Water for the 21st Century: Vision to Action

Framework for Action For North Africa

The Framework For Action – North Africa is part of the Framework For Action for the Mediterranean: Achieving the Vision for the Mediterranean (FFA).

The FFA aims to offer a framework action programme for achieving the "sustainable" scenario described in the Mediterranean Vision on Water, Population and the Environment (Vision). Within the elaboration of the FFA, three sub-regional FFA were prepared on: North of the Mediterranean, Mediterranean Islands and North Africa.

The FFA for North Africa was developed by CEDARE and coordinated by the Mediterranean Water Network (MWN) with contributions from a group of experts.

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INTRODUCTION:

Freshwater in the North African Region receives the first priority on the list for environment and development. Among several factors shaping the status of freshwater in the region, water scarcity, and Integrated Water Resources Management (IWRM) are identified as two issues of primary concern. The North African region is characterized by its arid and semi-arid conditions which is prevailing except for the northern strip. The middle and southern portions of the North African countries lie in the Sahara desert of Africa. Limited water resources in this region is an overwhelming condition, however there is still considerable room for sustainable development of water resources provided IWRM is adopted and implemented. The availability of fresh water resources is jointly governed by hydro-climatological features as well as population densities and geographic distributions. Other important parameters in defining the status of water resources include water quality, accessibility, and reliability of water supply. An essential distinction has to be made between the potential yield and the water development potential. The former refers to the availability of water resources whether it is surface runoff, groundwater, or directly utilized atmospheric water. The latter takes into account the dependability of the flow, time and spatial distributions, feasibility of extraction, and the availability of water after floods, navigation considerations, environmental and aquatic life minimum requirements. This portion refers only to the manageable part of the natural resource, which is often complicated and difficult to identify in an objective manner. Moreover, a distinction has to be made between abstraction and consumption of freshwater. Abstraction refers to the total amount of water which is withdrawn from the freshwater resources to satisfy various demands, while consumption refers to that portion of withdrawals which does not return back to the water resources.

By 2030, chronic water scarcity will affect more than three billion people in 52 countries all around the world. The demand for freshwater is escalating along with populations and economies, while sources of water are being rapidly degraded and depleted. Inequalities in the distribution of water supplies are also aggravated by inefficient management of water resources. In consequence, human welfare, ecological health and economic potential suffer. Under certain conditions, water scarcity threatens nation security (Chou et al 1997). A status of water stress occurs when the average annual share of an individual is less than 1700 m^3 of renewable freshwater (inclusive of all diversified water uses; drinking, industrial, agricultural, domestic, energy, navigation, etc.). Water scarcity conditions prevail when this share drops below 1000 m^3. Water scarcity poses a threat to national security when values like sovereignty, territory, food productivity, public health, economic prosperity, and cultural identity, are seriously affected. While security problems have the potential to lead to violence, they may also act as a stimulus for cooperation.

The North African region is dominated by arid climatic conditions which express the physical constraint for water availability. Desert conditions prevail throughout the region except for the narrow coastal strip along the Mediterranean shoreline.

As of the 1990s, most countries of the region started to realize that the business as usual scenario of dealing with water management and water security issues is no longer suitable to cope with future challenges. A gradual shift to integrated water resources management (IWRM) is being initiated throughout the region with variable

levels of implementation. The former issue has gained a unanimous acceptance during the Second World Water Forum (The Hague 2000) and is reflected through the World Water Scenarios (World Water Council 2000).

The document in hand presents a Framework For Action (FFA) for North Africa that paves the way for the implementation of IWRM. It covers key issues and challenges, strategies for avoiding water crisis and for the preparing for the transition to IWRM, then the way forward for the FFA.

CHARACTERISTICS OF THE SUB REGION

Demography

The North African region includes from east to west the countries of Egypt, Libya, Tunisia, Algeria and Morocco with total area of 5.76 million km^2 excluding the Western Sahara. Egypt lies in the north-eastern corner of the African continent, with a total area of about 1 million km^2. The surface area of Libya is 1.75 million km^2 extending from the Mediterranean in the north to the Tibesti mountains in the south covering a great part of the Sahara desert. Tunisia extends from the Mediterranean coast in the north to the Sahara desert in the south and its total surface area is 164,150 km^2. Algeria, with a surface area of 2.4 million km^2, is the largest country in Northern Africa. The area of Morocco is 446,300 million km^2 excluding the Western Sahara.

In most of the of the North African countries, around 50% - 90% of the population are concentrated along the Mediterranean coast due to the harshness of the nature in the Sahara desert.

The population in Egypt was approximately 63 million based on the result of 1995 census. The growth rate is 2.1 %. The population is unevenly distributed. It is mostly condensed in the Nile Valley and Delta (4% of the total area) with a density of 1,492 inhabitants /km^2 compared to an average density of 63 inhabitants /km^2, representing an area that is among the highest in population density in the world. 55% of the population live in rural areas, the urban population is concentrated in the large cities of Cairo, Alexandria, Giza, Aswan, Port Said and Suez having 1/3 of the total population. Housing problems in Cairo is typical with a gap between 1.44 million available and 2 million required units. The difference is either covered by illegal settlements.

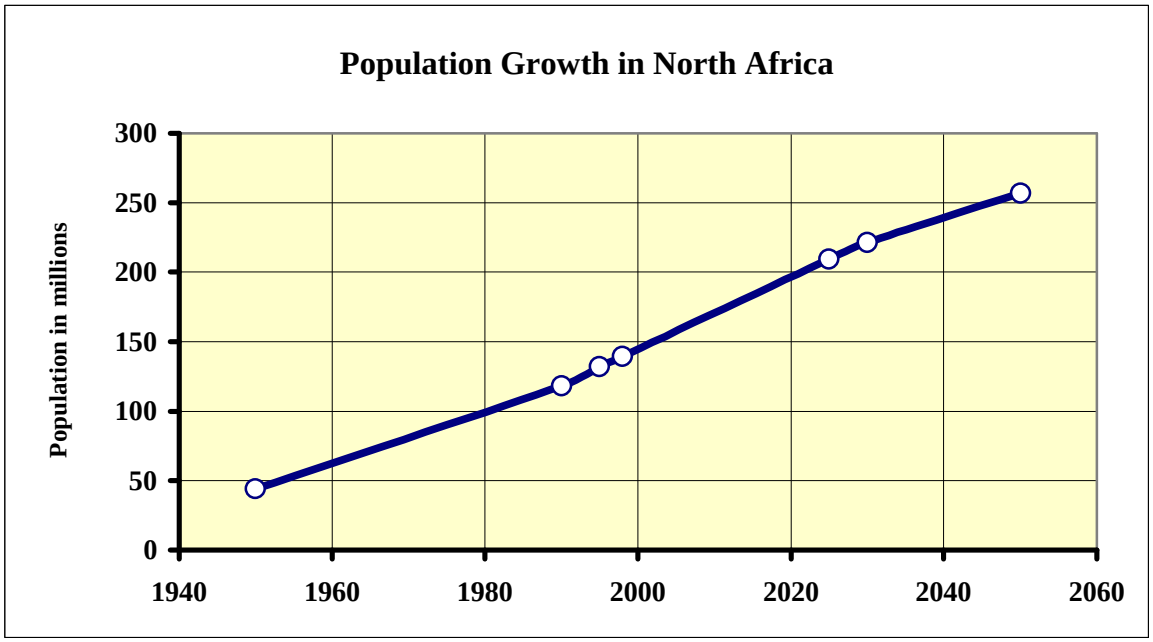
The Libyan population is 4.8 million according to the census conducted in 1995. There was a decline in the growth rate of population from 4.2% for the period 1973-1984 to 2.8% for 1984-1995. More than 80% of Libya's population live in a narrow strip along the Mediterranean coast. Libyan population is expected to reach 11.7 million in 2025.

The Tunisian population is about 9.2 million of which 50% are concentrated in the coast in urban and industrial areas; 37% of the population live in rural areas (compared to 60%, 35 years ago). The Tunisian population is expected to reach 13 and at most 16 million by the year 2030 depending on the demographic growth rate, respectively 1 or 1.7%.

The population in Algeria is 29.27 million inhabitants according to the 1998 census. More than 90 % of the population lives in the North of the country, that includes a coastal band along the Mediterranean Sea, plains, mountains, and high lands. The annual demographic growth rate was 3.06 % for the period 1977-1987 and 3.21 % for the period 1966-1977, and 2.28 for the period 1987-1998. The rate of the urban population has increased from 56.1 % in 1966 to 80.8 % in 1998. Five wilayas (Algiers, Setif, Oran, Tizi Ouzou and Batna) regroup more than the quarter of the

population. Apart from Algiers, there is a relatively important number of cities, in the north of the country, where population exceeds 50,000 inhabitants.

The population in Morocco in year 2000 was 28.7million, 15.8 million of which were urban and 12.8 million were rural. The estimated projection of population is 33.2 million inhabitants by year 2010. 62.3 % of which are expected to live in the urban areas, and 37.7 % in the rural areas. The population is expected to reach 38.9 million in year 2020. 68.7% in the urban areas and 31.3% in the rural areas.



Rainfall

In Egypt the rainfall occurs only in the winter months in the form of scattered showers amounting to 1.5 billion m^3/year that varies between 0 mm in the desert to 200 mm in the Mediterranean coast with an estimated overall average of 18mm. Egypt has no effective rainfall except in a narrow band along the Mediterranean coast. Therefore all the agriculture is essentially dependent upon irrigation. More than 95% of the irrigation water is supplied from the Nile. Some limited renewable and non-renewable groundwater resources are found in the Nubian sandstone of the western desert and in Sinai.

In Libya the highest rainfall occurs in its north western region (Jabal Nafusa and Gefara plain) and in the north eastern region (Jabal Akhdar), where the average yearly rainfall exceeds the minimum values (250-300mm) necessary to sustain rainfed agriculture. Rainfall average is less than 100 mm per year over 93% of the country's land surface.

In Tunisia the climate varies from Mediterranean to semi-arid and arid; it is characterized by hot and dry summers and mild winters receiving the major part of the annual precipitation. Total rainfall and distribution is highly variable from year to year and from North to South. Average annual rainfall is around 594 mm in the North, 289 mm in the Center, and 156 mm in the South; it is ranging from 1500 mm in the extreme North to less than 100 mm in the extreme South. Mean annual rainfall values

can be exceeded by factors of two to twelve during short and intensive rainfall events producing runoff and causing soil erosion (695 to 6050 tons per km^2 / year). On the other hand, one year out of two may be dry and unpredictable successions of dry years may seriously worsen the situation. The annual precipitation in Tunisia is on average equal to 37 billion m^3 and is ranging from 11 to 90 billion m^3. Water deficit is particularly significant from May to October. The annual evaporation varies between 1300 mm in the north to about 2500 mm and even more in the south.

In Algeria the annual amount of rainfall in the North varies between 300 and 1000 mm. In the Sahara and south the Saharian Atlas, the annual amount of rain is below 100 mm.

In Morocco the average annual rainfall is about 340 mm varying from more than 450 mm in the north to less than 150 mm in the southeast. More that 50% of the rainfall occur over 15 % of the country's area.

Water Resources Development

Surface water

In Egypt, based on the agreement signed between Sudan and Egypt in 1959, Egypt has an allocation of 55.5 billion m^3 /year calculated on the average flow of the Nile in the period between 1900-1959 which was 84 billion m^3 /year at Aswan. The average annual evaporation and other losses from the High Dam lake were estimated to be 10 billion m^3 /year, leaving a net usable annual flow of 74 billion m^3 /year, of which 18.5 billion m^3 /year was allocated to Sudan and 55.5 billion m^3 /year to Egypt. Internal surface water resources are estimated at 0.5 billion m^3 /year. This comes up to 56 billion m^3 /year as a total.

In Libya, the surface water resources are limited and contribute only a small amount to the total water consumption. The total average runoff for the northeastern and northwestern areas is estimated to be in the order of 200 Mm^3/ year. Under natural conditions (without dams) the runoff water is partly evaporating and partly infiltrating in the spreading zones and this explains why so little water is usually reaching the sea. Even assuming that 50% of the runoff can be intercepted this makes an additional of 100 Mm^3/ year. The total quantity of water recoverable from the surface reservoirs probably will not exceed 40 Mm^3/ year representing the exploitable runoff water resources.

In Tunisia, total annual rainfall is not sufficient to provide a year-round water source for agricultural crops and to satisfy other requirements. Hence, reservoirs, water transfer systems, and other hydraulic structures such as floodwater diversion are important to store rainwater and fill the gap between rainy and dry years. Many of these structures have already been completed. Others are under implementation or planned in order to store most of the potential surface water. 2.1 billion m^3 may annually be stored in large dams, hill-side dams and hill-side lakes and the remaining 600 Mm^3 through water and soil conservation techniques (DGRE, 1990). The existing 19 dams currently allow for 1.4 billion m^3 of utilizable surface water per year. The net development rate of surface resources is 52%. With the construction of

projected 24 dams, a total useful volume of about 2.1 billion m^3 in year 2010 will allow the storage of 78% of potential surface water resources.

Furthermore, surface water is the most affected by variability in space and time. Such variability requires specific strategies and tools for surface water management in terms of capacity for inter-annual regulation, especially with the reduction in available capacity due to silting (5 to 10% per decade), and water losses by evaporation (1 to 2 m per year). Existing reservoirs are therefore integrated into a complex hydraulic system. Owing to the interconnections, interregional transfer and spatial redistribution of water are feasible. Water is piped and conveyed over long distances from inland to the coastal areas (150 km) or from north to south (300 km) through systems of open canals (Canal Medjerda-Cap Bon) and pipelines, reservoirs, and pumping stations. This is to supply the coastal cities with drinking water and to preserve some agricultural regions such as the Cap Bon.

The salinity of 72% of surface water resources is less than 1.5 g/l (Kallel, 1995) and may be used without any restriction. Dam reservoir salinity depends upon rainfall and seasons. Water is stored for various uses, which depend on the water quality. Some of these are multiple purposes dams such as for potable water supply, irrigation, groundwater recharge, and/or flood control.

Other smaller structures have been implemented to store surface water: hillside-dams and hillside-lakes. These are essential for flood control and soil and water conservation and also contribute to groundwater recharge. They may also lengthen the expected life of the larger dams by reducing reservoir silting. In total, 66 hillside-dams (plus 45 under implementation) and 392 hillside-lakes (with a capacity varying from 3300 to 500 000 m^3), mobilizing 77 Mm^3 /year and around 37 Mm^3 /year, respectively, are already in operation. In the next century, 203 hillside-dams and 1000 hillside-lakes will be in operation. 30% of the volume mobilized by the hillside-lakes should contribute to groundwater recharge and 70% to fulfill local water requirements. Totally, 23 Mm^3 /year mobilized through floodwater diversion structures are actually used to irrigate 13,100 ha. These structures are mainly located in the central and southern part of the country. They are used to recover 47 Mm^3 /year.

In Algeria, there are 17 major hydrographic basins. Algeria also shares the Medjerda basin with Tunisia, and Tafna, Draa, Guir and Daoura basins with Morocco. The annual amount of rain is 100 billion m^3, of which 80% evaporate into the atmosphere. The available renewable water resources are estimated at 19.1 billion m^3/year, of which 12.4 billion are surface water and 6.7 billion are groundwater.

In Morocco, transboundary out going surface flow to Algeria is estimated at 0.3 billion m^3/year. Internal renewable water resources are estimated at 30.0 billion m^3/year. The total actual renewable water resources (ARWR) is considered also 30.0 billion m^3/year as of 1995 where the total population is projected to be 27 million inhabitant, thus generating a per capita share of ARWR of 1110 m^3/year. The available resources representing water development potential is estimated at 21 billion m^3/year out of which 5 billion m^3/year is attributed to groundwater, and 16 billion m^3/year is surface water which needs regulation by dams. The total dam capacity in 1990 is about 11 km^3 corresponding to 34 operating dams. The total annual

freshwater withdrawal is 11 billion m^3/year (436 m^3 /cap/y) as of 1991, and divided as follows:

- 92% agriculture,
- 5% domestic uses, and
- 3% industrial uses

Of the 11 billion m^3/year of fresh water withdrawal, 7.5 billion m^3 /year is attributed to surface water and 3.5 billion m^3 /year is extracted from groundwater. The total water managed area in 1989 is 1.26 million ha representing only 17% of the cultivated area. The irrigation potential based on water development potential is estimated as 1.65 million ha. The annual hydroelectric production in 1991 was measured as 1,500 GWh contributing to 30% of the national energy production. In 1990, 0.23 billion m^3/year of water is used for hydropower and 150 billion m^3 /year for environmental protection (wadis). The water supply coverage as of 1990 is assessed as 100% in urban communities and 18% of rural population.

Shared Rivers

The Nile Basin with Egypt the downstream country is the second largest river in the world and is shared amongst ten African countries - Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. The Nile River Basin serves as home to an estimated 160 million people within the boundaries of the Basin, while almost twice that number, roughly 300 million live within the ten countries that share the Nile waters. Its ecological system is unique, hosting a number of varied landscapes, with high mountains, tropical forests, woodlands, lakes, savannas, wetlands, arid lands, and deserts. Population is expected to double within the next 25 years, placing additional strain on scarce water and other natural resources. Yet, cooperative development of the River Nile's resources holds significant opportunities for maximizing benefits from the river's resources.

The Nile Basin Initiative

The Nile Basin Initiative, launched in February 1999, is a regional partnership within which countries of the Nile basin have united in common pursuit of the long-term development and management of Nile waters. The Initiative is developing an agreed basin-wide framework and is guided by the countries' Shared Vision "to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources".

Groundwater

In Egypt, there are two sources of groundwater; the Nile Valley and Delta aquifer composed of quaternary and late Tertiary sediments. It is recharged from irrigation and drainage system seepage, and therefore its quality depends mainly on the drainage water and irrigation water quality. The capacity of the Nile aquifer is 600 billion m^3 but only 7.5 billion m^3 is rechargeable live storage.

The other major aquifer is the Nubian Sandstone Aquifer extending in the western desert of Egypt and across borders with Libya, Sudan and Chad. This aquifer is non-renewable with unconfined conditions in the south below latitude 26 and confined

northward. Development in Kharga, Dakhla, Farafra, Bahareya, Siwa, and Oweinat depends on groundwater resources of the Nubian aquifer which is the only source of water in the western desert. Abstraction from the Nubian aquifer in Egypt as of year 1998 is estimated at about 900 Mm^3/year.

In Libya, groundwater accounts for more than 97% of the water in use. Starting from the early sixties groundwater extraction rates accelerated rapidly to meet the growing water demand. Groundwater resources can be broadly divided into renewable and non-renewable. Renewable groundwaters occur in the northern aquifers of the Gefara plain, Jabal Akhdar and parts of Hamada and central coastal areas. Non renewable groundwaters occur in the great sedimentary basins of the Kufra, Sarir, Murzuk and the Hamada. (Bakhbakhi and Salem, 1999)

In Tunisia, the groundwater resources are about 1.97 billion m^3 of which 650 Mm^3 non renewable and located in the South (DGRE, 1997b). 1250 Mm^3 are in deep aquifers (267) and 719 Mm^3 in shallow ones (212) (Hamza and Khanfir, 1991). Their net rate of development is 93%: 86% from 2400 tubewells pumping the deep aquifers (about 85% of the tubewells are 100-400 m deep) and 106% from 123000 shallow wells (less than 50 m deep) (DGRE, 1997a). This number of wells was 60000 in 1980. In total, 59 Mm^3/year are provided by springs. Water pumped from shallow aquifers is mainly used for irrigation and to a less extent for drinking purposes. Deep groundwater is used for agriculture (74%), for potable water supply (18%), industry (8%), and tourism in the arid and semi-arid parts of the country where surface water is lacking. Water is sometimes transported several kilometers to supply cities such as Sousse, or Sfax. Groundwater resources are exposed to various types of pollution and deterioration, increasing their vulnerability and scarcity. Shallow aquifers are already over-tapped. Groundwater resources in coastal regions (Cap Bon, Sahel, and Mareth) and in the vicinity of chotts (Nefzaoua and Jerid) suffer from salinization problems due to seawater or saline water intrusion. As a result, the quality of these aquifers has deteriorated considerably. Pollution of some shallow aquifers by nitrates constitutes also a major risk for domestic requirements. Generally, deep aquifers composition is rather stable over the year while the shallow aquifers' one depends on location and season and is often salt-affected. Therefore, salinity of 8% of the shallow aquifers is less than 1.5 g/l, 71% are ranging between 1.5 and 5 g/l, and 21% are above 5 g/l. In the deep aquifers, 20% have a salinity of less than 1.5 g/l, 57% are between 1.5 and 3 g/l and 23% are above 3 g/l (Mamou, 1993). In the south, there are three main fossil aquifers with different water qualities (1-7 g/l) which are already under development.

In Algeria, the safe extract of non renewable fossil water is around 3.5 billion m^3/year.

In Morocco, The groundwater availability is estimated at 5 billion m^3/year. In 1990 the total number of wells in rural areas is 236,000 corresponding to 1 well per 50 inhabitants of which 91% where supplied through wells, 8% through springs, and 1% through surface water. However, about 82% of the water points are delivering non-potable water.

Shared Aquifers

There are two major shared aquifer systems in North Africa, namely the Nubian Sandstone Aquifer System and the North Western Sahara Aquifer System.

The Nubian Sandstone Aquifer System (NSAS) located in North East Africa is shared between Egypt, Libya, Sudan and Chad. The aquifer underlies an area of approximately 2.2 million Km^2, 828,000 km^2 of which in Egypt, 760,400 km^2 in East Libya, 235,000 km^2 in North Chad and 376,000 km^2 in North Sudan. The four countries sharing the aquifer have established a "Joint Authority for the Study and Development of the Nubian Sandstone Aquifer". The groundwater management officials of the four concerned countries are the members of this Joint Authority whose mandate is to collaborate and develop co-operative activities for the development of the Aquifer. It also ensures transparency and exchange of information. A regional programme for the development of a regional strategy for the utilization of the aquifer was executed by the Centre for Environment and Development of the Arab Region and Europe (CEDARE), funded by the International Fund for Agricultural Development (IFAD) and the Islamic Development Bank (IDB).

The North Western Sahara Aquifer System (NWSAS) is shared amongst Libya, Tunisia and Algeria. The Sahel and Sahara Observatory (OSS) joined forces with the International Fund for Agricultural Development (IFAD) and the Food and Agricultural Organization of the UN (FAO) to develop a consultation mechanism for the management of the shared aquifer and to develop a legal framework for coordinating development activities of the NWSAS.

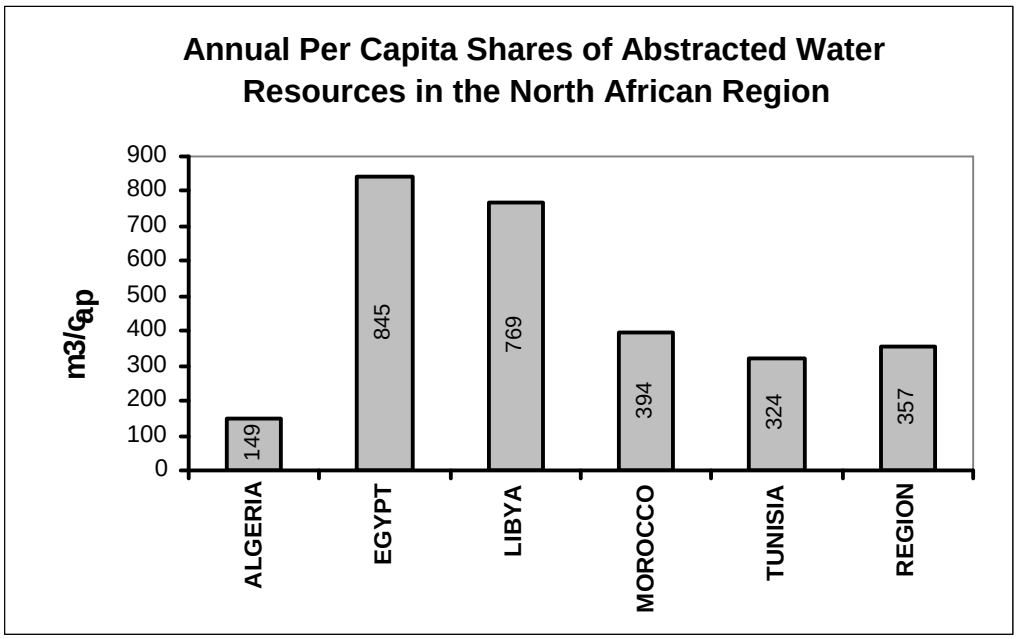
WATER BALANCE

	IN (billion m^3/year)				*OUT (billion m^3/year)*				*Beneficial Abstraction (billion m^3/year)*				
	Precipitation	***Runoff***	***GW***	***Sum***	***Runoff***	***GW***	***Sum***	***Evaporation + Unutilized water***	***Irrigation***	***Domestic***	***Industrial***	***Sum***	***Natural ET***
EGYPT	18.1	55.5	0	73.6	0	0	0	19.737	47.73	3.33	4.44	55.5	0
LIBYA	46.1	0	0	46.1	0	0	0	42.799	4.002	0.506	0.092	4.6	3.011
TUNISIA	33.9	0.6	0	34.5	0	0	0	26.157	2.706	0.277	0.092	3.075	5.267
ALGERIA	162.9	0.3	0	163.2	0.6	0	0.6	150.1	2.7	1.125	0.675	4.5	8
MOROCCO	150	0	0	150	0.3	0	0.3	114.303	10.161	0.552	0.331	11.044	24.356

(Source: CEDARE's Water Resources Assessment Model and Information System, 1999)

Annual Per Capita Share of Abstracted Water

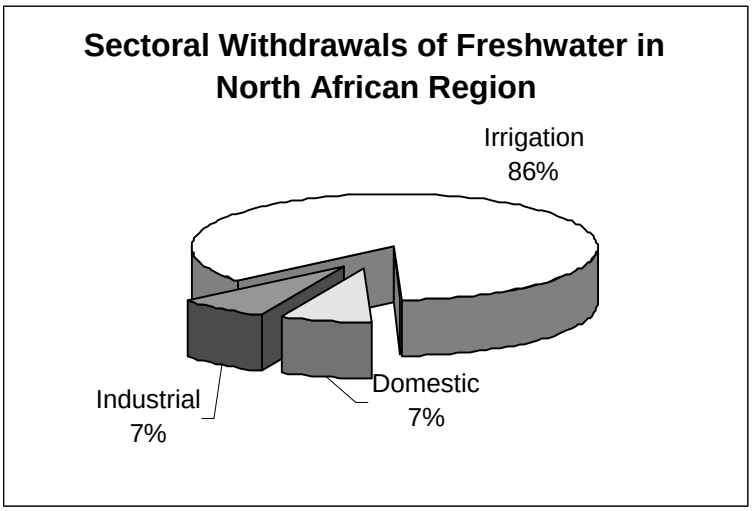
The annual per capita shares of abstracted water resources as of 1998 are shown in the figure below. The average per capita share in North Africa is 357 m^3 /capita/year.



(Source: FAO)

Sectoral Water Use

From the pie chart below it is shown that the agriculture sector in North Africa consumes 86% of the water resources whereas the industrial and domestic uses consume 7% each.



THE KEY ISSUES AND CHALLENGES IN NORTH AFRICA

The challenges in the water sector in North Africa could be identified under these broad categories:

1. Water Scarcity

Limited water resources in North Africa is an overwhelming condition. The region lies in the arid or semi-arid climate zones, where dry conditions prevail all over except for a narrow strip in the northern coast along the Mediterranean. A large portion of the renewable water resources originate outside the region (e.g. the Nile river). Groundwater storages are mostly non-renewable aquifers. As the region's countries are developing ones, agriculture is one of the major economic activities by most of the population. The agricultural sector consumes about 85% of the water resources use in North Africa. Due to scarcity and prolonged drought periods which are often practiced, farmers were urged to reuse drainage water for irrigation of crops. The rapid growth of population is overstraining the water resources in the region. Agricultural land is lost to urbanization. Consequently, threat is posed to food security. It is foreseen that the entire region of North Africa will suffer from water scarcity by year 2025. This will result in severe environmental, economic and social complications as well as its consequences on the political dimension.

The adoption of modern irrigation techniques, extensive reuse and recycling of wastewater, extended use of non-conventional water resources, modification of cropping patterns, and increased irrigation efficiency are the ways forward for resolving the water scarcity problem.

2. Lack of Accessibility to Water Supply and Sanitation

Access to clean and safe drinking water and sanitation has been identified as a fundamental right for every human being living on this globe. Scarcity of renewable water resources, lack of financial resources, and poverty, in general, have been major impediments towards securing this right. The problem maybe more illustrated in rural areas all around the world, and in this respect the North African region is no exception. In fact, the arid to hyper arid climate coupled with unfavorable economic conditions induces more challenges towards safeguarding a fair and clean share of potable water supplies.

Tremendous numbers of people in the region lack access to safe water and sanitation. This results in a number of water related diseases such as infant diarrhea, bilharzia, etc. In spite of attention given and the efforts done on the provision of water and sanitation services to the deprived, still much more is deemed necessary along this way. According to the current growth rates in the North African countries, the population would almost be doubled (or slightly less than doubled) by year 2025, therefore a serious challenge facing the governments would be to cope in its water and sanitation supply services with the population increase, particularly in light of the moderate economic development.

Attaining effective functioning of the water services available and the proper maintenance of water networks in urban areas is a further challenge.

3. Water Pollution and Environmental Degradation

Environmental degradation is a serious issue. Water contamination in the region results from urbanization and its associated impacts, and expansion of irrigation that is coupled with poor on-farm water management and lack of proper drainage systems. Sources of water contamination of surface water and groundwater in the region are primarily from one or a combination of the following:

- Inadequate waste treatment and discharge of untreated sewage and solid wastes into drains, canals, and surface water bodies
- Poor sanitation practices resulting in the leaching of untreated municipal wastewater from poorly maintained septic tanks, and other wastes disposal that seeps to groundwater
- Seawater intrusion in coastal aquifers due to overexploitation of groundwater
- Untreated industrial effluents, discharging into municipal sewer networks or directly into surface and groundwater
- Seepage from unproperly-designed landfill sites where solid wastes are dumped
- Seepage and runoff of agro-chemicals such as fertilizers and non-biodegradable pesticides

It is worth noting that these complications not only affect water quality severely, but have tangible influence on public health and environmental degradation in general. Water quality degradation results in; loss of agricultural land, water-borne diseases, economic overburden in groundwater remediation processes, migration of farmers to cities, increased unemployment rates, and shortage of clean water needed to sustain the ecosystem and meet future water requirements.

4. Management of Shared Waters

In light of the increasing water scarcity and the escalating water demand due to developmental activities and efforts done to increase the livelihood standards, conflicts over shared water resources would be a major problem to confront. This could result in instability, unless cooperation among riparians is profoundly adopted, and shared visions for development of shared resources are introduced.

Most of the region's water resources are shared with a number of countries. Egypt is sharing the Nile River with 9 riparian countries. Egypt and Libya are sharing the Nubian Sandstone Aquifer with another two African countries namely Sudan and Chad. Libya, Tunisia and Algeria are sharing the North Western Sahara Aquifer System. The political awareness in these countries have increased and they realized the necessity of regional cooperation. Within this context, advances took place on the level of institutional arrangements, bilateral and multi-partite coordination, frameworks for information sharing and experience exchange in addition to enabling the environment for the implementation of IWRM. In transboundary aquifers, these included the establishment of the Joint Authority for the study and development of the Nubian Sandstone aquifer and the regional project for developing a strategy for its utilization, as well as the consultation mechanism for the development of the North Western Sahara aquifer. In surface water resources, the Nile Basin initiative presents a model for regional cooperation and development.

Nevertheless, mechanisms should be developed to enforce the adoption and implementation of regional policies and strategies. Long-term cooperation would

certainly help minimizing disputes and reduce stresses of water problems in the region.

5. Food Security

Despite the population increase in North Africa, the expansion in the irrigated lands does not cope. Current cereal imports in North Africa amount to more than 20 million tons per year.

It must be noted that food security does not mean self-sufficiency. Food security is determined by the ability of a country to ensure that all people at all times have both physical and economic access to fulfill basic food needs. This definition has four dimensions for food security. These are: *Food availability* either from domestic production or/and imports, *Stability* of food supply within season and between seasons, *Accessibility* to all segments of the population through distribution systems and reasonable prices and food *Affordability*.

In light of the limited resources of the region, irrigation efficiencies should be improved, modern irrigation systems should be acquired, IWRM principles should be implemented, cropping patterns and food habits should be changed and regional food trade should be enhanced. A balanced understanding of the security problems of food and water supply must also be achieved.

6. Awareness of Decision Makers and the Public

Water is taken for granted by the public. This reflects on the consumption habits of people. Their ignorance of the water scarcity and water pollution problems discourages them from conserving water and managing it rationally. Hence, the public must be made aware of the magnitude of water problems and its impacts on their lives in the near future and on the long run.

Decision makers, though aware of the water crisis, should reform their way of thinking by adopting long term policies and IWRM plans, rather than reactions and response plans to crises and short term problems.

Making the public aware of the scarcity and pollution problems and involving them in the pollution prevention and management process paves the way for improved use-efficiency and quality of water. Close collaboration between communities and government agencies is imperative. Together they should get engaged in the processes of managing and learning about their water resources. Together, they can decide on the location and design of any pilot project, etc.

Hence, equitable access to water resources through participatory water governance, which includes supporting effective water users associations, involvement of marginalized groups and consideration of gender issues, is what needs to be promoted. A participatory communication strategy has to be developed and implemented to support IWRM.

7. Decline of Financial Resources Allocation

Due to global economic recession and financial difficulties faced by governments in order to balance budgets and reduce deficits, allocations of financial resources to irrigation and water supply projects were reduced. This decline is quite obvious on

the scale of overseas development assistance, and national fiscal plans. There is a trend for attracting and encouraging the private sector investments in the water sector, but a lot more needs to be done on this scale.

8. Skilled and Motivated Water Professionals

This is quite a complicated challenge. The capacity building programs of the government water professionals needs to be strengthened through enhanced training programs on the state-of-art approaches and techniques for IWRM. However a very common practice in Africa with particular reference to North Africa, is that due to low financial income, skilled professionals look for more compensating job opportunities outside government institutions and sometimes beyond the border of their countries. Therefore a system of incentives and motivation strategies should be designed for retaining of trained and skilled water professionals.

Another challenge is associated with new development areas and retaining new settlers after preparation of water infrastructures and new communities.

9. Institutional Aspects and Fragmentation of Water Management

At national levels the water management is divided among a number of jurisdictions, municipalities and the private sector; or worse, left unattended. This institutional chaos has led to competition among users, conflicts, duplication of efforts and contradictory policies, plans and actions. Consequently, this has perpetuated wastage of resources, and usage deficiency; further exacerbating allocation inequity and hindering attempts at coordination. Therefore it is both essential and mandatory that institutional policies, strategies and legal frameworks be harmonized and coordinated at some kind of centralized level.

Successful implementation of water projects depends on having strong and stable institutions capable of designing, implementing, monitoring and evaluating coordinated activities. The institutional weakness and malfunction are main causes of ineffective and unsustainable water resources management. With the increasing competition among water uses, the operating institutions become paralyzed in playing the effective role towards achieving the balance between the requirements and the available resources.

10. Sustainable Management of Non-renewable Groundwater Resources

As the largest portion of North African countries lack surface water resources, they intensively depend on their groundwater resources which in some cases are non-renewable. In Libya, the non-renewable groundwater resources are 78% of the total water resources of the country. In Tunisia, 33% of the groundwater resources is non-renewable. The rational utilization of non-renewable groundwater and the protection of groundwater quality is quite a complicated problem to sustain future generations. There is no clear answer to this sustainability question. Rational utilization and pollution prevention are the real challenges and the only answers to such question.

THE WATER VISION

"A peaceful future where socially, economically, and environmentally sensitive water allocation and management underpin people's well-being with secure and equitable access to safe water for everyone." (Source: Bari, MENA Water for Food Consultation Meeting, May 1999)

"The Water Vision for Africa is one in which there is an Equitable and Sustainable Use of Africa's water resources for poverty alleviation, socio-economic development, regional cooperation, and for the environment." (Source: African Water Vision)

North Africa is part of Africa, the Mediterranean region, and before all of the whole World, therefore the Water Vision for North Africa is derived from the African Vision, the Mediterranean Vision, and the World Water Vision. Main aspects pertaining to the North African Vision are:

- *Sustainable access to safe water and sanitation for everybody*
- *Equitable use of water resources for socio-economic development and poverty alleviation*
- *Developing water resources for food security of the region*
- *Ensuring enough water for sustaining ecosystem*
- *Water as a basis for reversing potential conflict to cooperation potential*
- *Water for improving health conditions of mankind*

A comprehensive integrated development plan designed to address key social, economic and political issues and including Integrated Water Resources Management in a coherent and balanced manner is needed for governments to leap over the water crisis and stretch to the future.

STRATEGIES FOR AVOIDING WATER CRISIS (HIGH PRIORITY SHORT TERM ACTIONS)

Wastewater Reuse

Reuse of collected and treated wastewater is the most reasonable approach to augment the gaps in the water demand and supply of the region. More than any other action, wastewater reuse is the appropriate means for avoiding the water crisis. It is also the most appealing option for most of the countries because it is renewable and even increasing with the increased urbanization and developments in the sewage services. In this regard, national policies incorporating wastewater management and reuse should be adopted by governments. Operating institutions to implement the wastewater reuse programs should have the capacity in terms of waste disposal, water pollution control, and monitoring facilities.

Conjunctive Use of Surface and Groundwater Resources

Conjunctive use is one way in which water demands can be met. Conjunctive use in its broadest sense is the utilization of multiple sources of water with different characteristics. The classical example of conjunctive use usually pertains to the use surface and groundwater. Conjunctive use provides a resource that can be applied to non or poorly irrigated, undeveloped or new lands. It could provide water to meet the peak crop requirements that exceed the available supply. Conjunctive use facilitates flexibility in the release patterns from the surface supply system and timing of water distribution. It helps a great deal in achieving water conservation, plus it could provide vertical drainage, obviating the need for extensive tile drainage systems and expensive works required for the removal of drainage water. It is possible that the development of groundwater in a conjunctive use scheme can provide an additional benefit in that it may lower the water table and provide a degree of drainage that leads to the alleviation of water logging problems and controlling the soil salinization phenomena.

There are more than one scenario that can be applied for conjunctive use management. These include inter-annual (between the years) schemes, where during periods of above normal flood yields, surface water is utilized to the maximum extent and also artificially recharged into the ground to augment groundwater storage and raise groundwater levels. Conversely, during periods of low flood yields, limited surface water resources are supplemented by pumping groundwater. Providing there is a long-term balance, the aquifer can be over-pumped in years of short surface supply, recharged and allowed to recover in years of abundance. The second possible scenario is the intra-annual (within the same year) or seasonal development schemes, where surface water is used whenever available and groundwater is used to supplement surface water during periods of peak water requirements.

Conjunctive use could be approached with a variety of methodologies. The choice is dependent upon objectives, water resources and amounts, and available funds. Management by conjunctive use requires physical facilities for water distribution, artificial recharge, and groundwater pumping. It requires reliable data on surface water resources, groundwater resources, geologic conditions, water distribution systems, water use, and water quality. Conjunctive use of surface and groundwater is widely applied in Egypt, Tunisia, and Morocco.

Artificial recharge for groundwater protection and storage - Tunisia

Artificial groundwater recharge is practiced for groundwater protection and underground storage of surface water in rainy years. From 1992 to 1996, 25 aquifers were concerned by recharge practiced in river beds, quarries, using infiltration basins or through well injections. 262 Mm^3 have thus been recharged plus 22 Mm^3/year through water and conservation structures. Recharge increased underground water levels (from 1 to 5 m) and improved the chemical water quality (DGRE, 1997c).

(Source: Country FFA for Tunisia)

Drought Management

Pre-planning is imperative to drought mitigation. Reliable data collection, analysis and dissemination is essential for developing national drought plans. Measures necessary in response to projected shortfalls for various drought events should be adopted. Comprehensive drought contingency plans and studies as well as drought mitigation tools/initiatives should be put. Within the frameworks of plans, drought indices should be defined and hydro-meteorological preconditions should be delineated in order to identify the drought severity and set the appropriate measures. These drought management plans should comprise the following sequential measures:

- Drought prediction
- Minimization of drought impacts
- Mitigation of drought impacts
- Compensation

The first set of measures is applied as a drought preparedness action in an attempt to avoid the crisis, and is usually achieved by means of monitoring of climatic and hydrological parameters. The second and third sets are applied during the drought period to minimize and mitigate its impacts. The fourth set of measures is applied to compensate the effects of the drought.

Frequent droughts hit Tunisia, Algeria, and Morocco. Morocco adopts a drought management and mitigation plan.

Increasing Water Use Efficiency

One of the reasons why farmers use water inefficiently is due to subsidy. Subsidies should be removed. Cost recovery of operation and maintenance services should be implemented. This, together with increased awareness and the use of low water consumption irrigation techniques will, undoubtedly, increase the water use efficiency.

Modernising Agriculture (Measures to enforce appropriate cropping pattern)

The irrigation sector will have to face new challenges with the new scenario of agricultural trade liberalisation. Food strategies might change by re-allocating water

resources to the production of high added value export products instead of the traditional water consuming low-value crops. This in fact contradicts with the food security concepts of governments. Adoption of balanced strategies is required.

Efficient Management of Distribution Networks
This requires efficient management of irrigation and drainage networks. It also includes monitoring of municipal networks for leak detection and repairs

Rehabilitation of the drinking water networks - Algeria

The Ministry of Equipment had launched in 1993, with the help of the World Bank, the idea of a diagnostic and rehabilitation of the drinking water networks of the eleven main cities of Algeria (Algiers, Oran, Annaba, Constantine,...) This project, includes the following elements:

- Complete diagnostic of the networks,
- Improvement of the network efficiency so as to reach, after for or five years an efficiency of 80 %
- Commercial assistance to the distribution enterprises, so as to reduce the rate of the unaccounted-for-water
- Economic incentives: the contract receives a payment proportional to the reduction of unaccounted-for-water
- Training for the staff of these enterprises in order to allow them at the end of the project to continue the efforts

(Source: Country FFA for Algeria)

Legislation Enforcement
The legal frameworks governing development and preservation of water resources are in place in most countries. However, enforcement of regulations is seriously hindered. Legislation enforcement is of prime importance in many aspects. It would contribute to the conservation of water quality and quantity. It would also help in regulating the utilization of groundwater resources.

Pollution Abatement
Pollution prevention should be prioritized, because it is normally more cost effective than the restoration of polluted waters. Water contamination in the region results from urbanization, poor on-farm water management, lack of proper drainage systems, water logging and soil salinization, industrial pollution, poor sanitation practices especially in rural areas, seawater intrusion in coastal aquifers due to over-exploitation, inadequate waste treatment, discharge of untreated sewage, solid wastes thrown into drains, and leachates from landfill sites, in addition to industrial pollution and absence of law enforcement. Water pollution abatement policies should be adopted to integrate the following:

- Promoting awareness of serious problems associated with water pollution at all levels; i.e. communities, decision makers and planners.
- Rational utilization of coastal aquifers to be governed by principles of wisdom.

- Adoption of proper solid waste management plans.
- Installation and good functioning of sewage systems to avoid pollution of surface and groundwater.
- Measures for monitoring industrial effluents.
- Extension of drainage networks.
- Enforcement of environmental and water protection laws.

Actions for industrial pollution abatement - Egypt

The Ministry of Water Resources and Irrigation of Egypt is responsible for issuing permits to industries to control discharges into the waterways. It is also responsible for setting regulations, standards and specifications for treated wastewater and receiving water bodies before discharge into surface water.
All new industrial communities are located in the new cities in the desert areas and provided with sewers; all new industries are equipped with new production technologies which have been developed for source reduction and recycling. In regard to the old industries, the government supports technology changes comprising production processes, equipment, layout, use of automation or changes in operating conditions which require heavy capital investments. Inspection and legal actions would be taken within the permitted period that was by the end of 1998.

(Source: Country FFA for Egypt)

STRATEGIES FOR PREPARING FOR THE TRANSITION AND IWRM

Water Resources Assessment

Many efforts have been exerted in the field of water resources assessment in the region. However, due to the complexity of the arid and semi-arid nature of the area and the variability in magnitude and distribution, pushes for more efforts for more reliable assessments. Also, the assumptions put and the hydraulic parameters estimated when groundwater resources are assessed play a big role in the obtained estimates of groundwater storages and availability values.

In light of these gaps and uncertainties, assessment of water resources is needed. Data on water resources availability, use, and quality should be collected and made accessible to all involved parties.

Within this context, the following are needed:

- Developing a yearly state of the water report for North Africa, in terms of quantity and quality for surface and groundwater resources, domestic, agriculture, and industrial uses, and water supply and sanitation average. This will provide a sound basis for water resources planning and management.
- Developing comprehensive monitoring plans. These should include monitoring of water resources quantity and quality as well as monitoring the variations caused by the climatic changes.
- Enhancing knowledge on the hydraulic parameters and aquifer characteristics for the assessment of renewable and non-renewable groundwater resources
- Evaluation of exploitable amounts of groundwater
- Calculation of safe yields for groundwater aquifers
- Assessing the environmental and the socio-economic impacts of water resources development plans
- Assessing the savings envisaged by the implementation of modern irrigation techniques
- Developing effective water information systems and updating them continuously

Non-conventional Water Resources

There is an immediate need for wastewater reuse to substitute good quality water for those uses that do not require it such as irrigation of green belts and others. Wastewater reuse may reduce the stress in place by overexploitation of aquifers where this occurs.

Actions to be taken for promotion and regulation of wastewater resue:

- Assessment of wastewater resources in terms of quantity and quality
- Adoption of plans for the extensive expansion in the wastewater reuse
- Promotion of wastewater reuse in landscape irrigation

Desalination of salt and brackish water requires:

- Assessment of brackish water resources in terms of quantity and quality
- Regulating the exploitation and utilization of brackish groundwater resources
- Designing schemes for conjunctive use of good and brackish waters

- Encouraging further research on development of low cost and affordable desalination techniques

Non conventional water resources - Libya

Contribution of the existing desalination and sewage treatment plants represents 39% and 32% of their installed capacity respectively; the production of these plants should increase to their installed capacity. If 50% of domestic water use is considered feasible for treatment, then by the year 2025, Libya should be able to produce around 500 Mm^3/y of wastewater, which could effectively contribute to the irrigation water supply. On the other hand desalination of seawater could offer the advantage of making almost unlimited amounts of water available, if costs were no constraints. (Bakhbakhi and Salem, 1999)

Mobilizing Political Will

Access to safe water is acknowledged as a basic right for everybody in the Convention on the Rights of the Child, promoted in the Water for People Vision 21 report, and emphasized on and coupled with access to sanitation in the Johannesburg World Summit on Sustainable Development.

Specialists and professionals are the only group of people who are well aware of water issues and problems. This awareness should be conveyed in an easy straightforward way to the public and at the political level. Awareness to the parliamentarians would play a major role in the formulation of wise water related policies.

Actions must be taken by everybody at all levels to achieve the Millennium Development Goals and World Summit for Sustainable Development targets which include:

- Halving people with no access to drinking water by 2015
- Halving people with no access to improved sanitation by 2015
- Develop IWRM plans including integrated coastal areas and river basin management (ICARM) plans by 2005

Governments must identify their challenges and adopt water related policies that suit their water status and achieve their water and food security.

Mobilizing political will need:

- Building awareness of policy makers on water problems
- Promoting change for adoption of water related policies through parliaments
- Managing the change

Capacity Building

In order to promote good water governance, it is of prime importance to develop training programs to water managers on water wisdom, concepts of IWRM, state of the art tools in water and information management. There is also a need for knowledge sharing, experience exchange and innovative technologies in water management. Besides, research should be directed to real needs with specific focus on water problems solving.

Public Awareness

There is a strategic need to build awareness and consensus of the public on the water problems and their roles in water conservation and protection. This could be achieved by developing advocacy and communications programmes for wide dissemination of information to multi-stakeholders through the media (TV, radio and newspapers), NGOs, associations, universities, youth organizations, schools and campaigns on water resources management, improved sanitation and their contributions to sustainable development.

Awareness on the importance of water, its scarcity, and the responsibility of everybody in the conservation of its quantity and quality should be promoted to children and youth in schools and universities by incorporation of such information in the educational materials.

Also, information should be widely disseminated on proven, low-cost and/or appropriate technologies for leak detection, lower water use appliances, recycling in industrial processing and efficient and modern irrigation techniques through publications and their dissemination in the printed media, as well as through radio and TV and other traditional means of communication.

The establishment of country water partnerships would also be very useful to disseminate awareness and technical information via various communication channels. Egypt will launch its Country Water Partnership in 2003.

Public awareness programs are widely applied in Egypt to preserve Nile water quality, and to rationalize water use.

Improving Knowledge of the Water Systems

Availability of data about water resources; surface and groundwater, is essential for the efficient design of policies related to the use and conservation of such resources. Efforts have to be made in order to harmonize data between the different structures in charge of water resources. This should be done by establishing reliable databanks that are regularly updated and shared amongst various water related institutions. The use of modernized telemetry systems for data collection and transmission would facilitate and make the information updating processes easier.

Institutional Reform

There is an actual need for the development of institutional frameworks for strengthening national and local institutions in the water sector, management of shared waters, strengthening river basin and aquifer management and empowering the institutional capacities in the implementation of IWRM and good water governance.

Decentralization of the decision-making processes, and the establishment of community-based organizations, private service providers and water users associations are key elements in the improved water management strategies.

Organization of the water sector - Morocco

La loi n° 10-95 sur l'eau, considérée comme bien public qui a été promulguée en Juillet 1995 constitue le cadre législatif a même d'assurer un développement rationnel et efficient des ressources en eau désormais considéré aussi comme un bien économique, basée sur l'intégration, la décentralisation , et la concertation de la gestion de ces ressources.

Les principaux apports de cette loi sont : (i)-la confirmation du rôle du Conseil Supérieur de l'Eau et du Climat en matière de concertation et d'orientation de la politique nationale de l'eau, (ii)-la décentralisation de la gestion par la création des agences de bassin (iii)-l'institutionnalisation de la planification à moyen et long terme des ressources en eau, (iv)-la mise en oeuvre du principe de l'unicité de la ressource en eau par l(interdépendance des ressources en eau de surface et souterraine, (v)-le développement de mesures réglementaires et financières pour la protection et la conservation quantitative et qualitative des ressources en eau, (vi)-l'institutionnalisation de la solidarité nationale et régionale et l'ouverture sur le secteur privé pour la gestion de l'eau, (vii)-le développement de la concertation en matière de gestion de l'eau au niveau local et régional.

L'ensemble de ces stratégies et mesures concourent vers une utilisation efficiente et efficace des ressources en eau par les différents secteurs usagers et une meilleure optimisation des investissements consentis en matière de mobilisation et de conservation des ressources en eau.

(Source: Country FFA for Morocco)

Water Demand Management

The water needs of the region, which for a long time had remained stable were covered exclusively by developing and using the water available in nature. Water policies should allocate considerable weight to the demand side rather than the *'business as usual'* supply management solely.

Water demand management should be promoted to improve water-use efficiencies before new water projects are implemented. Water demand from the point of view of uses is not always equivalent to the needs strictly determined by the necessities of the activities. It also depends on the means of uses and the condition of supplies. Water demand can be higher in case of wastage or lower in case of high application efficiency.

Actions to be taken within the demand management framework to reduce losses and leaks are:

- Diagnosis of drinking water supply networks
- Programmes for improving the efficiencies of these networks
- Installation of water saving irrigation methods such as drip irrigation and implementation of irrigation improvement projects such as canal lining
- Adoption of cost recovery approaches to improve water savings

- Promoting and expanding the establishment of water users associations, with support of governments in enhancing their managerial systems
- Governments should provide advisory services to farmers on crops, fertilizers, markets, modern irrigation techniques, etc.
- Empowering the coordination structures for water demand management
- Institutional reform of the water sector with more involvement of the private sector and community participation
- Modernizing the education and research systems to cope with the new challenges

Only recently it has been recognized in the region that water demand management is essential for achieving economic efficiency, social equity and sustainable development.

Improvement of irrigation efficiencies and use of efficient irrigation systems - Tunisia

Surface irrigation methods (75% of the irrigation systems) are applied with on-farm irrigation efficiencies of 50-60%. Upgrading of irrigation techniques and increase in irrigation efficiency have to be done as well as reduction of water losses in conveyance and distribution systems in order to achieve 70-80% on-farm irrigation efficiencies. Owing to the water scarcity, measures have been taken to convince the farmers to adopt more efficient irrigation techniques and methods. Incentives for acquiring irrigation water-saving technologies varying between 40 and 60% of the equipment costs have then been created as well as tax exemption for some imported hydraulic equipment. Research programmes related to improvement of irrigation efficiencies and use of efficient irrigation systems are also under development.
During the drought period of 1994-95, rationing and rotational deliveries achieved good control of irrigation demand and resulted in 30% reduction. Potable water supply was not affected, except a slight increase of the salt content without exceeding the standards. Surface water deficit was compensated by groundwater. Restrictions resulted in water-savings and a specific control and management of conveyance, distribution and storage networks. A drought management strategy is under study at the ministry of agriculture.

(Source: Country FFA for Tunisia)

THE WAY FORWARD FOR THE FRAMEWORK FOR ACTION (ACHIEVING THE VISION)

Development and management strategies

Development and management strategies should be developed with the aim of attaining good water governance. Water governance incorporates the wide range of political, social, economic and administrative systems that are in place to regulate the development and management of water resources and provision of water services at different levels of the society. Water-related strategies should aim at enhancing or reducing the detrimental effects on the environment and its natural resources.

Water resources policies and strategies plan - Egypt

Egypt has drawn up a 'Water resources policies and strategies plan' covering the period of 1997 to 2017 to satisfy all the water related ministries' policy and strategies (i.e. agriculture, industry, domestic use and others).. It is therefore essential for the 5-year national plans to cope with the main strategic plan. This plan was prepared by the Ministry of Water Resources and Irrigation. Additionally, the Ministry formed the North Sinai Development project and Toshka management Board to be in charge of all infrastructure works of these projects.

Egypt recent water policies and strategies are set to deal with water management sectors and users rather than with supply side. This is a substantial change in the policy approach. The water policy till 2017 is based on: 1) the management and the development of the existing resources in terms of quantity, 2) the Control of all sources of pollution and serious hazard, and 3) the development of new water resources by working closely with the upper riparian countries of the Nile Basin.

(Source: Country FFA for Egypt)

Enabling environment for IWRM

The North African region has started to create the enabling environment for IWRM including formulation of the legal framework governing development and preservation of freshwater resources, and the institutional framework for conducting such an approach. However, the level of enforcement of regulations and the appropriate operation of institutions are still subject to various constraints.

Regional Cooperation

Bridges for regional cooperation should be extended. Joint projects must be implemented for the development and management of shared water resources, including the Nile River, the Nubian Sandstone aquifer and the North Western Sahara aquifer.

Regional strategies for management of shared water resources in North Africa has been considered as a priority for the sustainable management of these resources. Regional cooperation, exchange of experiences and information sharing are prerequisites for the establishment of regional strategies.

Information on best practices and experiences should be disseminated among the region.

Regional programme for the development of a regional strategy for the utilization of the Nubian Sandstone Aquifer System (NSAS) - CEDARE

The NSAS is shared between Egypt and Libya together with Sudan and Chad. This programme was executed by the Centre for Environment and Development of the Arab Region and Europe (CEDARE), and funded by the International Fund for Agricultural Development (IFAD) and the Islamic Development Bank (IDB). Within the regional programme, which started in 1998, agreements were signed between the four countries for regular monitoring and continuous exchange of information. The capacity of the four countries was empowered for better management of the aquifer. Regional thematic maps, a regional mathematical model, and a regional information system were developed. Throughout the regional programme as well, the role of the Joint Authority for the Study and Development of the NSAS was revitalized. This programme which provides a model for management of transboundary water resources in general and shared aquifers in particular, enables the environment and paves the way for the utilization of the aquifer within principles of rationality and wisdom. Based on the national plans of the four countries and facilitated by the regional cooperation among the riparian states, a regional strategy for groundwater utilization was developed.

Stakeholders Participation

Sustainable water resources management can only be achieved through some sort of arrangement where water management responsibility for operation and maintenance is that of the stakeholders (mainly farmers). This will create a sense of "ownership" of water, thereby, ensuring stakeholders' active participation in protecting and maintaining the management system efficiently and minimizing conflicts and disputes in distribution.

However, close collaboration between communities and their government agencies is imperative. Together they should get engaged in the processes of discovering and learning about their water resources. Together, they decide on the location and design of any rehabilitation projects and other priorities.

Hence, equitable access to water resources through participatory and transparent management, including the support for effective users' associations, involvement of marginalized groups and consideration of gender issues, should be promoted.

Experience also shows that what works is partnerships between governments and stakeholders, with governments playing a vital role in creating the enabling environment, and in providing technical and enforcement support. Empowering community-based groups including women, the poor, and the youth to have an adequate voice in the participatory decision making is a necessary pillar of this approach. Enacting such an approach would see the role of government as 'enabler'

and 'regulator,' thereby increasing the flow of private investment and mobilizing community resources and labor.

New water policy based on stakeholder consultation and IWRM principles - Algeria

In 1993, the Ministry of Equipment, after an analysis on the situation of urban water and sanitation, initiated a large process of changes in the sector. After a consultation with the main concerned sectors (agriculture, industry, local authorities), a new water policy was adopted, based on four main principles: 1) water must be protected, in quantity and quality, 2) water is a collective resource, whose use is subject to an agreement between all the users, 3) water must me managed within a natural hydrological unit, the hydrographic basin, and 4) water is an economic good.

Also, hydrographic basin committees called "Parliaments of Water" were created. They have to assure consultation within the basin, and are composed, at equal parts, from representatives of the administration, local authorities, and the water consumers (associations).

(Source: Country FFA for Algeria)

Legislative Frameworks

Actions needed:

- Establishing and modifying the legislative mechanisms to define roles, specify responsibilities, and assure enforcement.
- Legislation on water rights and benefits must be included, especially to pursue strategies for integrated water resources development and management that take into account equity and the needs of the poor.
- Governments need to ensure the participation of all stakeholders in the process of creating new and modifying existing legislation.

Mobilizing Financial Resources

Actions are needed to mobilize all sources of funding, including public funding form general budget revenues, water tariffs and charges, international aid, and private investments to overpass the gap between current and required levels of expenditure.

There is a need to set tariffs that will recover costs from users that can afford to pay. Subsidies to any water-related activity should be reduced and finally eliminated if they are leading to inefficient use of water or causing negative impacts on the environment. This should be done cautiously without affecting the socio-economic value of subsidies.

There is also a need to develop appropriate regulatory arrangements, transparent contracting procedures, and reliable cost recovery mechanisms of operation and maintenance to make water projects attractive for private investments.

Restructure sector investments by reallocating a higher proportion of funds to affordable and appropriate sanitation projects in rural and low-income urban areas, where needs are greatest.

Research and Development

The expenditure on research and development in North Africa is very low compared to the total world expenditure on research and development. It amounts only to low percentage of GDP. Further, the distribution of the scientific resources and expenditure is uneven between disciplines and countries of the region. In order to make science effective in technology transfer and adaptation,

- The regional efforts should be linked to international centers of research to create a more beneficial platform for development better than the existing scattered weak systems.
- Research and development should be promoted on important issues such as water valuing, water sectoral reallocations, and legislative frameworks.
- More financial resources should be allocated for research and development in the region.
- Research centers have to integrate their work and experiences in order to avoid duplications
- A network of the research centers of water resources and irrigated agriculture in North Africa could be established to facilitate the exchange of experiences and dissemination of best practices within the region

Water Uses Reallocation

Inter-sectoral reallocations versus social stability, foreign dependency, and evolution into market economy should be considered. The sectoral water use in North Africa shows that agriculture uses up to 86% of water resources, domestic uses are 7%, and industry uses account for 7%. Employment in the agricultural sector (irrigated) accounts for 26% in Tunisia, and about 40% in Egypt and Morocco. Irrigated agriculture contributes 17% of national GDP in Egypt, and 13% in Morocco.

Integrated Water Resources Management in the North Africa

Issues	State	Pressures	Impact	Responses
Integrated Water Resources Management (IWRM)	• Hydrological management of water resources is not comprehensively integrated with national agronomic, economic, environmental and social management strategies. • Water supply management has been dominating national plans except recently (1990s) where most countries are shifting to demand management measures to confront escalating scarcity of resources. • Water quality and environmental concerns are lagging behind the efforts to augment the available quantities of freshwater. • The legal framework governing development and preservation of freshwater resources is in place in most countries. However, enforcement of regulations is seriously hindered. • The institutional framework for IWRM is in place in most countries. However, appropriate operationalisation of involved institutions is subject to various constraints. • Irrigated agriculture contributes 13% of national GDP in Morocco, 17% in Egypt.	• High rate of population growth, among the highest in the world, population doubled in 30 years for the region. • Need to develop, or to make available, additional quantities of freshwater to fulfill requirements of expanded agriculture, domestic and industrial supplies. • Global climate changes may pose threats to available water. • Lack of regulatory mechanisms to ensure enforcement of laws and regulations. • Fragmentation in institutions and authorities concerned with water resources management. • Inadequate wastewater treatment. • Proper capacity building for institutions is highly required. • Lack of funds required to finance the water sector. Conditional foreign assistance limits the anticipated benefits. • Inter-sectoral reallocations versus social stability, foreign dependency, and evolution into market economy. • Maintaining the equilibrium between urban and rural (agronomy dependent) development. • Economic instruments to	• Need to integrate, at **basin level**, hydrologic, agronomic, economic and social relationships into a comprehensive modeling frame-work, generating policy instruments, which will ensure more rational use and management of freshwater resources. • Need to establish national and regional information frameworks and networks for IWRM. • Need to improve cooperation among centers of Excellency to provide for better processing and dissemination of information. • Depletion and Salinization of coastal aquifers and rapid encroachment of the salt water interface along the Mediterranean shoreline. • Excessive extractions from fossil water reserves. • Degradation of water quality of drains, and some irrigation channels. • Potential for eutrofication of water bodies at the downstream end and loss of natural wetlands. • Inappropriate hygienic conditions associated with lack of sanitation services, pathogenic contamination	• National policies for stabilizing population growth achieved partial success in Tunisia and Egypt. • Major demand management measures include: - Extensive reuse of mixed agriculture drainage water for irrigation in Egypt. - Drought management and mitigation plan for Morocco. - Aquifer recharge in Tunisia. - Programs for modernizing of irrigation techniques, and rationalizing of irrigation water use in Egypt and Tunisia. - Recycling and reuse of treated domestic wastewater (Egypt). • Examples of cooperation for IWRM for shared resources: - The Nile Basin Initiative (shared by all Nile riparian). - Strategies for rational utilization of the Nubian Sandstone aquifer (Chad, Egypt, Libya and Sudan). • Major environmental preservation measures include: - National program for abatement of discharge industrial wastewater to the Nile in Egypt (1998-1999). - Control and restriction of water use from lakes, natural bodies, … etc., in Tunisia, for preserving the

	• Employment in the agricultural sector (irrigated) accounts for 26% in Tunisia, and about 40% in Egypt and Morocco. • Access to safe drinking water is close to 100% for urban population of Libya and Egypt, and may drop to less than 50% for rural communities of Morocco.	encourage IWRM are not effectively applied. • Lack of appropriate treatment. • Increased rates of agro-chemical applications. • Poverty and low economic returns for farmers. • Political instabilities in parts of the region. • Elevated pressures to join the globalization trend, international market economy, GATT, …etc. • Imposed economic sanctions on parts of the region.	resulting from illegal dumping of raw wastewater to surface and groundwater. • Social stability concerns calls for more development of land and water resources. • Need to mobilize the political will, which usually over-rules other water resources management efforts. • Probable reduction of flow of the Blue Nile as a result of global warming and regional climate variations. • Insufficient technical and financial resources impede efforts for controlling water hyacinth in upper Nile reaches. • Excessive siltation and reservoir sedimentation hinders effective operation of flow control structures in Morocco, Algeria, and Tunisia. • Jeopardizing of development projects with promising benefits, like the Jongly Canal Project, as a result of political instabilities and foreign interventions. • Loss of valued biodiversity of aquatic fauna. • Associated impacts on rural/urban migration.	ecosystem. - Constructed wetlands systems are tested in Egypt for biological treatment of wastewater. • Major institutional and policy reform measures include: - Creation of five basin authorities for IWRM in Algeria (1996). - Revised national water resources management plans in all countries attempt to formulate their policies within an IWRM framework. However, implementation of these polices will judge its adherence to IWRM principles. - A mature system of water user associations is in place in Tunisia, and Morocco. - National water research centers are operating in Egypt, Tunisia, and Morocco. • Conjunctive use of surface and groundwater is widely applied in Egypt, Tunisia, and Morocco. • Public awareness programs are widely applied in Egypt to preserve Nile water quality, and to rationalize water use. • Coordination for joint land and water resources management.

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