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Integrated water resources management is a tool for ensuring Arab water security

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Abstract

Freshwater used unsustainably in the majority of the Arab region. In most Arab countries, water predicted to become scarce by 2020 due to demand continuing to grow in parallel with increased agriculture production increased pollution, population, and economic growth. The apparent difficulties in managing freshwater resources, have led to the development at the international level of a framework: Integrated Water Resources Management Concept (IWRM). IWRM is a process that promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without comprising the sustainability of vital ecosystems.

This paper will try to evaluate the progress made by the Arab countries in formulating and implementing IWRM national strategies and analyzing the difficulties that they faced. It will assess who each country perceived its achievements, priority needs and challenges in implementation.

The paper will analyze how these strategies could help the Arab countries in achieving a sustainable development and consequently their water security.

A case study for implementing IWRM using decision support system for managing water and land resources will also be discussed in the paper. It concerns the sustainable management of a region which is facing an acute competitively for water.

Introduction

Today, freshwater is used unsustainably in the majority of the Arab countries, which extend over the driest and highest water stress region in the world. In almost all these countries water is predicted to become scarcer by 2025 or even before due to continuous demand increase. This reality constitutes a major threat towards sustainable development and achievement of millennium development goal in the region. About only 1% of world freshwater, occur in the region with 5% of world total population. Water demand has dramatically increased as a consequence of high population growth rate, expansion of agriculture, lack / weak water policy. Several Arab countries are now suffering from water deficiency and others are on the way. The prevailing climatic conditions characterized by low and variable rainfall, occurrence of frequent drought are also considered one of the major causes of this acute crisis. Other major challenges facing the region is the issue of water resources shared with countries outside the region (more than 60 per cent of surface water resources originate from outside) such as Tigris and Euphrates, Nile, Senegal) , as well as between the countries within the region (Jordan and Orontes rivers). This issue remains also as a major problem threatening the region's stability. The increasing demand for water and the declining per capita availability of water in the Arab region become an important factors in the design and implementation of a development strategy. This strategy should take into consideration the social and economic implications of declining natural water resources and how to maximize the benefits of water under conditions of increasing water scarcity . Up to now policy interventions have created or aggravated in the majority of the Arab countries environmental problems, such as establishing inappropriate subsidies that encourage overexploitation of water, mainly in agriculture sector.

In order to address water challenges in the region most Arab countries have started to revise their water policy and shift water management towards integrated approaches.

Water Resources in the Arab region : Present situation and perspectives

As stated before the Arab region is suffering from shortage of water due mainly to the climatic condition prevailing all over the region. About 95% of the area is considered as arid or semi arid which receive less than 200mm (fig 1) . These rarity of precipitation combined with high variability and frequent drought events places stress on available water resources and impacted negatively the sustainable development. The average share per capita of freshwater (fig.2) is already below the internationally accepted water poverty/ scarcity threshold of 1000 m3c/year and significantly less than the world average of 7243m3c/y (ESCWA 2005).

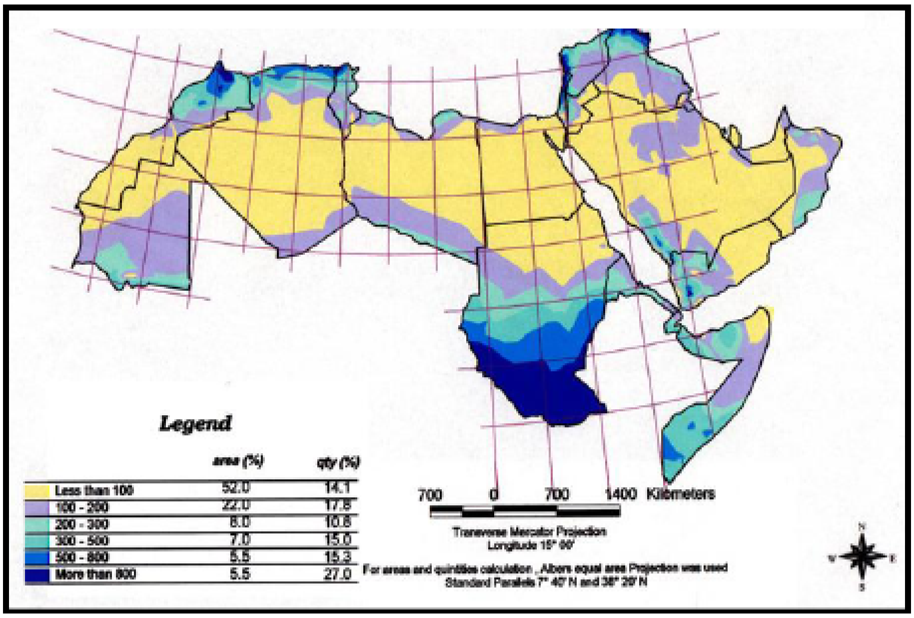

Fig. 1. Rainfall distribution in the Arab region (Source ACSAD)

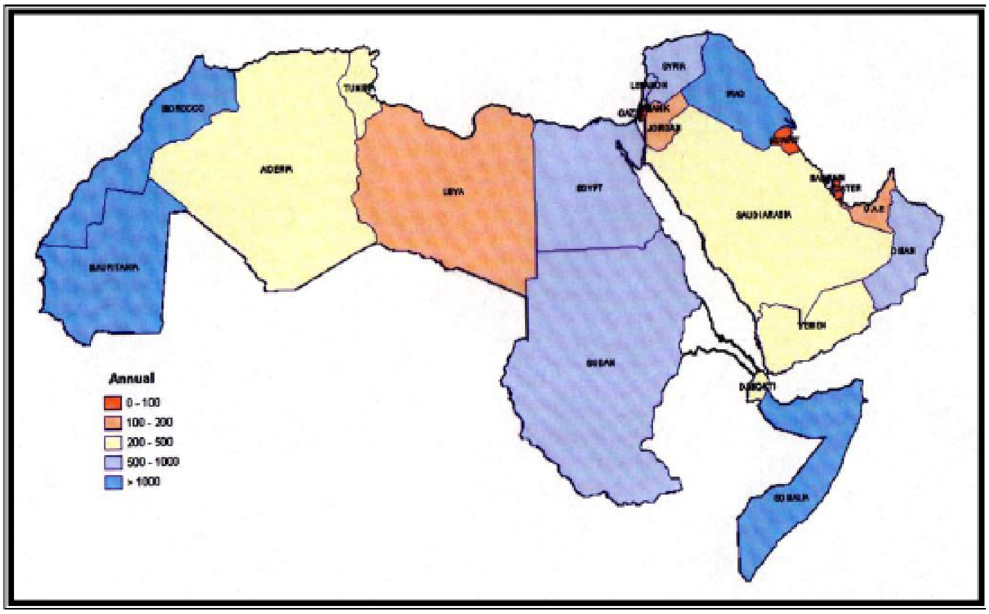

Fig. 2. Per capita water availability in the Arab region in the year 2000

The sever water –related problems have been compounded in recent years by a sharp increase in water demand due mainly to the fast growth population in most of the Arab region (3% in average) and the expansion of irrigated agriculture as part of the food security policy adopted in the years80th by most of the Arab countries. The demand now exceeds supply in many countries of the region and freshwater is used today unsustainably in the majority of the region in the absence of effective control measures or regulating mechanisms. Ten countries in the region are already consuming more than 100 percent of their renewable water resources. The extraction is almost 180% of the renewable resource base in Jordan,140% in Yemen and 99% in Tunisia (Droubi,2006 Abu Zeid and Hamdy,2004, World Bank, 1995,2000).Even in countries estimated to have significant unused reserves such as Morocco, Lebanon and Algeria, the amount that is economically exploitable became reduced. In Morocco the percent use of renewable groundwater is 63% (World Bank, 2000). Since the groundwater is considered the main source of supply in most countries of the region, due to the absence or very localized surface water resources, and even it is more accessible to water users, over extraction of aquifers is becoming severe in many areas resulting in lowering of the water table. GIWA (Global International waters Assessment) report that water table has fallen as rapidly as 0.6 m/y in Azraq basin in Jordan (GIWA 2006) leading to hard increase in the groundwater salinity. (fig.3). In Yemen the abstraction of groundwater in Sanaa area is more than three times higher than recharge and aquifer levels are declining at rates of up to 8m/ year (World Bank, 2000). Water pollution constitute another major element reducing the availability of water for human use in many countries of the region.

Increasing of salinity due to sea water intrusion in coastal aquifers which is the case in Syria, GCC countries (Cooperation Council of the Arab States of the Gulf), Tunisia …or mixing with saline groundwater is also another aspect of groundwater deterioration (this situation is well demonstrated in Oman, Bahrain and Qatar).

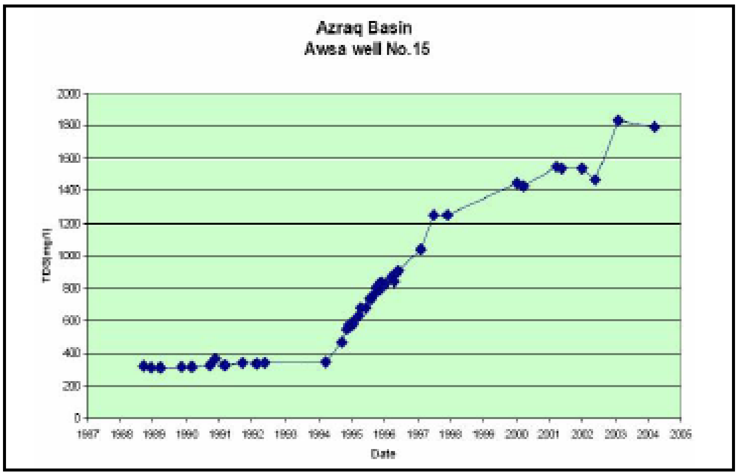

Fig. 3. Increasing of groundwater salinity due to overexploitation in Azraq basin, Jordan (AlHadidi, 2005)

The actual water withdrawal in the region is about 265bcm from both surface and groundwater, 40bcm from groundwater and 225bcm from surface water. Dabour (2005) in his study has estimated that the total withdrawal is 231 billion cm (Table 1). In North Africa the total extraction from the shared aquifer between Tunisia, Algeria and Libya (fig.4) has increased from about 350 million cm in the year 1950 th .to about 2700 million cm in the year 2000 (SSO 2003).

Domestic water consumption in the West Asia region (including the six Arab Gulf states and Mashreq countries, Syria, Jordan, Lebanon, Iraq, Yemen, Palestine) escalated from 7.8 bcm in 1990 to about 11 bcm in 2000 (40 per cent increase), a trend expected to persist until the year 2025, projected to reach about 24 bcm. Rapid urbanization, presents a major challenge in the struggle to meet increasing domestic water demands with scarce public funds. Water shortage for domestic use is a problem in key cities, especially Sana'a, Amman and Damascus (Elhadj 2004, ESCWA, 2003b).

Table1; Total withdrawal and water use in the Arab region (Dabour 2005) .

	Total Withdrawal			Agricultural withdrawal		
	Km^3/year	% of IRWR	% of TRWR	Km^3/year	% of Total Withd.	% of Actual TRWR
Maghreb	28.07	58.4	46.9	23.42	83.4	39.1
North-Eastern Africa	109.27	278.0	79.3	93.207	85.3	67.6
Arabian peninsula	28.65	369.4	361.7	25.15	87.8	317.6
Middle East	65.04	134.1	60.3	59.99	92.2	55.6
All Arab Countries	231.02	160.8	73.7	201.77	87.3	64.4
World	3240.0	8.1	8.1	2235.6	69.0	5.1
As % of World	7.1			9.0		

IRWR: Internal Renewable Water Resources TRWR: Total Renewable Water Resources.

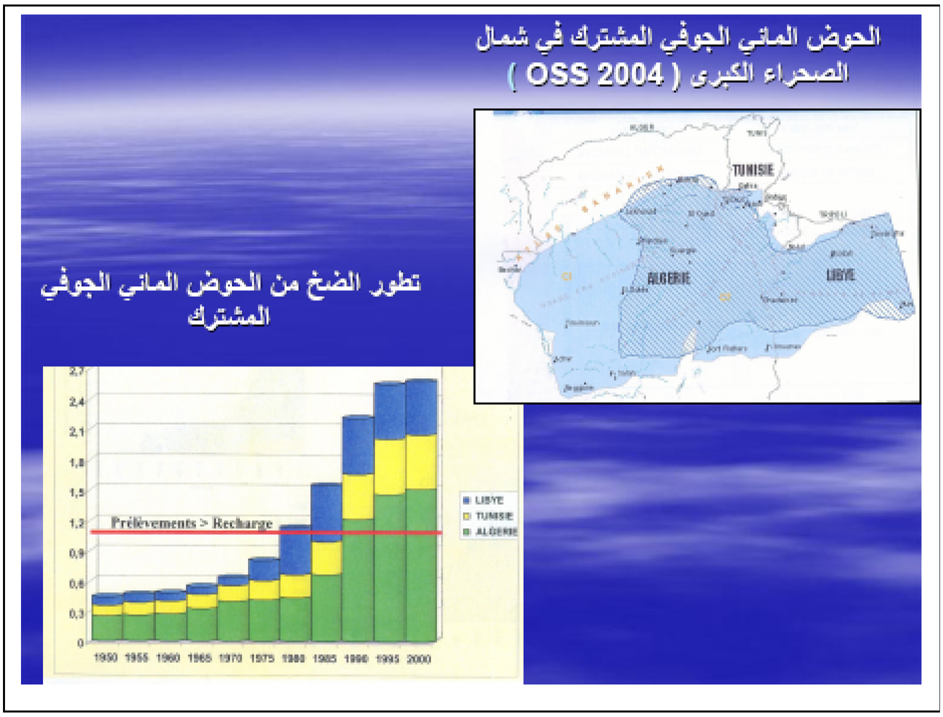

Fig.4 ; Total groundwater extraction from Northern Sahara shared aquifer (SSO, 2003).

Despite pressures exerted by domestic sector, the agricultural sector is still the largest water user of all sectors in the Arab region, consuming more than 80 per cent of total water used and the remaining is shared between the domestic and industrial sectors at almost 12% and 8% respectively (fig.5).

During the past few decades, economic policies in several countries of the region, especially the GCC, have given priority and support to the development and expansion of irrigated agriculture. Food selfsufficiency and socioeconomic development were the major goals. Agricultural water use has increased from about 17bcm in 1990 to more than 22 bcm in 2000 (World Bank, 2005), exerting immense pressures on the limited water resources in the region (table 2) . Even with the recent abandonment of these policies in many countries, it is expected that the agriculture sector pressure will continue in the future and water consumption will increase by 36 per cent by 2025.

Another major problem of great concern in the Arab region is that most of the groundwater resources is by definition non renewable and has been recharged during the past pluvial periods (Fig 6) . Any extraction from these aquifers is considered as aquifer mining and consequently the water table will continuously decline. Here the concept of aquifer sustainability (as it is defined as the level of development of groundwater that meets the needs of present generation without compromising the ability of future generation to meet their needs) is not applicable (UNEP, 2003) . The world bank reports that about 35% of nonrenewable groundwater resources in Saudi Arabia were depleted by 1995. In the

UAE about 78% of the remaining groundwater is still fresh while the rest is brackish water (World Bank 2005) .In Jordan it was estimated that the extraction of 150Mcm of groundwater from Disi aquifer in South Jordan for supplying drinking water to Amman

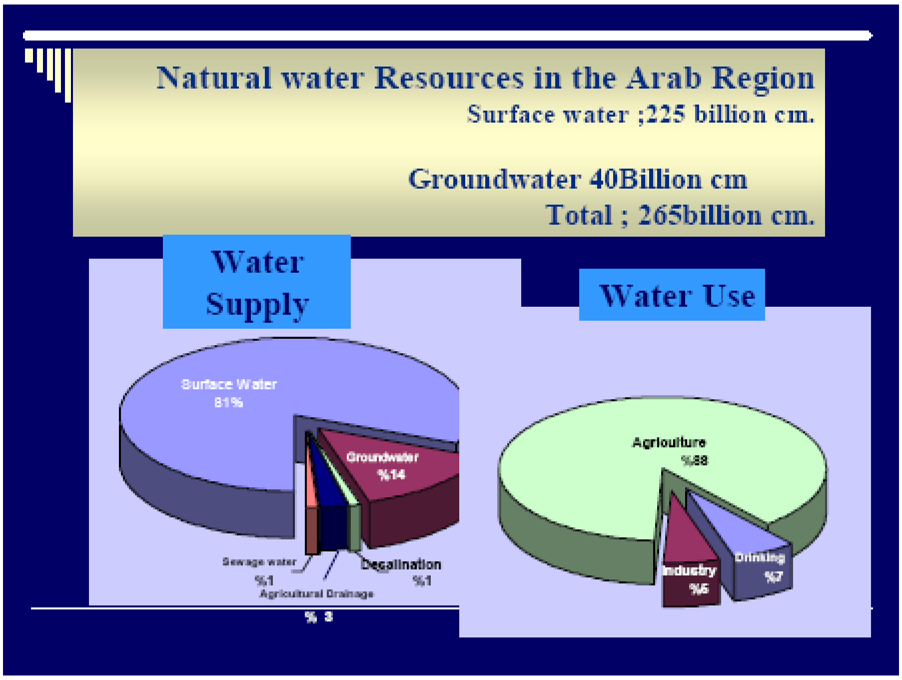

Fig.5. Natural water resources and water uses in the Arab region.

Table 2 : Groundwater irrigation and agriculture in GCC countries (World Bank,2005)

	1990		2000			1990-2000	2000
Country	Irrigation Water (MCM/year)	Total groundwater abstraction (MCM/y)	Irrigation Water (MCM/y)	Total groundwater abstraction (MCM/y)	Irrigation water share of total groundwater abstraction (MCM/y)	Groundwater Irrigation volume increase (%)	Agriculture GDP share (%)
Bahrain	120	167	137	195	70%	14%	<1%
Kuwait	80	143	221	393	56%	176%	<1%
Oman	1150	1204	1124	1240	91%	-2%	2.1%
Qatar	109	111	270	270	100%	148%	<1%
SaudiArabia	14600	15505	18300	19680	93%	25%	6.4%
UAE	950	1148	2162	2673	81%	128%	3.6%
Total	17009	18278	22214	24451	91%	31%	

would result in a total drawdown of less than 250 meters over the next 50 years (about 5m per year) . In Egypt, current policy supports an increase in groundwater extraction from 5.1 billion cm /year in 1997 to 11.6 billion cm in 2017 (most of it is non renewable) in order to partially support development of 1.4 million hectares of new irrigated area (World Bank 2000). A carefully planned intensive use of non renewable groundwater resources is recommended.

While the overall primary adopted strategy in the past has been to look for new supplies to meet growing water demand, depletion of local sources and declining quality have forced the search to focus more on water demand management. Regulating the competing claims of agriculture, industrial and domestic water consumption sectors against a background of population growth, increasing food requirements, industrialization and urbanization require new water allocation policies which take also into account the socioeconomic aspect of water use. In the course of the past two decades new important interconnected concepts have begun to constitute the heart of water resources management efforts in the region, the first deal with integrated management and the second with demand management. Both constitute what is known as the concept of integrated water resources management (IWRM) . This concept has been declared in 1990s and articulated in 3 rd .World Water Forum in Kyoto 2003.

IWRM is a systematic process for the sustainable development, allocation and monitoring of water resources use in the context of social, economic and environmental objectives. Simply it means not making decision about water resources development and management from a single standpoint, considering only the needs of a specific sector, in isolation from the needs of other sectors. It is defined as a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (ESCWA,2004) .

Progress achieved by the Arab countries for the implementation of IWRM

In view of the above mentioned challenges and constraints facing the Arab region, most of the Arab countries has started to modify their water policy. In the past, government and water users (mainly farmers) have focused on how to tap larger quantities of groundwater to promote rural development and secure urban drinking water supplies. Now a day most of the those countries has started to review their national water policy within the IWRM framework making a shift from supply side to comprehensive demand side management and are developing related institutional, organizational and legal measures to implement the new ones.

A IWRM tool box has been introduced by the Global Water Partnership at the International Conference on Freshwater, held in Bonn in December 2001. This tool box can be used for conducting a comprehensive analysis of the progress achieved in the Arab countries toward IWRM. It compromise 49 tools distributed along three axes including (ESCWA,2004) ;

- ❖ An enabling environment for the strengthening of integrated management
- ❖ Institutional roles
- ❖ Water management tool

Regarding West Asia countries, ESCWA has identified three groups (ESCWA 2005) ;

- ❖ Countries that have prepared studies or applied IWRM programs at the local or basin level or that have applied some policies with the concepts and guidelines of IWRM such as, Iraq, Lebanon, Oman, and Syria.
- ❖ Countries that are at advanced stage of formulating their national strategies (Bahrain, Kuwait, Qatar, Saudi Arabia and UAE)

- Countries that completed their national strategies for the implementation of IWRM (Egypt, Jordan, Palestine and Yemen) .

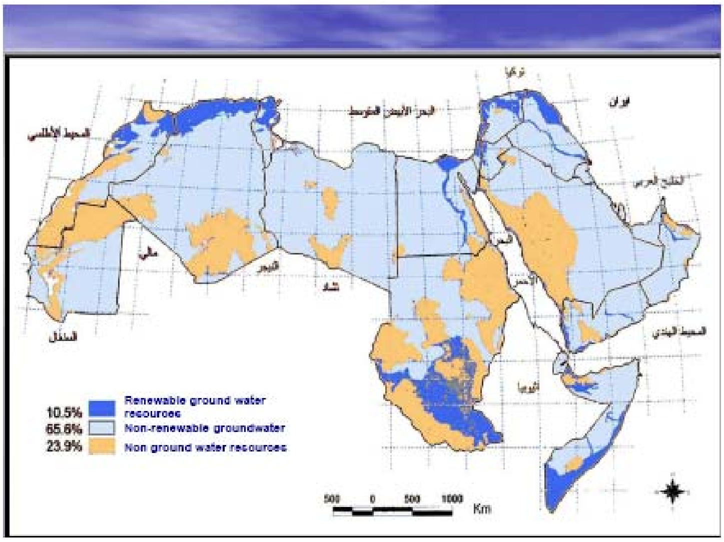

Fig. 6. Groundwater resources in the Arab region

CEDARE in a recent report about the status of IWRM plans in the Arab region (CEDARE,UNDP 2005) has mentioned that Egypt, Jordan, Palestine, Tunisia and Yemen have advanced status in developing IWRM plans. Other countries (Algeria, Bahrain, Iraq, Lebanon, Libya, Morocco, Saudi Arabia, Sudan, Syria, UAE) have developed frameworks which contains elements of policy. Kuwait, Oman, and Qatar are likely in progress. In Tunisia for example the legal aspect of water user associations has been confirmed since 1975 and now they are managing small scale irrigation systems. the farmers are responsible for all operations and management, including hiring the appropriate labor and paying the electricity (World Bank, 1995) .

As one of the aims of IWRM is to make optimal use of water at every stage in the hydrological cycle without causing environmental degradation. This means moving away from continuously building new reservoirs or deeper wells and focusing exclusively on the direct socioeconomic benefits. Despite that most of the Arab countries recognize this fact and acknowledge the limited availability of new water supply sources, there is uncertainty at various stage, as to the scope for technical measures undertook for demand side management for optimizing use of water.

The basic elements for water demand management is, improving water use efficiency, reducing water leakage, ensuring water supply during drought event and preserving the water quality.

As mentioned above the agriculture sector is still the major water consumer in all Arab countries (about 85%) with very low water use efficiency and limited contribution to their national incomes (less than 6% for GCC countries, World Bank 2005, and less than10%for other countries) as shown in table 3, (Dabour,2005).Surface irrigation is by far the most widely used technique in the Arab region, practiced on 88.3% of the total full or partial control irrigation area (Dabour, 2005) .This sector In some cases, such as in Tunisia, has witnessed significant progress in improving irrigation efficiency through the implementation of water loss reduction programs. Efficient irrigation techniques have been adopted in approximately 200000 h (more than 50% of irrigated area. This progress has been achieved through financial incentives provided by the state to the farmers (the state compensates farmers for 60% of the cost when they purchase water conservation technologies. (World Bank, 2000).In Jordan water use efficiency in irrigation is around 65%..In Syria it is around 40% but they started to adopt the same approach as in Tunisia to transfer the traditional irrigation technique into new ones within a ten years strategy. It is estimated that the water loss in irrigation is about in average 65%. This means that a great volume of water is lost (about 48 billion m3) and it is supposed that if we can reduce this rate to be about 80% which is technically possible it is possible to increase the irrigated areas by 50% (Sadik and Barghouti, 1997) .But we should recognize that this sector has a social part which can not also be neglected. It employs about 30% of the total population of the Arab countries and is assumed to still playing a significant role in the economies of most of those countries. This is the case for the Arab countries in North Africa and Mashrek countries (table 4).

The leakage rate from water distribution systems is generally very high (between 30 to 50%). This is due to the fact that most urban water agencies do not have incentives to deliver water efficiently and in some cases are unable to accurately determine the efficiency of their service delivery . Fig 7 shows the water loss and possible saving per sector in the Arab region (AbuZeid and Hamdy, 2004) .

Up to now and even with the efforts undertaken by most Arab countries for using sustain ably their water resources non of them has adopted a fully integrated approach to the planning, development and management of their water resources.

The major challenge facing water management issue in the Arab countries is that are using unsustainably their water resources.

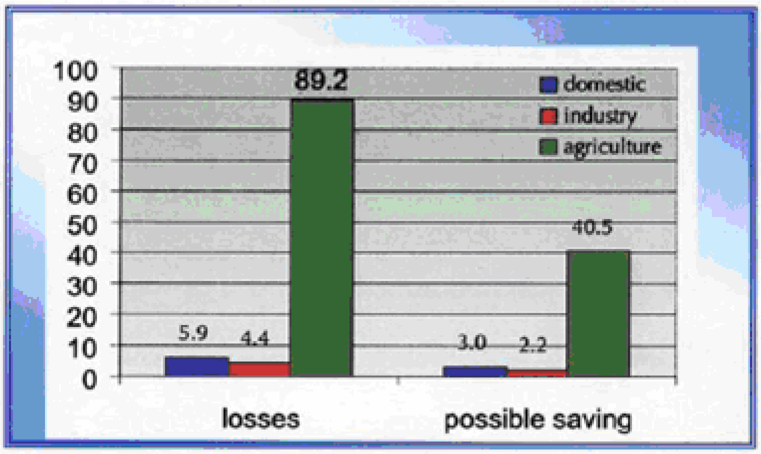

Fig 7 Water losses and possible saving (in billion cm/ year) per Sector in the Arab region (Abuzeid and Hamdy, 2004)

Table 3 Population in agriculture and share of agriculture in GDP (Dabour, 2005)

Sub-regions/Countries	Population in Agriculture 2003		Share of Agriculture in GDP (*)
	(million)	% of total	(%)
Maghreb	**21.9**	**27**	**11.3**
Algeria	7.5	24	10
Libya	0.3	5	8
Mauritania	1.5	52	21
Morocco	10.3	34	16
Tunisia	2.3	24	12
North-eastern Africa	**48.2**	**42.8**	**19.5**
Comoros	0.6	72	39
Djibouti	-	-	4
Egypt	22.6	31	17
Somalia	5.4	75	
Sudan	19.6	58	40
Arabian Peninsula	**12.66**	**23.8**	**4.2**
Bahrain	0.07	1	1
Kuwait	0.03	1	1
Oman	1.0	34	2
Qatar	0.06	1	1
Saudi Arabia	1.9	8	5
United Arab Emirates	0.1	4	4
Yemen	9.5	47	15
Middle East	**8.6**	**15**	**14.8**
Iraq	2.8	16	15
Jordan	0.6	10	2
Lebanon	0.1	3	12
Palestine	0.4	11	7
Syria	4.7	27	23
All Arab Countries	**91.36**	**30**	**9.1**
World	**2673.6**	**43**	**4**
Developing countries			**12**
As % of World	**3.4**		

Sources: FAO Database (FAOSTAT).
(*) Average 1999-2003. World Bank, World Development Indicators, various issues.

Table 4 :Percentages of population working in agriculture sector and volume of water used in this sector (ACSAD, 1997, Dabour, 2005) .

Country	% of workers in agriculture sector comparing to total population in 2003	% of Water used in agriculture compared to total water used
Egypt	31	78
Syria	27	95
Morocco	34	90
Tunisia	24	82
Jordan	10	75
Algeria	24	65
Sudan	58	97
Yemen	47	95
Mauritania	52	88
Saudi Arabia	8	89
Oman	34	91
Qatar	1	72

Managing water scarcity: the way for the Arab water security

On the basis of the previous discussions concerning the critical water management issues facing the Arab countries, and taking into account drought frequency occurrence and the achievement of Millennium Development Goals of reducing by half the percentage people without access to safe drinking water and proper sanitation in the future by 2015, the strategy to manage the inevitable competition between different water use sectors (domestic, industry, agriculture) should focus on ;

- A broad base water demand management policy based on the concept of optimizing to maximum the return of cubic meter used by different sectors This imply ;
  - enhancing urban water demand management
  - improving the efficiency of water use and reducing waste and
  - losses
  - adopting a comprehensive program for nonconventional
  - water resources including desalinated water, reclaimed waste water,
  - brackish water.
  - reforming the agriculture water policy and increasing water
  - productivity in this sector.
  - preserving the water quality and environment.
- Reforming institutional roles and relationships

This include ;

  - enhancement of water legislation
  - institutional capacity at the national and local level
  - cost recovery policy of water delivery (metering, revisiting subsidy policy in agriculture sector and direct it towards on technologies which promote water

conservation or using high productive crops with less water consumed instead of water production, fertilizers and price support program.) ,

- ❖ participatory approach in water management and promotion of water
- ❖ users associations and communication with stakeholders
- ❖ participation of private sector in water resources development
- ❖ capacity building and water awareness
- ❖ increasing investment in water sector.

- Development of a tool that will help decision makers weigh up the various alternatives available and arrived at viable decision. this require ;
  - ❖ enhancement of water knowledge bas (enforcement of water monitoring systems).
  - ❖ on going water resources assessment
  - ❖ developing of models and decision support systems
  - ❖ developing of a plan for IWRM

Achieving food security was and still in some Arab countries is considered a strategic goal , but the implication of this goal on available water resources has unfortunately induced unsustainable use of those resources and led to hard deterioration of the environment in many areas. Even if additional sources of water were developed, the remaining reserves of renewable water resources are
largely marginal. Their development would be at great cost than was in the past and would still not be sufficient to meet the amounts of water needed to achieve the goal of self sufficiency, even in cereals (Sadik and Barghouti,1997).

Coping with water scarcity requires that measures and policies of water management be in line with the concept of sustainable development.

Desalination is also a strategic option for the future. This strategy was already adopted by the GCC countries for providing the principal / industrial supply of water. The percentage share of desalinated water of the total urban water demand is about 100% in some countries as is the case in Qatar (table 5) .But through out the GCC countries there are few, if any, efforts to improve demand
management of urban water supplies through metering, pricing and other efficiency improvement measures. The average per capita water consumption is very high, about 500l/day in average comparing to Tunisia which is around 106 l/day (World Bank, 2005) .

Table 5 ; Desalination water supply share in 1990 and 2000 in GCC countries (World Bank 2005)

Country	1990			2000		
	Municipal water (MCM/y)	Desalination water production (MCM/y.)	Desalination share%	Drinking water (MCM/y.)	Desalination Water production (MCM/Y.)	desalination share
Bahrain	103	56	54%	115	76	66%
Kuwait	303	240	79%	465	418	90%
Oman	86	32	37%	169	55	33%
Qatar	85	83	98%	132	132	100%
SaudiArabia	1700	795	47%	2500	1022	41%
UAE	540	342	63%	831	674	81%
Total	2817	1548	55%	4212	2377	56%

As a conclusion, a new perspectives for integrated management of the soil and water are urgently needed. The concept of IWRM meet the needs of the present without compromising the ability of future generations to meet their needs. It is a process of change in which the exploitation of resources, the institutional changes and orientation of development are all in harmony.

One of the main tool for the implementation of IWRM recently developed is the decision support system (DSS) .This tool aim to facilitate the implementation of the integrated management of the water resources and to avoid potential conflicts arising from competing demands of complex water resources systems.

Decision Support System

This system is based on a holistic approach taking into account the interlinkages between different stakeholders to meet the water demands of growing population without requiring new water transfer from region to another and without also creating high pressure on the environment.

The inter-linkages between different ecosystem components and the services which this system could provide for sustaining and fulfilling human life needs and the ability to capture the competitive interaction between all is considered as the main target of establishing the DSS (fig.8).

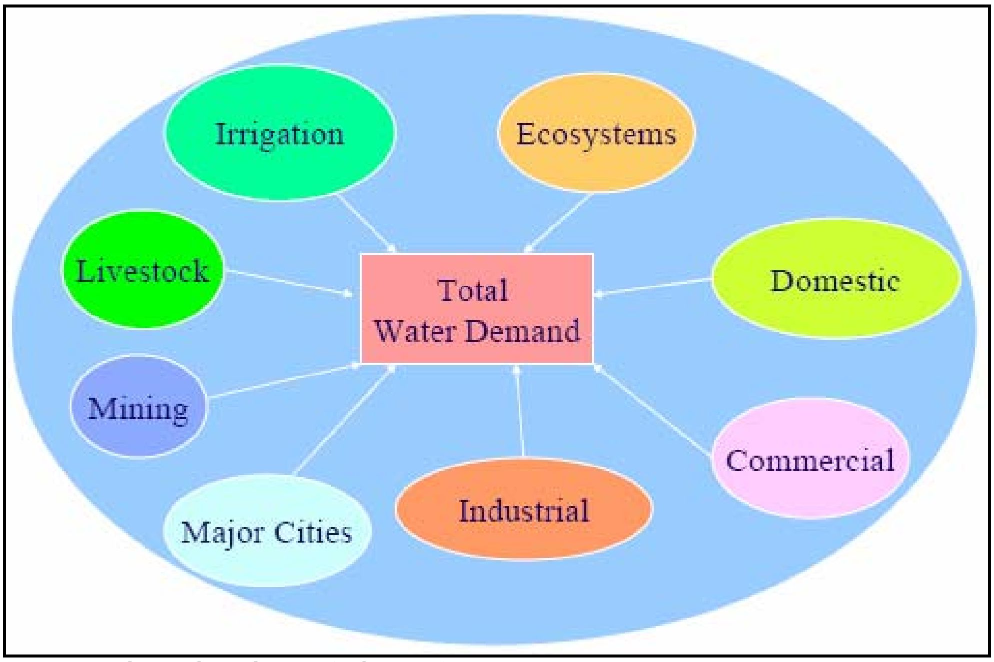

Fig.8 . Sectoral water demand system (Seiber, 2006)

A DSS for WRM is usually a combination of:

- An information system databases, GIS, etc
- Advanced engineering Mathematical Models (water quantity, water quality, lake, waste load, etc.) with a simulation model where optional WRM strategies under various scenario's are defined and analyzed on their impacts on water issues, overall environment, and socioeconomics
- Graphical User Interfaces (GUI) that connect decision-makers directly to the models and data they need to make informed scientific decisions.

ACSAD –BGR cooperation project in using DSS in water resources management

ACSAD has started, two years ago within a technical cooperation with BGR (Federal institute for geosciences and natural resources, Hanover, Germany) to implement a project entitled Sustainable use and management of groundwater resources and soil in the Arab countries. Through this project it was decided to use WEAP21 (Water Evaluation and Planning Model Version 21) as a system for managing the water resources in the two pilot areas, one in Syria and other in Morocco. This system which was developed by Stockholm Environmental Institute –Boston – USA (Yates and al, 2005 part 1 and 2) is an integrated water resource management tool designed to evaluate user–developed scenarios that accommodate changes in the biophysical and socioeconomic conditions of watershed over time (Yates and al. 2005, Raskin and al.1992).

One of the WEAP21's strength is that it places the demand side of the water balance equation on a par with supply side. It describes the water related infrastructure and institutional arrangements of a region in a comprehensive, outcome –neutral, model based planning environment that can illuminate strategies and help evaluate freshwater ecosystem services. This capability is powerful in reducing potential conflicts among users in a study area through, for example, scenario-based gamin approaches. WEAP21 is operating on the basic of water balance accounting, and can address a range of inter –related water issues facing municipal and agriculture systems, water allocation, sectoral demand analyses.

The Decision Support System (DSS) for Soil and Groundwater Management in the two pilot areas will give decision makers the necessary insight into the current status and the possible scenarios of the future development (population growth, agriculture development, etc.). In both pilot areas (Zabadani basin Syria, Berrechid basin Morocco) a water conflict between concurrent users already exists and so far no abstraction limits/ abstraction monitoring is implemented. Therefore the project aim is to collect all relevant data, get the representative water users together and jointly decide after the winter rains and the resulting calculated stored groundwater volumes by the aid of the DSS on the water shares for the current hydrologic year and beyond.

Groundwater is the main water source in both areas and heavily over extracted as shown in Fig. 9, 10 and11.

ACSAD has previously study the Zabadani area by preparing a groundwater model (Al Sibai and als,2003)

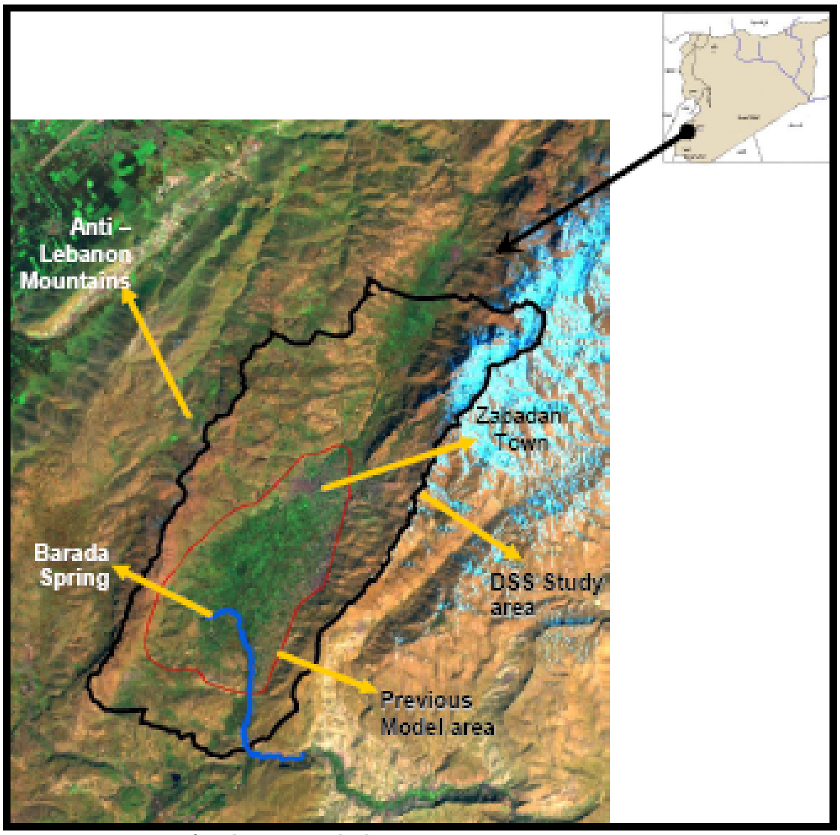

Fig. 9. Location map of study area in Zabadani - Syria

Fig. 10; Some views of the study area in Zabdani - Syria

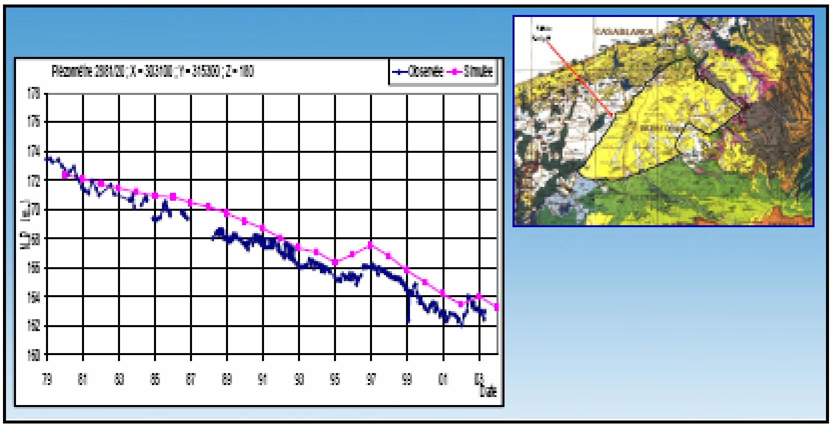

Fig.11. Location of the study area in Morocco

The DSS consist of 3 major components (Fig12):

A) Project database: climate, boreholes, spring, groundwater level, river discharge, groundwater/ surface water abstraction, soil, land use, irrigation data, etc.
B) Groundwater Flow Model (MODFLOW): for spatial assignment and calculation of the actual groundwater storage at each time step
C) WEAP21 Model: as a user friendly planning, evaluation, Scenario-calculation and visualization-tool.

The Project Database will be designed for each pilot area separately, depending on the available local data sets. For the DSSmodels the open source code MODFLOW 2000 and for developing countries freely licensed software WEAP21 will be applied in order to share and spread the DSSTool through the Arab region.

For implementing the project in both areas, several steps have been adopted ;

- ❖ Updating of the existing water data base where additional information are assessed.
- ❖ Developing an interactive link between Modflow and WEAP21
- ❖ Building a conceptual and mathematical model for the area taking into account the hydrogeological conditions.
- ❖ Developing/Applying a DSS software (WEAP/MODFLOW/Additional Models)
- ❖ Application of DSS in the two pilot areas
- ❖ Institutionalization (including capacity building)
- ❖ Dissemination

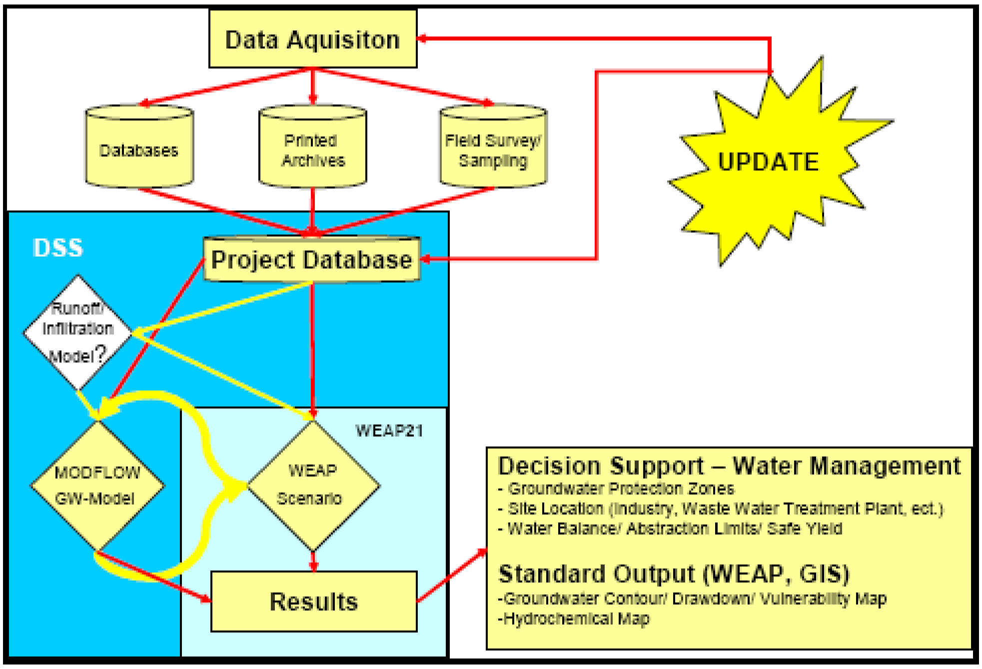

Fig.12 . The proposed DSS Structure.

The first two activities are undergoing now. It is expected to test a beta version of DSS by end of autumn 2006.

Conclusions

In view of the above mentioned challenges and constraints, among many others appropriate solutions have to be found to mitigate the prevailing problems and to prevent others from arising in the near future which could affect the economic development in the Arab region. In this regard a new water policy should be adopted based on the following points ;

- ❖ Water is a free natural commodity, but the cost recovery of its delivery must be considered. A maximum benefit of the cubic meter consumed should achieved. This not an easy task to recover the cost of water delivered, especially from farmers who have received during long time water without economic consideration for efficient water use and protecting its quality In this regards, a new institutional reforms and legal arrangements must be undertaken .
- ❖ Adopting technical and economic policies for increasing water use efficiency and agriculture productivity. In this case subsidies must be adopted for water conservation and agriculture production rate than for water production or basic elements of agriculture activities (fertilizers, pesticides ….).
- ❖ Water management has to move from expanding supply to managing demand

- ❖ Enhancement of participatory approach, where water users should be involved in decision affecting their interest.
- ❖ Public financial resources are limited and will not be able to cover the accelerating demand on water, private sector must be encouraged to take part in this domain (mainly in operation and management) .
- ❖ There is an urgent need to reconsider the population growth policy in all Arab countries and try to reduce the actual growth, which is now around 2.8% or even more. The natural resources in the region (mainly land, water,) will not be able in the future to cover the water and food demand.
- ❖ Data collection, scientific research and social and economic study related to water issue must be strengthen. This would serve to enhance sound decisions and policies about the efficient allocation and use of water resources.
- ❖ Expand use of treated waste water
- ❖ Finally adopting the systematic approach on water management based on the concept of IWRM and DSS in defining the new water policies in the Arab countries.

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الإدارة المتكاملة للموارد المائية كأداة لضمان الأمن المائي العربي

عبد الله الدروبي

إ دارة الموارد المائية - أكسا د – دمشق – سوريا

الملخص

يستعمل الماء العذب بطريقة غير مستدامة في معظم الدول العربي ة، ومن المتوقع أن تواجه هـــذه الدول أزمة مائية بسبب ازدياد الطلب على الماء الذي يترافق مع التوسع الزراعـــي والنمـــو الـــسكاني والاقتصاد ي، إضافة إلى ارتفاع نسبة تلوث الميا ه.

لقد ساهمت الصعوبات التي واجهت تحقيق إدارة سليمة للموارد المائية في تطوير مفهوم جديد على المس توى الدولي حول ا لإدارة المتكاملة للموارد المائي ة .يعتمد هذا المبدأ على تحسين التنسيق في مجـــال تنمية و إدارة الموارد المائية والأراضي والموارد الأخر ى، وذلك بهدف تعظيم الاستفادة وزيادة المـــردود الاقتصادي والاجتماعي من حيث تحسين مستوى المعيشة بطرقة عادلة بين ال سكان وبدون أن يؤثر ذلك على ديمومة النظام البيئ ي.

ستحاول هذه الورقة تقييم الجهود التي تبذلها الدول العربية من أجل تحقيق مبدأ ا لإدارة المتكاملة للموارد المائية وتطبيقها على أرض الواقع من قبل هذه الدو ل، إضافة إلى تحليل الصعوبات التي تواجـــه تحقيق هذا المبد أ .كما ستحاول الورقة تحديد رؤية معظم الدول العربية لتحقيق هذا المفهوم والأولويات التي وضعتها من أجل ذلك والتحديات التي تواجهه ا.

ستحاول الورقة أيضا تحليل كيف يمكن لهذه الاستراتيجية أن تساعد الدول العربية في تحقيق تنمية مستدامة وبالتالي أمنها المائي.

كما سيتم التطرق إلى حالة دراسية عن تطبيق ا لإدارة المتكاملة للموارد المائية باستخدام نظام دعم القرار لإدارة موارد المياه والتربة وذلك في منطقة تتعرض لمنافسة كبيرة وأزمة حادة في التنافس على موارد المياه المتاحة.