consultation with respect to climatic changes and the over-vaporization of water. Syria joined the agreement in 1983. Meetings of the Committee since then were irregular and the Committee was unable to verify the implementation of adopted recommendations. Of late, the Committee has resumed its meetings on a regular basis. This might be a serious step towards concluding a comprehensive agreement between the three states that would preserve the rights of the three riparian countries to the water of the two rivers on an equitable basis and establish a base for future dispute settlement. Negotiating a legally binding agreement for the management of Tigris-Euphrates shared water is unavoidable to ensure trust, commitment and long-term cooperation between riparian countries (Al-Mahdawi, 2008).

6.3.4 The Senegal River

The Senegal River is practically the only shared surface water resource governed by a comprehensive convention (1972). Not all the riparian states of the river basin are party to this convention since Guinea is only an observer. A joint authority, the Organization for the Development of the Senegal River (ODSR), is in charge of the implementation of the agreement, in a way that safeguards the interests of all the riparian states. Articles 2, 3, 4 and 5 of the Convention include the legal principles upon which the legal system for using shared water resources is founded, particularly on the issue of exploiting the resources of the river and sharing its benefits for non-navigation purposes. Article 2 of the Senegal River Agreement indicates that joint cooperation to utilize the resources of the river is to be based on the principle of "reasonable utilization" and takes into consideration the principle of "absolute equality" between the users of the river.

The Senegal River Agreement signed on 21 December 1978 and annexed to the comprehensive Convention provided for the principle of joint ownership of the hydraulic infrastructure established on the river. By virtue of this annex, each co-owner has a share in the capital according to the principle of co-ownership. This realizes their common interest on the basis of absolute equality and equity.

The Senegal River Convention and its Annex are a live testimony to how International River Basins could be an arena for joint cooperation among the nations of the region as a whole, instead of being a source of conflict on water wealth and borders. Yet there is a need today to call for revising the Senegal River Agreement so that more justice is achieved for the riparian states who share its water, thus making the river a vital element for communication, stability and welfare for the states of the basin.

6.4 Water in Occupied Territories

Palestinians living in the Occupied Territories and Syrians living in the Occupied Syrian Golan Heights after the 1967 War suffer from scarcity of water, not due to the limited water resources available in these areas, but due to the control over these resources by the Israeli Occupation Authority. Under the conditions brought about by the siege imposed by the Israeli Occupation Authority, civilians in the Occupied Palestinian Territories are suffering from lack of basic rights to access to necessary resources for the maintenance of their daily needs and basic health. From the 1967 War to date, the Israeli Occupation Authority has adopted a discriminatory policy with regard to allocating water to Israeli settlers and Palestinians (LAS, 2008b).
The average (renewable) quantity of freshwater available in Israel and the Occupied Palestinian Territories per year is slightly over 2.4 billion cubic meters. Israel allocates approximately 90% of this amount to itself, leaving the Palestinian population just over 10%. If water resources were divided into equal per capita shares, Palestinians would receive approximately 45%. Of the water available from the West Bank aquifers, Israel uses 73%, West Bank Palestinians use 17%, and illegal Jewish settlers use 10%.

The Israeli Occupation Authority has destroyed 140 Palestinian wells to divert the water through Israel's national carrier. Palestinians were only allowed to dig 13 wells in almost 20 years. Meanwhile, Israel has drilled a chain of very deep wells alongside the eastern and northern borders with the Gaza Strip to hunt for more groundwater of the coastal aquifer thus depriving the Palestinians of their own water. In so doing, UN scientists estimate that Gaza will have no potable water within 15 years. Nonetheless, continued destruction of water infrastructure by

[8] The Senegal river covers territories in the African states of Guinea, Mali, Senegal and Mauritania.

the occupying forces leaves the Palestinian population without basic water supply and sanitation services for extended periods. Moreover, the Israeli Separation Wall, whose main part is built over the Territories of the West Bank, is considered a very important tool for seizing more than 85% of the Palestinian water resources. Despite the water struggle with Israel, the Palestinian Water Authority (PWA) that was established in 1996 managed to issue the water law only in 2002. It has been concluded that most of the water rights for Palestinian people are in the hands of Israeli authorities, who are encroaching on the Palestinian water right which is a tributary to the right of self-determination (Biswas et al., 2008).

The Israeli Occupation Authority also exploits all the water of the Baniyas River spring and the tributaries of the Yarmuk River in the occupied section of the Golan Heights. They have also drilled many wells all around the Occupied Syrian Golan to deplete millions of cubic meters of groundwater and divert this water to settlers inside Golan and Israel. Furthermore, the Israeli Occupation Authority depletes the Tiberius Lake and diverts its water through pumping stations and pushing pipes inside Israel and the Negev. The over-pumping of the water of the lake and the diversion of some of the rivers that feed the lake by the Occupation Authorities have led to the reduction of the level of the lake and have caused a significant decrease of the water that flows from the lake feeding the Dead Sea. Meanwhile, the Israeli Occupation Authority also prevents the inhabitants from drilling wells in their farms and fields.

The International Community should bear the legal, moral and human responsibilities to lift the injustice done to the rights of Palestinians and Syrians on their national water resources.

6.5 Conclusions and Recommendations

Arab water resources shared with non-Arab countries constitute the principal water sources for some Arab states at a time when there is a looming freshwater scarcity. This issue merits considerable attention at the national, regional and international levels and is at the core of security and stability in the region. Although the International Law on Water offers a general and a solid platform for protecting water rights and interests in shared surface water and ground water, there is a dire need for a set of legal and institutional mechanisms to manage and protect the interests of Arab countries in shared water for each river basin, protecting the rights of all riparian states.

Lessons learned from the NBI and ODSR show that cooperation on shared water resources increase the range of direct benefits to riparian states and help minimize the impacts of extreme events (e.g., floods, droughts) and adaptation to climatic change. Increased storage and improved watershed management in upstream countries, for example, can reduce flood risk and sedimentation in downstream countries. In addition, beyond these direct gains of cooperation, a legal and institutional framework for joint management among riparian countries would reduce any tension or dispute that would be associated with unilateral developments. The direct benefits achieved from cooperation could spur trade in food, power and other commodities and services, and promote other economic ties that may bind countries together within a framework that promotes regional peace, stability, sustainable development and economic growth.

The behavior of the Occupying Authority in Palestine and Golan Heights of Syria deprives people in the occupied territories of their basic rights to access their own water resources and leaves them to suffer from lack of basic water services. The International Community should practice its responsibility to stop this aggression. It is clear that no solution could be reached to the water problems of the occupied territories in the Arab region without a comprehensive settlement to the Arab Israeli conflict.

The following recommendations require utmost attention by the governments of riparian countries as well as by the regional and international institutions and communities. In the case of occupied territories none of these recommendations should preempt a comprehensive settlement:

1. Promote and support cooperation among riparian states within a properly conceived framework which leads to a "win-win" situation in managing shared water resources and maximizing their benefits.
2. Encourage joint work between water scientists and practitioners to create a common knowledge base which improves the understanding about potential benefits in and beyond the river and opens new windows of cooperation between the riparian states.

3. Intensify the efforts towards the conclusion of comprehensive agreements based on the rules of international law and conventions regarding shared water tailored to accommodate the specific conditions of each basin in a way that ensures equitable and no-harm uses of the shared resource.

4. Countries sharing a common water resource should agree on terms defining the equitable and reasonable use of the water body in a more practical way. Equity in shared water resources should take into consideration benefits from both rainwater (green water) and river water (blue water)

(AbuZeid and Elrawady, 2008).

5. Keep water out of political conflicts to avoid putting innocent people in disastrous situations due to lack of basic water services, loss of jobs, starvation and miserable health conditions.

6. Riparian countries should be prepared to challenge the status quo, both in relation to political power and water availability.

7. It is only peaceful conflict resolution and recognition of fair and equitable water rights that open the door for crafting agreements which are sustainable over time, based on customary international law.

8. The international community should not allow any Occupying Authority to confiscate the national water resources in occupied territories to their own benefits and deprive the people of their legitimate rights to access their own water.

7

Bridging the Water Divide between Knowledge and People

7.1 Introduction

The need for more interactions between water management and society is receiving growing recognition worldwide for securing sustainable development. This requires a change in the past focus on developing infrastructure while overlooking the need for a strong knowledge base and capacity to plan, manage and utilize the infrastructure towards a proper governance of the water sector (chapter 5). As presented in the United Nations, 2006, "knowledge" takes a variety of forms: as databases; as the competence to integrate and interpret data and create meaningful information that can inform decisions; as capacity to generate new data and information, to identify gaps, to learn from past experiences and to explore the future; and as education and dissemination mechanisms." On the other hand, capacity development can be defined as the process by which individuals, organizations, institutions and societies develop abilities to perform functions, solve problems and set and achieve objectives (Lopes and Theisohn, 2003). It includes elements of developing competent human resources, providing sound institutional capacity and the creation of an enabling environment.

In the developed world it was possible to couple large investments in infrastructure with capacity development and knowledge building and in that way they eliminated any gap or DIVIDE between the people and innovation/knowledge. Unfortunately, this is not the case in developing countries, particularly those located in arid zones such as the Arab region, where water scarcity could represent an additional constraint. Though, in general, those divides appear more significant in low-income countries, this cannot be broadly applied to all Arab region countries, especially those that have prospered due to the availability of huge storages of mineral resources such as oil. Such divides should be reduced or eliminated in all countries in recognition of the preciousness of their finite water resources. In spite of the importance of this goal, not all countries in the Arab region have initiated processes, in this direction, which could ultimately enhance the socio-economic development in a sustainable manner.

7.2 The Knowledge Base in the Arab Region

As defined earlier, the knowledge base goes well beyond databases and includes documents, models, procedures, tools and products. An effective knowledge base is essential for each country to achieve sustainable development.

7.2.1 Acquisition of data

An important entry to establishing an appropriate knowledge base is the capacity to acquire relevant data due to the wide interactions in the water sector which touch food production, health, industry, energy, ecosystem and recreation, and draws on skills and knowledge from scientific, technological, economic, health, legal, and social aspects. It is thus important to decide on the relevance and reliability of the needed data.

One of the important data for integrated water resources management is the hydro-meteorological data where the World Meteorological Organization (WMO) and UNESCO take a significant lead in advising states, regions and the globe on the most appropriate methods and approaches such as remote sensing for the acquisition of this form of data. Though great benefits on data acquisition could be made from continuous advances in remote senses, yet ground monitoring systems are still essential for confirming the accuracy of the remote sensing data. This is particularly important for the arid zones of the Arab region where the hydrological characteristics (rainfall, evaporation, etc.) are temporally and spatially extremely variable.

Another outstanding development in the last few decades is the establishment of databases and monitoring guidelines in many countries in the world. This has been facilitated by the advances and availability of huge computational and GIS facilities. The main problems in making such a wealth of information accessible to all include: the hastiness in sharing these data at both national and international levels; difference in data characterization; and record duration. Some Arab countries have taped this type of knowledge and made remarkable progress but the capacity of others still needs to be built. Acquisition of hydro-meteorological data as well as other data essential for establishing a proper knowledge base is becoming increasingly important to close the present knowledge gap as described in Table 1.

Table 7.1. Knowledge Index for the Arab states, 2005 (United Nations, 2006)

Score range (0, lowest, 10, maximum)	No data	0 – 2	2 – 4	4 – 6	6 – 8	8 – 10
Countries in the Arab region	Qatar, Somalia	Sudan, Yemen	Algeria, Lebanon, Morocco, Oman, Syria, Tunisia	Egypt, Saudi Arabia	/	/

7.2.2 Research

The crucial roles of research in enhancing the knowledge base for education and training should be emphasized. Few Arab countries have highly reputed water research centers that carry out research covering the whole spectrum of water resources management. The National Water Research Center (NWRC} in Egypt is an example. Its research agenda and products are geared with the national water plan of the country.

7.3 Capacity Development in the Arab Region

Capacity development as defined earlier requires adequate development of human resources, strengthening institutional capacity and creating an enabling environment to enhance the current divides that hinder sustainable development of the scarce water resources of the Arab region.

7.3.1 Development of human resources

Continuous improvements of human resources can only be achieved through a program of research input and the continuous redefinition of the competencies, knowledge and skills to be acquired during the periods of education and training, preparing for up-to-date job competencies. This process can be greatly enhanced through the participation of all stakeholders and ultimately aims towards reducing any gap or divide between knowledge and people.

7.3.2 Strengthening institutional capacity

Well-developed human resources cannot achieve capacity-development without an adequate institutional capacity. Institutional capacity relates to the overall performance of the organization and its capacity to function properly, as well as its ability to forecast and adapt to change (United Nations, 2006). Its resource base comprises the organizations personnel, facilities, technology, knowledge and funding, while its management capacity is determined by its procedures, programs and external relationship. Both the resource base and the management capacity make up the overall institutional capacity of the organization. A successful organization should develop an efficient, effective and expedient decision-making organizational structure, an effective partnership with all stakeholders, "a spirit of transparency, sharing responsibility and delegation with accountability; sense of ownership by all involved and attractive term of services for its employees."

Relevant research and development could greatly enhance the institutional capacity and improve its performance and running cost. Successful organization invests in Research and Development (R&D) to keep competitiveness in the market and attract better human resources.

7.3.3 Creating an enabling environment

This is the third side of the triangle of capacity development, together with human resources development and institutional capacity. It consists of the policy, legal, regulatory and administrative frameworks that serve as boundary conditions for the organizational functions of the agency. As in the previous sides of the triangle, R&D is key to improving the policies and legal frameworks for a better enabling environment.

7.4 Challenges and Opportunities for the Arab Countries

World literature is currently oversaturated with a wealth of knowledge bases and well-tested approaches for capacity development. The Arab states need to acquire these resources and adapt them to their situation and initiate appropriate systems of monitoring all key components of the hydrological cycle and water needs of the society and establish a unified system of databases for their management purpose and for easier exchange among the countries. The starting point should be a comprehensive assessment of the knowledge base and capacity in all countries utilizing the same guideline (if possible), identifying the gaps, and establish country-wise strategies and plans of action for the elimination of these gaps and divides. The plans of action should include the sustainability of the system to avoid the creation of new divides in the future. It must also put greater emphasis on sharing knowledge and experience among the countries of the region and riparian states of transboundary basins.

7.4.1 Role of research in enhancing the situation

The previous review has emphasized the important role of research in enhancing the knowledge base and capacity development, particularly in the Arab region where a great divide exists between these issues and the people of the region. An excellent review in this subject has been published by the International Council for Science (ICSU) in a report entitled "Harnessing Science, Technology and Innovation for Sustainable Development" (ICSU, 2005). The report proposed the addition of "Innovation" to the traditionally linked "Science and Technology" to become "Science, Technology and Innovation" for sustainable development. It described innovation as the means by which individuals and groups apply their creative, adaptive capacities and their social, organizational and institutional knowledge for the generation and application of new scientific and technical knowledge. Innovation can also be reached through informal, grassroot ideas and inventions of people not associated with formal scientific/ technological institutions.

7.4.2 Research and Development in the Arab countries

Compared to other regions and countries of the world, excluding Africa without South Africa, the Arab region is on the bottom of the World Scale in Science and Technology as reported by UNESCO Institute of Statistics (UNESCO, 2001) in a comparative study for the year 1996/1997. As illustrated in Table 7.2, Arab states are by far very inferior to all regions/countries of the world in the share of R&D expenditure, in gross domestic expenditure in research and development (GERD) as a percentage of the GDP, in the number of researchers per million inhabitants, and in R&D expenditure per researcher. The contribution of Arab states to the world production of publications on science and technology (S&T), patents and exports of high-tech products was very insignificant to a level that cannot be reported.

This inferior position of Arab states in their contribution to S&T has unfortunately continued to appear in all of UNESCO's biennial science reports with minor fluctuations from the poor indicators shown in Table 7.2. The indicators quoted for water 2000 in this report showed comparable inferior figures to those compiled in Table 2 for 1996/1997. There is no change in GERD as percentage of GDP; the number of researchers per million inhabitants has decreased to 124; and the expenditure per research has only increased to US$48,000 as compared to US$238,000 in USA. The report has confirmed the same low levels for 2000 in all other indicators of Table 2 and has given more details in the level of these indicators in different countries of the Arab region. For example, Saudi Arabia showed good progress in registered patents (67) for the period 1995-1999 if compared to all other countries in the region. However, the Republic of Korea registered 9,984 patents within the same period. Furthermore, the Gulf countries indicated higher users of internet in 2003 as percentage of population if compared to other countries in the region. The report also indicated poor performance of the countries of the region in indicators such as low level of translation and publication of scientific papers and number of cited articles in reputable journals. For example, the number of frequently cited scientific papers per million inhabitants amounts to 0.01 in Algeria, 0.02 in Egypt, 0.07 in Saudi Arabia and 0.53 in Kuwait compared with 43 in USA and 80 in Switzerland.

Region / country	Share of world R&D expenditure in 1996/97 (%)	GERD as a % of GDP	Researchers per million inhabitants	R&D expenditure per researcher (US$1000)	World production of S&T publication (%)	Patent world share (%)		Exports of high-tech products %
						EPD	USPTO	
USA	36.2	2.6	3,698	203	36.6	35.2	51.5	26.2
Europe	28.8	1.7	2,476	89	37.5	46.3	19.2	19.9
Asia	27.8	1.3	537	85	15.2	15.5	27.5	37.3
Latin America and Caribbean	3.1	0.5	715	48	1.8	0.2	0.2	-
Africa (excluding Arab states)	0.5	0.3	113	49	0.7	0.2	0.1	-
South Africa	0.4	0.7	1,031	49	-	-	-	-
Arab states (all)	0.4	0.2	356	24	-	-	-	-
World	100	1.6	946	105	-	100	100	100

Table 7.2: The state of S& T in Arab states in 1997[9] as compared to other regions/ countries of the world (Adapted from UNESCO, 2001).

GERD=Gross Domestic Expenditure in R&D; GDP=Gross Domestic Product; R&D= Research and Development; EPD=European Patent Office; USPTO=United States Patent and Trademarks Office.

Nabil Salih (2008) presented "R and D Indicators in the Arab States: Past and Present" which summarized the situation in a few challenges and opportunities. The reported challenges included lack of (a) S&T policies, (b) coordination on a national level, (c) quality data, and (d) competent individuals/systems; and the unawareness of industries of the potentials of R&D.

7.4.3 Science, technology and water

Science, technology and innovations are needed in all the components of an integrated water resources management approach. It is needed in all of the components of the hydrological cycle and the nonconventional water supply sources. The hydrological characteristics of arid zones are still vaguely known and the related data acquisitions benefits from current progress in remote sensing while databases are very modest in most countries.[10] This may include both transfer of knowledge developed in similar situations in the advanced world as well as researches to be carried out in the region itself. According to ACSAD, 1997, the average annual rainfall in the Arab region reaches 2,576 billion cubic meters. This is a huge quantity which could be partly harnessed through innovations in water harvesting and storage. To do that, researches are needed in understanding more about the characteristics of rainfall, evaporation, infiltration, runoff and groundwater in arid zones. More research is also needed on how to harness and integrate nonconventional water resources (desalination, wastewater reuse, cloud seeding, long-distance water transfer, utilization of saline water in irrigation, etc.) into the local components of the hydrological cycle in a sustainable manner and without creating negative consequences.

A great focus should aim towards developing a culture of water saving and conservation, noting that the region cannot follow the same pattern of utilization, for all purposes, as in regions with less constraints on their available renewable water resources.

7.4.4 A starting land mark

On the bright side, there are solid infrastructure and human resources already existing in research centers and universities almost in all countries which could serve, if effectively networked, as a region-wide hub to enhance knowledge and capacity development with a view to reduce the current divide. Some examples are the National Water Research Center of Egypt; the Regional Center for Studies and Research in Arid Zones established under the auspices of UNESCO in Cairo; ACSAD, ICARDA; the International Center for Bio-Saline Agriculture (ICBA); and other regional and national water-related centers established in most Arab countries; and the considerable number of highly trained staff and some facilities of great potential for research and training ties scattered in the universities of the region. All that is needed is an effective networking framework with a focus on specific priority areas. Each of these areas could be entrusted to relevant member(s) of the network while making available the necessary financial and political support.

Many signs of relevance and excellence could be noticed nowadays in the Gulf countries, where research and innovations have become central in their strategies and plans. The reward could be very fast as one could notice how the international rating of King Saud University of Riyadh has been significantly enhanced in a short period due to an aggressive program of academic development.

All these efforts will not lead to the needed change without moving from the current disciplinary approach to an interdisciplinary performance supported by real action towards a culture of knowledge and resources-sharing among all members of the proposed network.

[9] There is a current study sponsored by the UNESCO-Cairo Office, ALECSO and Arab Academy for Science in coordination with UNESCO Institute of Statistics with the main aim of updating the statistics on the state of the art of Arab's S&T.

[10] The Arab Water Council has partnered with NASA, U.S. Department of Agriculture, USAID, the World Bank and US universities to pursue how the use of satellite data may improve water resources management in the Arab region (chapter 4).

This is in addition to the creation of a solid link with the industry and the end users to transmit the research results into innovations, pilot schemes and end products that enhance the socio-economic life of the served people. Done in this way, it would be possible to reduce or eliminate the divide. This is done in many parts of the developed world through a system that links universities to the industry utilizing series of incubators and science parks while keeping the related population always as part of the process.

7.4.5 The role of professional networks in capacity development

Scientific and professional networks could play a great role in enhancing the knowledge base and capacity of the water sector in arid countries and consequently contribute to reducing the current gap/divide. Numerous networks are available at the national, regional and international levels and most of their scientific, technological and innovative products can be accessed without being an active member of these networks. The benefits from these networks could broadly be enhanced if given the necessary support and attention and if their efforts are better coordinated. Table 7.3, which is, by no means a comprehensive compilation, gives an example of these networks.

Table 7.3. Examples of regional and international networks.

Network Name/Type	Regional	International	Membership/Example	Remarks
Major Water Scientific Entities		✓	IAHR, IWRA, IAHS, IAH, IWA, ICOLD, ASCE, ICE (UK)	Most of them publish journals and scientific publications
Gulf Water Science and Technology Association (WSTA)	✓		Arabian Gulf countries	Organizes scientific conferences on a regular basis
Global Observatory of Units for Technology, Training and Ethics of Water (Goutte of Water)		✓	ICP, TECHWARE, EWA-Ring, WUP, ETNET, ETNETZI, Water Net, EWASIA, WET-Water, CAPNET, etc.	For more information note Bogardi et al. 2004
Major water-related IGOs and NGOs	✓	✓	World Water Council (WWC), Arab Water Council (AWC), CEDARE, ACSAD, AOAD, Egyptian Water Partnership (EWP), AHWA, SIWI, RAED	Famous for the World Water Fora; Arab Water Fora, Regional Activities, Stockholm Water Week
UN-Water		✓	Composed of 24 UN water-related organizations and 16 partners including ICID, IAH, IAHS, IWMI, IWA, GWP, IUCN, PSI, WWC, SIWI and WSSCC	It publishes the WWDR regularly; organizes UN Conferences on Water
UNESCO Water Family	✓	✓	UNESCO-IHP, UNESCO-IHE, WWAP, Water centers, Water Chairs, MAB, Global network on water and development Information for arid zones (G-WADI), FRIEND; HELP; UNESCO Cairo Office Networks: Groundwater Protection, Wadi Hydrology (all Arab countries), Asian G-WADI (13 arid countries of Asia)	Research, capacity-building activities, publications, training activities, conferences

7.4.6 The role of Information and Communication Technology (ICT) in reducing the divide

As mentioned previously, a wealth of knowledge made available by the reviewed networks and other sources could be accessed through the Internet as well as other ICT-related communication methods. With the huge advances in ICT, it has become possible for many members of these networks to run their business from their locations all over the world utilizing the current advances in communication and information.

7.5 Glimpses of Hope or Opportunities?

There are huge opportunities to reduce the divide in the knowledge by an initiative on transfer and adaptation of the huge knowledge base developed in similar regions in other parts of the world utilizing the current development in ICT and the wide global networking opportunities. Achieving this requires the creation of a Regional Network that should start with a regional needs assessment exercise identifying the gaps and drawing a plan of action that include financial and implementation mechanisms, making use of the available resources in the region as much as possible. This is certainly doable if a regional political will is available and if this need is well presented to the top policy makers through the Arab Water Council or an Arab Council of Water Ministers which was recently created under the auspices of the LAS. The second greater divide is at the capacity development level whether on the human resources side, the institutional development, or the provision of an enabling environment. This deficiency has been identified in the recommendations of many studies, particularly at the level of policy and decision makers.

Three current initiatives could form glimpses of hope and represent great opportunities for addressing these divides in a serious manner to achieve positive changes. These initiatives are represented in the recently established Arab Water Ministers Council, the Arab Leaders' Economic Summit held in Kuwait in January with "Science and Technology for Development" as the major agenda; and the Arab Water Academy (AWA) recently launched by the Arab Water Council (AWC).

7.5.1 The Arab Water Ministers Council

Arab water ministers, met in Cairo in July 16, 2007, at the headquarters of the Arab League, have announced the creation of an Arab Water Ministers Council. The establishment of the Council comes as an important development and agreement of the Arab States to join in a coordinated effort towards achieving water security at the regional and state level and to face the water challenges in the region.

7.5.2 The Arab leader's economic summit

This summit was held in Kuwait in January 2009 to discuss four issues with Science and Technology as a major item of the agenda. Water has so far been considered on top of the proposed themes identified at an early stage of this exercise. The Summit was an important opportunity which the Arab States seized to put water on top of the political agenda. It should be followed by more similar steps to be taken by the Arab Ministers of water and Science and Technology to to bridge the water divides in research and technowlogy.

7.5.3 The Arab Water Academy (AWA)

The Arab Water Academy (AWA) is an innovative regional capacity development facility which operates as a center of excellence in the Arab region. It creatively combines water sciences and water governance thinking, with an Arab identity, addressing the water-related challenges typical of the region, to promote and improve water innovation, governance, leadership, management and technological changes for sustainable growth. It was officially launched in Abu Dhabi, United Arab Emirates, in July 2008 in partnership with the Environmental Agency, Abu Dhabi (EAD) and the International Center for Bio-saline Agriculture (ICBA) in Dubai.

Within AWC's mandate, the mission of the Academy is:

(a) To mobilize the regional, global and national educational and knowledge base in integrated water management (e.g., science, technology, political economy and governance thinking) to enhance the human capacity operating in the water sector and the societies as a whole by filling the gap in education and training which conventional institutions cannot deliver.
(b) To operate as an 'agent of change' by active engagement in change, reform and/or transformational initiatives in the Arab region to develop 'role models' of organizations and to demonstrate improvement in water management. Here change is meant at three levels: facilitating the improvement of enabling environments, assisting in formulating institutional frameworks and policies, and strengthening organizational capacity operating in the political economy of water.

With its promising objectives and the expected impacts, AWA could be an important agent of change towards a sustainable management of the scarce water sources of the Arab region. AWA is already engaged in building its governance structure following its success in securing adequate premises, an approved statues and outline of core activities prepared by outstanding international experts, drawn from the region and aboard.

7.6 Conclusion

The Arab region is confronted with huge challenges in managing its scarce water resources mainly due to climatic conditions, geographical locations and socioeconomic factors. This scarcity is not new to the region and the ancient people of Arabia had managed to utilize the available knowledge at the time to devise innovative coping mechanisms reflecting great ingenuity. Regrettably this is not the case now where a huge divide has been created between the vast advances in the knowledge base and capacity and the people of the region. This sad situation can be rectified if an understanding of the problem is reached, a political will is created and water becomes the "issue" in the minds of all citizens. The indigenous water scarcity and the current divides could be looked at and treated as an "opportunity" rather than a "constraint" as done by the ancient people of this region. Glimpses of hope in this direction could be observed at both the levels of a few countries and in the framework of regional initiatives. To mention a few; the Economic Summit of the regional leaders and the establishment of the Arab Water Academy of the Arab Water Council as well as the establishment of the Arab Water Ministers Council, could represent important opportunities for a significant change. Key words for these changes are networking, knowledge enhancement, capacity development, interdisciplinary approach, effective water governance and participatory approach.

8

Conclusion and Key Messages for Future Directions

8.1 Conclusion

Historically, the MENA/Arab region has a lot to be proud of in water management. However, the business-as-usual scenario is not sustainable and will compromise the future of the Arab nations, peace and prosperity in the region. The dynamics taking place in water policy reforms across the region are indeed bold steps in the right direction. Yet, water governance is where strong national and regional endeavor is needed to ensure transparency and accountability. However, hard water policy decisions and commitments are needed at the highest political level to address political economy drivers. The right to water and its responsible use and conservation are key challenges to be packaged and pursued together. Access to water, water rights under occupation, transboundary water, groundwater management, water pollution and demand management are the most salient prospective issues that already have macro-economic implications in several Arab countries. The global challenges (climatic change, soaring food and energy prices, and financial turmoil) are an extraordinary opportunity for the Arab region to "walk the water talk" and implement the right water policies. The Arab countries support the new era of regional cooperation with their neighbors to manage shared water resources on the basis of "No Harm" and "Win-Win" principles. As a key to peace and stability in the region it is high time that the occupying authorities halt depriving nations under occupation in the region of their sovereign access and use of their national water resources.

8.2 Key Messages and Recommendations

The regional process of the MENA/Arab concluded a number of key messages which set the directions for the future. The messages are addressing those thematic topics identified as regional priorities during the regional process.

Theme 1. Global Changes and Risk Management

Topic 1.1: Adapting to climate change: Understanding the impacts of climatic change, vulnerability assessments and adaptation measures for water resources.

- The fragile water situation in the region is more sensitive to climate change which may cause far-reaching economic,

social and environmental effects.

- Adequate information is needed for attracting political attention and building public support to adaptive measures.
- Climate change should increase the urgency for more sustainable water policy and investment choices.
- Political focus on climate change offers new opportunities to improve overall results of water management.
- Urgent steps are needed towards developing a regional preparedness policy to adapt to extremes water events.
- Climate change adaptation measures have to be aligned into water policy reforms. Need to first understand the intended water services and how they are delivered and use of modern technologies such as remote sensing to determine indicators of change.
- Develop quantitative local (country scale or regional scale) baseline data on selected climate variables to define today's baseline and change rates.
- Use the results from the Arab LDAS[11] (or similar downscaled climate models) to quantitatively demonstrate in selected countries or regions the expected changes in climate variables to be expected due to climate change.

Topic1.2: Managing Disasters

- Water should be kept out of political conflict dynamics to avoid putting innocent people under disastrous situations.
- International community has responsibility to protect national water resources and water infrastructure in occupied territories.
- Political backup to regional organizations (governmental and nongovernmental) to mobilize the international community to intervene and enforce international conventions to secure access to safe and sufficient water under occupation and in conflict areas.

Theme 2. Advancing Human Development and the Millennium Development Goals

Topic 2.1: Ensuring water, sanitation and hygiene for all - ensuring adequate infrastructure - protecting public health in the short term.

- Scale up investments, and improve institutions and water technology to achieve the MDG's for water supply and sanitation.
- Move to stronger partnership with the civil society and put greater emphasis on sustained economic growth and social equity.
- Encourage national and subregional monitoring and evaluation (M&E) programs for enhancing the achievement of the water MDGs.
- Expand social integration over the region, where wealthy countries and development banks contribute to an Arab Water MDG Fund that can finance achieving the Water MDGs in the less-fortunate Arab countries.

Topic 2.2: Water for food for ending poverty and hunger

- Since available water resources will never be sufficient for food self-sufficiency, virtual water represented by imported food will remain a factor to close the gap between supply and demand.
- Increase of imported food prices reemphasized the role of irrigation in food security.
- Various economic policy instruments and improved cropping and irrigation practices are needed to reduce water consumption in irrigation.
- Nonconventional water resources will have a growing role in closing the water- supply-demand gap.

[11] Land Data Assimilation System

Theme 3. Managing and Protecting Water Resources and Their Supply Systems to Meet Human and Environmental Needs

Topic 3.1: IWRM basin management and transboundary cooperation

- A properly conceived framework of cooperation leads to a "win-win" situation in managing shared water resources.
- Crafting sustainable agreements, using customary international law offers "no harm" solutions.
- Joint work between water scientists, institutions and practitioners in riparian countries creates a common knowledge base and opens opportunities for cooperation.
- National IWRM plans need to be set, implemented and monitored country-wise and across the region.
- Water demand management should be encouraged at practice and policy levels.
- Enforcing and updating policies and laws related to pollution control, water resources protection and conservation of ecosystems as national strategic targets to be implemented at the local level.
- Desalination and wastewater reuse provide the options for meeting future water demands, principally for domestic consumption.

Theme 4. Governance and Management

Topic 4.1 Right to Water

- Address power relations and interests as part of the determinant of the water policy cycle.
- Improve water governance as a priority to improve water management and to address the scarcity challenge.

Topic 4.2 Institutional Arrangement

- Promote decentralization of water management in urban and agricultural water management.
- Sustain the political support to reforms in the water sector and cease the opportunities of global challenges (food, climatic change, etc.) to take hard policy decisions.
- Encourage involvement of all stakeholders in water planning and decision making.
- Institutionalize anticorruption and transparency mechanisms through effective and efficient institutions
- Support the independence of regulatory bodies and create mutual accountability between stakeholders in the water sector.

Theme 5. Finance

Topic 5.1: Sustainable financing for the water sector

- Encourage all forms of economic incentives to promote efficient use of water in urban and rural agriculture without compromising social equity.
- Cost recovery is necessary for water use efficiency and financial sustainability without compromising the principle of water as a "public good."
- Improve the enabling environment to scale up private-sector participation in water investments and management.
- Charging for water services should not impact the least-able to pay and vulnerable groups most.
- Engage International and regional financing agencies and the Arab Funds to finance water-sector development and reform.

Theme 6. Education, Knowledge and Capacity-Building

6.1: Education, Knowledge and Capacity-Development Strategies

- Recognize the balance between knowledge, capacity development and infrastructure to achieve the most appropriate water-governance strategy.
- Set strategic plans to respond to human resources and financial needs of institutions in the water sector.
- Encourage and support the (Arab Water Academy) AWA as an innovative regional capacity-development facility which creatively combines Water Sciences, Water Business

Management and Water Governance Thinking.

- Encourage networking between research centers and universities in the Arab region and between the region and international centers of excellence to enhance knowledge and capacity-building.

ABBREVIATIONS AND ACRONYMS

ACSAD	Arab Center for the Studies of Arid Zones and Dry Lands
AHWA	Arab Healthy Water Association
ALECSO	Arab League Educational, Cultural and Scientific Organization
AOAD	Arab Organization for Agricultural Development
ARWR	Available Renewable Water Resources
ASCE	American Society of Civil Engineers
AWA	Arab Water Academy
AWC	Arab Water Council
AWF	African Water Facility
BOT	Build Operate and Transfer
CAPNET	Capacity-Building for Integrated Water Resources Management
CC	Climatic Change
CEDARE	Center for Environment and Development for the Arab Region and Europe
CFA	Cooperative Framework Agreement
CIA	Central Intelligence Agency
COWAWS	Centre of Water studies and Arab Water Security
COWAS	Consumer Welfare Association
CSREES	Cooperative State Research, Education, and Extension Service
ENSAP	Eastern Nile Subsidiary Action Program
EPO	European Patent Office
ESCWA	Economic and Social Commission for Western Asia
ETNET	Environment-Water Thematic Network for Education and Training
EWP	Egyptian Water Partnership
FAO	Food and Agriculture Organization of the United Nations
GCC	Gulf Cooperation Council
GDP	Growth Domestic Product
GERD	Gross Domestic Expenditure in Research and Development
GIS	Geographical Information System
GTZ	German Development Agency
G-Wadi	Water and Development Information for Arid Lands
GWP	Global Water Partnership
ha	hectare/s
HDI	Human Development Index
HPI	Human Poverty Index
HYDROMET	Hydrometeorological Survey of the Equatorial Lakes Project
IAH	International Association of Hydrologists
IAHR	International Association of Hydraulic Engineering and Research
IAHS	International Association of Hydrological Science

ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Center for Bio-Saline Agriculture
ICE	Institution of Civil Engineers
ICID	International Commission on Irrigation and Drainage
ICOLD	International Commission of Large Dams
ICP	Innovations in Civic Participation
ICSU	International Council for Sciences
ICT	Information and Communication Technology
IDRC	International Development Research Center
InWent	Internationale Weiterbildung und Entwicklung (Capacity-Building International, Germany)
IPCC	Intergovernmental Panel on Climate Change
IPCC-WGII	Intergovernmental Panel on Climate Change Working Group Two
IUCN	International Union for Conservation of Nature
IWA	Inland Waterways Association
IWMI	International Water Management Institute
IWRA	International Water Resources Association
IWRM	Integrated Water Resources Management
Kcal	Kilocalorie
KfW	Kreditanstalt fŸr Wiederaufbau
LAS	League of Arab States
LDAS	Land Data Assimilation System
LDC	Least Developed Countries
M&E	Monitoring and Evaluation
MAB	Man and Biosphere
MAIB	Mediterranean Agronomic Institute of Bari
MDGs	Millennium Development Goals
MENA	Middle East and North Africa Region
MGD	million gallons per day
N-AMCOW	North African Ministerial Council on Water
NASA	National Aeronautics and Space Administration
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NBI	Nile Basin Initiative
NWRC	National Water Research Center
NWS	Nile Water Sector, Ministry of Water Resources and Irrigation, Egypt
O&M	Operation and Maintenance
ODSR	Organization for the Development of the Senegal River
PPP	Purchasing Power Parity
PSP	Private Sector Participation
PWA	Palestinian Water Authority
R&D	Research and Development
RAED	Arab Network for Environment and Development
RWR	Renewable Water Resources
S&T	Science and Technology
SAP	Subsidiary Action Programs
SIWI	Stockholm International Water Institute
SVP	Shared Vision Program
TECHONILE	Technical Co-operation for the Promotion of the Development and Environmental Protection of the Nile Basin
TECHWARE	Technology for Water Resources

UAE	United Arab Emirates
UNDOGO	A Swahili word means "friendship" and refers to an unofficial regional economic African grouping created in 1983
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO-IHE	UNESCO Institute for Water Education
UNESCO-IHP	UNESCO International Hydrological Programme
USAID	United States Agency for International Development
USPTO	United States Patent and Trademarks Office
WB	World Bank
WHO	World Health Organization
WMO	World Meteorological Organization
WRM	Water Resources Management
WSSCC	Water Supply and Sanitation Collaborative Council
WUAs	Water User Associations
WUP	Web Usability Partnership
WWAP	World Water Assessment Program
WWC	World Water Council
WWDR	United Nations World Water Development Report
yr	Year

ANNEX 1

Main Organizations and Institutions Offering Technical and Financial Support to Water-Related Issues

No.	Organization	Objectives	Assistance	Headquart	Contact	Tel	Web page
1.	Advisory Panel Project on Water Management (APP)	Supporting of exchange of knowledge and experience between Egyptian and Dutch professionals and researchers	Technical Assistance and financing	Egypt	Dr. Samia El -Guindy, Director	+20 2 4218 3326 / 6169	app@link.net http://www.app - wm.com/index.asp
2.	Al Akhawayn University	Education, capacity building and research	Technical Assistance	Morocco	Dr. Ahmed Legrouri	+2120 35862131	legrouri@aui.ma www.aui.ma/
3.	Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)	Developing scientific agricultural research in the arid and semi -arid areas	Technical Assis tance	Damascus Syria	Dr. Abdullah Droubi, Director, Water Studies Department	+963 11 5746893	droubi@scs -net.org www.acsad.org
4.	Arab Fund For Social and Economic Development (AFES D)	Social and economic development in the Arab region	Technical Assistance and financing	Kuwait	Dr. Abdel -latif Al Hamad, Director General / Chairman of the Board of Directors	+965 24 95 9000	hq@arabfund.org www.arabfund.org
5.	Arab Gulf Programme For United Nations Organizations (AGFUND)	Supporting of sustainable human development efforts	Technical Assistance and financing	Riyadh Saudi Arabia	H.R.H. Prince Talal Bin Abdul Aziz, President	+966 1 4418888	director@agfu nd.org www.agfund.org/
6.	Arab Network for Environment and Development (AOYE)	Promoting coordinated activities of NGOs in environment and Development in the Arab region	Assistance in Networking of NGOs	Cairo Egypt	Dr. Emad Adly, President	+ 202 516 1519	aoye@link.net www.aoye.org
7.	Arab Organization for Agricultural Develo pment (AOAD)	Promoting agricultural integration in the Arab region	Technical Assistance	Khartoum Sudan	Dr. Salem Al -Lozy, General Director	+249 11 472 476	info@aoad.org www.aoad.org
8.	Arab Water Council (AWC)	Promoting better understanding and management of the water resources in the Arab States	Technical Assistance	Cairo Egypt	Dr. Safwat Abd El Dayem Executive Director	+202 35449522	awc@mwri.gov.eg www.arabwatercou ncil.org
9.	Bushnak Group	Consultancies for development	Technical Assistance	Jeddah Saudi Arabia	Dr. Adil Bushnak, Chairman	+966 2 667 6200	adil@bushnak.co m www.bushnak.com

No.	Organization	Objectives	Assistance	Headquart	Contact	Tel	Web page
10.	Cairo University	Education, capacity building and research	Technical Assistance and applied research	Cairo Egypt	Dr. Ahmed Wagdy, Professor	+202 5732948	awagdya@yahoo.com www.cu.edu.eg
11.	Canadian International Development Agency (CIDA)	Aid for development worldwide	Technical Assistance and financing	Canada	Ms. Margaret Biggs, President	+1 800 230 6349	Info@acdi-cida.gc.ca www.acdi - cida.gc.ca
12.	CARE	Worldwide reduction of poverty.	Technical Assistance and financing for water supply, sanitation and development	USA with country offices	Ms. Sonia Vila Hopkins Regional Coordinator, Middle East & North Africa	+202 2525 3132 (ext# 252)	svila - hopkins@care.org www.care.org
13.	Center for Environment and Developm ent of the Arab Region and Europe (CEDARE)	Capacity building in environment and development in the Arab region	Capacity building and technical assistance	Cairo Egypt	Dr. Nadia Makram Ebeid, Executive Director	+202 2451 3921	mail@cedare.org www.cedare.org
14.	Center of Water and Arab Water Security Studies, League of Arab States		Technical Assistance	Damascus Syria	Ms. Kisa Chahra, Chief	+963 11 331 7874	cofws@yahoo.com
15.	CIHEAM/Bari	Capacity building and research in agriculture	Technical Assistance	Bari Italy	Dr. Cosimo Lacirignola, Director	+39 080 46 06 221	lacirignola@iamb.it www.iamb.it
16.	Council of Arab Economic Unity	Promoting Unity and integration in Economic fields within the Arab region	Technical Assistance	Egypt	Dr. Ahmed Goueli, Secretary General	+202 575 5321	mahacaeu@y ahoo.com www.caeu.org
17.	Darwish Consulting Engineers	Consultancies in water projects	Technical Assistance	Cairo Egypt	Dr. Raouf Darwish, Chairman	+202 258 1559	raoufdarwis h@dce-ltd.com www.dce _ ltd.com
18.	Egyptian National Committee for Irrigation and Drainage (ENCID)	Effective irrigation / drainage management	Technical Assistance	Cairo Egypt	Dr. Hassan Amer, Chairman	+202 446 4626	encid@link.com.eg
19.	Egyptian Water Partnership (EWP)	Promoting sustainable management of water resources at national and local levels	Technical Assistance	Cairo Egypt	Dr. Ahmed A. Goueli Chairman	+202-24513921	caeu@idsc.net.eg www.egyptianwaterpartnership.org
20.	Environment Agency - Abu Dhabi (EAD)	Capac ity building and research	Technical Assistance	Abu Dhabi UAE	Mr. Majid Al-Mansouri, Secretary General	+971 2 681 7171	malmansouri@ead.ae www.ead.ae
21.	European Investment Bank (EIB)	Financing development projects	Financing water projects	Luxembourg	Mr. Philippe Maystadt , President	+352 43 791	info@eib.org www.eib.org
22.	German Development Agency (GTZ)	Aid for development worldwide	Technical Assistance and financing	Germany with country offices	Ms. Marlis Weissenborn, Country Director, GTZ Office Cairo	+49 619679/0	gtz-aegypten@gtz.de www.gtz.de

No.	Organization	Objectives	Assistance	Headquart	Contact	Tel	Web page
23.	Global Environmental Facility (GEF)	Financing globally relevant environmental programs	Technical Assistance and financing	USA	Mrs. Monique Barbut, CEO	+202 473 0508	secretariat@TheGEF.org www.gefweb.org
24.	Global Water Partnership (GWP)	Fostering IWRM worldwide	Technical Assistance	Sweden	Dr. Ania Grobicki, Executive Secretary	+46 08 562 51 900	gwp@gwpforum.org www.gwpforum.org
25.	Holding Company for Water and Wastewater, Egypt	Water supply and sanitation services	Service Provider	Egypt	Dr. Abdelkawi Khalifa, Chairman	+20 2 392 9830	abdelkawi.khalifa@hcww.com.eg www.hcww.com
26.	International Center for Agricultural Research in the Dry Areas (ICARDA)	Cooperation in agricultural research in the region	Technical Assistance	Aleppo Syria	Dr. Theib Y. Oweis, Director of Water and Drought Program	+963 21 2213433	m.solh@cgiar.org http://www.icarda.cgiar.org/
27.	International Center for Biosaline Agriculture (ICBA)	Research in biosaline agriculture	Technical Assistance	Dubai UAE	Dr. Shawki Barghouti, Director General	+971 4 3361 100	s.barghouti@biosaline.org.ae http://www.biosaline.org/
28.	International Commission on Irrigation and Drainage (ICID)	Enhancing the worldwide supply of food by improving water and land management and the productivity of irrigated and drained lands	Technical Assistance	New Delhi India	Mr. M. Gopalakrishnan, Secretary General	+91 11 26116837 / 26115679	icid@icid.org www.icid.org
29.	International Development Research Center (IDRC)	Research in development issues worldwide	Technical Assistance and financing	Canada with Middle East and North Africa office in Egypt	Dr. Eglal Rached, Regional Director of IDRC Regional Office for the Middle East & North Africa	+202 3336 7051 /2 /3	erached@idrc.org.eg www.idrc.ca
30.	International Water Resources Association (IWRA)	Cooperation in water resources worldwide	Technical Assistance	Mexico	Dr. Ce cilia Tortajada, President	+27 11 805 3537	iwra-office@wisa.org.za http://196.36.166.88/iwra/
31.	InWEnt – Internationale Weiterbildung und Entwicklung (Capacity Building International, Germany)	Capacity buildi ng	Technical Assistance	Germany	Dr. Detlef Virchow, Division Environment, Energy and Water	+49 30 25482 118	detlef.virchow@inwent.org www.inwent.org/
32.	Islamic Development Bank	Poverty reduction and development in Islamic countries	Financing	Jeddah Saudi Arabia	Dr. Karim Allaoui, Water Resources Specialist	+966 2 646 6920	kallaoui@isdb.org www.isdb .org
33.	IUCN Water Programme	Conservation of Nature	Technical Assistance	Amman Jordan	Dr. Odeh R. Al Jayyousi, Regional Director	+962 6 5680322 /44	odeh.al.jayyousi@iucn.org www.iucn.org
34.	Japan International Cooperation Agency (JICA)	Aid for development worldwide	Technical Assistance and financing	Japan With country Offices	Mr. Sadako Ogata, President	+81 3 5352 5311 /5312 /5313 /5314	jicagap-opinion@jica.go.jp www.jica.go.jp
35.	Japan Water Forum	Solving water problems in the World	Technical Assistance	Japan		+81 03 5212 1645	office@waterforum.jp www.waterforum.jp

No.	Organization	Objectives	Assistance	Headquart	Contact	Tel	Web page
36.	King Fahd University of Petroleum and Minerals	Education and research	Technical Assistance	Saudi Arabia	Dr. Waleed Abderrahman, Professor	+ 966 3 860 2895	awalid@kfupm.edu.sa http://www.kfupm.edu.sa/
37.	Kuwait Institute for Scientific Research	Scientific research	Technical Assistance	Kuwait	Dr. Naji Mohamed Al-Mutairi, Director General	+965 4836100 / 4818630	public_relations@safat.kisr.edu.kw www.kisr.edu.kw
38.	Middle East Desalination Research Center	Desalination research studies	Technical Assistance	Oman	H.E. Koussai Quteishat, Center Director	+968 24 415 500	info@medrc.org.om www.medrc.org.om
39.	National Aeronautics and Space Administration (NASA)	Scientific research	Technical Assistance	USA	Mr. David Toll, NASA Water Resources Deputy Program Manager	+1 301 614 5801	dave.toll@nasa.gov www.nasa.gov
40.	National Water Research Center (NWRC)	Scientific research	Technical Assistance	Egypt	Dr. Shaden Abdel Gawad Chairperson	+202 44446180	nwrc@nwrc-eg.org www.nwrc-egypt.org
41.	Observation Du Sahara Et Du Sahel (OSS)	Studies in Sahara Region of Africa	Technical Assistance	Tunisia	Dr. Youba Sokona, Executive Secretary	+216 71 206 633/ 634	boc@oss.org.tn www.oss-online.org
42.	Office National Eau Potable Maroc assainissement (ONEP)	Water supply and sanitation services	Service Provider	Morocco	Dr. Asma El Kasmi, Responsible for International Cooperation	+212 37 75 96 00	aselkasmi@onep.org.ma onepbo@onep.ma
43.	Organisation for Economic Co-operation and Development (OECD)	Collecting data, monitors trends, analyses and forecasts economic developments	Technical Assistance and financing	Paris France	Mr. Angel Gurría	+33 1 4524 8200	http://www.onep.org webmaster@oecd.org.ma/
44.	Regional Center For Training and Water Studies (RCTWS)	Capacity building and research	Technical Assistance	Egypt	Dr. Dalal Nagar, Head	+202 38334107	http://www.oecd.org dalnagar@trainingcenter-eg.com
45.	Swiss Agency for Development and Cooperation (SDC)	Aid for development worldwide	Technical Cooperatio n and project funding	Switzerland	H.E. Mr. Martin Dahinden, Director-General/Ambassador	+41 31 322 3124	info@deza.admin.ch www.sdc.admin
46.	The Royal Netherlands Embassy in Egypt	Aid for development worldwide	Technical Assistance and project funding	Embassy in Egypt	Dr. Tarek Morad, Head of Economic Affairs Development Cooperation Division	+202 739 5500	tarek.morad@minbuza.nl
47.	The Wo rld Bank (WB)	Financing development worldwide	Technical Assistance and financing	USA With country Offices	Mr. Laszlo Lovei , Sector Director, MNSSD	+1 202 473 1306	Llovei@worldbank.org www.worldbank.org
48.	UN Economic and Social Commission for West Asia (UN -ESCWA)	Cooperation for socio - economic development in the region	Technical Assistance	Lebanon	Dr. Hosny Khordagui, Water Team Leader	+961 1 978 527	Khordagui@un.org www.escwa.org.lb

No.	Organization	Objectives	Assistance	Headquart	Contact	Tel	Web page
49.	UNESCO -IHE Institute for Water Education (UNESCO -IHE)	Strengthening the efforts of other universities and research centers to increase the knowledge and skills of professionals working in the water sector	Technical Assistance	Delft, The Netherlands	Prof. Richard A. Meganck, Director	+31 0 15 215 1701	r.meganck@unesco -ihe.org www.une sco - ihe.org
50.	United Nations Development Program (UNDP)	Aid for development worldwide	Technical Assistance and financing	USA With country offices	Mr. Elie Kodsi, UNDP RBAS	+961 1 981 301	elie.kodsi@undp.org www.undp.org
51.	United Nations Educational, Scientific and Cultural Organization (UNESCO) Cairo Office	Cooperation for education and science issues worldwide	Technical Assistance and financing in water	France, with regional office in Egypt	Mr. Tarek Shawki, Director	+202 794 5599	cairo@unesco.org www.unesco.org
52.	United Nations Environment Programme (UNEP)	Cooperation in Environmental issues worldwide	Technical Assistance	Kenya with regional office in Bahrain	Dr. Habib Elhabr, Regional Director	+973 1781 2777	habib.elhabr@unep. org.bh www.unep.org
53.	United Nations Food and Agricultural Organization (FAO)	Worldwide cooperation for agricultural and watershed management issues	Technical Assistance	Italy With regional offices	Jacques Diouf Director-General	+39 06 57051	FAO -HQ@fao.org www.fao.org
54.	United Nations University (UNU)	Capacity building	Technical Assistance	Canada with regional in UAE	Dr. Waleed Saleh, Regional Coordinator	+971 42977741	wsaleh .uni-inweh@nchrd.gov.jo www.unu.edu
55.	United States Agency for International Development (USAID)	Aid for development worldwide	Technical Assistance and financing	USA With country offices	Mr. David Barth, Office Director, Middle East/North Africa	+202 522 6846	npark@usaid.gov www.usaid.gov
56.	University of Jordan	Capacity building and research	Technical Assistance	Jordan	Dr. Muhammad Shatanawi, Profe ssor	+962 6 535 5000	shatanaw@ju.edu.jo www.ju.edu.jo
57.	World Bank Institute (WBI)	Builds capacity for development	Technical Assistance	Washington DC USA	Mr. Aldo Baietti, Lead Wa ter Resources	+1 202 473 27 50	Abaietti@worldbank .org http://www.worldban k.org/wbi/
58.	WorldMeteorological Organization (WMO)	Safeguarding the environment and enhancing the economic and social well-being of society sectors	Technical Assistance	Geneva, Switzerland	Mr. Michel Jarraud, Secretary General	+41 022 730 8111	wmo@wmo.int www.wmo.int

ANNEX 2

Bibliography

Abdel-Dayem, S., Anwar, M. and Rashad, A. 2008. Public-private partnerships in basic irrigation service. West Delta Water Conservation and Irrigation Rehabilitation Project (Egypt). Unpublished paper.

Abu-Madi, M., Al-Sa'ed, R., Braadbaart, O. and Alaerts, G. 2008. Viability of increasing the tariff of freshwater for irrigation as a tool to stimulate wastewater reuse in the MENA region. Water Science & Technology 57: 1475-1481.
AbuZeid, K. 2001, International water law from Helsinki rules to the United Nations convention on the law of the non-navigational uses of international watercourses. Water Resources Impact 3: 4, July 2001.
AbuZeid, K., 2005. Water rights & equity in Egypt. Presentation at the Workshop on water rights and equity. Egyptian Water Partnership (EWP), www.egyptianwaterpartnership.org.

AbuZeid, K., and Elrawady, M. 2008. Water MDGs in the Arab region: Status, challenges, and opportunities, Centre for Environment & Development for the Arab Region & Europe (CEDARE), www. cedare.org, water.cedare.int

ACSAD (Arab Center for the Studies of Arid Zones and Dry Lands). 1997. Water resources and their utilization in the Arab region. In the Second Symposium on Water Resources and their utilization in the Arab Region, Kuwait, 8-10 March, 1997.

Al-Mahdawi, Munadhil F. A. 2008. Transboundary water management towards promoting the integrated strategies in Tigris and Euphrates basins. General Directorate of Water Resources Management, Ministry of Water Resources, Baghdad. http://portal.worldwaterforum5.org/wwf5/en-us/Pages/HomePage.aspx.

Al-Weshah, R.A. 2000. Optimal use of irrigation water in the Jordan Valley: A case study. Water Resources Management 14 (5): 327-338, October 2000.
Al-Zubari, W. K. 2005. Groundwater resources management in the GCC countries: Evaluation, challenges, and suggested framework. Water Middle East 2005 Conference, Bahrain, Quoted in Chapter 6 Sustaining a common future 2007, UNEP Global Environment Outlook, GEO 4,Environement for Development 572p.

AOAD (Arab Organization for Agricultural Development). 2007. The strategy for sustainable Arab agricultural development for the upcoming two decades (2005-2025). Arab Organziation for Agricultural Development, Khartoum. Sudan.

Beaumont, P. 2000. The quest for water efficiency- restructuring of water use in the Middle East. Water, Air, & Soil Pollution 123: 551-564.

Biswas, A., Rached, R. and Tortajada, C. 2008. Water as a human right. International Development Research Center (IDRC), Routledge, New York NY 10016.
Bogardi, J., Hartvelt, F., Hugo, A., Mwanza, D.D., Jonker, L., Van der Beken, A., and Wietsma, E. 2004. Networking in the water sector: Suggestions and examples for best practices. IHP-VI, Technical Documents in Hydrology, No. 63. UNESCO, Paris, France.

Bush, R. and Sabri, A. 2000. Mining for fish: Privatization of the "commons" along Egypt's northern coastline Losing ground? The politics of environment and space, Middle East Report 216, http://www.merip.org/mer/mer216/mer216.html (accessed 13th October 2008).

CEDARE/AWC (Center for Environment and Development for the Arab Region and Europe/Arab Water Council). 2008. Status of water MDGs achievement in the Arab region, CEDARE/Arab Water Council report. Arab Water Council, Cairo.
CEDARE/AWC (Center for Environment and Development for the Arab Region and Europe/Arab Water Council). 2005. Status of water MDGs' achievements in the Arab region. The Arab Water Council, Cairo.

CEDARE/N-AMCOW (North African Ministerial Council on Water)/ AWF. 2008. A regional water MDGs' monitoring & evaluation program for North Africa. http://www.undp.org/mdg/

CIA (Central Intelligence Agency). 2003. CIA world factbook. CIA, New York.

Cline, W.R. 2007. Global warming and agriculture: impact estimates by country. Center for Global Development and Peterson Institute for international Economics, Washington, D.C:
Dabour, N. 2005. Water resources and their use in agriculture in Arab region. Workshop on groundwater and soil resources protection in the Arab region, Amman, Jordan ACSAD-Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Federal Institute for Geosciences and Natural Resources in Hannover.

Defra, 2008. Ensuring UK food security in a changing world. Defra, London, UK.

Doll, P., 2002. Impact of climate change and variability on irrigation requirements: a global perspective. Climate Change 54: 269-293, University of Kassel, Center for Environmental Systems Research, Germany.
ESCWA (Economic and Social Commission for Western Asia). 2001. Current water policies and practices in selected ESCWA member countries 102 p. United Nations Economic and Social Commissions for Western Asia, New York NY.

FAO (Food and Agriculture Organization of the United Nations) 1986. Organization, operation and maintenance of irrigation schemes. FAO, Rome.

FAO (Food and Agriculture Organization of the United Nations), 1997. Irrigation in the Near East region in figures. FAO Water Report #9. Rome.
FAO (Food and Agriculture Organization of the United Nations) 2006. World agriculture: Towards 2030/2050. Interim Report. Global Perspective Studies Unit, FAO, Rome, Italy.

FAO (Food and Agriculture Organization of the United Nations) 2008a. Climate change: Implications for agriculture in the Near East. Twenty-Ninth FAO Regional Conference for the Near East. Rome

FAO (Food and Agriculture Organization of the United Nations) 2008b. Near East agriculture towards 2050: Prospects and challenges. 29th FAO Regional Conference for the Near East, Nerc/08/3, Cairo .

FAO AQUASTAT Database. http://www.fao.org/ag/agl/aglw/aqua/stat/dbase/index.stm.

Ferragina, E.. Marra, M. and Quagliarotti, D.A.L. 2002. The role of formal and informal institutions in the water sector. Plan Bleu Regional Activity Centre, Sophia Antipolis.

Gagne, D. 2006. The world's largest membrane-based water reuse project. http://www.gewater.com/pdf/Technical%20Papers_Cust/Americas/English/TP1030EN.pdf

Gardner-Outlaw & Engelman. 1997. Sustaining water, easing scarcity: A second update, Washington, D.C., Population Action International.

Government of LIBYA. 2005. Libyan National Strategy: Agricultural Competitiveness Assessment. Draft Report, Tripoli.
Haddadin, Munther J. 2008. Bridging the water divide between the Arab states and their neighboring countries. Paper prepared as a contribution for preparing the regional document of the MENA/Arab Countries, Amman.

Hamdane, A. 2008. Tunisian experience in water demand management. A paper presented at the workshop organized by Water Demand Management Initiative at the First Arab Water Forum in Saudi Arabia, November 19th, 2008, www.idrc.ca/wadimena)

Hamdy, A. 2008. Irrigation management transfer: Monitoring and evaluation concepts and approaches. Unpublished paper. CIHEAM/Bari, Italy
Houri, A. 2006. Prospects and challenges of using hydropower for electricity generation in Lebanon. Renewable Energy 31, 1686-1697.

IPCC, Working Group II. 1996. Climate change 1995: Impacts, adaptation and mitigation of climate change. Scientific-technical analyses. Cambridge University Press, Cambridge, U.K.

IPCC (Intergovernmental Panel for Climate Change). 2001. Climate change 2001: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). University Press for the IPCC, Cambridge.
IPCC 2008. Climate change and water, Intergovernmental Panel on Climate Change Technical Report IV. University Press for the IPCC, Cambridge.

Kauffmann, C. and Wegner, L. 2007. Privatisation in the MEDA region: Where do we stand? http://www.privatizationbarometer.net/upp/uppdoc/D3.1_3.pdf (accessed 14th October 2008)
Kundzewicz, Z.W., Mata, L.J., Arnell, N.W., Döll, P., Kabat, P., Jiménez, B., Miller, K.A., Oki, T., Sen, Z. and Shiklomanov, I.A. 2007. Freshwater resources and their management. In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds. Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, pp. 173-210.

Laban, P. 2008. Accountability and rights in right-base approaches for local water governance, International Development Research Centre, http://www.idrc.ca/en/ev-127201-201-1-DO_TOPIC.html (accessed 2nd October 2008).

Lambsdorff, J.G. 2007. Corruption Perceptions Index, 2007 In: Global Corruption Report, 2008. Corruption in the water sector. Transparency International. The global coalition against corruption. Cambridge University Press, Cambridge, UK.

LAS (League of Arab States). 2008a. Institutional and legal issues in managing shared water resources: The Arab region's experience. League of Arab States (LAS), General Secretariat, Economic Affairs, Department of Environment, Housing and Sustainable Development, Cairo. http://portal.worldwaterforum5.org/wwf5/en-us/Pages/Home-Page.aspx

LAS (League of Arab States). 2008b. Right to water in the Arab occupied territories. League of Arab States (LAS), General Secretariat, Economic Affairs, Department of Environment, Housing and Sustainable Development, Cairo.

Lopes, C. and Theisohn, T. 2003. Ownership, leadership and transformation. Can we do better for capacity development? UNDP and Earthscan Publishing, London.

Molle, F. and Berkoff, J. 2005. Cities versus agriculture: Revisiting intersectoral water transfers, potential gains, and conflicts. Comprehensive Assessment Research Report 10. Colombo, International Water Management Institute.

Molle, F., Venot, J.-P. and Hassan, Y. 2008. Irrigation in the Jordan

Valley: Are water pricing policies overly optimistic? Agricultural Water Management 95(4): 427-438.
NWS (Nile Water Sector). 2008. Local experiences and recommended appropriate actions for policy improvement, Case of Egypt and its neighbors. Nile Water Sector, Ministry of Water Resources and Irrigation, Egypt, Cairo. http://portal.worldwaterforum5.org/wwf5/en-us/Pages/Home-Page.aspx

Plan Bleu. 2008. The Bleu Plan's sustainable development outlook for the Mediterranean. Plan Bleu. http://www.planbleu.org/publications/UPM_EN.pdf (accessed 18th October 2008)

Rabat, D.G.H. 2002. Analysis of the case study on the drink water supply in Rabat-Casablanca coastal area. Plan Bleu. Fiuggi.
RAED (Arab Network for Environment and Development). 2008. Obstacles and challenges facing the achievement of MDGs from the point of view of RAED. Reseau Arabe pour l' Environment et le Developpment, Cairo.

Richards, A. and Waterbury, J. 2008. A political economy of the Middle East. Third Edition 2008. Westview Press, Colorado.
Salih, N. 2008. R and D indicators in the Arab states: Past and present. A UNESCO/ALESCO/UIS Workshop, Muscat, Oman (Project under Progress), UNESCO, Cairo Office.

Schiffler M. 1998. The economics of groundwater management in arid countries: Theory, International experience and a case study of Jordan. GDI book series, 11. Frank Cass Publishers, London.
Smakhtin, V. 2008. Basin closure and environmental flow requirements. International Journal of Water Resources Development 24: 227–233.

Thivet G. and Blinda, M. 2008. Improving water use efficiency for facing water stressed and shortage in the Mediterranean. Plan Bleu, Sophia, Antipolis.
Thompson, J. 2001. Private sector participation in the water sector: Can it meet social and environmental needs? International Institute for Environment and Development WSSD Briefing Papers, http://www.iied.org/pubs/pdfs/11004IIED.pdf (accessed 7th October, 2008).

UNDP (United Nations Development Programme), 2008. Human development report 2007/2008. United Nation Development Programme, New York.

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2001. The state of science and technology of the world. UNESCO Institute of Statistics, Montreal, Canada.

United Nations, 2006. Water: A shared responsibility. World Water Assessment Programme, World Water Development Report 2, UNESCO, Berghann Books and UN-Water, UNESCO, Paris. http://unesdoc.unesco.org/images/0014/001444/144409E.pdf

WHO/UNICEF, 2008. MDG assessment report. Joint Monitoring: Programme for Water Supply and Sanitation. http://www.wssinfo.org/en/40_MDG2008.html

World Bank, 2003. Better governance for economic development in the Middle East and North Africa: Enhancing inclusiveness and accountability. Washington, D.C.
World Bank. 2007a. Making the most of water scarcity: Accountability for better water management results in the Middle East and North Africa http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/MENAEXT/

World Bank. 2007b. Emerging public-private partnerships in irrigation development and management. http://siteresources.worldbank.org/INTWSS/Resources/WS10_txt.pdf (accessed 2nd October 2008)

World Water Forum.2006. Middle East and North Africa Regional Report. Fourth World Water Forum, Mexico City.
Zekri, S., Kotagama, H. and Boughanmi, H. 2006. Temporary water markets in Oman. Agricultural and Marine Sciences 11 S.I., 77-84.

Zubari, W. 2008. Gulf drops. Water issues and challenges in GCC countries. Science and Water Technology Society. Arabian Gulf University, Manama, Bahrein, 421 p. (in Arabic).