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ADU-RES

**Co-ordination Action for Autonomous Desalination Units
based on Renewable Energy Systems**



**Institutional and Policy Framework
Analysis of Water Sector
JORDAN**

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List of Acronyms and Abbreviations

ADS	Autonomous Desalination Systems
ADU-RES	Autonomous Desalination Units Based on Renewable Energy Systems
AIIE	Aqaba International Industrial Estate
ASEZ	Aqaba Special Economic Zone
ASEZA	Aqaba Special Economic Zone Authority
AWC	Aqaba Water Company
BOO	Build Operate Own
BOT	Build Operate Transfer
CSP	Concentrated Solar Power
DPDI	Directorate of Planning, Development & Information
EDR	Electrodialysis Reversal
GNP	Gross National Product
HCST	Higher Council for Science and Technology
JIEC	Jordan Industrial Estates Corporation
JRV	Jordan Rift Valley
JV	Jordan Valley
JVA	Jordan Valley Authority
KWh	Kilo Watt per hour
KWp	Kilo Watt Peak
LEMA	Lyonnaise des Eaux Montgomery Watson-Arabtech Jardaneh
MCM	Million Cubic Meter
MOA	Ministry of Agriculture
MoEnv	Ministry of Environment
MOH	Ministry of Health
MoP	Ministry of Planning
MTOE	Million Tones of Oil Equivalent
MW	Mega Watt
MWI	Ministry of Water and Irrigation
NERC	National Energy Research Center
PBI	Parsons Brinckerhoff International
PMU	Project Management Unit
ppm	part per million
PV	Photovoltaic
RE	Renewable Energy
RO	Reverse Osmosis
SG	Secretary General
TDS	Total Dissolved Solid
TOE	Tones of Oil Equivalent
WAJ	Water Authority of Jordan

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Executive Summary

The intention of this report is directed at drawing a picture of the prevailing institutional and policy framework conditions of the water sector in Jordan. To achieve that purpose, a literature review of pertinent documents on water policy, legislation, regulations and administration were reviewed and a questionnaire was sent out to active professionals in the water sector. The latter aimed at assessing the appropriateness and effectiveness of the existing institutional framework from the viewpoint of the various stakeholders in the public and private sector, academia and donor agencies.

Combating water scarcity remains a strategic challenge that Jordan faces and the country is in dire need for augmenting its water resources. On the supply management side, desalination constitutes one major effort which has been adopted for that purpose.

Legislation: Three laws constitute the main legal framework of the water sector in Jordan; the Water Authority of Jordan (WAJ) law 18 of 1988, the Jordan Valley Authority (JVA) law 30 of 2001 and the Ministry of Water and Irrigation (MWI) law 54 of 1992. These laws were essentially drawn up to establish the respective institutes and regulate their activities. Nonetheless, responsibilities can be overlapping which can lead to a state of ambiguity. The presence of a water law for the sector should prove more prudent for the sector vitality than these three laws.

Strategy & Policies: Jordan has a water strategy and policies for water utilities, irrigation and groundwater management since 1997/8. They haven't been reviewed ever since. They stipulate that economic, social and environmental considerations are to determine the extent to which water resources are to be exploited, priorities for project implementation and for additional allocations. A periodic assessment of potential water resources and respective uses should be conducted including marginal and brackish waters. Legislation and institutional set-up is to be frequently reviewed particularly in response to emerging needs. Legislation shall allow for stakeholder participation and should ensure public-private cooperation. Cost recovery of utilities and service provision shall be sought out. The standard practice shall be the cost recovery of operation and maintenance. However, capital cost recovery shall be approached with care. Cost recovery shall be set while accounting for the cost of living and per capita share of Gross Domestic Product. Also, in setting water tariffs, the need for and requirements of private investment shall be taken into consideration. Non-domestic users shall pay a fair cost. The policy stresses the need for educating the public about the need for water to be used in a sustainable manner. Private sector participation and decentralization in the water sector are being promoted in government reform plans.

Stage of Privatization: The creation of government-owned companies is an emerging form of management of the water sector in Jordan. The Aqaba Water Company has been created and another is in the making for Amman. This is to replace a management contract which was given to a private sector consortium since April 1999. Another form is utility management decentralization on a commercial basis exemplified by the Northern Governorates Water Administration.

Financial: The water sector increases government debt problems. About 25% is known to go for interest payments on external loans contracted for investments in hydraulic infrastructure. WAJ consume seventy five percent of this amount. On the other hand, there are the indirect energy subsidies given out to farmers. Only half of the water sector expenditures are recovered through levies and associated charges. The low water tariffs are seen somehow justifiable because JVA main mission is to promote social and economic development in the Jordan Valley. Nonetheless, full cost recovery is targeted for 2020. Consumer payments analysis showed that roughly, 64% of consumers pay 0.31 – 0.37 USD/m³, 34% pay up to 1.00 USD/m³ and only 2% are paying more than that. This is to be borne in mind somehow when new more costly methods are employed to produce more water.

Desalination: Opting for desalination has been slow somehow in Jordan. This is attributed to the high costs entailed for desalination and the low water tariffs in the country. However, this is changing rapidly now as water scarcity is becoming more acute. The construction of 55 MCM surface water desalination plant is a strong indication of how the water sector in Jordan is adapting to this treatment technique. This project has been contracted to the private sector on a Design-Build-Operate basis for two years. At present, most installed desalination plants are owned and operated by the private sector for irrigation purposes. Only one desalination unit is operated by photovoltaics in Aqaba.

Energy Sources: Jordan imports its energy needs which currently amount to six million tones of oil and is expected to double every 15 years. With soaring oil prices, the country is striving to find alternatives. More emphasis is being made on renewable energy sources as a potential alternative. Solar thermal energy has been widespread for decades and other forms are getting increasing attention e.g. wind, biomass and hydropower.

Environmental Aspects: Regulations stipulate that environmental impact studies should be conducted for water and wastewater projects. Brine disposal emanating from inland desalination remains a cause of concern in Jordan. The country is signatory to regional and

international treaties and conventions pertaining to environmental protection that it needs to observe e.g. the Kyoto Protocol ratified in 2003.

Introduction

This report is intended to present an analysis of the stature of institutional and policy framework conditions in the water sector in Jordan. This is one of six country reports being conducted for, Tunisia, Greece and Spain, Algeria and Morocco. These reports are prepared in fulfillment of Workpackage number 7 of the project Autonomous Desalination Units Based on Renewable Energy Systems (ADU-RES). The objective of ADU-RES is to take advantage of technological advances made in the field of autonomous desalination systems (ADS) through actual implementation. This, in turn, will contribute towards combating the looming water crisis in the Mediterranean countries. In concept, ADS advocate the principles of subsidiarity and decentralization which can be pivotal in improving water accessibility. This stipulates that better progress will be made in managing water resources if all stakeholders play their part, with actions being taken at the lowest appropriate level.

Prudent institutional and policy framework conditions are essential for the success of water resources management. This framework encompasses legal, regulatory and organizational aspects, the comprehension of which is vital for the promotion of ADS. This report has been prepared within this context. It is based upon available literature and on information obtained from completed forms of a questionnaire that was prepared especially for this purpose. The questionnaire was sent to about fifty professionals in public and private water sectors, academia, donor agencies and non-governmental organizations in Jordan. In total, fifteen forms were completed; 7 from public sector, 4 from private sector, 3 from academia and 1 from a donor agency.

Jordan's Map

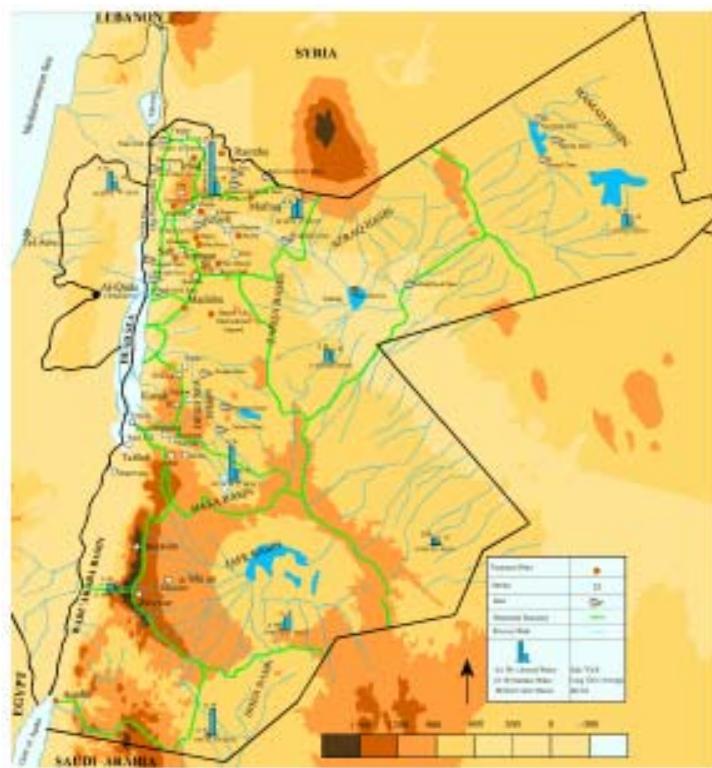


Figure 1. Map of Jordan

Country profile

With a total area of 92,300 km², the country is bordered by Syria to the north, Iraq to the east, and Saudi Arabia to the east and south. Jordan has a small coastline, the Gulf of Aqaba on the Red Sea to the south. Palestine and Israel are on the west. Topography and climate vary greatly. The country is predominantly arid. Physically, it may be considered to have three distinctive regions; the Jordan Rift Valley (JRV), the mountainous heights and the desert (known as Badia region). JRV encompasses the main agricultural activities of the country. Population is mainly concentrated in the highlands of the cities of Amman, Zarqa, Irbid and Karak. Elevations range from the lowest point on earth at the Dead Sea (~ 410 m below sea level, estimated in year 2003) to 1500m. The country has a warm, pleasant climate, but receives little rain. Temperatures below freezing are sometimes experienced in January while average temperature in the summer in the capital Amman is around 25°C. Desert, in the eastern part, constitutes some two-thirds of the country and is scarcely populated. Its climate is renowned for extreme diurnal and seasonal temperature variations and average annual rainfall amount to less than 50mm.

In 2004, Jordan had a total population of 5.35 million with a natural growth rate of 2.8% (<http://www.dos.gov.jo/>, 2004) and with about 70% living urban areas. On the whole, however, actual population growth was 4.3% due to immigration resulting from the war on Iraq. About 38.8% reside in the capital, Amman.

The total agricultural area is considered low, at 5% of the total land area. Agriculture is greatly influenced by the varying nature of rainfall and the decline in the quality and quantity of available water resources. Rainfall ranges from about 660 mm in the north western part of the country while the far eastern part receives less than 130 mm. In terms of actual water resource availability, Jordan is one of the ten poorest countries in the world. The per capita share of renewable water resources, at 142 cubic meters in 2003¹, is well below the World Bank water poverty threshold of 500 cubic meters. Intermittent water supply has become normal practice in the country, particularly during the summer months. The per capita municipal consumption is estimated at 86 l/day at present. There is little hope of Jordan achieving a trade balance in food commodities given that there is only 0.1 hectare of rain fed agricultural land per capita. Likewise, the country can afford to allocate only a modest annual quantity of municipal water supply² to its population, averaging only 48 cubic meters per capita (132 liters per capita per day) in 2003. It has been anticipated that after the year 2005, Jordan's freshwater resources will be fully exploited (MWI, 2002a).

Deteriorating water quality also adds to existing problems of water scarcity in Jordan, where in some parts of the country significant quantities of water have been limited to restricted use or rendered completely unfit for any useful purpose. Both natural and anthropogenic sources of pollution contribute to this problem. This is eminent in the natural elevated salinity levels originating from saline springs and drainage from agricultural areas.

Combating water scarcity remains a strategic challenge that Jordan faces. The country is exerting tremendous efforts to balance increasing demands from consuming sectors but naturally considers domestic demands as having highest priority. On the demand side, efforts have been directed at water conservation by means of leakage reduction, water reclamation and through the application of more efficient irrigation techniques. On the supply management side, water desalination and construction of more reservoirs have been the major efforts to augment available resources.

International soaring oil prices are having a significant impact on Jordan's economy and population as the country has to import its oil needs. This has prompted policy makers to seek alternative energy sources like natural gas and shale oil of which great reserves are believed to exist in the country. Table 1 clearly indicates the enormous increases of energy

¹ The National Water Master Plan Directorate

² Including touristic water supply.

imports in the last three years. This will surely increase consumers' hardship as prices are likely to be subjected to further increases next year as has been announced by the government. Investments in conventional energy amounted to 150 million JD/year during 1998-2003. On a business as usual scenario this has been estimated to increase to 195 million JD/year during the years; 2004-2015. Annual expected growth till 2020 is estimated at 3.5% in energy and 4.6% in electricity (Al-Taher, 2006).

Table 1. Cost of Energy Imports in Jordan Relative to GNP

Year	Imported Energy Cost (Million JD)	Imported Energy Cost relative to GNP
2000	568	9.6
2001	566	9.0
2002	610	9.3
2003	764	10.9
2004	1153	14.5
2005	1830	21.6
2006 (expected)	2110 (7.3 MTOE)	23.0

Source: (Al-Taher, 2006). **MTOE**: million tonnes of oil equivalent.

Institutional Framework and Policy Analysis

The Water Law

The main legal framework of the water sector in Jordan is synchronized mainly by three laws. The Water Authority of Jordan (WAJ) law 18 of 1988, the Jordan Valley Authority (JVA) law 30 of 2001 and the Ministry of Water and Irrigation (MWI) law 54 of 1992.

Law 18 of 1988 was essentially promulgated to establish and regulate WAJ which was established as an autonomous corporate body, with financial and administrative independence. It is authorized to institute legal proceedings, own movables and real estate, acquire water rights by purchase or acquisition, conclude loans, accept grants or contributions and sign contracts. It is to carry the full responsibility for all water and wastewater systems and the related projects and shall set forth a water policy. In order to achieve its objectives, WAJ was assigned with the following responsibilities and tasks:

1. Survey the different water resources, conserve them, and determine ways, means and priorities for their implementation and use, except use for irrigation.
2. Set up plans and programmes to implement approved water policies related to domestic and municipal waters (commercial, industrial and touristic) and sanitation, and to develop water resources in the country and to exploit them for domestic and

municipal purposes, including digging of wells, development of springs, treatment and desalination of waters, and execute works to augment the potential of water resources and to improve and protect its quality.

3. Direct and regulate the construction of public and private wells, investigate water resources, and drill exploratory, reconnaissance and production wells, and license well drilling rigs and drillers.
4. Study, design, construct, operate, maintain, and administer water and public wastewater projects including collecting, purifying, treating, disposing of water and wastewater, and the methods of dealing with water.
5. Draw terms, standards and special requirements in relation to the preservation of water and Water basins, protect them from pollution, and ascertain the safety of water and wastewater structures, public and private distribution and disposal networks, and take the necessary action to ensure technical control and supervision, including, all necessary tests.
6. Carry out theoretical-and applied research and studies regarding water and public wastewater to achieve its objectives including the preparation of approved water quality standards for different uses and technical specifications concerning materials and construction.
7. Issue permits to engineers and licensed professionals to perform public water and wastewater works; and participate in organizing, special training courses to qualify them in order to improve the standard of such works and to reduce water losses and pollution.
8. Regulate the uses of water, prevent its waste, and conserve its consumption.

By this Law, WAJ is to have a Board of Directors, chaired by the Minister of MWI and comprised of the Secretary Generals of JVA, ministries of Planning, Agriculture, Municipal and Rural Affairs, Environment, Health, Industry & Trade, Finance, Energy and Natural Resources and a member with expertise and specialization appointed for two years. The Board undertakes the following duties and responsibilities:

1. Set a water policy that reserves the rights of the country in all its water resources including the development, maintenance and use of the resources.
2. Approve the water policy of the country and the plans for the development and conservation of water resources, specify water distribution and uses, provide

additional water resources and approve plans regarding, the construction of water and public wastewater networks.

3. Study WAJ's draft Regulations and submit them to the Council of Ministers for approval.
4. Study WAJ's proposed annual budget.
5. Obtain foreign and local loans with the approval of the Council of Ministers.
6. Recommend to the Council of Ministers tariffs for connections, subscriptions, price rates and deposit fees that should be collected for various water and public wastewater uses.
7. Invest WAJ funds and revenues with the approval of the Council of Ministers.
8. Appoint members of Water Councils in the districts.

WAJ Secretary General (SG) is the executive manager, responsible to the Minister. He is responsible for the implementation of its policy and plans and administers its financial and employee affairs.

WAJ capital consists of government contributions, donations and subsidies. Its financial revenue is made of water prices, subscriptions, deposits fees collected in return for its various services, loans, donations and subsidies. WAJ funds are considered State Funds and to be collected according to the State Funds Collection Law in effect. Thus WAJ SG is entitled to exercise the powers of the Administrative Governor and of the Collection of State Funds Committee provided for in this Law. WAJ has the right to issue Debt Bonds or Loan Certificates or any other bonds according to the laws in effect. All existing buildings in the country, on the coming into effects of this law, and those erected thereafter, except buildings of worship, are subject to an annual contribution of 3% three percent on the net rent as evaluated in accordance with the tax on buildings and lands Law within the municipality boarders. This contribution is levied together with buildings and lands tax by the Ministry of Finance and transferred to WAJ.

The Law requires WAJ to allocate an amount not less than 10 percent of its net profit per annum as a Compulsory reserve. This shouldn't, however, exceed 20 percent of its Capital at the end of the fiscal year. It is further required to allocate the balance of the net profit to finance its projects.

By this Law, all responsibilities related to water and wastewater which were previously delegated to other governmental department, are to be transferred to WAJ. This Law has also given WAJ the authority to:

Establish the required departments in all parts of the country in order to fulfill its obligations.

Purchase, acquire or lease properties, land and the related easement rights and the water rights required for the various WAJ and provide a prohibited area as deemed necessary for its water and wastewater networks and the related buildings and construction.

Manufacture and produce commodities needed for its water and wastewater works, and provide all the equipment necessary for water and public wastewater projects.

Take the necessary action to ensure technical control and supervision regarding the construction, operation and maintenance of all water projects and public or private sewers.

Obtain data and information regarding the needs of the country and the actual consumption of water for different uses, and utilize such data for future planning, to provide for the Country's needs for water and to conserve its consumption.

This law stipulates that all water resources available within the boundaries of the country, whether they are surface or ground waters, regional waters, rivers or internal seas are considered State owned property and shall not be used or transferred except in compliance with this Law. Any water resources that are not under the management, responsibility or supervision of WAJ, shall not be used in excess of personal or domestic needs or other acceptable private usage; nor in excess of legal water rights in accordance with the laws and regulations in effect including drinking, and irrigation rights applicable to the area of land which contains that resource. All natural and juridical bodies are prohibited to sell water from any source or grant or transport it, without obtaining in advance the written approval from WAJ and within the conditions and restrictions decided or included in the contracts or agreements concluded between them and WAJ. All persons on whom the provisions of paragraphs (b) and (c) of this Article are applicable, shall adjust their conditions to suit these provisions within a period of three months of the date this Law becomes effective. Otherwise, such persons will be subject to the legal and other punishments stated in this law.

The Council of Ministers, upon the recommendation of the Minister, may assign any of WAJ` duties or projects or the execution of any stage or part to any other body from the public or private sector, or to a public shareholders company, or to a limited-liability company owned totally by WAJ or in which WAJ contributed to the capital. Such assignment may include the transfer of the management of these projects or the lease, or the transfer of ownership to any of these bodies, in accordance with the conditions and for the durations to be set in the contracts that shall be concluded for this purpose, provided that they abide with the legal provisions in force relating to leases and transfer of ownership. In the case of conclusion of contracts to transfer the management of the projects or the lease thereof, the decisions of the Council of Ministers may include the authorization to the officials of the bodies contracted

therewith, to exercise the same powers bestowed on WAJ officials in pursuance of legislations in force relevant to the execution of these contracts.

Law 18 also specified penalties of no less than a six months sentence, and no more than two years imprisonment or to a fine no less than JD 1000 and no more than JD 5000, or both punishments if any, inter alia, of the following acts is committed:

Polluted any water resource, which is under the management or supervision of WAJ directly or indirectly, or caused its pollution and failed to remove the causes within the period fixed by WAJ.

Drilled unlicensed ground water wells or violated the conditions of the license issued to him.

Also a sentence of no less than one month, and no more than six months, imprisonment or a fine not less than JD 100 and not more than JD 1000, if any, inter alia, of the following acts is committed:

The illegal usage of water, water resources, related projects or the public sewers, contravening the provisions of this Law, or other pertinent issued regulations, including the selling, granting or transporting water, using or utilizing it or committing any act that may cause harm or damage to any of these resources or water related projects, or using the public sewers in a manner that conflicts with the provisions of this Law.

Carrying out any works regarding water or wastewater without obtaining the licenses, permits or approvals required under this Law. Or carrying out any of these works in violation of the regulations issued.

Law 30 Of 2001 is an amended law of Jordan Valley Development Law of 1988 according to which the Jordan Valley Authority (JVA) has been established to conduct, inter alia, social and economic development of the Valley . The boundary of the Valley is defined as the area between the Northern Frontier of Jordan to the North and the Northern edge of the Dead Sea to the South and the Jordan River to the West until elevation 300 meter above the sea level to the East. It also includes the area between the Northern edge of the Dead Sea to the North, and to the Southern Boundary of Qatar village to the South, and to the Western frontier of Jordan to the West, and to elevation 500 meter above sea level to the East. Through this Law, JVA is mandated to develop and protect water resources of the Valley for purposes of irrigated agriculture, domestic and municipal uses, industry, generating hydroelectric power and other uses. This is to be done through conducting studies, planning, design, construction, operation and maintenance of irrigation projects, land reclamation, overseeing of public and private wells.

JVA may be considered an autonomous corporate body. It is also entrusted with Development of tourism in JV. With the exception of irrigation projects and water resources development projects, JVA can adopt commercial basis in managing its projects but according to instructions issued by the Cabinet of Ministers. Similarly, JVA is entitled to entrust its projects to any entity from the private sector whether by leasing, management or operation, in accordance with the effective laws and regulations.

JVA is comprised of the Minister of MWI, Board of directors, Secretary General and Executive and Administrative Units. Composition and role of the Board are somehow similar to those of WAJ. Notably however, is the inclusion of members from the Ministry of Tourism and Farmers Association. This is driven by the nature of the region under JVA jurisdiction. The role, duties and responsibilities of JVA Secretary General is analogous to those of WAJ SG.

The waters acquired by means of projects constructed by the JVA and which were not used or exploited for irrigation purposes in any area prior to the declaration of a water settlement in accordance with the land and water settlement law in effect, shall be considered Government property. Such waters may be sold, leased, or otherwise disposed of in a way as may be decided by the Board. JVA determines allocation and usage of surface and ground water, developed under its supervision, in accordance with guidelines issued by the Cabinet of Ministers upon Board recommendations. Before constructing any irrigation projects, JVA has to consider the rights to water in the Water Register. Excess water is considered Government property. JVA divides irrigable lands into farm units and exercises its authority on them in many ways as set by the Board. One of which are the set of regulations for controlling the use of water in farm units. Control includes basis for water supply or barring it. Determining the maximum quantities to deliver in accordance with water availability and the nature of the crops planted in the unit. Water prices, however, are determined by the Cabinet of Ministers upon recommendations from the Board.

JVA implements water quality testing programs in an effort to identify pollution causes. It is mandated to punish polluters, by cutting off water supply to farming units in which pollution was found. Water supply is only resumed when pollution is removed by the owner of the farming unit.

MWI By Law 54, 1992 is the Regulation for the Administrative Organization of the Ministry of Water & Irrigation. Attached to the Minister are MWI, WAJ and JVA. Under this regulation and with due observance to the provisions of the aforementioned WAJ and JVA laws, MWI is entitled to assume full responsibility for water and public sewage in the country. It is to develop and communicate water policy to the Council of Ministers for adoption. Also, MWI shall assume full responsibility for the economic and social development of the Jordan Valley

as well as carry out all the works which are necessary for achieving this objective. MWI is to have directorates of Planning, Development & Information, Financing & Loans, Legal Affairs, Citizens Service and Financial & Administrative Affairs. The Regulation allows for the creation, cancellation or merger of directorates and / or units. MWI has a SG responsible for, inter alia, policy implementation. By this Regulation, the Directorate of Planning, Development & Information (DPDI) is required to participate in setting a strategy for the water sector, preparation of programs, conducting and evaluation studies pertaining to economic, social and population feasibility pertaining to water policy. Formulate work plans proposals on the productivity of MWI manpower. Participate in conducting studies on water resources, evaluation and determination of the productive capacity; formulate the basis for its preservation and protection from pollution. Conduct studies, compile and organize the information water quality, industrial waste, follow up of changes in the water specifications and propose the necessary solutions for their treatment. By this regulation, DPDI is also expected to establish a computerized Information Bank in order to analyze and classify the information on the water sector and its development.

MWI directorates are to conduct their undertakings in cooperation and coordination with WAJ and JVA in accordance instructions issued by the Minister. A Consultative Body comprising SGs of MWI, WAJ, JVA and four qualified members appointed by the Council of Ministers is to be formed. This Body is to provide technical, economic, legal, financing, and administrative advice on the policies, programs and plans put forward by MWI. It is also to evaluate present and future water projects, strategies and policies.

While the aforementioned laws; of WAJ, JVA and MWI constitute the main legal framework of the water sector in Jordan, there are the health and environmental laws which contain clauses addressing respective aspects of the sector. Temporary Public Health Law No. 54 of 2002 insinuates that the Ministry of Health (MOH) shall in coordination with the relevant authorities; control the potable water, regardless of its source, in order to ensure its fitness from health point of view. MOH is entitled to control potable water resources and their networks, in order to ensure that they were not exposed to pollution. It is also to have control over the method to be used in the treatment, transmission, distribution, and storage of potable water, in order to ensure the availability of health conditions in such processes, including the quality of materials used in the potable water processes, its transmission, distribution, and packing, as well as the prevention of using any material that may harm the consumer's health. Any person who is responsible for a water resource, network, station, or potable water bottling factory must inform MOH or WAJ, or both of them, as the case may be, of the occurrence of any pollution to the water placed under his supervision.

Environment Protection Law for the year 2003 caters for the protection of environment and promotion of all its elements including water. The Ministry of Environment (MoEnv) is delegated

the responsibility of protecting the environment and promote all its elements such as water, air and land in a sustainable manner. MoEnv is to monitor these elements and their components. Article (23)(A) demands that Cabinet Council shall issue a host of Regulations for the implementation of the provisions of this law including those for the protection of nature, water, sea shore and a regulation for environmental impact assessment. Article (8) specifically prohibits and subjects to the legal responsibility, to cast away any polluting or harmful substance to the sea environment in the regional waters of the country or on the shore area.

The questionnaire was completed by middle management water professionals in governmental bodies, academia, the private sector and a donor agency. The major purpose of this questionnaire has been to endeavor to analyze the institutional and policy framework conditions in the water sector in Jordan through the eyes of active water professionals. This necessitates that policies, legal, regulatory and organizational roles be analyzed based on implementation experiences. Although 50 forms were sent out for completion, only 15 filled forms were sent back. Table 2 shows a summary of completed questionnaires on water legislation by 7 people in MWI, WAJ, JVA and MoEnv, 3 from Jordanian universities, 4 from the private sector and one donor agency. The following may be concluded from the completed questionnaires:

Although the law allows for private water rights, public and private sectors don't have equal legal rights in the development and utilization of water. More respondents believe that such rights are granted to individuals rather than to groups.

While it is largely believed that there is legal sectoral prioritization in the development and utilization of water by consuming sectors, the ranking varied greatly among the respondents. This reflects a lack of clarity in the legislation in this regard. Naturally, nonetheless, all agree that priority is directed towards satisfying domestic needs in the development of the water sector. It is mostly believed that prioritization is dominated by the state of the resources, then by economic factors followed by equity considerations and lastly by cultural and political considerations.

The present water legislation is believed to be effectual in protecting water quality from pollution. However, replies were not emphatic enough.

The majority of replies were of the opinion that the present water legislation advocates centralization. However, replies varied somehow regarding the issue of whether it allows / provide for or promote none governmental involvement in water planning, development and management. More were inclined towards the notion that the legislation allows for private sector involvement. The majority of the positive and more emphatic replies came from respondents from governmental institutes while private sector respondents emphasized this

for the management stage. On the whole, the participation of communities and community based organizations were seen as being provided for in the legislation.

Opinions were somehow split on the appropriateness of present water legislation for the status quo. Respondents from the private sector thought mostly it isn't. Some expressed the opinion that although emerging issues such as those related to private sector participation are covered by resolutions taken by the council of ministers, however the legislative sector still lacks laws that address watershed management and guidelines to protect groundwater resources, which as of this date are not yet approved. The legislation should deal with water conservation and reclamation which are in need to be further development. Water pricing and water allocation must be revisited and a more efficient and effective system must be adopted to reflect our exact needs for the present and future targets and expectations. Furthermore, some expressed the belief that the legislation should include stringent standards for water pollution of natural water courses. Also, it should address the concept of the "right to water" in terms of affordability and availability and environmental components. Some have suggested that the legislation should stipulate that water services be delivered on a cost recovery bases and allow for greater private sector participation.

Table 2. Summary of Completed Questionnaire on Water Legislation

No	Question	Respondent's Answer From			
		Government	Academia	Private Sector	Donor
	On Water Legislation				
1	Name, number and year of legislation:				
	Water sources considerations and legal rights in the present water legislation?				
	1.2.1. Do public and private sectors have equal legal rights in the development and utilization of water?	" Yes	" No	Yes(1) ; No(6)	No(3)
	1.2.2. Does the law allow for private water rights?	" Yes	" No	Yes(4) ; No(2)	Yes(3)
2	1.2.2.1. If YES, are these rights granted to:				
	Individuals	" Yes	" No	Yes(4)	Yes(3)
	Groups	" Yes	" No	Yes(3)	Yes(1)
	Other:				
	1.2.2.2. If NO, is this because of:				
	Equity and social considerations?	" Yes	" No	Yes(1)	
	Difficulties in control ?	" Yes	" No		Yes(1)
	Traditional customs ?	" Yes	" No		Yes(1)
	Other:				
3	Is there a legal sectoral prioritization among consuming sectors of domestic / agriculture / industrial / tourism in the development and utilization of water?	" Yes	" No	Yes(6)	Yes(3)
4	Is priority of development of the water sector directed towards satisfying domestic needs?	" Yes	" No	Yes(6)	Yes(3)
5	Rank legal prioritization of water rights of:				

Question		Respondent's Answer From			
		Government	Academia	Private Sector	Donor
No	On Water Legislation				
	Irrigation	Tourism	Tourism	Environmental	Tourism
	Industrial	Industrial	Irrigation	Industrial	Irrigation
	Tourism	Irrigation	Industrial	Irrigation	Industrial
	Environmental	Environmental	Environmental	Tourism	Environmenta l
6	On what grounds was the above prioritization done? (indicate ranking on a 0 to 10 scale)				
	Equity considerations	4.4 (5)	4.6 (3)	6.4 (3)	8 (1)
	Economic factors	8.8 (6)	6.3 (3)	8 (3)	9 (1)
	State of water resources	8.5 (6)	8 (3)	8 (3)	9 (1)
	Other, specify (e.g. culture, tradition, politics...)	4.3 (3)	4 (1)		6 (1)
7	Is the present water legislation effectual in protecting water quality from pollution?	" Yes	" No		
	On a scale of 0 to 10?			Yes(5) ; No(2)	Yes(2) ; No(1)
	If No or points less than 5, are the reasons :			Yes(2) ; No(2)	Yes(1)
	<i>Social</i>	.....		1 st : Lack of control	1 st : Lack of control
	<i>Economical</i>	.....		2 nd : Economical	2 nd : Social

Question			Respondent's Answer From				
			Government	Academia	Private Sector	Donor	
No	On Water Legislation						
		Lack of control	.....	3 rd : Social	& Social*	3 rd :Economical*	
8	Does the present water legislation advocate centralization?	" Yes	" No	Yes(6) ; No(1)	Yes(3)	Yes(3) ; No(1)	Yes(1)
	If yes, how strong is this advocacy? (On a scale of 1 to 10)	.....	7.4 (5)	8 (2)	7.5 (3)	8 (1)	
9	Does the present water legislation allow / provide for / promote none governmental involvement in water planning /development / management?	" Yes	" No	Yes(5) ; No(2)	Yes(1) ; No(2)	Yes(2) ; No(2)	No(1)
	If yes, how much is it, On a scale of 1 to 10 for						
		<u>Planning</u>	<u>Development</u>	<u>Management</u>			
	Private sector	.....	.....	.....	6(4); 6.3(3); 6.5(4)	8(1); 1(1); 2(1)	4(1); 2(1); 6.5(2)
	Communities	.....	.....	.....	4(4); 2(3); 2.6(3)	4(1); 1(1); 1(1)	4(1); 2(1); 2(1)
	Community Based	.....	.....	.....	3.5(4); 2.6(3);		4(1); 3(1); 2(1)

Question			Respondent's Answer From				
No	On Water Legislation		Government	Academia	Private Sector	Donor	
	Organizations	NGO's					
10	Do you think the present water legislation is appropriate for the Status quo?	" Yes	" No	Yes(4) ; No(3)	Yes(2) ; No(1)	Yes(1) ; No(3)	Yes(1)
	If No, Why ?			³			
11	Does the present water legislation tend to deal with emerging water technologies ?	" Yes	" No	Yes(4) ; No(3)	Yes(3)	Yes(1) ; No(3)	Yes(1)
	If yes, how emphatic is it, on a scale of 1 to 10?	.....	8(2) ;3(1)	5.3(3)	6(1)	7(1)	

* One person answered this question..

N.B: X(Y) – X denotes average scale given by respondents and Y number of replies.

³ Emerging Issues such as those related to PSP are covered by resolutions taken by the council of ministers. However the legislation still lacks laws that address water shed management, as well as guidelines to protect groundwater resources, which as of this date are not yet approved
Water conservation and water recycling and reuse must be further developed water pricing and water allocation must be re visited and a more efficient and effective system must be adopted to reflect our exact needs for the present and future targets and expectations “
Does not include stringent standards for water pollution of natural water courses, Does not include the concept of the "right to water" in terms of affordability and availability, no concern for environmental components”
No services are delivered at cost bases. The law does not allow for a greater role for the private sector in decision making process”

The Water Policy

The MWI has issued its water strategy and policy in 1997 & 1998. They were published in 2002 (MWI, 2002). This had been to satisfy the relevant legislative requirements of Article 5 of WAJ Law 18 of 1988. The relevant issued documents are:

- Jordan's Water Strategy (MWI, 1997a),
- Water Utility Policy (MWI, 1997b),
- Irrigation Water Policy (MWI, 1998a),
- Groundwater Management Policy (MWI, 1998b),
- Wastewater Management Policy (MWI, 1998c).

The strategy and policies were formulated with an obvious target of promoting sustainable utilization of the already scarce natural water resources. Improvement in the quality of life for the Jordanian citizen has been the ultimate development goal and thus dictated the prevailing approach of implementation.

As would be expected, the strategy duly recognizes pressures imposed by population increases, due to natural growth as well as to sudden waves of immigration that Jordan had encountered. The fact that populations are concentrated in distant locations from water resources resulted in higher costs for water supply projects and associated services. Prominent among which is the high annual cost of operation and maintenance of which energy is responsible for 55%. Increasing water demand has necessitated over abstraction from groundwater aquifers. Relaxed controls on drilling wells and lack of controls on abstraction rates resulted in some ground water aquifers being depleted and others salinized.

By international standards, the marginal cost of water is considered high and is on the rise. Water networks have been in need of rehabilitation and yet present another formidable technical and financial challenge. Additional water resources that can be mobilized are modest.

In view of the aforementioned status and anticipated trends in the water sector, the Water Strategy was adopted by the Government of Jordan. Policy documents mentioned above were issued with an aim of detailing Government's policy and intentions pertaining to water sector and respective sub-sectors. Including Resource Development, Resource Management, Legislation and Institutional Set-Up, Shared Water Resources, Public Awareness, Performance, Health Standards, Private Sector Participation, Financing and

Research & Development. Highlights of the most relevant aspects to serve the purpose of this report are as follows:

On Resource Development: Water is and shall be always considered as a national resource. Economic feasibility, social and environmental impacts are to determine the extent to which surface and ground waters may be exploited. A periodic assessment of potential water resources and their respective uses should be conducted, including marginal and brackish waters. An overall far-reaching water resources development plan is to be formulated, from which a revolving and dynamic five year plan shall be drawn in line with other economic sectors. Concurrently, an investment plan is to be drawn. Economic, social and environmental considerations should dictate the priorities of project implementation and for additional water allocation. Allocation of new water sources should be determined through a critical path approach. This has to be considered within the context of the sustainability pertaining to national water balance, the socio-economic and environmental factors. At any rate, foremost priority should be given to satisfying basic human needs. One hundred liters per capita per day is the priority amount allocated to domestic water supplies. Priority is then for municipal purposes, followed by tourism and industrial purposes.

On Resource Management: Sustainability of use of already developed sources is given priority. Exploitation of renewable groundwater aquifers should be reviewed, brought under control and extraction rates made sustainable. A dynamic demand and supply management approach is to be pursued making use of instruments of advanced technology. Persistent efforts shall be exerted to improve efficiency of conveyance, distribution, application and use. Water requirements for future industrial, commercial, tourism and agricultural projects should be included into the cost of production.

On Legislation and Institutional Set-Up: Existing institutional provisions and legislature are to be subjected to frequent review and subsequent adjustments as deemed appropriate. In particular, to respond to emerging needs. Legislation shall allow for stakeholder participation and ensure public – private cooperation.

On Financing: Cost recovery of utilities and service provision shall be sought out. The standard practice shall be the cost recovery of operation and maintenance. However, capital cost recovery shall be approached with care. Cost recovery shall be set while accounting for the cost of living and per capita share of Gross Domestic Product. Also, in setting water tariffs, the need for and requirements of private investment shall be taken into consideration. On the other hand, non-domestic users shall pay a fair cost. Project financing will depend on loans, private borrowing and/ or BOO and BOT arrangements. This is to remain so till the cost recovery is full, and the domestic savings become capable of local financing of development projects.

On Research and Development: Efforts shall be exerted to promote indigenous water research in the various fields; e.g. resource management, resource economics. Forging partnerships with international research institution shall be encouraged in order to keep current with technological advances and to facilitate technology transfer and adaptation.

On Public Awareness: It is recognized that water administration alone is insufficient to confront the water problem. Educating the public about the need for water to be used in a sustainable manner and underlining its importance for economic and social development is equally important.

On Health Standards: National water standards shall be set and enforced. Water quality testing laboratories shall be maintained and properly equipped.

On Private Sector Participation: Role of the private sector shall be expanded. Management contracts, concessions and other forms of private sector participation in water utilities shall be considered and adopted as appropriate. BOT and BOO concepts shall be considered. However, these are to be subjected to continuous assessment to identify and mitigate negative implications. The Government of Jordan has been carrying out economical restructuring enabling the private sector to assume a more important role. In this, water and wastewater services management are considered of priority in regard to private sector participation (MoP, 2002).

Analysis of Questionnaire on Water Policy

1. To a certain extent, Jordan's water policy is believed to reflect Jordan's water law.
2. According to governmental respondents, the water policy is substantially affected by the country's agricultural, economic, environmental, social and human development and financial policies in descending order. However, while all have put the agricultural policy as the number one policy having an effect on the water policy, replies from the private sector has put the environmental rather than the economic policy in second place.
3. Inter-sectoral water use prioritization varied widely among the respondents. As expected municipal usage occupied first priority while in second place priority varied from industrial to tourism to agriculture. Environmental usage was ranked last by all (see Table 3).
4. On the driving forces behind the above prioritization, state of water resources is seen as the determining factor followed by economic factors and equity considerations.
5. The determining factors in project selection varied greatly. While some maintained it is the meeting of increasing demand that determines projects selection, others asserted that it is the donors who are the ones who decide. Some attributed it to

socio-economic considerations while others expressed the opinion that it is the vested interest of decision makers that determines how projects are selected. On the whole, project selection is highly influenced if the project is funded locally or from international aid agencies. Also, it is influenced by the consumer sector type.

6. Water tariffs are regularly reviewed for municipal water while it is irregular for agricultural and industrial waters. On the whole, tariffs are partially subsidized for municipal and agricultural waters while they are based on a cost recovery basis for industrial usage.
7. Existing policies do encourage water sector privatization; however, it is still in the middle to early stages for the municipal urban sub-sector. While it is in the early stages for the municipal rural, agricultural and industrial sub-sectors.
8. Opinions were somehow split over consumers' attitude towards privatization. Nonetheless, they were slightly more in favor of the 'generally unacceptable attitude'.
9. To some extent, the present water policy is seen conducive to public participation and centralization in the management of water consuming sectors. This was seen much less conducive in the case of planning and development stages.
10. Professional government employees are not generally inclined towards public participation. They are partially inclined towards decentralization.
11. The effectiveness of private sector involvement in the management of the water sector is seen as good but to a lesser extent in the planning, funding and execution. International aid agencies are perceived to be more effective in all aforementioned stages. Conversely, the involvement of communities and local non-governmental organizations were not seen as effective.

Table 3. Summary of Completed Questionnaire on Water Policy

Question		Respondent's Answer From			
		Government	Academia	Private Sector	Donor
No.	On Water Policy				
1	Does your country have an issued water policy? <i>If yes, give details:</i> Name Year Issued by Is it subjected for review? " Yes " No <i>If yes, how often?</i> <i>How is it formulated: national plan? Programmes? directives?</i> <i>..etc.....</i>	Yes(6) Yes(5) ; No(1)	Yes(3) Yes(2) ; No(1)	Yes(4) Yes(4)	Yes(1) Yes(1)
2	To what extent does the present water policy reflect the water law? <i>(on a scale of 0 to 10)</i>	6.3(6)	7.3(3)	5.5(4)	-
3	Which of the following policies would have substantial impact on the water policy? <i>(tick more than one if appropriate)</i> Agricultural policy Economic / investment policies Environmental policy Financial policies Social and Human development policy Other (e.g. water and/or environmental laws.)	X(7) X(7) X(5) X(3) X(4) X(1)	X(3) X(3) X(2) X(2)	X(4) X(2) X(2)	X(1) X(1) X(1)
4	Is inter-sectoral water use prioritized ? <i>If yes, rank the following sectors:</i>	" Yes " No	Yes(6)		Yes(1)

Question		Respondent's Answer From							
		Government		Academia		Private Sector		Donor	
	Municipal Agriculture Industrial Tourism Environmental	Rank: Municipal Industrial Agriculture Tourism Environmental	Rank: Municipal Tourism Agriculture Industrial Environmental	Rank: Municipal Agriculture Industrial Tourism Environmental	Rank: Municipal Agriculture Industrial Tourism Environmental	X(3) Rank: 1st : State of water resources (3). 2nd : Economic factors (2).	X(2) Rank: 1st : State of water resource s (2).	X(4) Rank: Please refer to base document	X(1) Rank: 1st Equity/social considerations 2nd State of water resources
5	What are the driving factors behind the above prioritization? <i>(tick more than one and assign a rank if appropriate)</i> Equity/social considerations Economic factors State of water resources Other, specify (e.g. culture, tradition, politics..)	X(3) X(5) X(5) X(2)	X(2) X(3) X(3) X(1)	X(4) X(4) X(4) X(1)	X(1)	X(1) 1st Equity/social considerations 2nd State of water resources			
6	What are the determining factors in the selection of water projects? <i>(tick more than one and assign a rank if appropriate)</i> Equity/Equity/social motive Cost-benefit considerations Environmental concerns Other factors?	X(5) X(4) X(5) X(3)	X(3) X(3) X(2) X(1)	X(3) X(4) X(3) X(1)	X(3)	X(1) 1st Environmental concerns 2nd Cost-benefit considerations			
7	Are the above factors influenced if the project is: Funded locally or from international aid agencies? " Yes " No	Yes(6) ; No(1)	Yes(3) ;	Yes(3) ; No(1)	Yes(1)				Yes(1)

Question			Respondent's Answer From			
			Government	Academia	Private Sector	Donor
	For municipal purposes	" Yes " No	Yes(5) ;	Yes(3) ;	Yes(3) ; No(1)	Yes(1)
	For Irrigation purposes	" Yes " No	Yes(5) ; No(1)	Yes(3) ;	Yes(2) ; No(2)	Yes(1)
	For industrial purposes	" Yes " No	Yes(5) ; No(1)	Yes(3) ;	Yes(3) ; No(1)	Yes(1)
	For tourism purposes	" Yes " No	Yes(4) ; No(1)	Yes(3) ;	Yes(3) ; No(1)	Yes(1)
	A new or an upgrading scheme	" Yes " No	Yes(4) ; No(1)	Yes(1) ; No(2)	Yes(2) ; No(2)	Yes(1)
	A capacity building and institutional development project	" Yes " No	Yes(4) ; No(2)	Yes(1) ; No(2)	Yes(3) ; No(1)	Yes(1)
8	To what percentage you estimate the influence of the following factors on the selection of water projects:					
	Economical	.....	53.3% (6)	53% (3)	75% (4)	50% (1)
	Social	.....	41% (5)	53% (3)	39% (4)	30% (1)
	Environmental	.....	12.6% (6)	16% (3)	31% (4)	30% (1)
	Other(precise)	.....	10% (1)			20% (1)
9	a. How often are water tariffs subjected to revision in the consuming sectors?					
		<u>Regularly</u>	<u>Irregularly</u>	<u>Seldom</u>	<u>Never</u>	
	Municipal	.....	.....	.....	.....	Regularly(5); Irregularly (1)
	Agriculture	.....	.....	.....	.....	Regularly(1); Irregularly (5)
	Industrial	.....	.....	.....	.....	Regularly(3); Irregularly (3)
	b. On what basis are water tariffs based in the consuming sectors?					
		<u>Total Cost</u>	<u>Partially</u>	<u>Totally</u>		

Question				Respondent's Answer From			
		Government	Academia	Private Sector	Donor		
	Municipal - Urban	<u>Recovery</u>	<u>Subsidized</u>	<u>subsidized</u>			
	Municipal - Rural	.....	.....	.....	Partially Subsidized(6)	Total Cost Recovery(1); Partially Subsidized(2)	Total Cost Recovery(1); Partially Subsidized(3)
	Agriculture	.....	.....	.....	Partially Subsidized(5); Totally subsidized(1)	Total Cost Recovery(1); Partially Subsidized(2)	Total Cost Recovery(1); Partially Subsidized(3)
	Industrial	.....	.....	.....	Partially Subsidized(5); Totally subsidized(1) Total Cost Recovery(2); Partially Subsidized(5)	Partially Subsidized(3)	Partially Subsidized(3); Totally subsidized(1)
10	Do existing policies encourage privatization in the water sector ?	" Yes	" No	Yes(6) ; No(1)	Yes(2) ; No(1)	Yes(3) ; No(1)	Yes(1)
	If yes, at what stage is the privatization in the below sectors?	<u>Early stages</u>	<u>Middle</u>	<u>Advanced</u>			
	Municipal - Urban	.....	.....	.....	Middle(5); Advanced(1)	Early stages(1); Middle(1)	Early stages(1); Middle(1); Advanced(1)
	Municipal - Rural	.....	.....	.....	Early stages(6)	Early stages(1); Middle(1)	Early stages(2); Middle(1)
	Agriculture	.....	.....	.....	Early stages(4); Middle(1)	Early stages(1); Advanced(1)	Early stages(3)

Question		Respondent's Answer From			
		Government	Academia	Private Sector	Donor
	Industrial	Early stages(3); Middle(2)	Early stages(2)	Early stages(2); Middle(1)	Middle(1)
11	How would you describe consumers' attitude towards water sector privatization? i Generally acceptable i Generally unacceptable i Don't care i Against it	Generally acceptable (3) Generally unacceptable(2) Don't care(1)	Generally unacceptable(2) Don't care(1)	Generally acceptable (1) Generally unacceptable(2)	Generally acceptable (1)
12	Is the present water policy conducive to public participation and decentralization? <i>If yes, rank the following sectors: (on a scale of 0 to 10)</i>	" Yes " No	Yes(3) ; No(3)	Yes(1) ; No(2)	Yes(2) ; No(2)
	Municipal - Urban	<u>Planning</u> <u>Development</u> t <u>Management</u>	4.7(3); 4.7(3); 7.7(3)	3(1); 3(1); 7(1)	2(1); -- ; 7(1)
	Municipal - Rural		3.6(3); 3.6(3); 6.3(3)	2(1); 2(1); 2(1)	
	Agriculture		4.7(3); 4(3); 7.7(3)	2(1); 2(1); 6(1)	
	Industrial		3.3(3); 4(3); 7.3(3)	2(1); 2(1); 2(1)	2(1); -- ; 5(1)
13	How widespread is public participation? <i>(on a scale of 0 to 10)</i>	<u>Planning</u> <u>Development</u>			

Question				Respondent's Answer From			
		Government	Academia	Private Sector	Donor		
13	Municipal - Urban	<u>t</u>	<u>Management</u>				
		.....	.....	3.5(4); 3(3); 6.7(3)	2.6(3); 1(2); 1(1)	4(2); -- ; 4(2)	2(1); 1(1); 0(1)
	Municipal - Rural	.	.	2.5(4); 1.7(3); 3.3(3)	1.5(2); 1(2); 1(1)	1(1); 1(1); 3(1)	2(1); 1(1); 0(1)
	Agriculture	.	.	3.75(4); 2.3(3); 5.5(2)	2.6(3); 2.3(3); 3.3(3)	2.5(2); 2(2); 2(2)	5(1); 1(1); 0(1)
14	Industrial	.....	.....	3.3(4); 2.3(3); 4.3(4)	5(3); 6.5(2); 6.5(3)	2(2); -- ; 5(2)	2(1); 1(1); 0(1)
	How inclined are professional government employees towards public participation and / or decentralization? (select only one)						
	Generally inclined	.....	<u>Public participation</u>	<u>Decentralization</u>	Public participation(2); Decentralization(1)		
	Partially inclined	.....			Public participation(3); Decentralization(6)	Public participation(2); Decentralization(3)	Public participation(1); Decentralization(1)
15	Don't care	.....			Public participation(1)	Public participation(1)	Public participation(2)
	Against it	.....			Public participation(1)		
	How successful / effectual / helpful has the involvement of non-governmental organizations in the various aspects of the water sector? <i>(measuring on a scale of 0 to 10)</i>						
	<u>Planning</u>	<u>Funding</u>	<u>Execution</u>	<u>Management</u>			
				<u>t</u>			

Question					Respondent's Answer From				
		Government	Academia	Private Sector	Donor				
Municipal sub-sector	Private sector	.....		.....		.....		.....
	Int'l Aid Agencies	.....		.....		.....		.....
	Int'l companies	.....		.....		.....		.....
	Communities	.....		.....		.....		.....
	Local NGO's	.....		.....		.....		.....
	Agriculture sub-sector					.....		.....
	Private sector	.....		.....		.....		.....
	Int'l Aid Agencies	.....		.....		.....		.....
	Int'l companies	.....		.....		.....		.....
	Communities	.....		.....		.....		.....
	Local NGO's	.....		.....		.....		.....

N.B: X(Y) – X denotes average scale given by respondents and Y number of replies.

Water Administrative Structure

Water resources were managed and regulated by WAJ, JVA, Ministry of Agriculture and Ministry of Health until 1988 when the MWI was established. The major objective of establishing the MWI has been to centralize water sector activities in an endeavor to improve its management. This made MWI the official institute in charge of water sector activities that include planning, setting of strategies and policy and research and development.

There are three Secretary Generals within MWI, one for MWI itself, one for WAJ and another for JVA. They are required to answer to the Minister. MWI contains eight directorates. Namely, Legal Affairs, Water Resources Development, Deep wells and Drilling, Water Resources Planning, Environment, Public Information Affairs and Awareness, Financial and General Affairs and Project Directorate.

According to the *Ministries and Public Institutions and Departments Linked Organization By-Law No.16 of 1988* WAJ and JVA are linked with the Minister of Water and Irrigation. Nonetheless, WAJ is an autonomous corporate body, with financial and administrative independence. It is responsible for public water supply and wastewater services. It is also in charge of the overall water resources planning, construction, monitoring, operations and maintenance. WAJ Secretary General has five assistants; for Technical Support, Planning and Investment, Maintenance and Workshop, Financial Affairs and Administrative Sectors. WAJ has been undergoing reform according to an improvement plan.

Private sector involvement and decentralization in the water sector are being promoted in the Government reform plans. This is in line with overall government policy directed at the promotion of private sector participation in various governmental sectors. A Project Management Unit (PMU) has been established within WAJ since 1996 to regulate water and wastewater utilities under private management. For example, the Greater Amman water supply management contract which has been introduced in 1999. The PMU is mandated to initiate and follow-up privatization contracts. Management contracts and BOT systems have been set up for the construction of water conveyance and water supply projects and wastewater treatment plants. The establishment of public water companies is another emerging form managing the water sector. Such a company has its own board of directors with representatives from MWI, concerned ministries and authorities.

MWI embarked on an ambitious restructuring programme in order to increase efficiency in Water Sector. Decentralization has been at the center of such efforts. This has been epitomized by delegating management responsibilities from WAJ to regional units operating on commercial basis with Private Sector Participation (PSP). An example is the Northern

Governorates Water Administration (NGWA) which was founded in 2001. NAGWA is comprised of the 4 Northern governorates of Irbid, Jerash, Ajloun and Mafraq (including North Badia). It started operation in January 2002, and provides water supply and wastewater disposal services to more than 1.4 million people living in a predominantly rural service area. The PMU of WAJ is managing the transition period with support from an international aid agency.

Established in 1977, JVA has been entrusted with the social and economic development of the Jordan Rift Valley, Jordan's major agriculture region. It has also been delegated the responsibility of developing, maintaining and protecting water resources. In addition to the 110 km King Abdullah Canal, JVA is also responsible for all dams and reservoirs in the country. JVA has a Secretary General who has six assistants; for Planning and Environment, Southern Ghors and Wadi Araba, Lands and Urban Development, Administration, Finance and Tenders, Northern and Middle Ghors, and Studies and Projects.

The water sector is known to increase government debt problems. This is attributed to the annual subsidies paid to WAJ and JVA. About 25% is known to go for interest payments on external loans contracted for investments in hydraulic infrastructure. WAJ consumes seventy five percent of this amount. On the other hand, there are the indirect energy subsidies given out to farmers. Only half of the water sector expenditures are recovered through levies and associated charges. It is worth mentioning that the total water quantities billed by WAJ amount to about fifty percent of the water quantity produced. This has been attributed to "technical and financial losses" caused by the unaccounted for quantities of water. While this is for municipal water, water for irrigation in the Jordan Valley is sold by JVA at 11-12 Fils/m³ (JD is 1000 Fils, One JD equals 1.41 USD) which is considered rather low as farmers in the highlands put up with a 50 Fils/m³. The low water tariffs are seen somehow justifiable because JVA main mission is to promote social and economic development in the Jordan Valley. Nonetheless, full cost recovery is targeted for 2020. It is estimated that 30% of the "cost recovery gap" can be achieved through improvements in operational efficiency and a further 30% by the institution of better integrated investment planning.

The government of Jordan has been persistent in decreasing debt. Every economic sector in the country is expected to play its role in this policy. The water sector is no exception. To achieve this, three main areas of action have been identified in the water sector. These are increasing WAJ and JVA efficiency through technical and administrative measures including privatization, increasing water tariffs and intensification of the investment planning process. However, it is believed that about 40% of the financial deficit of the water sector would have to be covered through tariff increases. Further still, the average cost of production and

conveyance will be on the increase due to more costly investments and environmental requirements. Nonetheless, in doing that, it is recognized that tariff reviews should take into account socio-economic implications. Examples of the structure of current residential water tariffs are shown in Table 4. For non-residential uses, one cubic meter cost one JD plus an additional 0.56 JD for sanitary discharge for those connected to the sewerage network. The water tariff follows a tiered structure such that the more the volume of water consumed the higher the price per cubic meter. Water bills are issued on a quarterly basis. For the sake of comparison of cost of provision of water with other water supply means, column 3 of Table 4 is perhaps the most appropriate manifestation. Figure 2 is a graphical representation of non-commercial tariff structure adopted in 2001 by MWI (Source: first quarterly bill, 2003). This is the total charge and includes cost of water, sewerage, meter fee plus special charges. It can be concluded from the aforementioned table and figure that 64% of consumers are paying 0.31 – 0.37 USD/m³, 34% pay up to 1.00 USD/m³ and only 2% are paying more than that.

Table 4. Structure of Residential Water Tariffs in Jordan

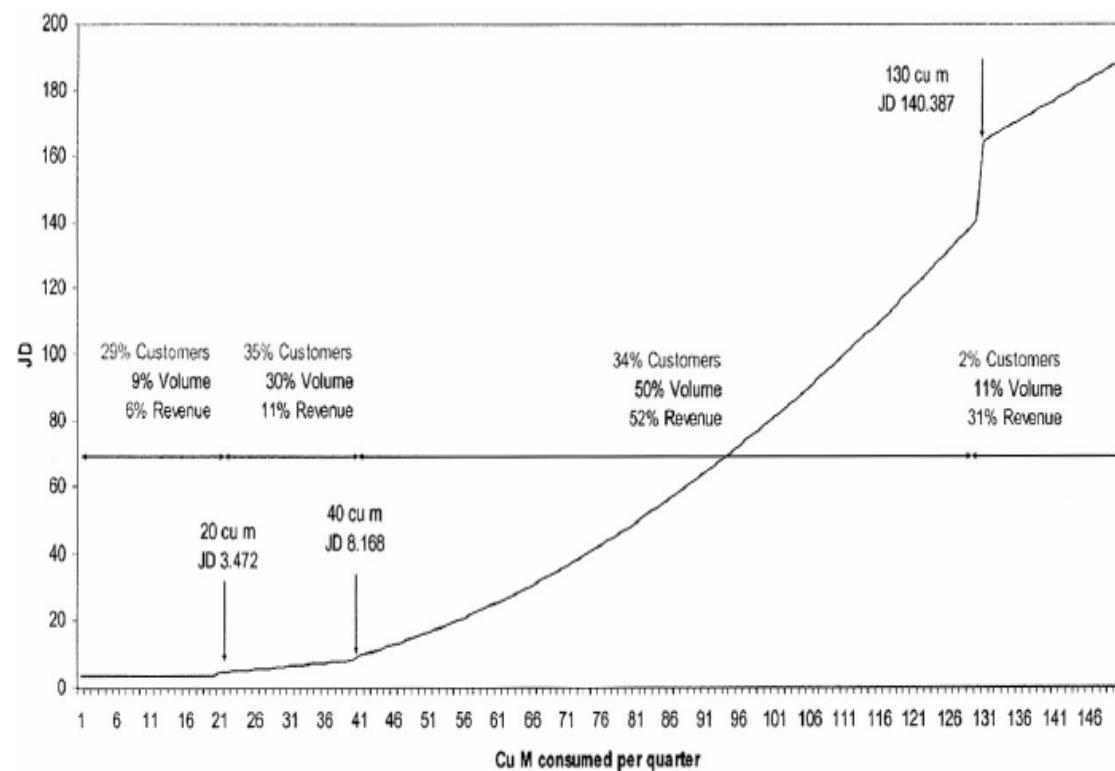
Consumption (m ³)	Total Amount of Water Quarterly Bill Excluding Sanitary Discharge Charges (JD)	Cost of Water per m ³ *		Total Amount of Water Quarterly Bill including Sanitary Discharge Charges (JD)
		(JD / m ³)	(USD/ m ³)	
Less than 21	4.45	0.22	0.31	5.122
30	7.85	0.26	0.37	8.970
40	9.25**	0.23	0.33	10.818
50	15.728	0.31	0.44	19.586
60	21.717	0.36	0.51	28.288
70	29.018	0.41	0.58	38.949
80	37.629	0.47	0.66	51.567
90	47.552	0.53	0.74	66.145
100	58.786	0.59	0.83	82.680
110	71.331	0.65	0.91	101.174
120	85.188	0.71	1.00	121.627
> 130	---	---		850 fils/ m ³ for water + 392 fils / m ³ for wastewater discharge

Source: Translated form MWI first quarterly water consumer bill, year 2006.

* Calculated. ** Seems illogical as rate decreases.

Regulatory Aspects: In accordance with MWI strategy and policies, national health standards are to be promulgated and enforced. This is particularly for municipal water supply. Compliance to these standards ought to be ensured regularly by utility owners through laboratory testing. Records of tests should be maintained and be available for inspection by the governmental agencies. National drinking water standards are listed in the Jordanian Standards for Drinking Water No.286 of 2001. There are also guidelines for microbiological water quality of raw water intended as a source for treatment to drinking water levels (Unpublished). Other relevant standards include those; Jordanian Standards for Reclaimed Domestic Water No.893 of 2002, Jordanian Standards for Industrial Wastewater No.202 of 1991, WAJ's Regulations for the Quality of Industrial Wastewater to be connected to the Collection System. Each of the WAJ Central Laboratories in Amman, JVA Laboratory in the Jordan Valley and Ministry of Health Laboratory has separate surveillance and monitoring programs for water and wastewater. The Ministry of Environment doesn't have its own laboratories but nonetheless contract others to execute its monitoring legislative duties.

Figure 2. MWI non-commercial water tariff structure (LEMA).



Analysis of Questionnaire on Water Management

1. The central government has the greatest influence on managing the water sector. Local municipalities and special authorities have some influence but much less than that of the central government. This is particularly so for the municipal sub-sector and

to a lesser extent in cases of the agriculture and industrial ones. Management responsibilities are divided among the various departments. These departments are created mainly on geographical considerations and a lesser extent, on political considerations, catchments areas or river basins and utilization patterns. There seems to be reasonable degree of coordination between these departments.

2. The present administrative set-up is fairly seen to be favourable to efficient water sector management. Private sector involvement is seen to have a positive impact on water sector performance.
3. The allocated water budget is seen to be insufficient to achieve water sector objectives. Private sector participation isn't seen highly capable of reducing this deficit.
4. The government is the only side that determines and controls water tariffs.
5. On regulatory procedures, monitoring and enforcement issues:
 - a. Laws, bylaws and directives do exist and are satisfactorily effectual.
 - b. There are water boards and committees and their role is reasonably effective.
 - c. There are environmental protection societies and groups but their role isn't satisfactorily effective.
 - d. Basin authorities do exist and their role is satisfactorily effective.
 - e. Groundwater directives are available and adequately effective.
6. Water sector data are not easily available. Neither to the public nor to the private sectors. Such data are available at MWI, WAJ, JVA and some research institutes and centres. Such data are considered safely stored and reasonably easy to retrieve. It is seen as being reliable and to a certain extent sufficient for management purposes. It isn't easily available to researchers.
7. The cooperation between decision makers and the research community is weak. However, new technologies addressing emerging challenges are on the whole seen to be easily embraced by the water sector.
8. Generally, the present water administration system does stimulate the implementation of water laws, regulations and policies.

Table 5. Summary of Completed Questionnaire on Water Management

No.	Question On Water Management	Government	Academia	Private Sector	Donor
<i>Municipal</i>	<i>Agriculture</i>	<i>Industrial</i>			
1	To what extent do the following bodies have an influence on the management of water sector? (measuring on a scale of 0 to 10)				
	Central government .....	.....	.....	9.3(7); 9(7); 8.8(6)	9.7(3); 9.3(3); 6.7(3)
	Local Municipality .....	.....	.....	6.4(5); 7.4(5); 6.7(6)	2(3); 1.3(3); 1(2)
	Special Authority .....	.....	.....	6.6(5); 6.8(5); 6.8(5)	7.5(2); 7(1); 7(1)
	Other (.....) .....	.....	.....		7(1); 5(1); ---
2	Is water sector responsibility divided amongst various departments ? If yes, what are they and what is the sub-sector it is responsible for:	Yes	No	Yes(6)	Yes(2); No(1)
	<i>Department</i>	<i>Sub-sector its responsible for</i>			
			
			
			
3	On what basis are the above departments created / organized?				
	Geographical considerations .....	.....		X(2)	
	Political considerations .....	.....		X(1)	
	Catchments' areas / river basin .....	.....		X(1)	
	Activities and use sectors considerations (agriculture, forest,...) .....	.....		X(1)	X(1)
	A combination of all of the above .....	.....		X(4)	X(1)
4	How strong is the coordination between these departments? (measuring on a scale of 0 to 10)	.....		6.8(6)	7.5(2)
					7(2)
					6(1)

No.	Question			Government	Academia	Private Sector	Donor
		On Water Management					
5	Do you consider the present administrative set-up favorable to efficient water sector management? <i>(On a scale of 1 to 10)</i>	Yes	No	Yes(3); No(3) 5.5(4)	Yes(2); No(1)	Yes(1); No(1) 5(1)	Yes(1) 6(1)
6	Is private sector involvement considered to have a positive impact on water sector performance? <i>(On a scale of 1 to 10)</i>	Yes	No	Yes(4); No(1) 7(3)	Yes(2) 2(2)	Yes(2) 8(1)	Yes(1) 5(1)
7	Is the allocated budget considered sufficient to realize water sector objectives ?	Yes	No	Yes(1); No(5)	Yes(2); No(1)	No(2)	No(1)
8	If no, to what extent can private sector participation help in reducing the financial deficit? (on a scale of 0 to 10)	.....		6(4)	5(1)	5(2)	4(1)
9	Who decides on / controls water tariffs?			Government	Government	Government	Government
	Municipal - Urban	.....		Government	Government	Government	Government
	Municipal - Rural	.....		Government	Government	Government	Government
	Agriculture	.....		Government	Government	Government	Government
	Industrial	.....		Government	Government	Government	Government
	Other .....	.....				
10	On regulatory procedures, monitoring and enforcement:						
		<u>Available?</u>	<u>If yes, how effectual (0 to 10 scale)</u>				
	Laws, bylaws and directives	Yes	No	Yes(6) No(1);	Yes(3); 8.3(3)	Yes(1); 6(1)	Yes(1); 8(1)

No.	Question			Government	Academia	Private Sector	Donor
		On Water Management					
	Water boards / committees	Yes	No	7.8(5) Yes(5) No(2); 6.8(5)	Yes(3); 5.7(3)	No(1); 4(1)	Yes(1); 6(1)
	Environmental protection agencies / societies / groups	Yes	No	Yes(6) ; 4.5(6)	Yes(3); 5(3)	Yes(1); 5(1)	Yes(1); 5(1)
	Basin authorities	Yes	No	Yes(2) No(4); 7.5(2)	Yes(1) No(2); 9(1)	No(1); 0(1)	Yes(1); 7(1)
	Groundwater directives	Yes	No	Yes(5) No(1); 7(4)	Yes(3); 8 (2)	Yes(1); 7(1)	Yes(1); 7(1)
	Others.....	Yes	No				Yes(1); 5(1)
11	Is data and information on the water sector easily available to public and private sectors alike?	Yes	No	Yes(2); No(4)	Yes(1) ; No(2)	No(1)	No(1)
12	Which agencies / departments / institutes possess water data? <u>Name</u> <u>Official Status</u>			MWI, WAJ & JVA Research Institutes	MWI, WAJ, JVA, MOH & MoEnv.	MWI, WAJ & JVA	
13	Can the available data be described as being: Safely stored Easy to retrieve Reliable for management purposes ... etc. Sufficient for management purposes ...etc. Available to researchers	Yes	No	Yes(7)	Yes(3)	Yes(1)	No(1)
		Yes	No	Yes(7)	Yes(2)	No(1)	No(1)
		Yes	No	Yes(7)	Yes(3)	No(1)	Yes(1)
		Yes	No	Yes(5) No(2)	Yes(2) ; No(1)	Yes(1)	Yes(1)
		Yes	No	Yes(3); No(4)	Yes(2) ; No(1)	No(1)	Yes(1)
14	Do you think the cooperation between the research community and decision makers in the water sector is : at its best satisfactory			Satisfactory(2) Weak (5)	Satisfactory(1) Weak (2)	Weak (1)	Weak (1)

No.	Question	Government	Academia	Private Sector	Donor	
	On Water Management weak non-existent					
15	Are new technologies addressing emerging challenges easily embraced by the water sector?	Yes No	Yes(5) No(2)	Yes(2) ; No(1)	No(1)	Yes(1)
16	3.16. In general, how effective is the present administration system in stimulating the implementation of water laws, regulations and policies? (on a scale of 0 to 10)	.....	6.3(7)	6.7(3)	4(1)	6(1)

N.B: X(Y) – X denotes average scale given by respondents and Y number of replies.

Analysis of Questionnaire on the Water Sector as a Whole

It can be seen from Table 6 that respondents' perception of the water sector in Jordan is less than satisfactory. This is particularly so in the case of the private sector respondent. With the exception of the provision of good quality water, the positions of most issues were ranked less than 6 on a scale of zero to 10. Lowest of all is the issue of the water sector ability in ensuring sustainability of water resources. Also, the general public satisfaction with water sector efficiency is seen rather weak. Issues of sector management of social implications of water shortage and price increases, inter-sectoral equity and embracing new water technologies and tools to tackle emerging issues were all rated low. This is a clear and overwhelming indication of dissatisfaction on the part of the respondents of these major issues.

Table 6. Summary of Completed Questionnaire on the Water Sector as a Whole

On the Water Sector as a Whole <i>(On a scale of 0 to 10)</i>	Average (Count) of respondents from				
	Government	Academia	Private Sector	Donor	Weighted Average
Reducing the demand-supply deficit	6.1 (7)	7.0 (3)	3 (1)	6 (1)	6.1
Provision of good quality water	7.5 (7)	7.7 (3)	7 (1)	7 (1)	7.5
Protection of water resources from pollution	6.0 (7)	6.3 (3)	4 (1)	5 (1)	5.8
Maintaining the water infrastructure	6.3 (7)	6.0 (3)	3 (1)	5 (1)	5.8
Managing inter-sectoral water competition	6.3 (7)	6.0 (3)	3 (1)	7 (1)	6.0
Managing the social implications of water shortage / price increases	5.0 (6)	5.7 (3)	4 (1)	7 (1)	5.3
Embracing new water technologies and tools to tackle emerging issues	5.7 (6)	6.3 (3)	2 (1)	6 (1)	5.6
Level of investment compared with actual requirements	5.4 (7)	6.7 (3)	4 (1)	6 (1)	5.7
Cost recovery in comparison with actual expenditure	5.7 (7)	5.0 (3)	5 (1)	7 (1)	5.6

On the Water Sector as a Whole <i>(On a scale of 0 to 10)</i>	Average (Count) of respondents from				
	Government	Academia	Private Sector	Donor	Weighted Average
Ensuring inter-sectoral equity	5.4 (7)	5.7 (3)	4 (1)	6 (1)	5.4
Ensuring sustainability of water resources	4.6 (7)	5.3 (3)	3 (1)	5 (1)	4.7
General public satisfaction with water sector efficiency?	5.1 (7)	6.3 (3)	3 (1)	4 (1)	5.1

N.B: X(Y) – X denotes average scale given by respondents and Y number of replies.

Desalination overview

Employing desalination to augment the scarce water resources has been modest in Jordan. This is perhaps due to the relatively high costs entailed. However, as the country is trying persistently to decrease the water deficit, desalination seems rather inevitable. While the country is known to have brackish water reserves, the Gulf of Aqaba is the only potential seawater source. It is far from population centers; for instance it is some 350 Km from the capital Amman which is also some 1000 m above mean sea level.

Some 27 brackish water desalination plants have been built and 7 were under construction until 2003 (MWI, 2006). The majority of these plants are privately owned and operated by farmers for irrigation purposes. Currently, a few small scale plants serving drinking purposes are being operated by WAJ. Some existing and under construction plants are shown in Table 7. A new Abu Zighan plant, with TDS feed of about 7000 ppm, will help relieve the stress on King Abdullah Canal through supplying water for municipal use to Amman.

Table 7. Some desalination plants for drinking water operated by WAJ

Location / Name	Governorate	Capacity (m³/h)	Cost per unit (million JD)	Cost per installed capacity (JD/m³/h)	Year of Construction
Abu Zighan (New Desalination Plant)	Balqa	1,500	2.50	1,670	Under Construction
Abu Zighan Desalination Plant (Well No.8)	Balqa	50	0.12	2,400	2001
Al Resheh Water Treatment Plant	Aqaba	50	0.12	2,400	2002
Al Rueished Water Treatment Plant	Mafraq	120	0.14	1,170	2000
Zarqa Water Treatment Plant	Zarqa	700	0.75	1,070	2002
Ghaza Camp Water Treatment Plant	Jerash	150	0.25	1,670	Under Construction

N.B/ One USD is equivalent to 0.708 JD. Source: Master Plan 2006.

There are 21 privately owned desalination plants in the Jordan Valley (Table 8). Located north of the Dead Sea, they have been mainly established for irrigation purposes. The average brackish water salinity is about 3000 ppm, with the maximum ranging from 7000 to 8000 ppm. Some studies have revealed the presence of up to 80 million m³ of water that can be used in the Jordan Valley. A relatively large project, with an estimated annual capacity of 9 to 15 MCM, is that known as the Hisban project which is likely to be realized by 2015. On the highlands in the second largest city of Zarqa, there is a 600 m³/hr desalination plant that has been in operation since 2004.

The largest surface water RO desalination effort in Jordan is the Ma'in, Zara and Mujib project. This is a Design-Build-Operate project whereby MWI and WAJ have contracted the private sector to execute and hand it over after two years of operation. The annual capacity is 55 MCM with a salinity of 1500 – 2000 ppm. The project includes a conveyor and will serve Amman with 38 MCM annually. Water is pumped approximately to a height 1500m. Brine is to be conveniently disposed of into the Dead Sea. Cost of production is estimated at 0.4 JD/m³. WAJ reported an operational cost ranging from 0.18 and 0.22 JD/m³ (Master Plan, 2006).

Table 8. Desalination Plants for Irrigation in the Jordan Valley

No	Location	(m ³ /h)	Source of Water / No of Wells	Water Salinity (ppm)	Quantity of Brine (m ³ /h)	Salinity of Brine (ppm)	Plants Irrigated
1	Kabed Ghor	50	Well / 2	5,630	27	14,000	Vegetables & Grapes
2	Al Ramah	80	Well / 1	1,895	23	6,170	Banana
3	Al Kafrein	42	Well / 2	2,000	13	4,320	Banana, citrus palm & some olives
4	Southern Shuneh	70 80	Well / 2	3,200 3,990	13 15	11,150 11,150	Banana
5	Southern Shuneh	40 75	Well / 2	3,580	50	7,020	Banana
6	Southern Shuneh	80	Well / 2	1,500	30	3,750	Banana
7	Al Kafrein	30	Well / 1	2,967	10	11,060	Banana
8	Al Ramah	30	Well / 1	1,805	12	3,730	Banana
9	Southern Shuneh	20 30	Well / 2	5,000	13	13,000	Banana, palm & vegetables
10	Al Ramah	30	Well / 2	1,300	10	3,730	Banana & citrus
11	Southern Shuneh	22	Well / 1	2,500	15	6,000	Banana
12	Southern Shuneh	40	Well / 1	3,000	8	3,890	Banana
13	Al Ramah	20	Well / 1	1,970	10	3,300	Banana
14	Al Ramah	20	Well / 1	2,100	8	7,000	Banana
15	Al Ramah	60	Well / 1	3,000	10	8,900	Banana
16	Southern Shuneh	60	Well / 1	2,960	10	8,400	Banana
17	Southern Shuneh	60	Well / 1	3,000	15		Banana
18		20	Well / 1	3,500	8	7,400	Banana

Source: Master Plan 2006.

In the Aqaba Special Economic Zone (ASEZ), the total water demand was estimated at 15.3 MCM in the year 2003, 36% for industrial and 15% for domestic usage. Aqaba secures its water supply from Disi fossil water aquifer with a long-term allocation of 17.5 MCM/year. However the hydraulic limit of the existing transmission system is 20.9 MCM/year. The demand is expected to be 26.8 MCM by year 2028. Desalination is expected to provide 10 MCM/year to be introduced in two phases of 5 MCM/year in 2013 and 2019 (Al-Basheer, 2004). Over 150 million JD in capital investments is needed over the 25-years planning period. First-phase desalination plant is estimated to cost 10.5 million JD. Reverse osmosis

has been assumed to be the desalination technology for pricing capital and operation costs and brackish water wells were assumed as the raw water source. The MWI, WAJ and ASEZA formed a limited liability company, the Aqaba Water Company (AWC). Of which WAJ owns 85% and ASEZA 15%. ASEZA is to grant AWC the right to manage and develop water transmission & distribution network, wastewater collection network & treatment facilities and the rights of first refusal to develop and operate seawater desalination facilities.

The proposed Red-Dead project is an integrated scheme for the development of the Jordan Rift Valley. It is to serve the domestic, agriculture, tourism and industrial sectors. It foresees bringing water from the former to the latter. It has been anticipated that water will be conveyed through an anticipated 141 km of tunnel and closed pipe and a 39 km of an open channel. There is a difference in the water level head of about 400m between the two seas. This provides the opportunity for hydropower generation. Generated electricity can be used for the desalination. With the intake at Aqaba, and an 850 MCM/year capacity RO plant south of the Dead Sea, 570 MCM/year desalinated water is anticipated to be conveyed to Amman.

A brackish water reverse osmosis desalination facility driven by solar photovoltaic electricity at Aqaba International Industrial Estate (AIIE) seems to be the only desalination plant in Jordan that is operated by a renewable source of energy. It was installed within the framework of the technological scientific cooperation between NERC and the Midwest Research Institute - National Renewable Energy Laboratory (NREL) Division in Colorado / USA. A photovoltaic solar powered reverse osmosis brackish water facility has been installed within the premises of AIIE to meet the demand for potable water estimated at 8000 m³ per year for the AIIE. The AIIE is owned by the Jordan Industrial Estates Corporation (JIEC), a semi-governmental organization with public and private sector participation. AIIE is located within ASEZA.

PBI Aqaba Industrial Estate LLP (PBI Aqaba), a subsidiary of Parsons Brinckerhoff International (PBI), and SUTA Construction, a land development company, has a 30 year concession to plan, finance, develop, market and operate the AIIE. PBI Aqaba, as an investor of the RO facility, has rented a plot of land from JIEC at the AIIE to construct and install the RO facility on. A well with 100 m deep was drilled by the WAJ in the selected site to extract brackish water over the lifetime of the project. In addition to the installed solar power supply system (16.8 kWp) of the RO facility, a utility grid connection was obtained by PBI Aqaba to electrify the lighting and the air conditioning systems within the facility. Also, electricity from the utility grid may be used to operate the RO facility up to 24 hours per day according to the water demand of the AIIE.

Desalinated water from the RO facility will be pumped to the main water reservoir of the AIIE where it is mixed with water from a WAJ utility and then sold to consumers at the AIIE. Desalinated water is to be supplied to AIIE free of charge for two years after which a new arrangement is to be worked out between NERC and AIIE.

The facility was installed and operated in September, 2005. The installed RO facility is expected to produce 3.4 m³/h of water at a recovery ratio of 60 %, according to its rated specifications. TDS of the brackish water is about 3700ppm, which is reduced by the RO unit to 70ppm.

A noticeable number of desalination plants are being constructed in the country and more are under planning. Most of which are Reverse Osmosis (RO) plants with a few Elecrtodialysis Reversal (EDR) plants. The latter is seen to have potential for small scale applications in remote areas. This is because EDR necessitate less pretreatment requirements. At present, all desalination plants in Jordan utilize conventional energy sources.

Energy sources

Unlike some of its surrounding countries, Jordan isn't an oil producing country. It has therefore to import its oil and gas needs to satisfy its energy demands. Currently, Jordan consumes about six million tones and this is expected to double every 15 years. The situation has become much more difficult with soaring oils prices internationally, which is more harshly felt in Jordan as it has been used to obtaining its oil needs from Iraq at preferential rates. This will certainly increase Jordan's economic burden. At \$70 a barrel, Jordan's 2006 energy bill is forecasted to reach 3 billion dollars (Bsieso, 2006). Naturally, government current policy is giving priority to the energy sector. Alternatives are tirelessly being sought in order to reduce dependence on imported sources of energy. Jordan has reserves of oil shale estimated at 40 billion tons. Currently, there are serious plans to make use of these reserves. Natural gas and oil resources are being explored. Gas is currently utilized for power production and is expected to be used to produce all electricity needs from local reserves in the long run. This will relieve Jordan of 40% of its energy imports. Jordan's generated electricity is estimated at 1660 MW while the peak load is 1255 MW. Electricity coverage is practically complete. Consumer prices for various categories are shown in Table 9. The tariff follows a tiered pricing system. So far, no price increases were introduced on electricity as a result of fuel price increases. Conservation of energy has been promoted especially in the industrial and commercial sectors. The use of energy saving devices is promoted through publication of information directories, conduct of training courses and

seminars. These efforts are in line with the National Energy Strategy. They are being mainly implemented by the National Energy Research Center (NERC) which is a science and technology centre acting under the Higher Council for Science and Technology (HCST).

Table 9. Electricity Tariffs in Jordan

Category		Range of Consumption (KWh)	Cost (fils / KWh)
1	Household	1 - 160	31
		161 - 300	57
		301 - 500	65
		> 500	80
2	Commercial		62
3	Industry (small)		39
4	Farmers		28
5	Water pump		38
6	Hotels		59

N.b/ JD is 1000 Fils. One JD equals 1.41 USD

Renewable Energy: NERC was founded with the prime objective of conducting research and development in the fields of new and renewable energy (RE) sources. The center is active in most fields of RE, including Wind Energy of which Jordan has good potential. At present, Jordan has two wind farms; a 1.125 MW in the north of the country at Hofa and another at Al-Ibrahimiah with a capacity of 320 KW. Wind measuring systems have been installed in the country and a database of wind potential is being prepared by NERC in order to promote the use of wind potential.

Solar thermal energy has been widely used in Jordan in the form of Solar Water Heaters. NERC design solar thermal systems for residential and industrial uses. It also provides consultation and training to the private sector.

With an estimated solar radiation of 5.6 kWh/m²/day, Jordan is considered to be rich in Solar Energy. Photovoltaic energy (PV) has therefore, great potential in the country. There are many PV installations serving various purposes in remote rural areas of Jordan. Applications include 24 systems ((108,026 kWp).for water pumping, 13 installations for telecommunications (18,601 kWp), 41 for electricity generations (25,180 kWp) and other applications making the total peak power 178,307 kWp.

There have also been some efforts to utilize biogas in Jordan. A biogas pilot plant was constructed on a municipal waste landfill site in the city of Ruseifa. This plant started production in the year 2000 with a rated capacity of 1 MW. The annual power production from this pilot plant is 7 million kWh due to burning of 2.14 million cubic meter of methane gas per year. The total municipal waste is around 1.5 million tons per year which is equivalent to 25,000 TOE (Al-Taher, 2006).

Geothermal energy is another source of energy believed to be of potential. Jordan has thermal and mineral waters scattered in various locations in the country e.g. the Zarqa Ma'in and Zara hot springs. The potential of these sources is under investigation. Also, if accomplished, the Dead Sea- Red-Dead Canal project has the potential of hydro power generation of 600 megawatts of electric power through a 400-meter head difference between the two seas (Al-Taher, 2006).

According to NERC (Al-Taher, 2006) sustainable renewable energy priorities for Jordan ranked in order of importance as follows:

1. Energy Conservation and demand management.
2. Renewable Energy
 - a) Solar Water Heating
 - b) CSP (Tri-Generation)
 - c) Wind Energy (Site Specific)
 - d) Biomass (Landfill / Municipal Waste)
 - e) Remote Electrification, pumping and desalination (Least Life Cycle Cost Option)
 - f) Hydropower (Site Specific)

Environmental perspective

Water projects can have positive and as well as negative environmental impacts. Negative impacts may occur during installation and / or operation stages. In the case of desalination projects, the use of desalinated water for irrigation (see Table 8) results in tangible positive improvements in the physical and chemical characteristics of irrigated soils. Nonetheless, if not handled properly, brine disposal can be very damaging to surface and groundwater resources, soil and vegetation cover. As yet, there have been no serious investigative studies of the status of brine disposal in Jordan. The proposed Red Sea - Dead Sea project

described above, present unique positive environmental impacts. Namely, the provision of a huge quantity of potable water utilizing hydropower generated by virtue of static head difference. It will also help save the Dead Sea from its decline emanating from receding water inflows. This is expected to improve surrounding landscape and thus increase tourist attraction. It is also anticipated that local flora and fauna habitats will improve. At the other end, however, the high energy needs for water uplifting from the Dead Sea to the Highlands is considered a negative impact.

The Zara – Main and Mujib project, outlined above, is also located in the vicinity of the Dead Sea. Cited negative environmental impacts during the construction phase include the likely disruption of migratory patterns of birds that normally go by the area. In the operational phase, increased air emissions by about 2% are considered an indirect negative environmental impact (Montgomery Watson Harza, 2002).

The above mentioned projects highlight somewhat unique environmental concerns other than those normally encountered in desalination schemes. This stems from the fact that potential desalination projects are within the locality of Dead Sea – Red Sea area. As mentioned earlier, most brackish water desalination in Jordan will occur in the Jordan Valley, nearby the former and Sea water desalination in the latter in Aqaba. Both Seas have well-known unique environmental standing. Aqaba is Jordan's only port and outlet to the sea and is a prime tourist attraction region in the country for its unique coral reefs, fish, marine flora and fauna, some terrestrial habitats and species. Special attention has always been given to environmental protection in Aqaba as it is considered an environmental national treasure. Additionally, Aqaba remains vulnerable to various types of pollution from industrial, commercial and tourism sources. ASEZA Environmental Protection Regulation No. 21 for the year 2001 demands that existing and would be investors take note of and satisfy environmental requirements of their investment. They are required to comply with all the relevant environmental requirements, rules and regulations in force within the Zone .

Brine disposal in inland desalination projects remains a cause of concern in Jordan. This is particularly so since there are no water receiving bodies (except the Dead Sea) that can accommodate such a discharge. Also, of environmental concern is consumption of energy and emissions of pollutants in cases of using conventional sources of energy.

According to the temporary Environment Protection Law No. 1 of 2003, the Ministry of Environment (MoEnv) is the main authority concerned with environmental protection in Jordan. However, other governmental bodies and entities are also active in this, *albeit*, with various degrees of involvement commensurate with their main line activities. These bodies include, but not limited to, MWI, WAJ, JVA, MOH, MOA, the Royal Society for the Conservation of Nature the Ministry of Tourism and Antiquities, the Ministry of Municipalities

and Rural Affairs and the Ministry of Industry and Trade. MWI Water Master Plan contains one volume (No. 7) on Water and Environment which aspires to draw an environmental planning framework for the water sector in Jordan. It outlines what it considers current and projected environmental and health concerns in the water sector in the country and suggests some countermeasures. It focuses upon issues of water quality management, environmental concerns and health aspects concerning water sector planning in Jordan.

MWI water policies stipulate that Environmental Impact Assessment (EIA) studies of water and wastewater projects be conducted before any commitment to implementation is made. Mitigation countermeasures are to be taken of any negative impacts. It has been a standard procedure to conduct EIA studies for large and medium-sized MWI projects. While the Groundwater Management Policy encourages brackish water desalination by the private sector, it stresses the obligation giving due attention to environmental impacts in general and the issue of brine disposal in particular.

WAJ Law No. 18 of 1988, Public Health Law No. 54 of 2002, JVA Law No. 19 of 1988 and Law of Agriculture No. 44 of 2002 contain clauses addressing environmental protection pertaining to the water sector. On the international perspective, Jordan is signatory to several international treaties and conventions pertaining to environmental protection. Examples include the 1994 Peace Treaty with Israel which obligates both countries to protect shared water resources from pollution. The “Convention on Wetlands (the Ramsar Convention) ratified in 1977, The Convention on Biological Diversity ratified by Jordan in 1993 and the Kyoto Protocol ratified early 2003.

Water quality standards and specifications in Jordan are based upon the World Health Organization and other international ones like United States Environment Protection Agency. In certain cases and to some extent they are adapted to suite local condition. Promulgation and issuance procedures are normally conducted through a technical committee of experts from local scientist and stakeholder. Most relevant specification for the purpose of this report include the Jordanian Standards for Drinking Water No. 286 of 2001, Jordanian Standards for Industrial Wastewater No. 202 of 1991 and Jordanian Standards for Reclaimed Domestic Water No. 893 of 2002. Water quality monitoring is mainly conducted by various institutes and ministries; MWI, WAJ, JVA, MOH, MoEnv and MOA. Sometimes responsibilities and extent of involvement overlap which can result in confusion and / or dilution of responsibility.

Conclusions

Jordan is a water scarce country and is in dire need for augmenting its water resources. Desalination is increasingly seen as an inevitable option for that need. This is in spite of the entailed higher water costs entailed compared with what consumers have been accustomed to over the past decades.

Experience in Autonomous Desalination Systems is at its infancy in Jordan. The present institutional and policy framework setup is fairly accommodating to new technologies. However, an updated set-up can greatly accelerate adoption and expansion of desalination systems such as ADS. A new set-up should be explicit in addressing water desalination and associated economic, social and environmental issues. It should stipulate a cost recovery approach while sustaining those who can't afford to pay. A tradeoff should be made, between cost recovery and affordability, in order that private sector investment requirements and interests are also accounted for. There is a strong need to educate the public on water scarcity realities, especially on the costs entailed in the production of water from unconventional resources. This is particularly essential as Jordan has been advocating private sector participation for water sector management since 1999, when the first management contract entered into effect for the Amman area.

Jordan is increasing efforts to find alternative energy sources, especially after the upsurge in international oil prices in the last few years. Renewable energy sources are given second priority only to energy conservation and demand management. Renewable energies are considered indispensable in achieving sustainable development since they are considered as the least long-term cost option for energy and water security. However, it is realized that more actions are needed to achieve that. Prudent policies are needed to create an enabling environment for the expansion of renewable energies. Decision makers, planners, engineers and scientists in the water and energy sectors need to work more closely together. This is specifically required here since energy costs constitute the highest segment of the total cost of water desalination.

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