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Session IV
Challenges to the management of water resources and to countering desertification in the Mediterranean region

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Water Demand Management in Jordan

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Abstarct : Assessments and forecasts of water demand in Jordan show that demand already exceeds the capacity of available water resources. By the year 2020, Water Demand will increase to about 1620 MCM as a result of increase in population, improvements in living standards and growth in economic activity, according to a Master Plan recently developed, while the new sources of water supply are expected to increase the available water from the current level of 850 MCM per year to 1,289 MCM per year. Thus, a shortfall of 331 MCM representing 20 percent of total demand will remain and will have to be managed through appropriate demand-reduction programs

Accordingly, careful consideration and control of water demand is an important component of water management in Jordan. Water demand management includes planning and controlling water uses using social, economic and technical measures in an attempt to reach equilibrium between limited water resources and demand. In order to facilitate water demand management activities at the national level a Water Demand Management Unit (WDMU) has been established at the Jordan's Ministry of Water and Irrigation. The current and future water demand management activities in Jordan represent a serious attempt at reducing the demand on fresh water resources to match it with the available water supplies. This paper describes Water Demand Management activities and programs currently implemented in Jordan that aim at bringing greater efficiency to municipal, tourism, industrial sectors and agricultural sector, while maintaining the economic and social benefits of water use.

Keywords: Water demand management, water conservation, water efficiency

1. Intoroduction

Jordan is a semi arid country with very limited freshwater resources. The availability of water is classified as very low on the Water Stress Index, which indicates the degree of water shortage or scarcity. Water Stress Index is the value of annual rainfall divided by the total population (m^3/capita/year). Countries with less than 1,700 m^3/capita/year are regarded as countries with "existing stress", while countries with less than 1,000 m^3/capita/year are regarded as having "scarcity" and countries with less than 500 m^3/capita/year are regarded as having "absolute scarcity." With 167 m^3/capita/year Jordan falls into the category of "absolute scarcity" (Yachiyo Engineering Co.,2001). The spatial distribution of rainfall in Jordan is shown on Figure 1.

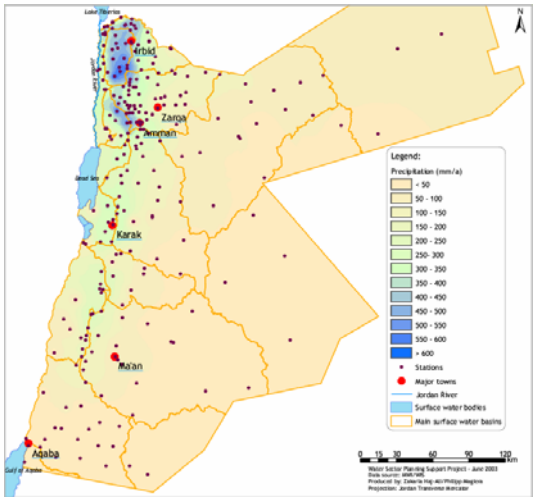

Figure 1. Spatial distribution of rainfall in Jordan

In 2004, the total use of water in Jordan was 866 million cubic meters (MCM) or 164 m^3/capita/year at the total 2004 country's population of 5.29 million people. This usage included 79.4 MCM of nonrenewable groundwater (groundwater mining) and 86.4 MCM of treated wastewater. The total renewable freshwater resources in Jordan are estimated at 850 MCM or 161 m^3/capita/year, however the presence of groundwater mining and wastewater reuse in 2004 indicates that the demand already exceeds the availability of renewable water during that year. Table 1 shows the most recent statistical data on water use in Jordan by user sector and water source.

Source	**Uses in MCM**				**Total Uses**
	Municipal	**Industrial**	**Irrigation**	**Livestock**	
Surface Water	66.13	3.64	202.74	6.0	278.51
Ground Water	214.73	34.1	251.45	0.80	501.08
Treated Wastewater	0.0	0.0	86.422	0.00	86.422
Total	280.86	37.74	540.62	6.8	866.02

Table 1. Sources of Sectoral Water Use in Jordan in 2004
(In Million Cubic Meters per Year, MCM/year)

The Kingdom of Jordan is facing an unremitting imbalance between the total sectoral water demands and the available supply of freshwater. A Water Resources Management Plan has been developed for Jordan in 2004. The plan examined conventional and non-conventional water resources and discussed quantitative and qualitative management issues, as well as institutional and regulatory issues. The plan concluded that the gap between demand and the available water supplies will continue to exist, even after implementing the plan's provisions for enhancing and expanding supplies. By the year 2020, Water Demand will increase to about 1620 MCM as a result of increase in population, improvements in living standards and growth in economic activity, while the new sources of water supply are expected to increase the available water from the current level of 850 MCM per year to 1,289 MCM per year. Thus, a shortfall of 331 MCM representing 20 percent of total demand will remain and will have to be managed through appropriate demand-reduction programs.

Current approaches towards water resources management tend to be "supply driven"; meaning that whenever there is a shortage, the solution usually involves the capital investment in new water supply projects. A shift from the traditional supply orientated approach towards one of water conservation and demand management is essential for the sustainability of water resources and the environment, as well as economic efficiency and social development. However, the move towards more integrated demand and supply approach takes a great deal of time, effort and commitment and is currently backed by key players at many levels in the institutional and political spectra (WMO/DIFD/UNISCO, 1999).

Demand management approach differs from supply-oriented approach by placing more emphasis on social and economic uses to which water is put (Environment Canada,1999). When used with current water supply management approaches, water demand management offers the prospect of greatly improved water management in comparison to its present status. Demand management is defined according to (Savenije, 2002) as the development and implementation of strategies aimed at influencing demand, so as to achieve efficient and sustainable use of a scarce resource. Besides efficiency it should promote equity and environmental integrity. Demand management is another approach to water resources management that contrasts with the traditional supply management, aimed at increasing the supply whatever the demand. It differs from supply management in that it targets the water user than the supply of water to achieve more desirable allocations and sustainable use of water. Apart from structural measures (such as low flush toilets, leak detection and control systems in water distribution networks, and drip irrigation in agriculture) demand management strategies mainly consist of non-structural measures: economic and legal incentives to change the behavior of water users and the creation of the institutional policy environment that enables this approach (Savenije, 2002).

Jordan Water Strategy

In order to address some of Jordan's water problems, a National Water Strategy was developed and approved in 1997. Water demand management is currently a part of the Water Strategy for Jordan (Hashmite Kingdom of Jordan, 1997), which states that "resource management shall continually aim at achieving the highest possible efficiency in the conveyance, distribution, application and use" of water resources. Among the 47 recommendations contained in the Strategy were the following five which pertain to water demand management:

- Priority of 100 liters per capita per day for basic human needs
- Creation of a national water data bank
- Full utilization of all wastewater for irrigation purposes
- Full but sustainable development of aquifer resources
- Adoption of a five-year resource development plan

In the demand management and conservation area, the Water Strategy cites the following four activities:

- Achievement of the "highest possible efficiency" in water conveyance, distribution and use
- Adoption of measures to "maximize the net benefit from the use of a unit flow of water"
- Definition and assignment of roles in water conservation to be played by the different sectors of society.
- Promotion of water saving systems and devices.

Although the Strategy does not identify any specific demand management programs, it is clear that the Ministry of Water and Irrigation, the official body responsible for the overall management of water and wastewater, supports the implementation of demand management efforts as a necessary part of the long-term solution to Jordan's water shortages.

Water Demand Management Activities in Jordan

A Water Demand Management Unit was established at the Ministry of Water and Irrigation by the end of 2002 to undertake the responsibility of Water Demand Management Programs for all sectors in Jordan. The mission of the unit is to increase water use efficiency in and among municipal, industrial, tourism and agricultural sectors while maintaining the social and economic benefits of water use

Activities of WDM Unit include:

- Providing support and Information to entities interested in reducing water consumption;
- Providing free audits service for Industrial, Commercial and Institutional Sector.
- Monitoring misuse of water and recommending enforcement and regulatory measures;
- Promoting information and events that lead the general public to a better understanding and appreciation for demand management; and
- Tracking how much water is being conserved in the Kingdom as a result of the Ministry's efforts.

Water Demand Management Programs

Water Demand Management Programs in Jordan vary from one sector to another. This is a result of the variation of the amount of water used in each sector and the economics of each sector.

The water using sectors in Jordan are:

- Municipal Sector
- Industrial Sector
- Agricultural sector

Irrigated agriculture is the largest consumer constituting around 63% of the overall uses compared to only 37 % for municipal, industrial and tourism (MIT) purposes. The paragraphs below present activities that are taking place in each of the water using sectors.

1- Water Demand Management at the Municipal Sector

Programs at this sector aim at achieving greater efficiency in residential, municipal and commercial, use of water. Activities include:

- A Tariff structure that promotes water conservation: water tariff is used as an economic instrument to set an incentive for water conservation. In this tariff structure, the price per unit of water increases continuously as the total amount of water used. This structure sends a signal to the consumer that increased water use results in an increased water bill.

- Increasing water awareness through water media campaigns: This includes campaigns through T.V. spots, radio and newspapers to explain the water situation and how to participate in efforts in conserving water or using water more efficiently.

- Private sector participation in management of supply systems: Private Sector Participation (PSP) in water utilities management has been considered as a tool to better and more effective management through improved practices. Under PSP, several management programs can be adopted to achieve water savings such as increasing the system efficiency through leakage control and better management, universal metering and pricing, improved customer services, public education for creating a water conservation culture and elimination of the illegal connections. (Abu Shams et al, 2004)

- Introducing Water Demand Management concepts at school curriculum: Education at school is used to as a way to increase understanding about water scarcity and learn about more efficient use of water. An interactive CD for Children on Water Demand Management concepts, to support school curriculum concepts has been developed.

- Introducing new water laws and regulations that aims at conserving water: For example, the principal code dealing with water consumption, the "National Jordanian Construction Code: Water Supply for building Codes" have been updated to address concepts of water efficiency and thresholds for flow rates in water outlets in buildings. Beautification Codes are currently being updated to introduce concepts of water savings in outdoor uses of water. Lectures that target design engineers and plumbing technicians to increase awareness of the new codes and their potential water savings are carried out.

- Promoting using technology and water saving devices: Using water saving devices has proved to save 30% of water used in buildings. Accordingly, Prime Ministry office in Jordan has issued instructions to all Ministries to install those water saving devices in all governmental buildings. Intensive campaigns through all sorts of media to encourage citizens and large consumers to use those devices were implemented.

- Retrofitting about 60% of consumers using more than 500 cubic meters of water per quarter (three month): Field visits to large consumers of water indicated that considerable savings would result from the retrofit programs and installing water saving devices. An intensive program was carried out to audit hundred of governmental and commercial buildings and to prepare feasibility studies on water savings that would result from retrofit and installing the saving devices. As a result of this intensive audit program sixty percent of the decision makers in those institutions have implemented the retrofit program in there building which have resulted in considerable savings in water use (AED, 2005).

- Promoting the idea of water conserving garden: Considering Jordan's scarce water resources, implementing the principles and practices necessary for the creation of water conserving landscapes is of paramount importance. However, such principles and practices are not widespread in Jordan (www.csbe.org). Intensive work has been carried out in raising awareness and to training in the field of water conserving landscape. Four public parks to demonstrate the principles of water conserving landscapes were implemented. Support was given community based organizations for the development of nurseries specialized in the propagation of native drought tolerant plants to be used in water conserving landscapes.

- Studying of the possibility of greywater reuse in areas with no sewer systems: Graywater is the output from bathtubs, showers, sinks, and washing machines, which although soiled, is not as contaminated as toilet water. As such it can be relatively easily treated on-site for reuse in non-potable contexts such as toilet flushing and garden

irrigation (www.csbe.org). Several pilot studies have been carried out, and many gray water reuse systems have been installed in both rural and urban areas in Jordan.

- Initiating a survey for a sustainable water and energy consumer protection program: A comprehensive study on the kinds of appliances that uses water and energy and are available in the marketplace in Jordan was completed. This study will act as basis for a consumer protection program including accurate labeling of water-efficient products..

- Establishing a Master's degree program in Water Demand Management at Jordan University for Science and Technology. This master program is a pioneer program that includes a series of highly specialized courses in Water Demand Management like Best Management Practices, Demand Forecasting and Analysis, Strategic Planning for Water Demand Management; Planning Urban Demand Management Programs, Alternative Water Supply; and Water Demand Management in Agriculture. This program is thought to help in institutionalize the profession of water demand management

- Initiating the work on upgrading plumber's education program in Jordan's vocational schools. Inefficient water systems and fixtures as well as poor plumbing in homes and commercial buildings are thought of an important area of improving efficiency (AED, 2005). Improving plumbers' education and training is an important area in which efforts are needed.

- A community grants program to provide assistance to poor communities Small grants were awarded to local communities in different parts of the country to implement projects that either conserved water or increased water use efficiency.

- Administering pilot projects in five rural communities to illustrate indoor and outdoor water and energy conservation. These sites were provided with solar energy water heaters and lights, water harvesting technology, water-saving devices, and in the case of the mosque, with a gray water system.

A major part of those activities were implemented under a five year program known as Water Efficiency and Public Information for Action Program (WEPIA**)**. A second program which is going to build on those activities will start soon.

2- Water Demand Management in Industrial Sector

Industrial sector in Jordan uses about 37.7 MM. This amount is expected to increase with more industries planned and the government efforts towards creating a favorable investment environment to increase the contribution of this sector to the national economy. Some of the measures taken include:

- Using treated wastewater for industrial purposes: For example, fertilizers industries in Aqaba, which is major water user have replaced fresh water with treated wastewater for its industrial processes.
- Use of Water of lower quality: Potash industries which is another major industrial water user, have introduced the use of irrigation drainage water and the use of brackish water in its processes.
- Use of technology that uses less amounts of water for the same industrial product.
- Installing water saving devices.
- Preventive maintenance and stopping leakages for internal networks at industrial facilities.

3- Water Demand Management in the Agricultural Sector

Agricultural sector is the major consumer of water in Jordan. Water consumption in this sector is about 540 million m3, that is about 63%. Some of the measures taken in this sector include:

- Reuse of treated wastewater in irrigation: In 2004, treated wastewater reused for agricultural irrigation purposes was about 86.4, that is 16% of the total irrigation water use. Restricted irrigation by the treated effluent is applied in the direct neighborhood of the plants and downstream of them without any dilution with fresh water. Unrestricted irrigation takes place, in particular, in the Jordan Valley by treated effluent of As Samra treatment plant after mixing it with fresh water (generally one portion wastewater to three portions of fresh water) (MWI, 2004). This represents the major reuse scheme in the country. All new

planned wastewater plants have there reuse schemes. Wastewater reuse releases fresh water resources for domestic use.

- A policy for Reduction of water use in highlands, which over-pumps groundwater, for more productive and efficient irrigation in Jordan Valley.
- Change of irrigation techniques and using of modern irrigation technologies.
- Change of agricultural production patterns into crops that use less amounts of water and have higher economic returns (avocado, mango,…).
- Issuing "Groundwater by lay in summer of 2002 which imposes financial tariff on water pumped from wells for agricultural purposes. This new water tariff will be used as an economic instrument to control pumping from groundwater.

Future Outlook

Further efforts are still needed in water demand management: these include programs (1) to promote a recognized industry for water efficient products; (2) setting national product standards and information;(3) training programs for managers and operators, (4) a program for peak demand reduction; (5) a program to promote rainwater use and a gray water reuse program for areas with no sewerage; (6) use of economic instruments for pollution control and technological changes (7) comprehensive research activities and data collection programs and (8) a continuous public awareness program to achieve long term awareness and change in attitudes of water users, in addition to, endorsing a national water demand management policy for the country.

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