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in

Hamdy A. (ed.), Monti R. (ed.).
Food security under water scarcity in the Middle East: Problems and solutions

Bari : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 65

2005
pages 183-197

WATER RESOURCES PLANNING AND DEVELOPMENT IN JORDAN

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SUMMARY – Water issues are linked to scarcity, maldistribution, and sharing. The development and management of water resources in Jordan presents a challenge for water managers and experts. The paper will present a shift in water planning in Jordan from supply- side water management to more integrated and demand-driven water management. Assessment of existing water supply and demand will be presented and strategies will be outlined. Potential available water resources and uses will be presented. Strategies to meet unsatisfied water demand will be presented. These include use of non-conventional water resources, privatization, efficiency enhancement in distribution systems and demand management. Scenarios for sustainable water management are developed. Each scenario was based on combinations of role of government in water sector and the national financial situation. Comparison among these scenarios will be performed for the case of Jordan and a set of recommendations will be stated. The adoption of a new strategy for water planning in Jordan is crucial for sustainable water development. This strategy should focus both on demand management and development of non-conventional water resources. With the same trends in population growth and water use, the gap between water supply and demand will continue to widen. The objective of this paper is to present the various components of water planning in Jordan along with future scenarios of water management.

Key words: water, shortages, planning, Jordan, scenarios, strategies

1. INTRODUCTION

While water shortage is recognized and experienced in many parts of the world, the Arab World is considered to be the largest single region where deficit between renewable water resources and demand for water is quite significant and extremely severe. Even with the existing non-conventional sources, relied upon in some of the Arab countries, this critical situation is expected to get worse with the ever – increasing population in most of these countries.

The Arab World faces acute water shortages. About 500 m^3 /yr are needed by each person for sustainable living, although the United Nations and others sometimes use 1,000 m^3/yr as more acceptable for modern life. The FAO (1995) carried out an intensive study on water resources development and management in the Arab Region and documented the per capita stake for selected countries that have less than 500 m^3 /year as actual renewable water resources (ARWR) per inhabitant, as shown in Table 1.

Table 1. Actual renewable water resources per inhabitant for selected Arab countries

Country	Actual renewable water resources per inhabitant (m^3/yr)
Kuwait	13
U.A.E	79
Qatar	96
Libya	111
Saudi Arabia	134
Jordan	161
Bahrain	206
Yemen	283
Oman	455
Tunisia	463

However, other countries from the same Arab region show higher per capita renewable water resources. Table (2) indicates that Syrian and Egyptian citizens still enjoy high level of renewable water resources.

Table 2. Actual renewable water resources per inhabitant (m^3/yr) in relatively water rich Arab countries

Country	Per Capita renewable water resources (m^3/yr)
Sudan	597 (Marginal)
Libya	720 (Marginal)
Egypt	926 (marginal)
Syria	1791 (high)
Iraq	1852 (high)
Mauritania	5013 (higher)

A comparison was carried out to show the countries with total water withdrawal greater than the national renewable water resources and contribution of other sources of water to the total withdrawal. Selected countries are shown in Table 3.

Table 3. Water withdrawal expressed as percent of Actual Renewable Water Resources (ARWR) for selected Arab Countries

country	Water withdrawal (% of ARWR)	Use of non-conventional water and groundwater depletion (% of the total water withdrawal)
Jordan	112	22.8
Syria	55	15.2
Egypt	95	2.9
Bahrain	206	62
Saudi Arabia	709	85.2
U.A.E	1405	94.3

It should be noted that most of the Gulf countries have very high dependency ratio of non-conventional to renewable water resources, mainly that of desalination. This dependency ratio ranges from 100% as in the case of Kuwait down to 53% as in the case of Oman. Where for the case of Jordan, still the non-conventional water resources represents small portion of the demand - supply formula.

2. THE CASE OF JORDAN

Water problems in Jordan are diverse and changing as the gap between supply and demand widens. Water issues are linked to scarcity, maldistribution, and sharing. The development and management of water resources in Jordan presents a challenge for water managers and experts.

The adoption of a new strategy for water planning in Jordan is crucial for sustainable water development. This strategy should focus both on demand management and development of non-conventional water resources. With the same trends in population growth and water use, the gap between water supply and demand will continue to widen. The objective of this paper is to present the various components of water development and planning in Jordan along with future scenarios of water management.

3. WATER SUPPLY AND DEMAND IN JORDAN

In Jordan, the gap between available water supply and demand was first observed in the domestic sector. The gap is more likely to widen further in the municipal, agricultural and industrial sectors unless adequate measures are taken.

Jordan's water resources are composed of surface water, groundwater and reclaimed wastewater. Total available water amounts to 1010 million cubic meters (MCM) in 1998 (MWI, 1999). Surface water contributes 450 MCM and reclaimed wastewater amounts to 52 MCM. Groundwater makes the largest contribution of 508 MCM/yr. Groundwater abstraction is 445 MCM from renewable aquifers and 63 MCM from non-renewable basins. The safe annual yield from the renewable aquifers is estimated to be 276 MCM, which means that about 170 MCM are being over pumped (i.e. the annual abstraction is 161% of the safe yield). This over exploitation of ground water resources imposes a major constraint on sustainable water development. Using 1999 figures, water uses from all resources were distributed as shown in Table (4) for all purposes.

Table 4. Current water uses in Jordan (MCM/year) in the year 1998.

Resource uses	Surface water	Groundwater	Wastewater	Total
Municipal	46	170	-	216
Irrigation	350	313	52	715
Industrial	2.5	22	-	24.5
Others	51.5	3	-	54.5
Total	450	508	52	1010

Municipal uses represent around 21% of the total consumption and irrigation uses represent around 69% of the total consumption. Ground water is considered the main source for irrigation and municipal uses followed by surface water. With the current trend in water use, it is anticipated that within the next decade, Jordan will have utilized all the potentially available conventional water resources. By 2010, the population of Jordan is projected to become 7.1 million. The demand in the municipal sector will be about 500 MCM and in industry about 100 MCM. Based on projections of water supply and demand, Jordan is likely to face a potable water crisis by 2010.

3.1. Available water resources in Jordan

3.1.1. Groundwater resources

Jordan's water resources, surface and groundwater, depend mainly on rainfall which is estimated at a long term average value of 8532 MCM/year (MWI, 1999). Moreover, the former figure is subject to substantial variations with the nature of rainfall patterns in the country. Variation may fluctuate at ± 4 averages as will be described later.

Groundwater constitutes the most important available resource that can be tapped in over 80% of the country in varying quantities and qualities, and at varying depths ranging from a few meters to more than 1000 meters. Groundwater in Jordan is of two types, renewable and fossil. The latter constitutes 5% of the total groundwater storage of most hydrogeological regimes in Jordan. Estimates of the groundwater safe yield are around 276 MCM/year.

For the fossil water quantities, found in the south eastern part of the country, estimates depend on the exploitable depth and other hydrogeological factors, however this reserve is estimated at 90 MCM/year for a period of 100 years. Quality of groundwaters varies from one aquifer to another; salinity ranges from 170 ppm to 3000 ppm in some places.

3.1.2. Surface water resources

Surface water resources in Jordan comprise two principal parts; base flow and flood flow. Baseflow is derived from groundwater drainage through springs. Surface water is developed through 13 water basins distributed all over the country. In 1998 the actual supply of surface water was 450 MCM/year (MWI, 1999) and this number is expected to increase to 550 MCM/year by the year 2005. This increase is due to the construction of four dams on Yarmouk River, Mujib, Wala and Tannur wadis.

The main surface resource is the Yarmouk basin in the north which contributes almost 45% of base flow and flood flow waters in Jordan. Eleven dams with a total safe yield of 130 MCM/year have been constructed along the main rivers and streams of the Jordan valley.

3.2. Other water resources in Jordan

Different non-conventional water resources are considered as potential water resources. These include reclaimed waste water, ground recharge, water harvesting, desalination of brackish and sea water and importation of water across national boundaries. A brief description of these resources follows.

3.2.1. Reclaimed wastewater

Reclaimed wastewater is an important non-conventional source in Jordan. Currently, there are 21 operating plants of which Khirbit Al Samra is the largest with effluent volume corresponds to about 75% of the effluent volume nation wide. Plans are underway to construct 23 more treatment plants to serve an additional 34 towns and villages in Jordan. These plants will have a combined treatment capacity of 75 MCM in the year 2005 and 110 MCM in the year 2010 (JRV study, 1995).

Extensive plans and studies are underway to assess the feasibility of using reclaimed water for irrigation in areas adjacent to the treatment plants. The current policy of Water Authority is to consider the reclaimed wastewater as a valuable commodity and should be utilized efficiently close to the treatment plants or at the potential areas. About 52 MCM/year is used currently for restricted irrigation purposes.

Recent studies at Water Authority (WAJ, 1999) showed that the average unit cost of treating one cubic meter of wastewater in Jordan is 0.52 $.

3.2.2. Water harvesting

Two types of water harvesting applications are considered for the case of Jordan; urban water harvesting such as the roof harvesting, and the agricultural water harvesting such as the cases of artificial recharges at potential catchment areas.

Some projects have been identified and implemented in Jordan to use excess water available during the rainy season by enhancing natural recharge. According to the Jordan Water Master Plan in 1977, about 5% of the total rainfall is infiltrated as natural recharge. Water harvesting has always been practiced in The Middle East and particularly in Jordan. This technique is popular in rural areas and is practiced with simple engineering design, where rainwater is collected from little watersheds or roofs of houses and stored in a concrete lined wells.

Water harvesting can be expected on a large scale by building big reservoirs to collect the runoff water developed by harvesting. Water harvesting is estimated to reach 6 MCM/year by the year 2005 (JRV Study, 1995). Net water harvesting from residential and industrial roofs was estimated for 2005 to be 9.5 and 4.3 MCM/year, respectively (Preul, 1994).

3.2.3. Desalination

Desalination of brackish and sea water seems to offer a sound alternative to arid lands bordering seas or salt lakes; desalination plants producing up to several million gallons per day are commercially available and already used for domestic and industrial purposes in some arid regions.

Figures show that a total desalination capacity of 15 million m^3/day is expected to be installed within the Arab World during the next 25 years. With present capital required for erecting desalination units ranging between $ 1000-2000 per (m^3/day) installed capacity, it is estimated that 15-30 billion US$ would be needed for such a purpose.

In Jordan, two main sources are available to be desalted: the red sea at the Gulf of Aqaba and brackish groundwater in Jordan Valley basins. Preliminary studies show that by the year 2010 more than 20 MCM/year could be developed in the Central Jordan Valley. This figure may reach 70 MCM/year by the year 2040 (JICA, 1995).

Costs of Seawater desalination at the Gulf countries ranges between 0.125$/$m^3$ – 1.25$/$m^3$ depending on cost of components, cost of energy and other technical items. This range doesn't include the transportation cost. The former figures to seawater desalination in conjunction with electric power generation. Employment of Reverse Osmosis technology (RO) is less expensive than the Multi-stage flash (MSF) technology for the plants that has less than 50,000 gallon/day. MSF is more financially feasible and preferred for the large scale plants)more than 50,000 gallon/day). The combined cycle desalination plants which entails both generating the power and desalination facilities showed reduction in the operational cost up to 30%.

For the case of seawater desalination at Aqaba, the transportation cost of fresh water from Aqaba to the capital Amman may add big burden on the total unit cost.

3.2.4. Importation of water

Preliminary studies have been conducted to assess possibilities for importing water to Jordan, and sources have been identified in Turkey, Lebanon and Iraq (GTZ, 1999). Conditions which are necessary for the success of such options are (a) the enforcement of regional monitoring of water resources and uses and (b) the establishment of a regional water commission to ensure sustainable water management.

A study was completed in 1985 to import 160 MCM/year from River Euphrates in Iraq to supply the northern part of country (Humphrey, 1985). Another major water importing project is the Turkish Peace pipeline. This project is intended to divert the water of Rivers Ceyhan and Seyhan in south Turkey to supply Jordan and other countries with water. The major concern with regard to importing water is political uncertainty encountered in such multi-national projects (Hussein and Al-Jayyousi, 1999). The estimated unit costs for all these options are described in the following sections.

3.2.5. Mega-scale projects

Three mega-scale projects are considered in the Jordan water sector investment plan. These projects are the Med-Dead project, Red-Dead project and Disi-Amman project. The first and second projects are multi-purpose schemes that entail a conduit that convey the water from the Mediterranean sea for the first project and from Red Sea for the second scheme towards a desalination plants using the difference in elevations that will generate electricity. The desalinated water will be conveyed again to Amman and other potential demand centres. The third project, Disi-Amman project entails a conduit .that convey the fossil groundwater from Disi aquifer towards the north up to Amman city (GTZ, 1999).

All these projects are considered as long term strategic projects that require regional coordination and international support.

3.2.6. Financial comparison among the different options

Financial analysis and cost estimates were carried out for all the non-conventional options, sea water and brackish water desalination, water importation for Turkey, Iraq and Lebanon and finally the mega-scale projects. A summary of the unit costs of these options can be shown in table (5).

Table 5. Comparison of unit cost for the Different alternatives

	Options	Developed quantities (MCM/year)	Development cost (US$/M^3)	Total Cost to Amman City (US$/M^3)
1.	Desalination of Red Sea Water at Aqaba, followed by pumping to Amman.	50	0.68	0.97
2.	Desalination of Brackish water at different areas of the country, followed by pumping to Amman.	74	-	1.05
3.	Sea Water importation from Manavgat River in Turkey to Ashkalon port In Israel using water tankers.	200	1.12	1.41
4.	Sea Water Importation from Manavgat River in Turkey to Ashkalon port in Israel using bags.	200	0.55	0.84
5.	Land Water Importation from Seyan and Ceyhan Rivers in Turkey to the region.	200	1.36 (to Daraa city near Jordan/ Syrian borders)	1.54
6.	Land Water Importation from Euphrates River in Iraq to the region.	150	0.94 (to Azraq water supply network)	1.13
7.	Land Water Importation from Litani River in Lebanon to the Region.	150	0.15 (To Daganga conveyor at King Abdalla Canal)	0.68
8.	Reclaimed Wastewater	70	0.52	-

The most attractive project from the financial point of view is the land importation from Lebanon to Amman. Then because of the economy of scale, the mega-scale projects showed lower unit cost per cubic meter, mainly the Med-Dead. But this option is considered politically sensitive which drop it from the high priority future options. In the third rank, desalination of sea water and brackish water are attractive from the financial point of view and raise no political and environmental sensitivity. The importation of water using water tankers and bags are at the fourth rank, and finally the most expensive are the land importation of water from Turkey. (GTZ, 1999).

4. PRESENT AND FUTURE WATER DEMANDS AND DEFICITS

4.1. Population growth trends

During the last three decades the rate of population growth and demographic distribution has been influenced by a variety of social, political and economic factors.

Migration from rural areas to cities, especially Amman and Zarqa, has resulted in fundamental demographic changes. Average growth of the nation’s population is around 3.6%, one of the highest rates in the world, which will effect directly on the demand of water for the different purposes which will scale up the challenges of supply adequate quantities for the different consumers.

4.2. Summary of the water demands and water budget

Table 6 shows the water demand and supply for different uses over the period 1990-2010. The deficits are calculated for the same time frame. The increase in water supply for the year 2000 and 2005 in due to expected development at Yarmouk River in the north and the Disi groundwater aquifer in the south. Both are considered the last potential conventional water resources in the country.

Table 6. Water demand, supply and deficit of Jordan for the period (1990-2010)

Item	1990*	1995*	2000	2005	2010
Population (millions)	3.7	4.4	5.2	6.1	7.1
Water resources (MCM/yr)	756	832	902	1042	1042
Water demand (MCM/yr)	821	930	1050	1375	1557
Deficit (MCM/yr)	65	98	148	333	515

* Actual numbers

Source : Pride, 1992; GTZ, 1995

Without consideration of non-conventional water resources, the gap between supply and demand will increase to about 515 MCM/year by 2010. These figures show the necessity of adopting a long term water plan that considers both demand management and non-conventional water resources i.e. desalination, waste water reuse, and importation.

Moreover, pilot experiments for cloud seeding were conducted in Jordan as documented by (Al-Kloub and Al-Shemmeri, 1995). Results of cloud seeding experiments indicated a possible increase in total rainfall of about 20 per cent can be achieved over an area of 8,000 km^2 in the northern part of Jordan. Besides the rehabilitation of water networks in Jordan and construction of dams, the Ministry of Water and Irrigation (MWI) had launched water conservation and public awareness campaigns. Results of these efforts showed positive impact on water conservation (WQIC, 1995).

4.3. Legal and institutional framework

Ministry of Water and Irrigation comprises three entities; the Ministry of Water and Irrigation itself, Water Authority of Jordan and the Jordan Valley authority. Unlike the service agencies whose responsibilities are defined by legislation, the MWI is empowered by a by-law (No. 54 of 1992) under article 120 of the constitution. The Ministry is responsible for formulation and implementation of water and wastewater development programs. Its main functions, according to its mandate, are to formulate policy and strategy, plan water resources development, carry out research and development, conduct socio-economic and environmental studies, monitor water and wastewater projects, implement human resource development and public awareness programs and establish information systems.

5. FUTURE SCENARIOS FOR SUSTAINABLE WATER DEVELOPMENT

The approaches for dealing with water issues in Jordan are characterized by crisis management. This was evident in three major areas of water management:

1. Rationing and interruptions of water supply for many users during summer times.
2. Water quality deterioration for both domestic and irrigation.
3. Delays of tariff adjustment after opposition from farmers are voiced.

The following issues in water management have been identified. These include problems related to fluctuations of supply, water pricing, water quality and user’s participation.

5.1. Uncertainty and fluctuations in water supply

Surface water resources depend on base flow and flood flow. Due to the erratic distribution of rainfall from one year to another, potential water supply in Jordan is uncertain and the range of fluctuations from year to another are high (above 25%) of the average annual figure. During the period of (1998-2000), rainfall experienced about 35% reduction in comparison to the long term average.

Subsequently, rationing of domestic water supply has been practiced. In addition, during the Gulf Crisis, an emergency plan was implemented to supply water for the domestic users.

Over-exploitation of ground water in the Jordan Valley basin is taking place. In 1993, the extraction rate was about 42 MCM while the safe yield was only 21 MCM/year. As a result, water quality deteriorated and moreover some aquifers faced mining. Therefore, preventive measures must be taken to ensure the sustainability of water development in Jordan.

5.2. Water pricing

A tariff of 0.2 cents per m^3 of irrigation water in the Jordan Valley was first introduced in 1961. In 1966, this rate was raised to 0.4 cents for water consumption exceeding 1800 m^3 per 1000 m^2 of irrigated land. This rate was increased again to 0.6 cents per m^3 with no limit of water consumption in 1974 and to 1.2 cents per m^3 in 1989.

Tariffs are usually opposed by users, especially farmers. The ability and willingness-to-pay for water are usually evaluated prior to any increase in water pricing (JRV study, 1995).

Based on a study for the recovery of operation and maintenance costs of irrigation water in Jordan, the average cost per m^3 sold was 4 cents. Revenues from irrigation water have averaged about one sixth of the current O&M cost during (1988-1992). The average annual subsidy of current O&M costs has been US$ 4.8 million. Policies for cost recovery and pricing should be proposed for the stability and competitiveness of the agricultural production. In this regard, Abu-Sharar and Bateikhi (2002) proposed an assessment method of irrigation water efficiency based on economic yield from unit volume of irrigation water.

5.3. Water quality

One major environmental problem in Jordan is related to water pollution. Such a problem is caused by water resources contamination with inadequately treated waste water, cess pools and other environmentally-hostile practices. Pollution of Zarqa river water course and King Talal Reservoir water is a representative example as of the above causes.

5.4. User's participation

Efficient and sustainable development in the Jordan Valley requires participatory irrigation management. This means joint involvement and shared responsibility by both the Jordan Valley Authority (JVA) and the users in the operation of an irrigation system. This requires a revision of relationships and involvement of users in the decision-making process.

The JVA is in the process of modifying its law to open the door for private sector participation in operation and management of irrigation activities.

5.5. National water policy formulation in Jordan

Several studies evaluated future water policies for Jordan (Al-Jayyousi and Shatanawi, 1995). Recommended solutions may be grouped under four categories: measures to increase supply from conventional sources, measures to increase supply from non-conventional sources and measures to promote greater efficiency and conservation.

The policy framework adopted in 1994 states that allocation priorities are set as follows: First priority in the allocation of water resources will be given to meeting the reasonable needs of domestic uses. Second priority will be given to industry, tourism and other service sectors. Third priority will be given to agriculture.

The World Bank has outlined a framework for improving water resources management. It is based on treatment of water as a public good, relying on water pricing, participation of stakeholders, and decentralized management of water resources. These principles and guidelines are consistent with the Dublin Statement (1992) from the International conference on Water and the Environment as well as with Agenda 21 from the 1992 United Nations earth Summit in Rio on Environment and Development.

The formulation of coherent water policies would help guide strategic decisions regarding water priority allocation, water rights, efficiency of service, and environmental protection. The adoption of this framework represents a shift in paradigm and a divergence from a traditional planning towards an integrated approach as illustrated in Table 7.

Table 7. A comparison of traditional and integrated approaches in water planning

Dimension	Traditional	Integrated
Resources Options	Supply option (demand is taken as given)	Demand and supply options (demand can be manipulated)
Resources Diversity	Utility- owned and centralized	Diversity of resources including demand side management
Resources Ownership	All infrastructure or resources utility- owned	Some infrastructure or resources owned by other utilities and other producers
Resources Selection Criteria	Minimize prices and maintain system reliability	Divers criteria, including risk reduction, technological diversity, environmental quality, and economic development
Focus of Economic Cost Analysis	Rate payers	Multiple groups (e.g., society, program participants, rate payers, and individuals)
Conduct of Planning	Internal to the utility, mainly system planning and financial planning	Several utility department as well as outside experts, commission staff, public

Adapted from M. Hanson, D.R. Kidwell, R. Stevenson (1991)

Recently, a national water program was developed. The overall objective of the program was to formulate water policies for the sustainable development of water resources in Jordan. Moreover, the program aimed to build consensus within the water sector and stakeholders. The program was characterized as a participatory approach where various groups (public officials, private sector consultants, and NGO's) were involved in the entire process.

A summary of the major water policy issues and their corresponding policy components is presented in Table (8). Critical policy issues include allocation priorities, investment options, conservation and efficiency measures, and privatization.

Table 8. A summary of water policy issues and their components as recently adopted by the Ministry of Water and Irrigation

Water policy issues	Water policy components
Water resources assessment and monitoring	- national monitoring program - central entity for integrated management - water sustainability
Rehabilitation versus new investments	- criteria for project priorities
Regional and shared water resources	- principles to reach agreements - mechanisms for cooperation and trust
Standards and guidelines	- quality control program - standardized procedures
Water rights and water markets	- define water rights - examine possibilities of water markets
Water pricing and cost recovery	- coverage of O&M cost - differential water pricing
Intersectional allocation	- highest priority to domestic uses - adopt water productivity criteria, employment generation and socioeconomic development
Waste water management and reuses	- treatment and reuse of effluent in accordance to standards
Pollution prevention	- integrated environmental management program
Conservation and efficiency measures	- measures to improve efficiency
Privatization and private sector participation	- private sector participation should be pursued to improve efficiency and accountability
Stakeholder Participation and public awareness	- promote participation at planning and operation levels - educate the public about water issues
Research and Development	- encourage research in all related water issues

To achieve the above proposed water policies, a coherent institutional framework is needed to ensure access and accountability. Such institutions should be characterized by a distinct separation between the management of water resources (regulatory functions) and the delivery of water services (functional activities). Water sector investment program for the period 1997 until 2010 is shown in Table (9).

Table 9. Water sector investment program 1997-2010

Name of the Sector	Costs in US$ (million)
Technical Assistance programs	100
Water projects	
Major projects	53
Ongoing rehabilitation	420
Disi Amman conveyor	250
Future groundwater projects	240
Municipal water networks	151
Amman municipal water network	104
Mujib Weir, Southern Ghors project	271
Smaller size	427
Sub-total	1916
Wastewater projects	
Major projects	30
Ongoing rehabilitation	195
Amman-Zarqa wastewater	65
Ain Gazal pre-treatment plants	81
South Amman phase I	73

Name of the Sector	Costs in US$ (million)
Jordan Valley sanitation	45
Irbid stage I	62
Irbid stage II	336
Smaller projects	39
Sub-total	926
Peace projects	534
Total	3476
Projects for implementation by WAJ	2795
Projects for implementation by JVA	681

6. FUTURE SCENARIO: SCENARIO BUILDING

To depict and assess current and future water issues, constraints and possible solutions, scenarios are developed. Scenarios help us to take a long view in a world of great uncertainty. They can capture a variety of possible interactions between driving forces. Schwartz (1991) describes scenarios as:

"Scenarios are stories about the way the world might turn out tomorrow, stories that can help us recognize and adapt to changing aspects of our present environment. They form a method for articulating different pathways that might exist for you tomorrow, and finding your appropriate movements down each of those possible paths."

One of the most efficient tools in building future scenarios to achieve integrated water resources planning and development is the Decision Support System (DSS). That includes three main subsystems, data, dialog and model subsystems. A shift in thinking from traditional to integrated approaches should be adopted. Table 8 shows for each water dimension, a comparison between traditional and integrated thinking.

The process of building scenarios considering the DSS involves steps that are outlined below:

1. *Identify focal issues and key decisions.* Scenarios are usually oriented toward a particular audience or organization, MWI in this case. Scenario builders must have in mind a set of key issues and important decisions facing the organization. For example, a focal issue may be the chronic water shortage during summer time. To decide for such a problem, all scenarios should be built to be doable and consistent with the client, MWI.
2. *Identify key factors in the local environment.* A variety of internal factors help from the context for a scenario plot. For instance, what type of information is needed for making decisions about a water system? Decision makers must have information about quantities and qualities of water. How will success be defined? It maybe defined by profitability, return on investment, improved predictability or manageability of the water system and satisfied customers. What internal factors may affect decision makers and secession outcomes? Factors to be considered include financial resources, accountability, predictability of the system, capital and labour productivity, and the degree of collaboration between water-system managers, public and other stakeholders. These factors are not the driving forces in scenarios; rather, they help determine which forces are most important to consider when building scenarios. For the case of Jordan, emergency plan during summer season will require an integrated database of information, maps, locations and site reactions in order to facilitate the decisions of the control room at the MWI.
3. *List and rank driving forces by importance and uncertainty.* This was performed through brain storming from a panel of water experts. The driving forces were grouped under six areas: management, finance/economics, policy institutions, technology, environment, and society. The list of driving forces should be reviewed and ranked. Critical uncertainties will be identified. Driving forces can be ranked according to the likelihood and importance. As an example in Jordan, one of the main driving forces is the financial environment.
4. *Select central scenario drivers and scenario plots.* A small number of the defined critical uncertainties will be selected as a central driver. For each critical uncertainty chosen as a

central driver, the scenario builders will assume a small number of outcomes. Combinations of these outcomes will determine the general nature of scenarios.

5. *Consider implications.* Develop narratives to illustrate how the world will look like in the future. The narratives revolve around the unfolding of the central critical uncertainties. They usually include stories about how the world gets from the present to each envisioned future. This is followed by an analysis of how a particular decision or strategy performing in each future.

The scenarios developed in the next section are intended to illuminate possible ways that could affect the future of domestic water in Jordan.

7. SCENARIO MATRIX FOR THE WATER SECTOR IN JORDAN

In examining future, one is confronted with myriad forces, factors, trends, and potential events to consider. One cannot evaluate all possible combinations of forces, since the dimensions of uncertainty are simply too many. A common approach to scenario building to choose two driving forces that are both very important and uncertain or unpredictable. For each of these two “critical uncertainties,” we assume two different but plausible future outcomes. Combining the two outcomes for the two forces yields a scenario matrix of four different futures.

The two critical dimensions of uncertainty were chosen for this scenario. These include:

7.1. The government role in water management

The dimension of uncertainty was chosen in order to explore questions concerning government future regulatory, policy-making and managerial powers and responsibilities. Movements to management and even ownership of many of water systems to lower levels of government, and in some cases to the private sector, have accelerated recently, but it is not all clear how far such efforts will get. Government involvement in water management has covered areas of water policy formulation, water resources development, monitoring, and data collection. For two scenarios, we have chosen to characterize it as *dominant*. In such futures, the government would continue to take the lead on standard setting and would have strong involvement in enforcement, water allocation, and centralized data collection. The other two scenarios envision a *reduced* government role. These future attempts to capture the potential devolution of some governmental powers, roles, and responsibilities.

7.2. The future nature of the financial environment

Municipal water systems are very capital-intensive. Construction, improvement, and replacement of water systems components require major investments. Substantial capital requirements to meet environmental regulations, accommodate growth, and address deferred maintenance are anticipated in the coming decades. Both the availability and cost of capital will be of significant concerns for water systems in the coming years. The reasons include: 1) Consumers will become more circumspect about increasing costs. 2) Government faces budget shortfalls and increasingly difficult choices in allocating funds to many public services. 3) Investors perceive increased risks in water utility securities. Uncertainties over the nature and future of regulations, potential revenue loss due to water shortages or increased conservation.

Two scenarios were considered with generally *weak* financial environment, where many utilities will have difficulty in obtaining and affording capital. In the remaining two scenarios, we have envisioned generally *supportive* financial environments in which capital is relatively available and affordable and increased costs are tolerated by rate payers. Combinations of these two critical uncertainties one can establish the general structures of the four scenarios as shown in Figure 1.

Many other factors will influence the future of municipal water systems besides the two critical uncertainties. Some of these factors pertain to public attitudes towards protecting the environment, public concerns about the safety of drinking water, regional patterns of growth resulting from increased population and migration, changing per-capita water demand, competition for water with other uses, and development in water-treatment technology.

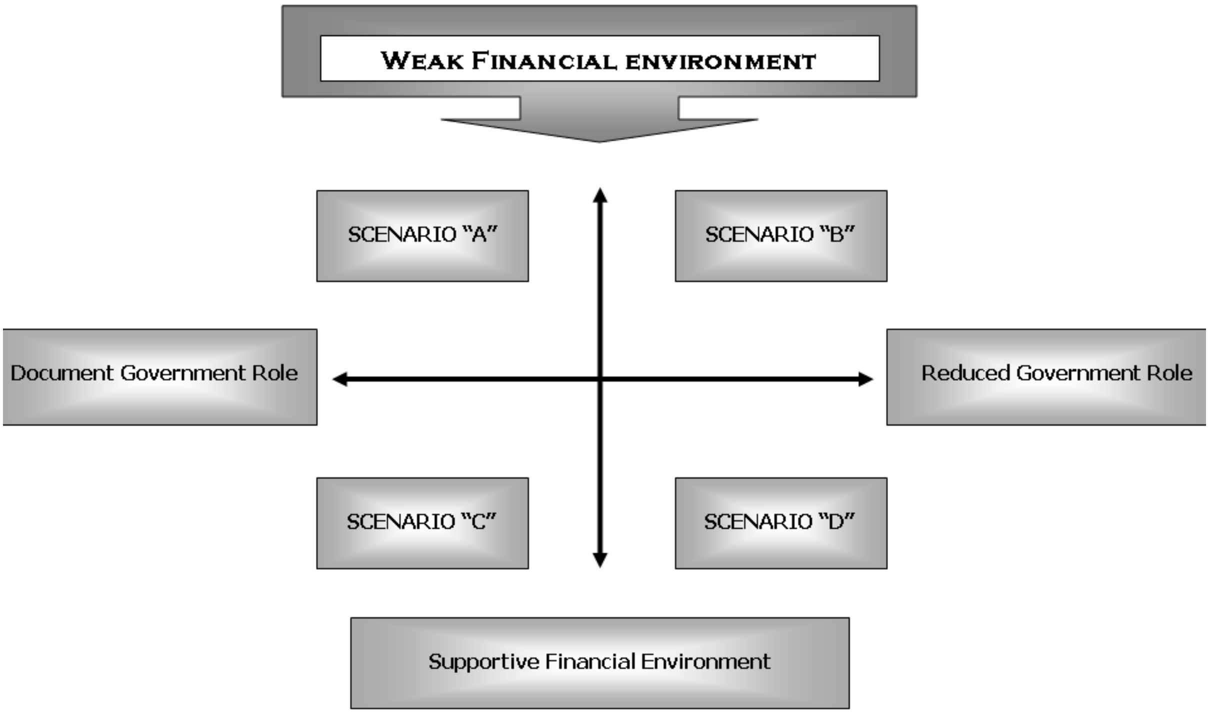

Figure 1. Scenarios of the management of water sector in Jordan

The scenarios, along with the stories they tell for the year 2010, should help water managers and citizens understand interplay of the forces. These are described as follows:

Scenario A: Dominant government role and weak financial environment

In this scenario, Government agencies maintain high standards for water quality and environmental protection but enforcement activities will become under funded. Budgets at all levels of government will be severely reduced. Citizens demand high standards for water quality, but they are overburdened by taxes and high cost of living that they resist rate increases necessary to support water system improvements.

Scenario B: Reduced government role and weak financial environment

This scenario is characterized by reduced role of government and lack of public funding. Government financial assistance for water and wastewater infrastructure is unavailable. Many powers-including standard-setting and enforcement authority for drinking-water quality and wastewater discharges-have devolved to local governments but most national and local budgets are also strapped. Despite public concern over the safety of drinking-water supplies, the majority of rate payers resist the higher bills necessary to finance needed infrastructure improvements.

Scenario C: Dominant government role and supportive financial environment

The public in this scenario demands a very strong Government role in addressing water-quantity concerns. National environmental agencies set high standards and strict enforcement. The agencies are intimately involved in water-quantity management across the country, strong economy is anticipated, rate payer is supported by private sector/banks, and loan guarantees to ease financing of water-system capacity expansions, major maintenance and treatment system improvements.

Scenario D: Reduced government role and supportive financial environment

In This scenario, the Government role in regulating water is minimal. Public funding for infrastructure is limited. National water programs are largely oriented toward partnership with lower levels of government and private sector. Major features of this scenario would be consolidation, privatization, support from investors and affluent rate payers to enable some water utilities to finance needed infrastructure improvements. This scenario is most likely to take place in the future.

8. CONCLUSION AND RECOMMENDATIONS

Water planning in Jordan had undergone (or experienced) a transformation from traditional water planning which focuses on supply-driven measures to demand management options. This shift is reflected in national water policies, strategies and water master plan.

Strategies to meet unsatisfied water demand include utilization of non-conventional water resources, privatization, efficiency enhancement in distribution systems and demand management. Proposed scenarios for sustainable water management were based on degrees of government involvement in the water sector and national financial situation. The discussion has shown that the most likely scenario is characterized by reduced government role and supportive financial environment. This scenario may entail more involvement and participation of the private sector. Government will be encouraged to work toward privatization in financing, operating and building new water and sanitation projects. This scenario will invite more investments in the water industry and open more opportunities for the private sector to participate positively in implementing the water investment plan of the country.

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