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Management of Water Demand in Arab Countries Using GIS

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ABSTRACT

The alarming increase in the scarcity of water in various parts of the world. Scarcity of water in the Arab countries is not a new phenomenon—although population growth and economic development exacerbate the scarcity. Therefore, it is useful to examine how the problem has been dealt with during millennia of experience in the Arab world. Water is a main issue in many countries especially in those Arab countries; it has focused a global attention on the need for a stronger and more appropriate water resource management and availability solutions. With about 170 million people in 17 countries suffering from water scarcity and about 275 million in 9 countries having "water stresses" conditions, it becomes imperative for nations to come up with more focused and direct measures that would address and stem this resource scarcity. Water sustainability needs a balance between demand and availability. The main objective of this paper is the application of these concepts to Arabs countries. Water demand management is about achieving a reduction in the use of water resources, normally through increased efficiency of water application. The management of water resources was not explicitly included in the past from thirty-five years in all most of those countries normative system partly because water was believed to be a free good in mind, and was not accepted to have a price to pay to use it. This work contributed to a low efficiency of water use and waste of it, and water prices are often well below levels needed to cover the costs of the system. Moreover, this contributes to a worse quality of water, and, as quality of water decrease, the management of water resources becomes more challenging and the need to integrate water quality into an overall water resources management grows. The main goal of this paper is showing, how Geographical Information Systems (GIS) can be used to support infrastructure planners and analyst on water demand of a local area in some Arabs countries such as(Egypt, Sudan, Libya, Algeria, Tunisia, Morocco, Jordan, KSA and UAE).

Keywords: GIS, Water in land, Water area, XML Schema.

I. INTRODUCTION

The use of water resources was decisive for the rise and the decline of the old civilizations that lived around the Arab Countries. All this wonderful achievements were guaranteed by the balance between resources available and their use. The Arab countries are dependent for some two-thirds of their water supplies on transboundary water. Egypt is the most extreme case, with some 95 percent of its water coming from the Nile. Apart from natural variability, investments in hydraulic infrastructure by upstream riparians change water availability to downstream users. For example, the Greater Anatolia Project affects water availability in Syria and Iraq. The Israeli water utility affects the availability of water in Palestine and Jordan. Dams constructed in Ethiopia and Sudan affect the calculus of Egyptian water planners.

But the modern world has a much bigger necessity of water, caused by the growing of the population while, at the same time, the use of water is becoming more and more inconsiderate and polluting. It is any way possible to imagine and new and more complex balance between people and nature, thanks to both the technological development and a better organization of society. This socio-culturally contributed to a low efficiency of water use and waste of it, and water prices are often well below levels needed to cover the costs of the system. Today is particularly efficient the “participative” decision-making support process that allows bigger parts of the population to take part actively to the choices that would influence their future.

In this way, all the stakeholders will contribute to reach the best solutions for the collection, treating, production, transport and distribution of water resources, considering their needs and those of next generations. This participative process consents to optimize also the economical and financial systems of water resources management. This means that, on one side the public role could be strengthened about choices and decision making supports, on the other side the management itself can be optimized with business oriented structures using GIS tools. The progress of civilization, which was born in the Arab Countries, could then move to a new form and a more complex balance, that will favour the development of people and societies and, at the same time, favour the

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preservation and valorization of the environment and natural resources. Water sustainability needs a balance between demand and availability:

- Water demand management: This demand may be managed by suppliers and regulations responsible persons, using measures like invoicing, consumptions measurement and users education in water conservation measures.
- Augmentation of water supply: this availability may be augmented by infrastructural measures, waste water reuse, non-conventional resources and losses reduction.

Water Demand Management is about achieving a reduction in the use of water resources, normally through increased efficiency of water application. The main objective of this paper is the application of these concepts to Arab regions. Unfortunately, often water policies are fragmented and the local legal framework is unable to fully deal with water management. National legislations today provide the basis for government regulation and operations, and establish the context for action by nongovernmental institutions and individuals. State permits are generally required for private exploitation of water resources, protection of water resources against pollution or overuse is organized by legislation under which the State assumes authority to ensure protection. This work contributed to a low efficiency of water use and waste of it, and water prices are often well below levels needed to cover the costs of the system. Moreover, this contributes to a worse quality of water, and, as quality of water decrease, the management of water resources becomes more challenging and the need to integrate water quality into an overall water resources management grows. Unfortunately, often water policies are fragmented and the local legal framework is unable to fully deal with water management. National legislations today provide the basis for government regulation and operations, and establish the context for action by non-governmental institutions and individuals. State permits are generally required for general and private exploitation of water resources, protection of water resources against pollution or overuse is organized by legislation under which the State assumes authority to ensure protection.

1-1 Use of Geographic Information System (GIS)

Advances in GIS technology have revolutionized the way that spatially distributed water resources data are managed (ESRI 2008). GIS captures, visualizes, and correlates spatial data. Not too long ago, it was practically un-thinkable to spatially represent a variables that directly or indirectly dictate the movement and availability of water resources in a basin to the extent that can be done today. This array of variables includes topography and land use/land cover at as low as 30m resolution; and soils, soil moisture content, and climate data at sub-km resolution. Thanks to advances in computer capacity and GIS technology, resource managers can better mimic the reality on the ground.

Today, if one has the primary data and model structure at any spatial scale, computer capacity and GIS technology support the analyses to provide water resource managers and decision makers with the decision tools needed at the scale of interest. Advances in GIS technology become especially important when dealing with complex river basins whose climate, soils, and land use/land cover distributions vary significantly with space. GIS technology is equally important in addressing a basin being used and managed by multiple actors. In this case, to facilitate optimal joint resources management and development decisions, one needs to spatially identify the sources and sinks of water and associated pollutants.

1-2 Deteriorating Water Quality

A fourth factor has been the political and economic pressure on decision makers to focus more on water quality. An IWMI survey of government irrigation officials in Egypt in 1995 produced the surprising result that many ranked pollution as the most important problem facing the sector. For example, in the congested rural settlements along the Nile River Delta, residents and farmers have become an important lobbying group. They have been demanding that municipal and agricultural pollution be cleaned out of their canals and rivers. Among farmers, exporters of high-value farm products have been concerned that the marketability of their products is affected by water pollution. Similarly, along the Mediterranean and Red Sea coasts, many countries are benefiting from tourism to historic and seaside resorts.

However, development of other high potential areas—such as the coastline of the Nile Delta—is constrained by beach contamination from polluted Nile waters. Tour operators and resort owners are powerful interest groups who have thus joined environmentalists and farm exporters to lobby for enhanced water quality management. A problem facing many countries in which groundwater is overused is the deterioration in quality that occurs as water tables fall. Deterioration is caused either from saline water that flows laterally into the depleted zone (especially near coasts); or from the deeper layers of water, which are more saline.

Many Middle East and North Africa Region (MNA) countries have successfully developed new water law regimes that address modern water demand and supply concerns, while remaining fully compatible with customary law and religious doctrine. Maintaining such a balance is feasible because society has internalized the customary laws and religious doctrines. Often, introducing new ideas and technologies is possible within the existing frameworks. For example, the region-wide interest in wastewater reuse has evolved gradually as stakeholders began appreciating that treated wastewater is a significant additional resource so long as treatment was adequate, and use restricted to tree crops and fodder crops.

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Where the balance has been disturbed (as in countries witnessing excessive drawdowns of groundwater), the problem has been caused by perverse economic incentives (such as the diesel subsidies in Yemen).Good examples of modern legal approaches exist for such key issues as groundwater management, water rights allocation, and wastewater reuse. Other chapters that follow deal with specific aspects of codifica-tion, such as financing rules aimed to better target government subsidies to the poor, and bidding rules aimed at creating incentives for private sector participation in irrigation infrastructure.

1.3 Institutional Framework in Egypt

In Egypt a water policy was established for the first time in 1933. It was updated in 1974, and followed by a comprehensive water policy drafted in 1975 after the completion of the High Aswan Dam. Persistent drought and reduced Nile flow prompted an updated water policy in 1990, focusing on reallocation among uses and improved water efficiency in irrigation. The current policy focuses on water management, forecasting, and enhanced drought preparedness, together with changes in agricultural strategies. The development of a comprehensive long term water policy remains a high priority. In Egypt is the Ministry of Public Works and Water Resources (MPWWR) the body in charge of water resources research, development and distribution, and it always this institution that undertakes the construction, operation and maintenance of the irrigation and drainage networks [15-17]. At central level, the Planning Sector is responsible for data collection, retrieval and analysis for planning and monitoring investment projects. Figure 1 shows the water area and resources in Egypt.

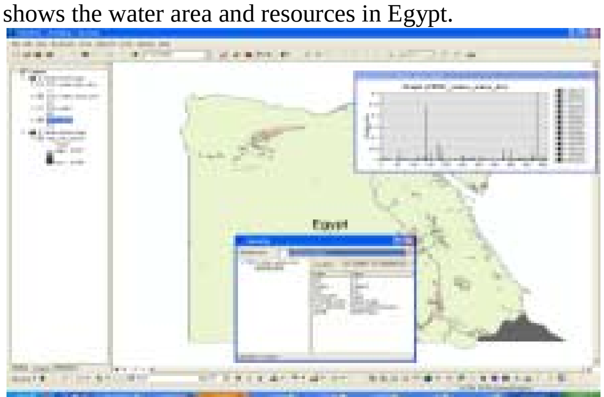

Figure 1: Show water area and resources in Egypt.

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Water resources development works are coordinated by the Sector of Public Works and Water Resources. The Nile Water Sector is in charge of cooperation with Sudan and other riverside countries[5-10]. The Irrigation Department of the Ministry provides for the technical guidance and for the monitoring of irrigation development, including dams. The Mechanical and Electrical Department is in charge of construction and maintenance of pumping stations for irrigation drainage. Further to these institutions, other public authorities operate in direct relation to the Ministry of Public Works and Water Resources. They are the High Aswan Dam and Aswan Authority, responsible for the Dam operation; the Drainage Authority, responsible for the construction and maintenance of tile drains; and the Water Research Centre.

The Water Research Centre comprises several institutes and is the scientific body of the Ministry for all aspects related to water resources management. In this field a main guideline is the Law 4/1994, that has become the newest framework for the protection of the environment. It has a greater role with respect to all governmental sectors as a whole. The law has been designated as the highest coordinating body in the field of the environment that will formulate the general policy and prepare the necessary plans for the protection and promotion of the environment. It wills also, follow-up the implementation of such plans with competent administrative authorities.

According to the Law 4/1994 for the Protection of the Environment, the Egyptian Environmental Affairs Agency (EEAA) was restructured with the new mandate to substitute the institution initially established in 1982. At the central level, EEAA represents the executive arm of the Ministry [17]. Later, in June 1997, the responsibility of Egypt's first full time Minister of State for Environmental Affairs was modified with a Presidential Decree and, from there on, the new ministry has focused, in close collaboration with the national and international development partners, on defining

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environmental policies, setting priorities and implementing initiatives within a context of sustainable development.

1.4 Importance of Water Resource Management for the Egyptian Economy

Egypt is an arid country with very limited rainfall. The Nile-Lake-Nasser system is one of the largest hydraulic infrastructure complexes in the world. It consists of a series of large barrages, canals, pumping stations, water and sewage treatment plants, and water supply and sewerage networks. The Nile-Lake-Nasser system is Egypt's only renewable supply source for surface water, and constitutes 95 percent of the country's total water resources. The rest of Egypt's water resources is mainly fossil (non-renewable) groundwater found in the coastal zones, deserts, and Sinai; and estimated at 3–4 Billion cubic meters (BCM)/yr.

Egypt's water requirements are increasing as a result of growing population, rising living standards, and the needs of industries and agriculture (particularly in the reclaimed new lands). Of the sub sectoral shares, agriculture (including fisheries) is the major user; it consumes approximately 70 percent of water. Municipal/potable and industrial subsectors consume only 3.5 percent and 1.5 percent, respectively. The balance, estimated at roughly one-quarter of the overall water stock, is lost through evaporation (5 percent), and, more significantly, as drainage water (20 percent) discharged into the Mediterranean Sea and the desert fringes of the Nile system.

A major challenge facing Egypt is to close the gap between the limited water resources available and the escalating demand for water from competing users. Available water per capita per annum amounts to some 900m³, which is already below the "water poverty" index of 1000 m³/capita/annum. From figure below is expected to fall to 670m³ by 2017, unless policies are implemented to sustainably manage growing demand. Managing sustainably requires developing appropriate pricing and financing rules along with an institutional framework that encourage-ages sustainable use. The result of focused on "balancing" water supply and demand through supply augmentation were significant investments in water supply, drainage, and rehabilitation of irrigation infrastructure, from both the national budget and donors. So, the need for a more integrated approach became apparent due to:

- Continued deterioration of water quality.
- Growing demand-supply gap.
- Intensification of inter-sectoral and inter-regional water allocation problems.
- Inadequacy of government funds to sustain new investments.
- Poor operational performance of water agencies.

Since then, the government policy has shifted to integrated water quality and quantity management. The integrated water resources management (IWRM) approach seeks to address sectoral concerns through a mix of institutional reforms, changes in incentive structures, and technical innovations. Finally, An Egyptian farmer in the Nile Delta pays the incremental cost of water delivery at the farm level but not the conveyance (and lifting costs) from the river system. A water supply consumer pays a tariff of approximately only 20 percent of the treatment and delivery costs. There is a wide gap between the actual costs of water supply (0.8–1.00 LE/m3) that they incur and the user-tariffs (average 0.15 LE/m3) that accrue to them.

For example, Cairo water tariffs are among the lowest among developing country megacities and pay for only 25 percent and 10 percent of the actual costs of water supply and sanitation, respectively. Cost recovery in secondary cities/towns is better for water supply (Alexandria's is as high as 50 percent), although equally low (10 percent) for sanitation. These entities regularly have been bailed out through sovereign aid and domestic loans that are never repaid.

1-5 Institutional Framework in Morocco

Morocco has in place a system for allocating all water held in the public domain through a permit system administered by Catchment Basin Authorities.68 Permits are required to (1) prospect projects for tapping underground or out-welling water, (2) construct dug wells with depths exceeding the maximum provided in law (Art. 26), (3) establish works to impound and harness natural spring water on private property, (4) establish works meant for using waters of the public domain (for five-year intervals with possibility of renewal), (5) establish intakes from the underground water table in excess of the maximum set by regulation, (6) establish water intakes on watercourses or canals de-rived from wadis, (7) establish intake of water of any kind for sale or therapeutic use, and (8) operate ferries or crossings on watercourse. The permit granted by the Catchment Basin Authority specifies the duration (not to exceed 20 years), and renewal is possible [55-66].

The permit also should include the measures to be taken by the recipient to prevent water degradation, amount of the fee and payment arrangements, and terms of use. The Authority is granted the ability to revoke a permit at any time, without compensation, following written notice, if (1) the terms of the permit have not been met, (2) utilization of the permit does not begin within two years, (3) permit is assigned or transferred without agreement of the Authority, (4) fees or dues are not paid, and (5) water was used for a purpose other than that authorized by the permit. The Authority also may revoke, amend, or restrict the permit for reasons of the public interest, subject to prior notice of not fewer than 30 days. The permit holder is entitled to compensation.

In addition, the law provides for a system of concessions for various categories of works, including development of thermal springs, construction on public water domain, water storage, flood protection, or derivation works. These concessions are considered real rights, but they do not entitle the holder to the right of ownership over the water. The law limits what the concessionaire may do under the contract, and specifies a set of events that would forfeit the concession contract. The Authority may demolish any structure constructed without a permit or concession and order the offending party to restore the area to its original condition.78Finally, in cases of water shortage, the law provides that the ad-ministration can declare a state of shortage, define the affected area, and enact the necessary local temporary regulations to ensure, at the least, potable water for human and livestock consumption.79 During this period, the administration is entitled to requisition water, provided it follows prevailing law.80 The cost imposed may be borne in part by the government. During times of shortage, specific regulations that restrict water use apply to areas under irrigation.

In Morocco is the Ministry of Equipment and Transport, with the Hydraulic department, which deals with problems related to water resources. It is responsible for the analysis and examination of the resources, the planning and their development, the overall management, the control and protection of water quality, and the construction and maintenance of work to move and transfer water. In the last years, Morocco began to implement a policy to increase its water resources, since water is an essential factor for the social and economical development of the country. Adding to this problem of unsustainable water use, International Panel on Climate Change (IPCC) projections imply increased variability and reduced river flows in areas that rely on surface storage in reservoirs. This situation already is a reality in parts of the Arab region.

For example, in Morocco, due to reduced annual precipitation, dams constructed over the last three decades have been able to store, on average, only approximately half of their design capacity. As a consequence, farmers have become acutely aware of the uncertain nature of their access to water. Irrigation agencies in the command areas struggle to ration uncertain water supplies to the politically important farmer constituency. Variability has local and regional implications. For the individual farmer, investing in the inputs for high-value crops is less attractive if there is a possibility of water shortage affecting yields. At the regional level, the relationship between rainfall and runoff is not linear. Runoff typically declines much more sharply than precipitation. Thus, variability is concentrated in the downstream areas. Therefore, the foundation for current allocation priorities, rules, institutional arrangements, and infrastructure is in doubt.

To secure a better organization and a comprehensive management of all national resources, Morocco has adopted in 1995 a new law called “Loi sur l’eau” (water law) [7-10], to unify it previous regulations, because the regulations that govern the public hydraulic domain had various origins [7]. In fact, the first text about this subject goes back to 1941, when, with this first regulation, every source of water, without any distinction, had been included into the public domain. Since then, water could not be used for private exploitation, except for some exceptions legally regulated.

More texts have been elaborated in the following years, to adjust to the new requirements of the country, but most of them were draft in the first decades of 1900, and remained as separated parts written in different periods. Therefore, this set of law was not adapted to the modern organization of the country and was not responding anymore to the developing needs of Morocco [7-12]. Without doubt, the conditions for the use of water were very different from those of a hundred years ago, because of the increasing demand that raise today and because of the new hydraulic techniques.

The reform of the legislation was designed to unify all previous set of rules in only one law, completed with new directives related to fields not yet covered in the past, and to make the general framework clearer. The “water law” aims at realizing a national water policy that, in the long term, considers both the evolution of the resources and the national needs for water. It plans to rationalize the use of water, to make widespread the access to water, and to reduce the differences between cities and countryside. The new law was intended to become the main legal basis for all national water policies, defining its intentions and objectives. Figure 2 shows the water area and resources in Morocco.

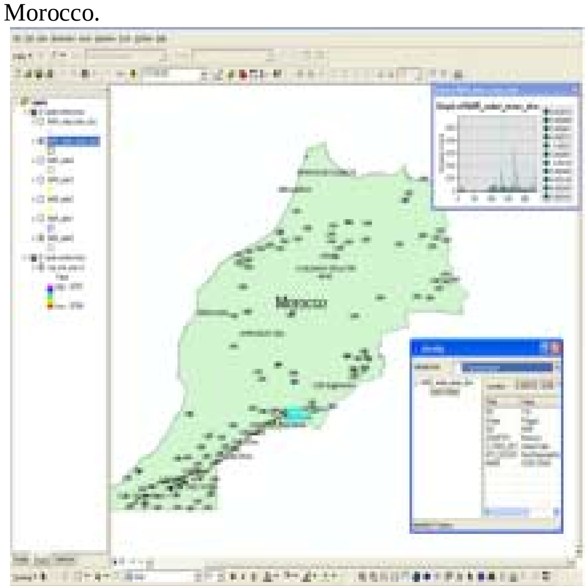

Figure 2: shows the water area and resources in Morocco.

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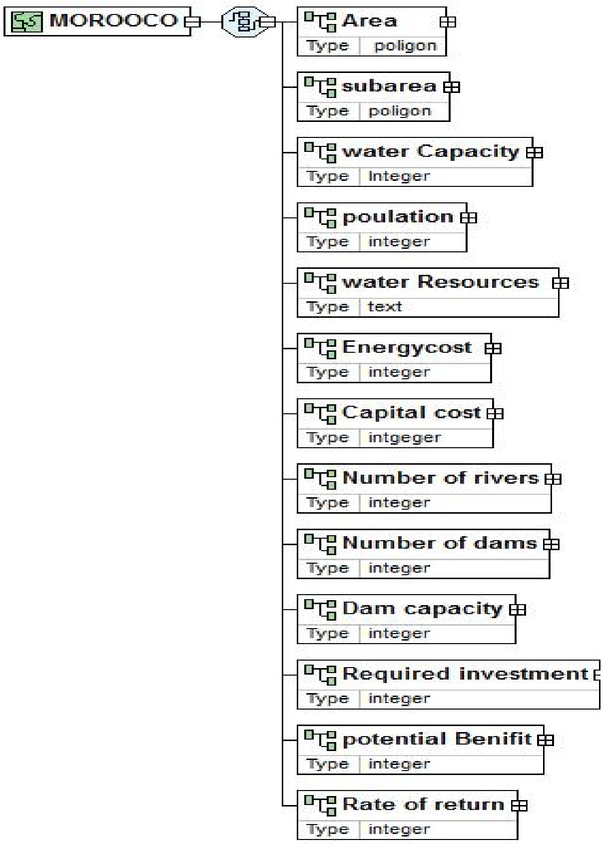

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Schema Component Representation

The principles include a coherent and flexible planning for the use of water resources, a rational management of these resources, taking into consideration national priorities. It also has to improve the protection and preservation of water amount and quality, and to emphasize the value of the resources, but, at the same time, making the situation profitable for investments and financing in this field [14-20].

2. WATER DEMAND MANAGEMENT

2.1. The water issues and the best available tools

Water scarcity has always been part of the history of the Arab Countries. As a basic element for food production, economic development and for life itself, water has been an axis and a symbol of our cultures. It is the essential element which is impossible to replace, expensive to transport and store, and difficult to purify. Water in most countries and regions of the Arab Countries is a limiting factor. The arid and semi-arid countries of the Arab Countries combine a low rate of rainfall and a high rate of evapo-transpiration. Therefore only a smaller amount flows into rivers or percolates to aquifers. The availability of water may significantly vary during the different seasons of the year, and from year to year [5-17].

Country	Destination capacity for cast 2025 (million cubic meters))	Capital cost at 2018 per cubic meters at 5% interest rate	Required additional capacity until 2025 1000 cubic meter a day	Investment cost at 5800 a day capacity	Energy cost at $ 0.21 per cubic meter at $ 0.06 per kilowatt hour	Total cost at $0.525 per cubic meter
Egypt	1.536	0.28	1008	806	118	294
Tunisia	.481	0.09	286	229	37	92
Algeria	8.214	4.48	5023	4018	630	1574
Libya	7.206	1.3	5337	4270	552	1381
Sudan	46,200	1,946	200	2.4	0	0
Jordan	1.541	0.28	1000	800	118	295
KSA	26.816	4.83	14252	11402	2055	5139
UAE	18.27	3.29	9240	7392	1400	3501
MOROOCO	0.862	0.15	577	462	66	165

Table 1-Populations, water resources and The expected cost and benefit of action and estimated rate of return on investment in improved water and sanitation provision for 2010-2020.

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Country	Estimated total dam capacity	Share of total dam capacity in Arab regions %	Per capaita dam capacity Cubic meters per inhabitant
Egypt	168.20	46.30	5038.0
Tunisia	0.06	0.69	237.10
Algeria	5.68	1.56	157.80
Libya	0.40	0.11	59.89
Sudan	98,320	481,520	020.4
Jordan	0.27	0.07	43.43
KSA	1.00	0.28	35.75
UAE	0.06	0.02	7.74
MOROOCO	16.90	4.65	523.70

Table 2-The expected cost and benefit of action and estimated rate of return on investment in improved water and sanitation provision for 2010-2020.

Country	Required investment in water and sanitation services in ($ millions)	Potential benefit ($ millions)	Rate of return	Average annual rate of return (%)
Egypt	4.484.4	11.073.6	146.9	13.4
Tunisia	1.461.9	2438.0	66.8	6.1
Algeria	3.622.3	19303.3	432.9	39.4
Libya	40,243	38,644	36,730	3,325
Sudan	30197.1	18834.3	-38.3	-3.5
Jordan	135.3	1635.5	1108.6	100.8
KSA	71,813	45,252	25,514	37.764
UAE	45,231	13,300	11,946	14.654
MOROOCO	8484.3	9608.3	13.3	1.2

Table 3 Desalination cost in selected Arab countries

Country	population	Water Resources Per capita potable water million m3/day	Required investment in water and sanitation services in ($ millions)	Potential benefit ($ millions)	Rate of return	Average annual rate of return (%)
Egypt	93.66	86.8	4.484.4	11.073.6	146.9	13.4
Tunisia	10.77	2.68	1.461.9	2438.0	66.8	6.1
Algeria	37.9	14.3	3.622.3	19303.3	432.9	39.4
Libya	6.2	0.6	0	0	0	0
Sudan	37.96	154	30197.1	18834.3	-38.3	-3.5
Jordan	6,47	.9	135.3	1635.5	1108.6	100.8
KSA	29.19	2.4	17.93	15	0	0
UAE	8.26	.2	5.69	5	0	0
MOROOCO	32.99	29	8484.3	9608.3	13.3	1.2

Table 4-Total and precipitate dam capacity and share of individual countries in Arab region

The arid and semi-arid regions of the Arab Countries are subject to extreme recurrent droughts. Scarcity is aggravated by variability of exploitability (especially with ecological security requirements), vulnerability, and partition among different countries. When water demand is higher than availability, there is a water stressed condition – usually it happens in regions with low rate of rainfall, high density of population or strong agricultural and industrial activity. The level of exploitation of water resources is generally high in most countries and pressure over water resources is increasing. Exploitation ratios over 50 %, or even nearing 100 % in many parts of Arab Countries (Egypt, Morocco, Sudan, Libya, Algeria, Tunisia, KSA and UAE)[17-25]. Figure 3 shows the water area and resources in Arab Countries.

Figure 3: shows the water area and resources in Arab Countries.

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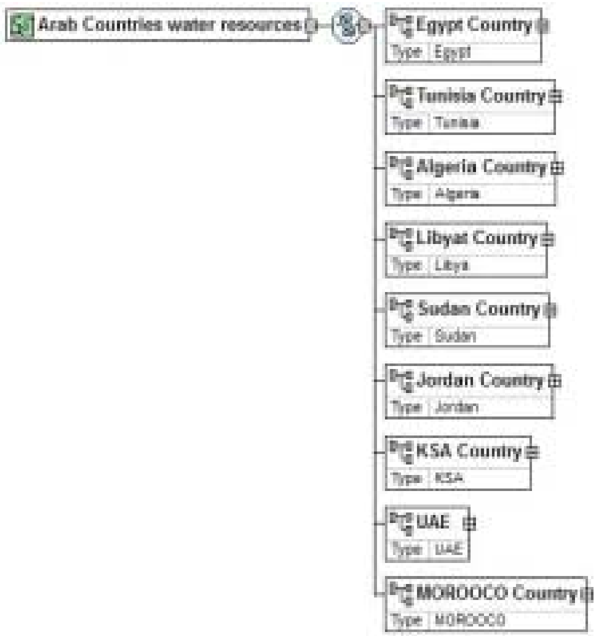

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Schema Component Representation

Exploitable amounts of water are decreasing, and may become scarce in time or region. Disruptions between water demand and renewable conventional supply may increase. Overexploitation of local character is a reality leading to widespread salt-water intrusion [26-36]. Particularly there are 4 kind of common and significant interventions:

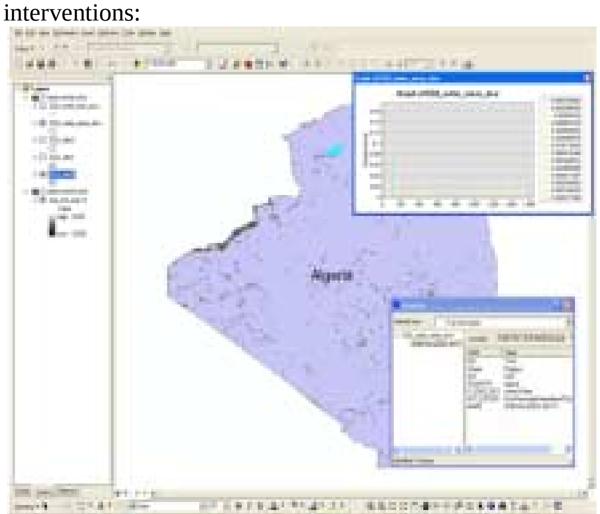
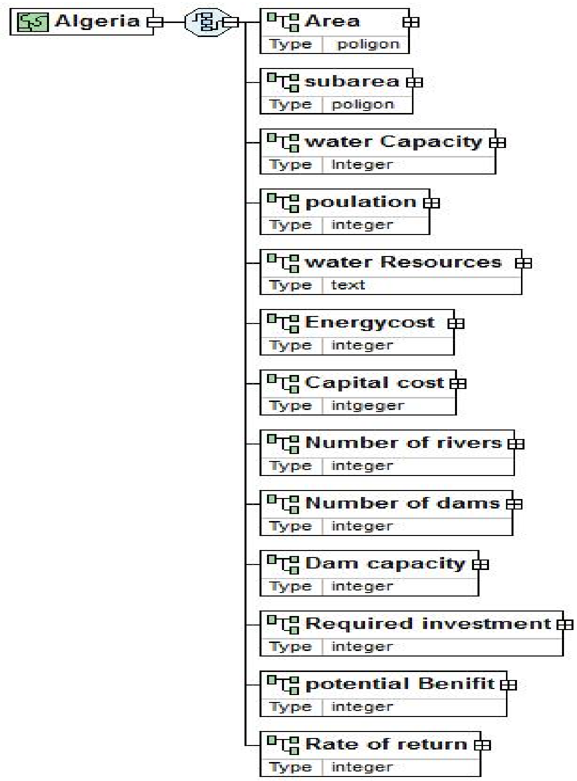


Figure 4: shows the water area and resources in Algeria.



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Dams building: most countries in the Arab Countries have built large dams to capture water in the wet season and store it to insure drinking water supply to the growing cities and to irrigation projects, during the long hot summer. These are also built to regulate floods and generate hydroelectric power. Population growth: Most North African and Eastern Arab Countries envisage an increase in pressure over their water resources because of the high population growth in the region. This is especially important because population could be doubling in the next 20 years and rural urban migration could provide additional pressures on the water supply and management systems in the big cities that are already badly stressed and on coastal areas where most population concentrates. Soil impermeabilization: caused by urbanization. Agricultural drainage: and protection against flood [37-47]. Figure 4 shows the water area and resources in Algeria.

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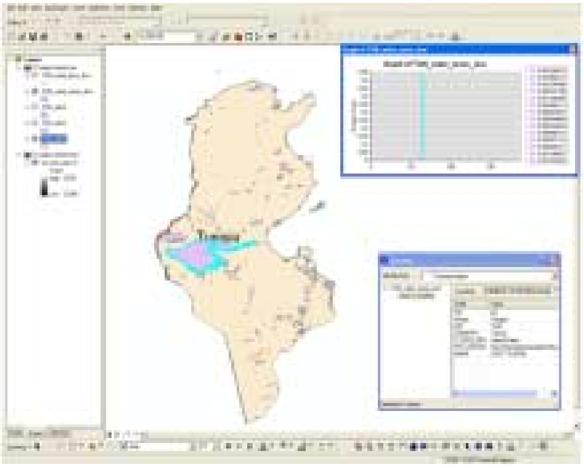
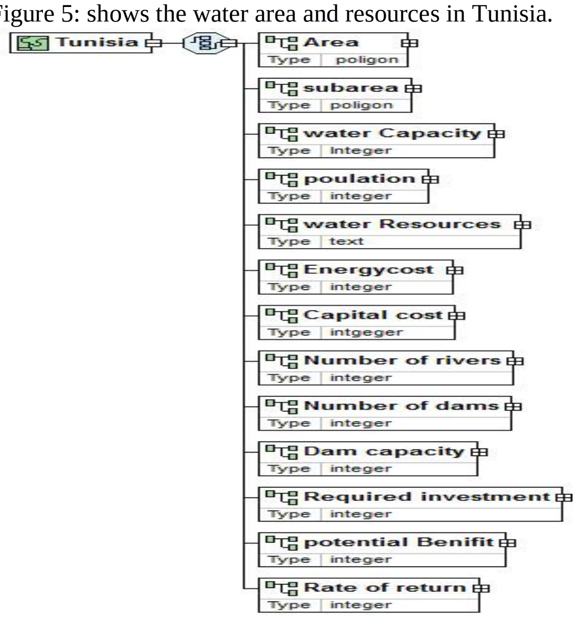


Figure 5: shows the water area and resources in Tunisia.



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The best sites have already been used. Still further development of conventional water sources is in the agenda of most countries. Those countries such as Egypt and Morocco that have relied heavily on mobilizing surface water are turning into the possibility of relying more on groundwater resources. Water scarce countries in the Arab Countries have made different options for the development of their water resources, determined to a greater extent by the characteristics of the natural availability. For example in the North of Africa, Egypt and Morocco rely mostly on surface water, other countries use both surface and groundwater resources (Algeria and Tunisia). Figure 5 shows the water area and resources in Tunisia.

Under the 1975 Water Code, Article 1, it is clear that most water in Tunisia is within the public domain. Water may be used subject to a simple authorization or concession, or under a water use right. An authorization is required (1) to use public domain water for non-permanent waterworks; (2) to construct infrastructures located within the overflow banks of a watercourse or on canals, lakes, and subkhas; (3) for groundwater exploration and exploitation activities, but not for the use of the water; and (4) for the exploitation and use of natural spring waters that are located on private lands but are not suitable for exploitation and use for public purposes. Concessions are granted for (1) permanent water intakes in watercourse beds, (2) use of underground or spring waters, (3) use of mineral and thermal waters, (4) construction of permanent dams and use of the water stored therein, and (5) drainage of lakes and subkhas and their use[45-55].

Concessions may be renewed, but the law is silent on the duration. The law does provide for specific instances in which concessions may be forfeited. In addition, the law exempts some uses from licensing requirements, including any well dug no deeper than 50 meters and rainwater falling on a landowner’s property. The concessions or authorizations can be altered or forfeited if the water is needed for a public purpose so long as compensation is paid for any damages or loss.90 Nothing in the legislation covers the recording of water rights or the monitoring and enforcement of water abstraction licenses.

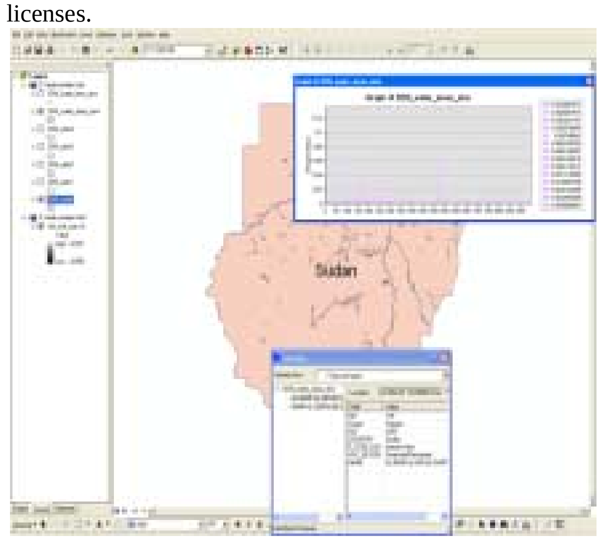

Figure 6: shows the water area and resources in Sudan.

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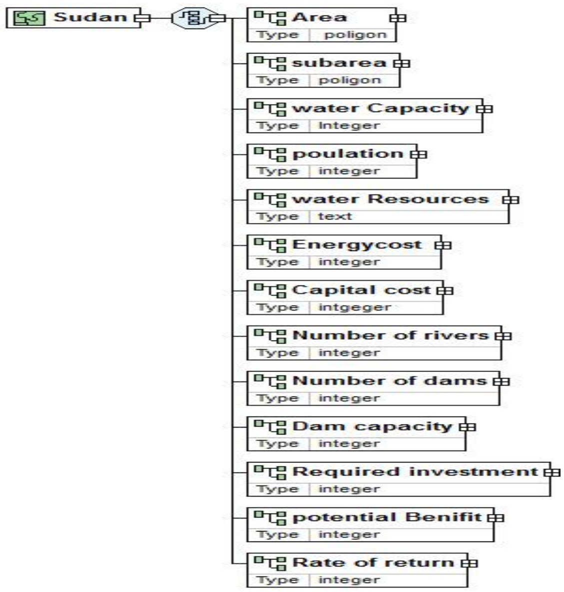

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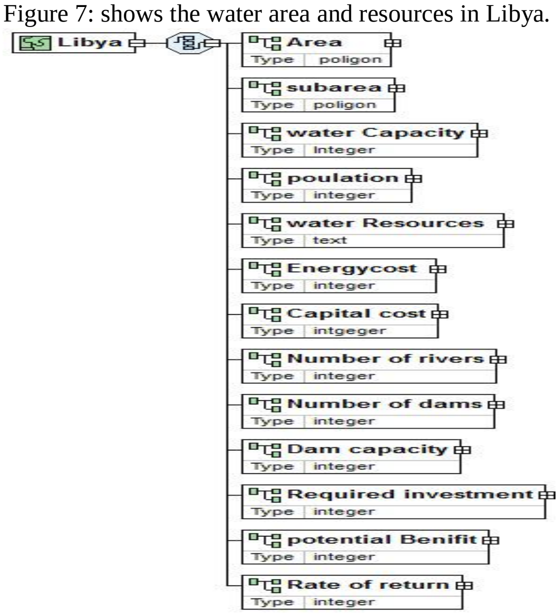
Libya has opted for a model of mining their considerable groundwater resources. Figure 7 shows the water area and resources in Libya The effect of climate uncertainties-decreasing precipitation, higher frequency of extreme rainfalls and droughts-is a reality in the region and climate change is considered a long term risk [57]. Flooding is an important issue: frequent and dangerous. Droughts are recurrent events, more difficult to deal with as scarcity increases. Risk management is not sufficiently developed in many countries of the region. Floods and other natural disasters related to water are not being confronted by adequate risk management measures. Considering the size of damages done by these disasters it could be considered as a hindrance to sustainable development in the sub-region [48-53]. Figure 6 shows the water area and resources in Sudan.

Figure 7: shows the water area and resources in Libya.



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Most of the rainwater that falls in the region is lost through evaporation from the soil and water surfaces or runs rapidly into the sea. Development of appropriate storage facilities including underground storage, water harvesting, and soil and water conservation measures to improve the water retention capacity of the soil and to reduce the stilting in water storage facilities will be the types of measures that may be useful. With the change in cultivation methods, and movement of the population the mountain areas have been depopulated and abandoned. Floodwater flow could be delayed for increasing groundwater recharge, for soil conservation and soil water recharge and for surface water. Figure 8 shows the water area and resources in Jordan.

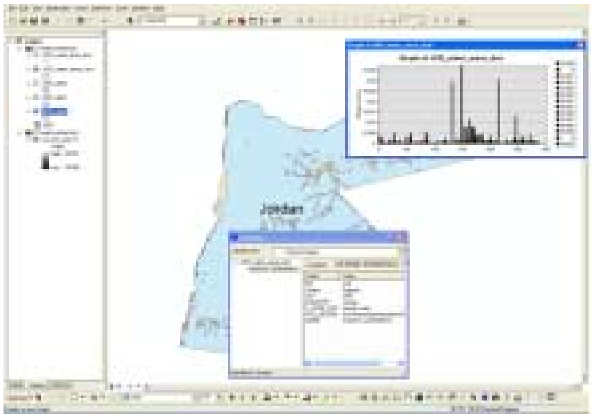
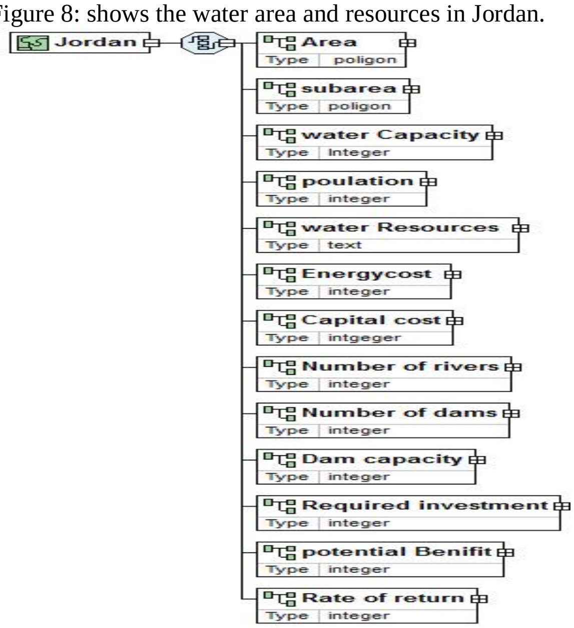


Figure 8: shows the water area and resources in Jordan.



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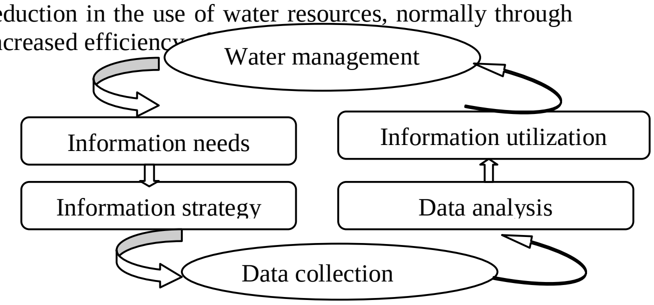
Impoundment. Sewage treatment facilities have tended to lag behind. There are two dangers for water resources in the region. The first one is the direct health risk of discharges of untreated sewage to underground and surface water resources, particularly when un-regulated settlement occurs in the drainage basins or when fields are watered with raw sewage. Second, there is a threat to marine ecosystems, as well as to wetlands and other transitional ecosystems which are crucial for maintaining the ecological balance, in case of the discharge of un-treated sewage. Dry sanitation and/or wastewater treatment would need to be introduced and improved. The latter would need to be looked at because it provides further opportunities to increase use of wastewater in agriculture and substitute good quality water for less quality demanding uses [50-55].

2.2 Water demand management

Water sustainability needs a balance between demand and availability:

1) Water demand management: demand may be managed by suppliers and regulations responsible persons, using measures like invoicing, consumptions measurement and users education in water conservation measures;

2) Augmentation of water supply: availability may be augmented by infrastructural measures, waste water reuse, non-conventional resources and losses reduction. Water Demand Management is about achieving a reduction in the use of water resources, normally through increased efficienc



Proposed Water Demands

The instruments used in water demand management include:

building and replacing infrastructures to reduce leaks in distribution networks, installation of metering, etc.; consumer education to encourage behaviour modification, insuring that the public are aware of the value and importance of appropriate water use; introduction of conservation tariffs encouraging less water use and penalizing the consumers that consume more water, as well as providing enough revenue to carry out investment and maintenance of infrastructures;

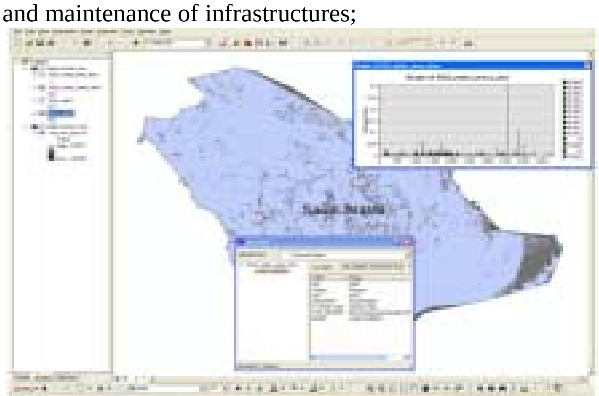


Figure 9: shows the water area and resources in KSA.

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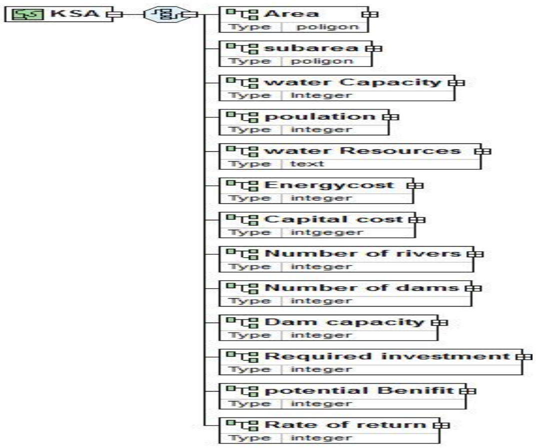

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greater efficiency of application and water use through the introduction of more efficient water appliances, more efficient processes in industry or drip irrigation, etc.. in agriculture; management changes such as changes in water shifts, water recycling in industrial plants, etc.. One of the most important sources of water is the possible savings through reduction of leakage in the distribution networks. The age of the pipes or insufficient maintenance is often the cause of leaks in pipes. Good maintenance and replacement of pipes is essential to deal with this problem. Overall efficiency in urban areas is poor in the Arab Countries, unaccounted for water is attributed not only to systems leaks but also to illegal connections, malfunctioning water meters and unbilled uses10. Most water used in urban areas is for domestic purposes. The use of water savings devices in home can help reduce demand in urban areas and this is often information that is not available. There is potential for reduction of between 50 and 80% of water use in toilet washing and introduction limiting devices in showers can reduce water use from 10 to 40%. Introducing water meters for individual households can also lead to reduction in water demand [45-50]. Figure 9: shows the water area and resources in KSA.

The water lost or wasted is an unexploited water bank that is of strategic importance in the water scarce Arab Countries. The potential for water savings must be looked from abstraction to distribution to final water use. It is technically possible to conserve an important amount of water lost or wasted and this could costs less than building new infrastructures. With demand management the need for building expensive infrastructure can be postponed and the result could be an improvement in water security and reduced water abstraction of economic and social uses, reducing stress on water resources11. It seems important that education campaigns and raising public awareness would need to be given priority. Education campaigns are important because they increase the level of acceptability and support of the population for water demand measures. Pricing often has effect when combined with education campaigns [53-56].

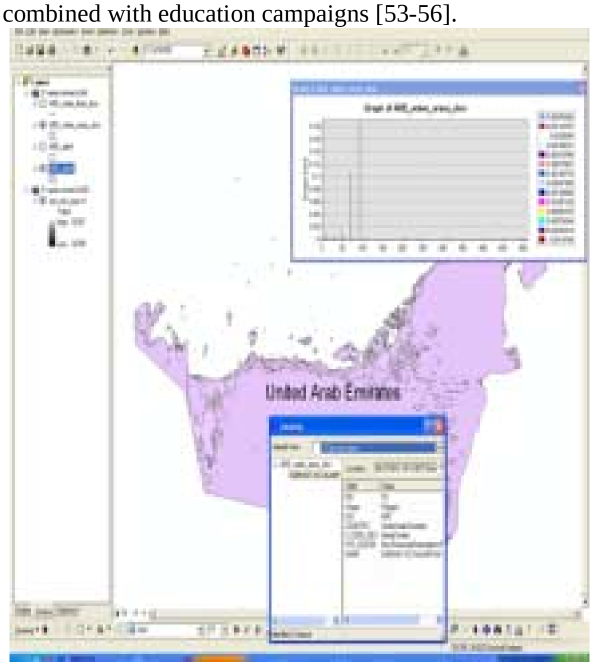
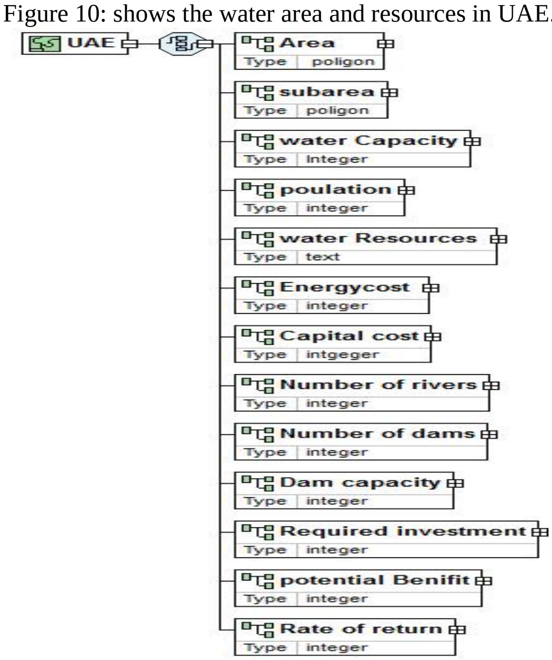


Figure 10: shows the water area and resources in UAE.



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Demand management in agriculture is about looking for greater efficiency in the irrigation system but also to adopt criteria of sustainable agriculture in terms of water conservation, protection of the environment and economic viability and social acceptability. The measures could include: those aimed at improving existing infrastructures: lining of main irrigation channels, placing localized irrigation systems, levelling of plots, improvement of drainage, etc.; those not related to infrastructure aspects such as improvement of management and organization of irrigation, improvement in knowledge about appropriate water quotas for different crops and about water looses and returns, tariff systems (better volumetric than per hectare to increase efficiency in water use). Figure 10 shows the water area and resources in UAE.

2.3 Augmentation of water supply

In spite of widespread water scarcity in the region there are important losses in distribution systems that range from 20 to 50% in some cities due to poor maintenance or to the age of networks. This is potentially a great waste of resources. In addition some cities are struggling with sub-standard services and water cuts because of management and financial problems of existing organizations. Good service is provided often where water distribution services have been privatized or delegated to an specialized agency. Here it is in the interest of water providers to reduce losses in order to show better financial results. A number of water saving incentives could be implemented in this field. Water conservation measures have not been widely applied in most countries of the region. In spite of the increasing difficulties in the development of new water resources through conventional means the technical efficiency of water distribution networks is low. There is an important potential for improvement in most countries.

Reducing loss of water both in urban and irrigation networks can provide from 30-50% saving of irrigation water and from 28% to 50% in urban water. Also the introduction of water saving devices in urban areas, and most important, the changes of on-farm water irrigation techniques and models of application and changes in crop patters can also lead to important water savings[17, 35, 49]. Remarkable diversifications in terms of energy sources and the intensification of deploying renewable energy options are evident around the world. Such endeavours are, on the whole, fuelled by a range of environmental, energy security and/or economic considerations. Indeed, it is no exaggeration to suggest that the world is progressively undergoing transition from a hydrocarbon-based economy to one based on sustainable forms of energy. It is notable, however, that there has been comparatively limited interest in examining the prospect of renewable energy in major oil-producing countries, especially in those characterized by heavily oil-dependent economies. Consequently, there has been a corresponding dearth of research.

Not only do these countries need to consider such sustainable energy means to further secure their energy and economic futures, but the potential key role that these countries could play in achieving a healthier future for generations to come should not be overlooked. In this regard, an instructive case to consider is that of the principal oil superpower, the Kingdom of Saudi Arabia. With at least a quarter of the world's proven oil reserves, it is also an increasingly urbanized and industrialized nation that is blessed with abundant solar radiation and a reasonable wind resource. Nevertheless, despite its several – yet somewhat tentative – undertakings in the field of renewable since the 1970s, its massive renewable energy resources have not yet been sufficiently exploited [15-17]. A substantial number of 'energy scenarios' have been developed around the world in order to provide a framework for the systematic exploration of energy perspectives (i.e. various possible combinations of energy options) and their potential implications.

Irrigation [39, 49] pricing proves especially difficult and countries that are applying it are following a policy of slow increases in prices, in parallel to subsidies to promote the incorporation of new technologies for irrigation. Implementation of increases in prices is part of the political debate also because increases in prices in urban and rural areas can be perceived by the population as the result of inefficient management and can lead to political defeat. Wastewater reuse will not be a substantial contributor to the water supply of the water scarce Arab Countries. However, wastewater reuse has strategic value because it substitutes good quality water for those uses that do not require it (gardens, some irrigation, etc.). It may allow a reduction for local overexploitation of aquifers. It can be important in coastal areas where there is strong competition for the resource. Wastewater treatment is also very important, and can be divided into two phases.

The primary treatment consists in the removal of floating and suspended solids, both fine and coarse, from raw sewage. Secondary treatment consists in following primary treatment by sedimentation, the second step in most wastewater systems in which biological organisms decompose most of the organic matter into an innocuous, stable form. Tertiary treatment: the process which removes pollutants not adequately removed by secondary treatment, particularly nitrogen and phosphorus. Groundwater in urban areas in some parts of the region is often unsuitable for drinking purposes but it can be used for other uses, such as for toilet flushing, and for gardening. This water, which is found usually not very deep and could cause major disruptions during floods, is a considerable resource, usually recharged from rainwater, return water from irrigation and losses from water supply and sewage systems. Promotion and implementation of measures for the use of lower quality water, found in aquifers in the inhabited areas, and which cannot be used for drinking purposes, can save for each dwelling up to 30% of its water consumption, thus reducing the demand on the fresh water resources.

Augmentation of water supply in this way is also possible by treating and reuse of domestic grey water within the house perimeter and by installing water storage facilities in the roof of houses (water harvesting). The employment of wastewater on increasingly larger levels constitutes a major management challenge. The use of wastewater might become environmentally threatening if not properly treated or used [34-39] . The main challenges for the implementation of this option include: the responsibility for developing and operating wastewater treatment facilities and reuse in irrigation projects is not clearly defined; there is a need to establish standards for treated effluent uses and in harmony with local conditions; more research work is needed to develop improved management techniques and on ways to reduce the cost of treatment processes and increase their efficiency; criteria need to be established for pricing treated wastewater according to quality and type of use; regulations often do not exist for utilization of sewage treatment sludge in agriculture.

In areas where water is insufficient to cover domestic water demand and other vital important needs, and where water transportation is not possible, the desalination of sea or brackish water would need to be considered. Promotion of this approach is based on the relative costs of the non-conventional methods of water supply (desalination or transport). The cost of desalinated water is relatively high now being around one US $ with a downward trend as a result of technological improvements (some estimates suggest that $0.25-$0.5 could be achievable in the forthcoming 5 years). On the other hand it is a high energy demanding process, and it is usually based on non-renewable energy resources that often need to be imported.

The price of fuel and its fluctuations plays a decisive role on the cost and the feasibility of generalizing the use of desalinated water. In addition, the use of fossil fuels increases carbon dioxide emission to the atmosphere polluting the atmosphere and contributes to the green house effect. That’s way it’s important to combine a desalination plant with renewable energy sources [51-55]. Brackish water can be used after desalination or directly in irrigated agriculture where it can be mixed with freshwater to achieve specific salinity levels appropriate for certain crop types. Also, certain industries can utilize brackish water effectively. Desalination technology has been developed to a point that can provide a reliable source of water at a reasonable cost. The desalination option may prove to be cheaper than building new dams and pipelines to provide water to urban centres. Desalination costs are expected to continue to decrease and become more attractive compared to most other options. Constraints to the development of brackish water resources in the region include lack of reliable data regarding cost and economic feasibility, technology transfer, training, capital and operation and maintenance costs [16, 22].

2-4 Water Pricing

In the Islamic world, this segment of water law is perhaps the most difficult to implement due to the right of shafa (“drink”) for every Muslim and his or her livestock. The Shi’ites believe that water may be trans-ferred or sold on a volumetric basis but not in globo. However, several Sunni branches are not as open to selling or transferring water. The Hanifites and Hanbalites allow only the sale of water from receptacles. In contrast, the Shafi’ites and the Malakites follow the principle that the owner of a water supply may sell and dispose of it at will, except water in a well dug for livestock. Clearly, these policies allow persons to sell water from private sources. Many Middle East and North Africa Region (MNA) countries charge water user fees for public water in Arab countries.

- Egypt

Egypt does not charge for the water itself. However, the law envisages that the state should recover the cost of all of the money expended in administering the water. MWRI is to accomplish this by preparing an inventory of expenditures for drainage and then adding 10 percent for administrative costs. These costs are to be shared proportionally among beneficiary land owners. MWRI is to impose fees on the use of government-owned water intakes, pumps, and drains. In addition, anyone who draws from a government-owned pump should pay for that water if it is not meant for agricultural use.

- **Jordan**

Jordan has a fairly well-developed system of water charges. It charges for the base resource as well as processing fees for ground water. First, a series of fees are levied for drilling licenses, drilling permit renewal, well deepening, well maintenance, and possession or use of a drilling rig. The prices levied annually for water ab-stracted from private sources are fixed by law. There is no charge for water use under 150,000 m3/yr. There is a 25 Fils charge/m3/yr from 151,000–200,000 m3/yr, and a 60 Fils charge/m3/yr for over 200,000 m3/yr. Prices also are fixed for water extracted annually from government-owned wells, for industry-owned wells, for wells used for tourism or university purposes, and for active unlicensed agricultural wells whose status will be rectified under the law.

There is a charge of 250 Fils per m3 for the sale of water from wells designated as drinkable water, as well as a lesser charge for water extracted from wells designated as non-drinkable. Finally, the law provides for charges imposed by the government for services rendered in

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supervision, technical field inspections, and other monitoring activities.

- **Morocco**

In Morocco, any individual or juridical person using public domain water is required to pay a water user fee. It is unclear whether the regulations ave been passed that would govern the collection and quantification of the fees. Collection of fees can be enforced against either the owner or the operator of a water intake (jointly and severally liable).Tunisia also provides for water use fees for authorizations or conces-sions not declared of a public nature. Charges are calculated based on the volume of water granted in the agreement.

- **Management of Water Pollution**

The law on managing water pollution is very rich in some countries. Egypt, Jordan, Morocco, and Jordan are at the forefront.

- **Planning and Development and Information**

The importance of long-term planning in the water sector has come into greater importance only in the last decade as water shortages coupled with dramatic increases in demand have captured the attention of policymakers. Only the most recent framework laws in the Middle East and North Africa region include any significant coverage of planning for the water sector. Both Yemen and Morocco have developed significant legal frameworks for planning. However, as with enforcement, the larger issue is really how well the law is applied. Although information gathering is critical for planning, almost no law includes any significant attention to providing a structure to gather information and translate it into plans for the short, medium, and long term.

- **Wastewater Reuse**

Wastewater reuse is of tremendous potential importance for the region. It can serve as additional supply for irrigated farming and groundwater injection, thereby reducing groundwater overdraws that plague many MNA countries. Fortunately, many countries have in place provisions to govern the handling, and in particular, the reuse of wastewater. Jordan, Morocco, UAE, and KSA have included wastewater reuse provisions in their laws.

- **Groundwater Management**

All of the countries reviewed in this study require some form of authorization for drilling new wells, but this is their only similarity. Only Jordan and KSA have laws with provisions for registering preex-isting wells. Morocco, and Lebanon do not require well permits unless the well will exceed a certain depth. Jordan requires a permit for all well-drilling activities regardless of depth. Jordan. and UAE are the only countries to require a license for professional drillers. Jordan also requires a license for drilling rigs. Given these significant differences, each country’s legal approach to groundwater management is detailed individually below.

3. PROPOSED ELEMENTS OF AN INNOVATIVE FINANCING SYSTEM

3.1 Promoting a public-private partnership

The vast majority of finance for water and sanitation is provided by the public sector in developing countries. The private sector provides around five percent whilst development assistance provides around 20%. However, developing country governments tend to allocate very little of their budgets toward pro-poor water and sanitation services, less than one percent in many sub - Saharan African countries. The international private sector finance also steers clear of explicitly pro-poor water sector initiatives. An analysis of finance flows in sub Saharan Africa shows that finance in the water sector goes less toward projects designed for the poorest and less to those countries that need finance for water most. Broadly, more finance is deterred from entering the water and sanitation sector in developing countries because of commercial risks, political risk and governance issues, a lack of good projects and a lack of national capacity. Out of these, unsatisfactory governance seems to be the biggest constraint. Current aid commitments could make a much more significant contribution to the problem if they were deployed to mitigate these constraints, thus “unlocking” the potential of the much greater volumes of user-finance and private sector finance that exist, to meet the financing challenge. Towards a more effective and efficient public–private- partnership (PPP) financing models:

Promoting viable and affordable investments through and increased focus on: - business development; - equity-based risk capital; - patient capital; - water services; Promoting effective and efficient public-private-partnerships (PPP) through dedicated: - investment funds - investment managers Additionally stimulating synergies by:

- promoting the technology transfer and the synergy between sectors (i.e. water and energy sector);
- promoting income generation, employment, and private sector development in view of reducing poverty also by enabling access to, water, health, food security, etc.

The primary focus is on making more effective and efficient use of existing public resources, to achieve a higher and measurable impact based on existing financial resources. This could be measured in terms of the leverage factors (for example the amount of non-treated waste water discharged reduced, or increased drinking water distributed per € spent) and their claim on human resources in the public and private sector18. Most public financial instruments available to support the transfer of water services and technologies to developing countries provide co-financing of non-profit based project. Projects that successfully passed the selection and evaluation process, are typically funded on a fixed percentage of the total eligible costs (between 30 and 70%) for the period covered (1 to 2 years on average). Only in some cases, costs related to long term assets expensed are eligible for

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public funding although such (pay back) expenditure is only covered for the duration of the project [16-25].

Few instruments exist or are used that allow capital grants, i.e. co-financing a share of the investment costs as opposed to the related expenditure especially for funding a waste water treatment plant (WWTP)[49, 52]. Projects are closed-end (mostly not extending beyond 2 to 3 years), related short-term project financing is not compatible with the investors' needs. Co-financing a fixed share of the costs associated with investments and operations does not encourage a least cost-approach, projects may be oversized or not adapted to the local supply and demand and chances of surviving in a market-based environment after reducing or stopping the public sector support are not sufficiently guaranteed especially in developing countries. Capital subsidy instruments do not require or cannot be used to structure investment ownership agreements, some investments failed to survive due to the lacking attention given to local ownership and aligning interests to take proper care of the investments and operations. Therefore each donor has a different set of requirements and often a limited opportunity for accepting and funding project proposals, project authors seeking grants spent large amounts of time securing donor funding which has often caused important delays in closing project financing deals or potential investors losing interest [52-56].

3.2 Increased focus on "business development"

Through an increased focus on "business development" as an alternative for project development, a number of these obstacles could be avoided. Attention to business development will lead to a shift from technology to water cycle services since it is water services (sanitation, delivery, collecting waste water and treatment) that will ultimately generate revenues (water still remain a right of all population for life). Attention will also shift from project-based to corporate based structures or community based structure as the most appropriate vehicles for the financial structuring and for delivering public support.

The need is than to seek reassurance over the enterprise's viability beyond the stage of public support as well as an increased focus on risk capital. "Equity" will receive more attention as a critical risk capital component whilst profitability also appears as one of the important criteria for measuring the enterprise's performance and viability. An increased attention to business development, opposed to a project driven approach, is useful to increase the focus on water services. Such a focus should prevent that investment decisions are too much technology driven but rather allow for sufficient flexibility to implement the most appropriate technologies given the "market" needs and potential.

Although the ultimate scope of Best Available Technologies supply will mainly depend on size of the investment that can be "afforded", the envisaged range of technologies should at least include tools for water demand management and services as well as the waste water technologies. When considering management issues it would be important to accommodate a wide range of investment stakes, including small joint-ventures, as well as a sufficiently wide geographical scope to ensure that investments only take place where they are warranted based on the local conditions.

3-3 Understanding the Present: Traditional and New Data Sources

To recapitulate, climate change is likely to increase the imbalance between supply and demand for water in the Arab countries. However, there is ample evidence that scarcity has been successfully managed in the Arab world for centuries. The components required to manage scarcity are information on resource availability; a bargaining process among the users to determine how water should be allocated, resulting in rules and responsibilities; and infrastructure to deliver the service. Although their details vary, similar patterns have been common across many MNA countries for centuries. However, traditional processes increasingly are under threat from ever-growing demand and new technologies that upset the "traditional" balance between availability and utilization. Climate change is adding to the strain.

The process that will be induced by declining availability, more un-certainty and variability, and declining quality will be multidisciplinary. It will draw in hydrologists, engineers, economists, agriculturalists, lawyers, and institutional specialists—just as the Assessment, Bargaining, Codification, Delegation, and Engineering (ABCDE) process does. Success will depend, among many factors, on (1) the ability of the participants in the process to communicate as effectively and unambiguously as possible across disciplines—that is, it will depend on developing a common terminology—and (2) placing the analysis of options in a basin context.

4. FUTURE WATER DEMANDS

No information is available about future water requirements in the delta. No strong population growth is expected. However, due to the increasing use of diesel pumps, abstraction of ground-water is expected to continue to grow. The growing abstraction will strongly determine future demand.

▪ Demand-Oriented Measures

As just noted, measures to strengthen groundwater recharge should be complemented by equally important actions to limit groundwater abstraction. The design and implementation of such demand-management measures are extremely complex and political. They require consultation and bargaining among numerous stakeholder groups. Consequently, this chapter does not propose specific packages for the Wadi area, However, given that demand management is an essential component of an integrated approach to groundwater sustainability, the four options below merit further investigation.

1. Downstream/upstream tradable water rights. The aim would be to create a financial incentive for upstream water users to allow more water to flow downstream as surface or groundwater. The increased flows would improve downstream groundwater balances. Clearly, the design of such a system would be extremely high risk and complex, and would require a long period of consultation and bargaining among stakeholders. Strict monitoring would be required to prevent farmers from both selling and using their water simultaneously.

2. Command and control measures, Regulatory measures could include requiring well-drilling permits and restrictions on abstractions. Water-saving measures, such as drip irrigation and the cultivation of more water-efficient crops, could be enforced. As for enhanced recharge, such measures would require better monitoring of the hydrogeological system. However, so long as groundwater is considered a free-access commodity, enforcement will be very difficult.

3. Community-based groundwater management. Given the difficulty of enforcing “command and control” measures, self-regulation seems to be the only approach to sustainable use of groundwater at the local level in rural areas. Self-regulation focuses on the development of local norms to control groundwater abstraction and use. The farmers themselves measure the water levels and water yields. However, the main challenge is to translate this data into information that helps the farmer or community understand the groundwater dynamics, increases their awareness of the need for regulation, and informs good decisions regarding water shortages.

4. Incentives. Extension and training should be integral parts of the implementation of the new measures and regulations. Alternatively, negative incentives, such as groundwater pricing or higher diesel prices, could help to limit abstraction.

5. CONCLUSIONS

The use of water resources was decisive for the rise and the decline of the ancient civilizations that lived around the Arab Countries. All this fabulous achievements were guaranteed by the balance between resources available and their use. But the modern world has a much bigger necessity of water, caused by the growing of the population while, at the same time, the use of water is becoming more and more inconsiderate and polluting. It is any way possible to imagine and new and more complex balance between men and nature, thanks to both the technological development and a better organization of society. Today is particularly efficient the “participative” decision-making process, that allows bigger parts of the population to take part actively to the choices that would influence their future.

In this paper, all the stakeholders will contribute to reach the best solutions for the collection, treating, transport and distribution of water resources, considering their needs and those of next generations. This participative process consents to optimize also the economical and financial systems of water resources management. This means that, on one side the public role could be strengthened about choices and decisions, on the other side the management itself can be optimized with business oriented structures.

The progress of civilization, which was born in the Arab Countries, could then move to a new form and a more complex balance, that will favor the development of men and societies and, at the same time, favor the preservation and valorization of the environment and natural resources.

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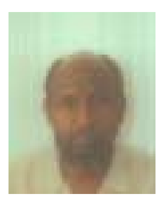

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