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Water Conflict among Sectors and Environmental Uses in Jordan

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Summary. The history of relations over the use of water resources is replete with incident of conflict. Jordan is now a source of conflict and no wonder that its groundwater has exhausted to support a growing population. While access to scarce water resources is a common cause of conflict, the continuing competition between sectors over the use of water. This complex interaction is leading inexorably to internal water conflict that inspiring the need of solutions over water use and availability. As such, increasing demand has been a constant concern for Jordanian's leaders because surface, groundwater reservoirs are under stress, and the need of several sectors to use limited water supplies; nevertheless, the subsistence of other water resources and instruments aid to overcome the conflict between sectors. Like other conflicts that revolve around limited water resources, identifying the water issues will guide to the different possible alternatives. The objective of this paper is to summarize the current problems regarding water shortages, supplies, and demand for Jordan including the relationship between the available water resources and the conflict between different sectors. The effective management, development, water allocation, monitoring, and policies can potentially reduce water conflict between sectors.

Keywords. Conflict- Groundwater - Sectorial use - Jordan

Conflits d'eau entre les secteurs et l'usage pour l'environnement en Jordanie

Résumé. *L'histoire des rapports qui règlent l'utilisation des ressources en eau est pleine d'événements conflictuels. A l'heure actuelle, en Jordanie l'utilisation de l'eau est une source de conflits et il n'est pas étonnant de constater que la nappe phréatique soit tarie, notamment en raison de l'accroissement démographique. Il existe une compétition croissante entre les secteurs utilisateurs de l'eau, alors que l'accès à une ressource déjà rare, est une cause récurrente de conflits. Cette interaction complexe mène inexorablement à des conflits internes de plus en plus importants. D'où la nécessité de trouver des solutions en termes d'utilisation et de disponibilité de l'eau. L'augmentation de la demande a été un souci constant pour les leaders jordaniens car le stress hydrique concerne aussi bien les eaux de surface que les eaux souterraines. Voilà pourquoi les différents secteurs devraient limiter les ponctions sur la ressource en eau. Cependant, l'existence d'autres ressources hydriques et de certains instruments permettent de venir à bout des conflits entre secteurs. Comme pour les autres conflits qui dépendent des ressources en eau limitées, l'identification du problème de l'eau permettra d'aboutir à différentes alternatives possibles. Ce travail fait le point des problèmes actuels relatifs à la pénurie, l'approvisionnement et la demande de l'eau pour la Jordanie tout comme de la disponibilité des ressources en eau et des conflits entre les différents secteurs. Une gestion efficace, le développement, l'allocation des ressources en eau, le monitorage et les politiques pourraient bien contribuer à réduire les conflits de l'eau parmi les secteurs concernés.*

Mots-clés. *Conflit - Eau souterraine - Utilisation sectorielle - Jordanie*

I - Introduction

1. Environmental Scarcity and Conflict

Within the next fifty years, the planet's human population will probably pass nine billion, and global economic output may quintuple. Largely as a result, scarcities of renewable resources will increase sharply. The total area of high-quality agricultural land will drop, as will the extent of forests and the number of species they sustain. Coming generations will also see the widespread

depletion and degradation of aquifers, rivers, and other water resources (Homer- Dixon, 1994, 1999).

Analysts often usefully characterize environmental problems as resource scarcities. Resources can be roughly divided into two groups: non-renewable, like oil, and renewable, like fresh water, forests, fertile soils, and the earth's ozone layer. The latter category includes renewable "goods" such as fisheries and timber, and renewable "services" such as regional hydrological cycles.

The commonly used term "environmental change" refers to a human- induced decline in the quantity or quality of a renewable resource that occurs faster than it is renewed by natural processes**.** Homer- Dixon (1994) explained that environmental change is only one of the three primary sources of renewable resources scarcity whereas; "environmental scarcity" encompasses all three sources. These sources include:

- Supply induced scarcity, caused by degradation or depletion of resources.
- Demand induced scarcity, caused by population growth.
- Structural scarcity arising from the unequal distribution of resources

According to Humer Dixon, these three resources of renewable resource scarcity often interact. The population growth reduces a resource's per-capita availability by dividing it among more and more people. The unequal resource distribution concentrates resource in the hands of a few people and subjects the rest to greater scarcity. The property rights that govern resource distribution often change as a result of large-scale development projects or new technologies that alter the relative values of resources. In other words, reduction in the quantity or quality of a resource shrinks the resource pie, while population growth divides the pie into smaller slices for each individual, and unequal resource distribution means that some groups get disproportionately large slices. If such, conflict will be precipitated.

In few words, "Conflict means disharmony of interests, dispute over incompatible interests, or a difference in preferred outcomes". Conflicts caused by scarcity and characterized by degradation in one or more of the following fields:

- Over use of the resources
- Pollution

Environmental scarcities are already contributing to conflicts in many parts of the developing world. These conflicts are probably the early signs of an upsurge of violence in the coming decades that will be induced or aggravated by scarcity. The violence will usually be persistent, and diffuse. Many societies are already suffering acute hardship from shortages of water, forests, fertile land and others.

2. Water and Conflict

Water is essential for human survival and for socio- economic development. As world population growth has increased, water has become recognized as an issue of global importance. Water resources have come under increasing competition worldwide as escalating inhabitants with increasing affluence demand more water in the form of agriculture, industry, domestic and environmental requirements. The problem is aggravated as the water resources systems are unable to absorb shocks caused by natural inconsistency under these conditions of increased demand and decreased supply. Like most areas around the world, most Arab countries are known for severe shortage of water resources as it is connected to geographic, meteorologic, and demographic factors.

Surface and groundwater basins are under stress due to the users pressure placed on them. The severity of competition in water use is inevitable for many countries in the near future. Water has become a major cause of disagreement among both different users and regions in a country and across international borders. This condition will create water conflicts and the conflict will rise as sacristy get inferior.

Water shortages cause stress in the domains of ecology, economic, and national security. It is a source of conflict in the dry lands of Jordan, where it is already a very scarce resource. Most of its surface water resources are shared the territories of three separate Arab political entities, and a Jewish one. These are respectively: Lebanon, Syria, the West Bank (represented by the Palestinian). Moreover, some aquifers are shared between Jordan and Saudi Arabia and Jordan and Syria.

Shatanawi (2005) in describing water conflicts and conflict management mechanisms in Jordan, he reported that conflict concentrated on the following aspects:

- Conflict among sectors due to water allocation.
- Conflict between domestic and irrigation demands in the Jordan Valley.
- Conflict on groundwater between government and users on the over- exploitation of resources, resources tax, controlling the flow and metering the wells.
- Conflict between agriculture and domestic in one side and protection of the wetlands as the of the Azraq case.
- Conflict on the use of Disi aquifer and Mudawarah Basin.
- Conflict over pricing of water for different sector.
- Conflict over water right and market.

Objectives

Water will determine how the competition among sectors of domestic, agricultural and industrial. This paper discusses the water conflicts of Jordan that are the outcome of continuing water stress and growing struggle between sectors. It covers the current problems regarding water shortages, where scarcity has led to water issues identification and causes.

Since water is basic to man and socio-economic betterment as well as for maintaining sustainability in the process of development, it is important that it will be managed in an integrated and equitable manner to meet the demands of competing water users and water use sectors. In this regard, this paper will concentrate on the possible ways, alternatives, actions, and policies of water conflict solution.

II - Description

Jordan is an arid to semi arid country with a land area of about 90 thousand km^2 of which over 80 percent is desert. The area of water bodies is about 482 km^2 that includes the Jordanian part of Dead Sea and the Gulf of Aqaba that gives the country its only port and access to the Red sea. Jordan is located to the east of the Mediterranean sea between latitude of 29^o: 11 N to 33^o: 22 N and longitudes of 34^o: 19 E ^{to} 39^o: 18 E. The country is bordered by Syria to the North, Saudi Arabia to the South, Israel and Palestine to the West and Saudi Arabia to the East.

Geographically, four main topographical features characterize Jordan:

- The lowlands (Ghors), which consist of three areas: the Jordan valley which starts at Lake Tiberias in the north (220 m below sea level), the lowlands along the Dead Sea (405 m below sea level) and the Wadi Araba which extends in a southerly direction to the northern shores of the Red Sea. Jordan Valley rainfall decreases from approximately 300 mm in the north to 102 mm in the south. Annual rainfall of southern Ghor is less than 100 mm. The Jordan Valley and the Southern Ghor are among the most important agricultural areas. Wadi Araba region possesses a hot arid climate with Average rainfall of 50 mm/ year, with limited cultivated areas using underground water.
- The highlands, these extend from north to south between 600 and 1600 m above sea level. Circumstances as high altitudes and high annual rainfall (350-600 mm) join to create a temperate Mediterranean climate, which ensures the area is home to the vast majority of the population and includes the cities of Amman, Irbid and Zarqa.
- The arid plains, these comprise the plains between the Badiah and the highlands. Rainfall ranges between 200 mm in the East and 350 mm in the West.
- Badiah (Eastern Desert), it is an extension of the Arabian Desert and covers about 90 % of the Kingdom. Annual rainfall of Badiah is less than 200 mm

III - Jordan Current Problems

1. Population

The population grew from an estimated at 586,200 people of 1952, to 900,800 by 1961 (the date of the first population census) and to 2,133,000 by 1979 (the date of the second census. Before 1994, the population was growing at 3.4 % due to three population influxes in 1948, 1967 and 1990. The latest census, conducted in 2006, demonstrated that the population of Jordan was about 5.9 million, and still increasing at 2.4 percent per year (DOS, 2006). Clearly, as the population increases the demand for water increases as well. Furthermore, the distribution of population is unevenly throughout the country as about 80 % of the population is located towards governorate of Amman, Zarqa, Mafraq, and Irdid, all of which are water deficit areas and depend on water importation from other areas. Although the current population growth rate is expected to decline, due to education and birth spacing, the population will continue to place a massive pressure on water resources.

2. Limited water resources

Rainfall is the main source of water in Jordan. The average total quantity of rainfall, which falls on Jordan, is about 8558 MCM per year, and it ranges over the years between 4000 and 17800 MCM per year. Approximately 90% of total annual rainfall is lost through evaporation and other abstractions, while the rest flows in wadis as flood flows and recharges the ground water.

The distribution of rainfall varies considerably with location, and variable topographic features. On the average, only 1.1 percent of the country receives over 500 mm of rain per year. Another 1.8 percent of the country receives between 300 to 500 mm, and 5.7 percent receives 200 to 300 mm. The rest of the country 91.4 percent receives less than 200 mm of rain per year.

Water resources in Jordan consist of surface water, ground water, and treated wastewater. Ground water is considered the major resource in many areas of Jordan, and the only water resources in some other. It is comprised of both renewable and nonrenewable resources among 12 basins. Renewable water resources are estimated at about 940 MCM per annum. An additional 143 MCM per year is expected to be available from fossil aquifers and 50 MCM from brackish aquifers after

desalination. Available treated wastewater for irrigation is about 73 -80 MCM per year. **Table 1** shows the estimation of different water resources in Jordan. Some of the renewable ground water resources are presently exploited at its maximum capacity and in some cases beyond its safe yield capacity and is approaching the red line limit of exploitation.

Table 1. Estimation of Different Water Resources in Jordan in MCM/year.

No.	Description	MCM
1	Renewable water resources	940
1.1	Internal	800
1.1.1	Surface	520
1.1.2	Groundwater	280
1.2	External	140
1.2.1	Surface	140
1.2.2	Groundwater	0
2	Non renewable water resources	270
2.1	Groundwater	143
2.2	Re-use	73
2.3	Desalination	50
3	Total water resources	1,210

Jordan's surface water is distributed unevenly in 15 basins. The major basins are Yarmouk, Zarqa, Jordan Riverside, Wadi Mujib, Dead Sea, Hasa. Zarqa River Basin is considered the second important basin after Yarmouk in terms of its water resources and population. **Table 2** shows the long-term average for surface water resources.

Table 2. Surface Water Basins in Jordan and their Available Water Resources.

Basin	Basin Area Km^2	Rainfall (mm/yr)	Available Supply (MCM/year)
Yarmouk	1426	375	260
North wadis of Jordan valley	2028	536	56
South wadis of Jordan valley	434	374	29
Zerqa River	3739	262	59
Dead Sea Wadis	1510	226	61
Mujib Wadi	6787	134	84
Hasa Wadi	2603	114	36
North Wadi Araba	1453	62	12
South Wadi Araba	1500	42	3
Yutum Wadi	3170	63	3
Southern Desert	5200	38	2
Jafar	12360	45	10
Sarhan	15730	60	15
Azraq	12710	68	27
Hammad	19270	71	5
Total	**90000**	**95**	**667**

(Source: Ministry of Water and Irrigation 2002).

The Jordanian Government has extensively developed surface water resources. Priority being given to the construction of Dams, irrigation projects in the Jordan Rift Valley, in order to maximize the utilization of water resources before being discharged to the Dead Sea or Jordan River.

Treated wastewater discharged from 19 existing treatment plants is an important component of the Kingdom's water resources. Wastewater is treated and discharged to surface water or directly reused for irrigation, mostly in the Jordan valley. Wastewater quantity is increasing with population growth, increasing water use and development of sewage systems. By the year 2020 when the population is projected to about 9.9 million, about 265.3 MCM per year of wastewater are expected to be generated.

3. Sectors demand on water resources

Jordan is facing severe and growing concern regarding the availability of water and meeting the rapidly growing demand for water resources, due to population growth, industrialization, expanding irrigation projects, and improving standards of living. These factors have led to increasing water use and overexploitation of groundwater. Due to that the per capita share of water is less than 180 m^3/year and it could reach less than 91 m^3 by the year 2020. Water used for irrigation, which is the largest use of water in Jordan, will be highly affected by water shortage as part of it would be diverted to meet the needs of urban areas and industry whilst remaining a prime engine of agricultural growth.

The current use of water is already exceeding the renewable water supply and the gap between water demand and supply is widening as times go by. Irrigation accounts for almost 65% of all water use. Farms in the highlands are irrigated by groundwater from private wells and exploited about 60 % of groundwater. Irrigation in the Jordan valley covers 33,000 ha which are irrigated by private wells and King Abdullah canal.

Municipal demand is growing rapidly, accounting of about 32 % of all water use. Demand cannot be met in most urban areas during half of the year. The storage results not only from lack of resource, but also from decisions of resources allocation (three-quarters of water goes to agriculture), inadequate infrastructure, and inefficiency of water distribution. The projected municipal water demand in year 2020 is expected to be about 500 MCM.

Industry consumes around 4% of all water use. Because of the unreliability and relatively high cost of public water supplies, many industries install their own private wells to reduce cost and improve reliability. Further industrial water demand depends on future industrial development in Jordan. The projected industrial water demand in year 2020 is expected to be 120 MCM. **Table 3** shows the quantity and usage of ground water distributed by Water Basin for the year 2002**, Figure 1** shows the water uses from the year 1985- 2002. **Figure 2** shows the municipal demand projection, and **Figure 3** shows the sectors demand projection.

Among the sources of water to close the deficit, overexploitation of ground water is the most serious. One of the water resources that are available is the recycled wastewater from municipal and industrial wastewater treatment plants. Obviously, this water will be used for irrigation and more fresh water will be available for domestic and industrial uses. Using treated wastewater in agriculture requires extra care in wastewater management to avoid environmental and public health hazards; and the reliance on fossil water of the supply of water can be justified when there is no other source for the supply for municipal water at affordable costs. There are limited options for increasing the resources, and using the fossil water for municipal uses is a forerunner in Jordan because of the absence of other feasible alternatives.

Table 3. Quantity and Usage of Groundwater Distributed by Water Basin for the year 2002 (MCM).

		Municipal		Industry		Agriculture		Remote Areas		Total			
Year	Safe Yield	Water Qty	N.Wells	Water Qty	N. of Wells	Water Qty	N. of Wells	Water Qty	N. of Wells	Use	N. of Wells	Balance	% Safe Yield
Renewable Groundwater													
Yarmouk	40.0	10.1	31.0	0.2	3.0	36.5	114.0	0.0	0.0	47.0	148.0	-7.0	117.0
Side Valleys	15.0	17.1	22.0	0.0	0.0	4.6	52.0	0.0	0.0	21.8	74.0	-6.8	145.0
Jordan Valley	21.0	7.4	41.0	0.0	2.0	27.4	213.0	0.0	0.0	34.9	256.0	-13.9	166.0
Amman-Zerqa	87.5	75.3	186.0	5.7	61.0	49.7	431.0	0.0	0.0	130.8	678.0	-43.3	149.0
Dead Sea	57.0	36.9	103.0	11.4	53.0	26.3	258.0	0.1	4.0	74.7	418.0	-17.7	131.0
North Araba Valley	3.5	0.1	2.0	3.0	11.0	2.4	19.0	0.0	0.0	5.6	32.0	-2.1	159.0
South Araba Valley	5.5	1.0	3.0	2.0	2.0	3.5	44.0	0.2	2.0	4.9	51.0	0.6	89.0
Azraq	24.0	26.6	33.0	0.3	2.0	30.8	514.0	0.6	13.0	58.3	562.0	-34.3	243.0
Serhan	5.0	0.0	0.0	0.0	0.0	1.8	16.0	0.2	5.0	2.0	21.0	3.0	39.0
Hammad	8.0	0.5	5.0	0.0	0.0	0.0	0.0	0.5	12.0	1.1	17.0	6.9	13.0
Nonrenewable Groundwater													
Disi and Mudawrah	125[1]	9.5	18.0	3.8	0.0	42.1	55.0	0.0	1.0	55.4	74.0	69.6	44.0
Jafer	9.0	7.7	28.0	6.0	20.0	8.1	106.0	0.2	5.0	21.9	159.0	-12.9	244.0
	18[1]												
Total	**418.5**	**192.4**	**472.0**	**30.7**	**154.0**	**233.2**	**1822.0**	**1.9**	**42.0**	**458.1**	**2490.0**	**137.86[2]**	

[1] Non renewable Groundwater
[2] Total Over Yield from Renewable Groundwater

(Source: Ministry of Water and Irrigation 2002).

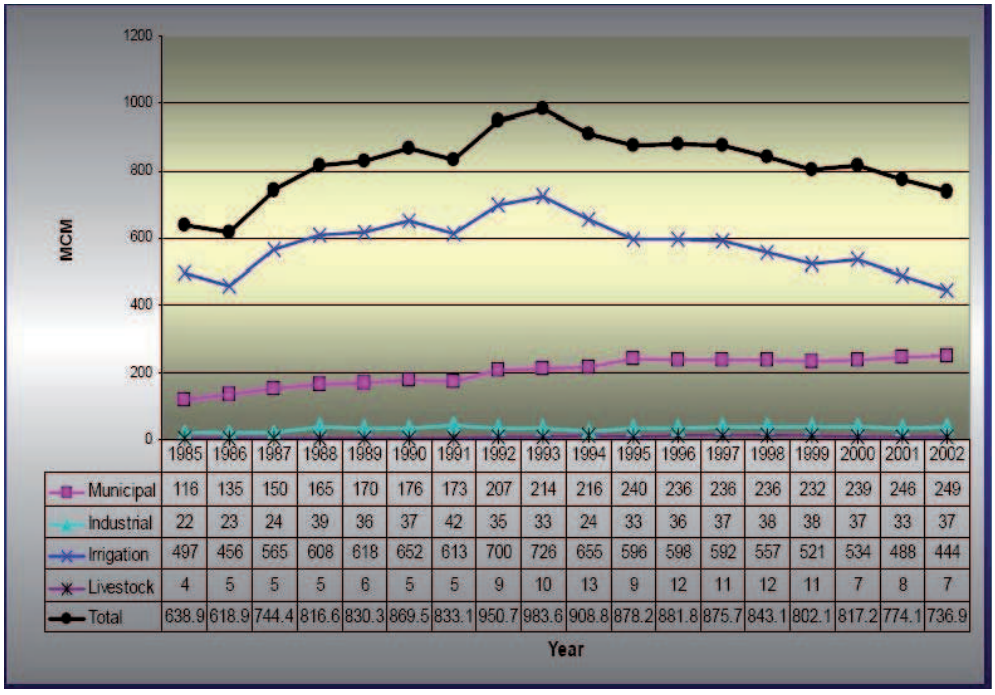


Figure 1. Water Uses 1985-2002. ***(Source: Ministry of Water and Irrigation 2002).***

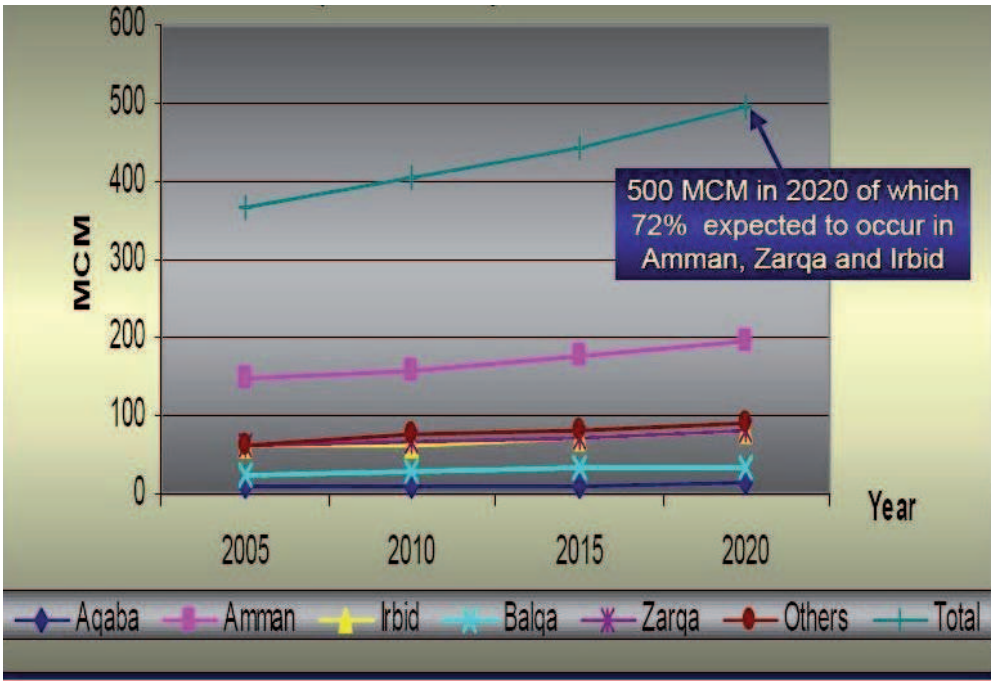
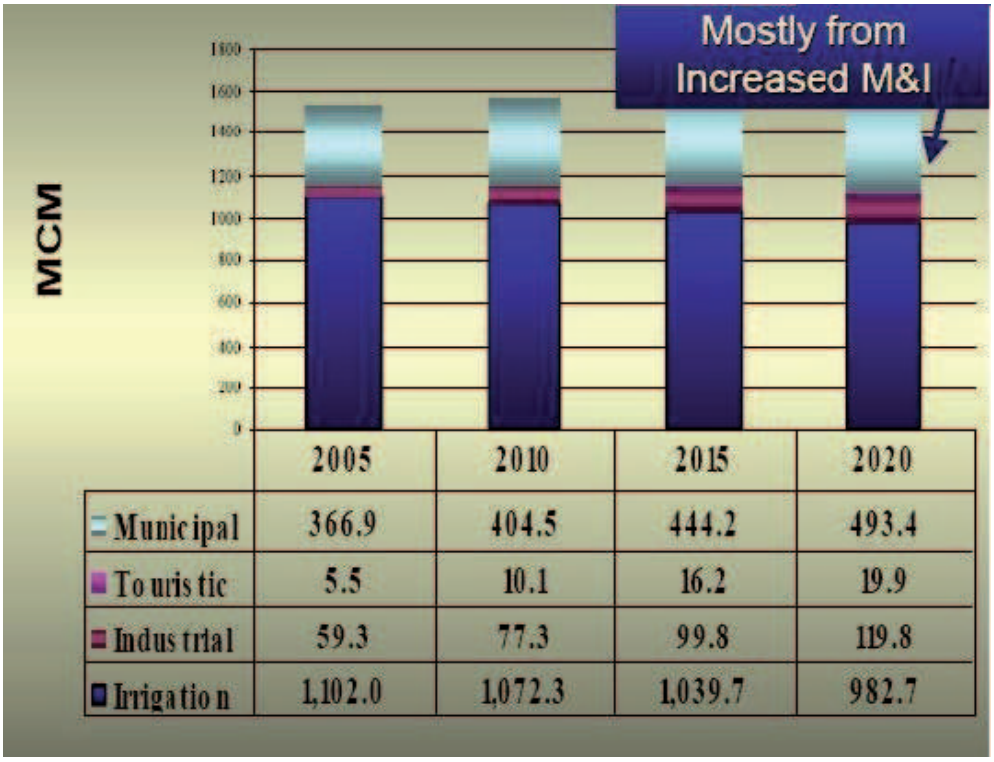


Figure 2. Municipal Demand Projection. (Source: Ministry of Water and Irrigation 2002).



	2005	2010	2015	2020
Municipal	366.9	404.5	444.2	493.4
Touristic	5.5	10.1	16.2	19.9
Industrial	59.3	77.3	99.8	119.8
Irrigation	1,102.0	1,072.3	1,039.7	982.7

Figure 3. Sectors Demand Projection. (*Source: Ministry of Water and Irrigation 2002*).

IV - Water Conflicts Issues

Because of limited water resources in Jordan, water has become the center of development targets. Jordanian government put its effort to utilize water in the most efficient and productive way. Measures were also taken to mitigate the conflicts related to the permanent water shortages. These include identification of water issues that are related to competition in water usage between municipal, agricultural, and industrial sectors. This will lead to solutions, such as public awareness programs in agriculture and domestics, rehabilitation of existing networks, water harvesting and others. Water issues can be summarized in the following:

1. Water management issues

- o Conflict and overlap of responsibilities between different institutions.
- o No single river basin authority has been set formally by law.
- o Competitions among different users and sectors are increasing.
- o Financial resources are often not sufficient to complete plan for river basin management (low investment in wastewater treatment).
- o Public awareness programs are improving and are done in collaboration between government and NGOs.
- o Research is limited and fragmented.
- o Difficulties in the enforcement of water laws and regulations.

2. Water Demand Issues

- o High demand compared to supply due to high population growth, urbanization, and increased agricultural and industrial activities.
- o Overgrazing, deforestation, land fragmentation, and other land use changes have influenced the pattern of flood.

3. Water Supply Issues

- o Climate change and occurrence of drought have decreased the annual rainfall over the last 80 years.
- o Water supply is influenced by variability in rainfall pattern which vary from year to year.
- o Drop in base flow for the basins. For example, the base flow of Zarqa River Basin was dropped to about 0.5-1.0 m3/s in summer and to about 2.0-4.0 m3/s in winter.
- o Effluent from WWTPs has modified the basins discharge, but it has greatly degraded the water quality.
- o Over abstraction of groundwater.

4. Water Quality Issues

- o Pollution of surface water from domestic and industrial effluents as well as solid wastes.
- o Over abstraction of groundwater has resulted in water quality deterioration of some wells.
- o Overgrazing, deforestation and agricultural activates as well as construction activities have increased the sediment load of surface water.

V - Planned / Proposed Actions and Conflict

The planned and proposed actions that might reduce and overcome Jordan water conflict can be summarized in the following:

- o Additional Waste Water Treatment Plants (WWTP) within the basins.
- o Upgrade and expansion of existing WWTP's.
- o Reduction in groundwater extraction for irrigation and municipal use (by law).
- o Reallocation of water to high value products (industry and Municipal).
- o Conveyance of Disi water to Amman, where water from Disi aquifer will be transferred to Amman area at a rate of 100 MCM/year.
- o Rehabilitation of pipe networks.

The pipe networks of major cities (Amman, Zarqa, and others) are very old and are made of steal or cast iron pipes. These materials are subject to corrosion and leaks that causes major water losses in the water distribution network. Therefore, the Water Authority has taken a major step of rehabilitate this system by one than can tolerate high pressure and has less frequency of breaks and leaks. The system is mainly replacing steal or cast iron pipes by PE pipes with electrical welding for pipes up to 6 inches. Larger pipes are replaced with ductile cast iron.

- o Desalinization of Zara-Ma'een and Abu Zighan water.
- o Red Sea- Dead Sea Canal.
- o Water Harvesting.

The encouragement of water harvesting projects at household and farm levels is needed in the future to utilize surface water supplies. Water harvesting projects is also proposed to reduce water conflict.

This technique can serve many purposes as:

- o Provide irrigation water.
- o Increase groundwater recharge.
- o This measure will follow the sound in keeping surface water clean. For example, water harvesting in upper catchments of Zarqa River Basin will prevent its water to reach Khirbet es- Samra wastewater.
- o Improved cropping patterns.

The intrusion of high value cash crops and crops suitable for low quality water is a future priority that should be taken into consideration within possible future law of land use. This technology is considered as environmental issue. It encourages on the expansion of the area under tree crops, forest, and rangeland to be irrigated by treated wastewater. The concept of organic farming and market competition were also proposed actions.

- o Desertification strategy.
- o Public awareness programs.

Farmer education is an essential component of a successful water conservation program of supporting agriculture since it will facilitate adoption of improved technology. The education and Training Program will be designed to support the implementation of a Water Saving Policy by ensuring that the farmer community accepts responsibility in reducing demand for water, and

secure a sustainable long-term water supply. The educational program will cover the basics of water use efficiency such as:

- How water is delivered to them.
- The costs of water service.
- Why water conservation is important.
- How they can participate in conservation efforts.
- Inform on water saving irrigation techniques and train farmers to use the water more effectively on the field, etc.
- The educational and training program may include the following actions. Communications, including public information and education campaigns using local mass media, public relations, events, brochures, information materials and other tactics to ensure that the farmer community is well informed, and that individuals are motivated to take their share of responsibility.
- Partnerships between government and major water users in agriculture to deliver specifically targeted education initiatives.

There is a strong belief that water conservation is one of the most reliable and cost-effective solutions to the water shortage problem faced by the region. This belief is clearly reflected in the recommendations made by regional and international meetings of water agencies and international bodies. Unfortunately, it is limited to the consumers (the public). This highlights two basic problems: first, the lack of such activities; and, second, the poor information exchange.

Public Awareness Program technology focuses on raising public awareness and educating the public through integrating teachings as part of the education program and materials. In this way, both environment and water shortage issues will be addressed because of their importance in the region.

- Optimization of water at farm level through improvement of irrigation systems.
- Construction of dams to utilize available surface water.
- Implementation of law by force (Police of Environment).

VI - The Policy

1. Ground Water Policy

The policy statements set out the Government's policy and intention concerning groundwater management aiming at development of the resource, its protection, management and measures needed to bring the annual abstractions from the various renewable aquifers to the sustainable rate of each. Government efforts for groundwater management policy were concentrated on resource exploration, monitoring, quality, development, allocation of groundwater, legislation, institutional arrangement, technology transfer, public awareness and on private sector participation (MWI, 1998).

The unsustainable abstraction of groundwater and the depletion of groundwater aquifers is one of the major problems facing the water sector in Jordan. The reaction to the abrupt surges in population levels has been over abstraction from groundwater aquifers. This was exacerbated by the lack of enforcement of regulations on private sector drilling operations, and the near absence of controls on licensed abstraction rates resulting in the rapid depletion of aquifers and

culminating in increased pumping costs due to the drastic drop in the water table, as well as increased salinity levels. Groundwater aquifers are exploited at more than double their sustainable yield in the average. The sustainability of irrigation in the highlands and the Badia areas will be greatly endangered unless strict measures are taken to address this issue. As such, the Ministry is implementing a program that sets out legal and financial measures aimed at controlling and gradually reducing groundwater withdrawals with the final objective of maintaining the safe yield of aquifers. Measures will also continue to be taken to protect the groundwater resources from all sources of pollution.

In order to improve the groundwater situation in the Kingdom, the Ministry of Water and Irrigation is establishing an integrated program to assess the availability and exploitability of all resources at rates that can be sustained over long periods of time. The mining of renewable groundwater aquifers will be checked, controlled, and reduced to sus-tainable extraction rates. In conjunction with this, the Ministry is pursuing planned and controlled groundwater mining from promising, extensive fossil aquifers as an option to secure incremental supplies for municipal and industrial uses. The groundwater use will take place conjunctively with surface water in places where such joint use has the potential for increasing the available supply. There will also be improvement and centralization of groundwater data collection, analysis, and monitoring, as well as the strengthening of the enforcement of groundwater legislation and regulations. The Ministry will futher encourage the application of applied research activities, including artificial recharge to increase groundwater supplies, and the employment of new technologies that will optimize the operation and development of groundwater systems and promote its more efficient and feasible uses.

2. Irrigation Water Policy

Irrigated agriculture is a trade of Jordanian ancestry practiced in the Jordan Rift Valley. Policy addresses the irrigation water and water-related issues of resource development: agricultural use, resource management, the imperative of technology transfer, water quality, efficiency, cost recovery, management and other issues. Most of the provisions of irrigation policy are being exercised, and some others are needed to maximize the benefit from irrigation water, and improve the social returns from its uses (MWI, 1998)

While the policy is national, its implementation is vested in the respective Government agencies as stipulated by applicable laws. Of particular importance is the role of the Ministry of Water and Irrigation and the Ministry of Agriculture.

3. Wastewater Management Policy

Since the year 1980, the government of Jordan carried out significant and comprehensive plans with regard to the different issues of wastewater management primarily related to the improvement of sanitation. About 75% of the urban population and 52% of the total population (at that time) gained access to wastewater collection and treatment systems. This has raised the sanitation level, improved public health, and strengthened pollution control of surface and groundwater in the areas served by wastewater facilities (MWI, 1998).

Currently, the characteristics of wastewater in Jordan are somewhat different from other countries. The average salinity of municipal water supply is 580 ppm of TDS, and the average domestic water consumption is low. This results in very high organic loads and in a higher than normal salinity in wastewater. This is particularly applicable to wastewater treated in waste stabilization ponds, where part of the water is lost through evaporation, thus increasing salinity levels in the effluents. In addition, high organic loads impose operational problems where the plants become biologically overloaded.

The major receiving streams for wastewater have very low flow with wastewater comprising a significant portion of stream flow. These streams are not used for bathing or fishing. Much of Amman's wastewater treated effluent is discharged in the Zarqa River and is impounded by the King Talal Dam where it is blended with fresh flood water and is subsequently released for irrigation use in the Jordan Valley.

The Jordanian standards and regulations that specify the quality of the treated effluents allowed to be discharged into wadis or destined for reuse in agriculture; require a secondary level of treatment. Quality specifications follow the WHO guidelines for the safe use of treated effluent in irrigation.

Wastewater Management Policy addresses the following considerations:

- Provision of adequate wastewater collection and treatment facilities for all the major cities and towns in Jordan.
- Protection of the environment and public health in the areas affected by the proposed systems, especially, surface waters and ground waters.
- Consideration of treated effluents as a source for irrigation reuse.
- Improvement of the socioeconomic conditions in the areas to be served by the proposed systems.

4. Surface Water Utility Policy

Development of the country's remaining limited surface water potential can contribute to meeting rapidly increasing demands for all categories of water use in the country. Surface water supplies contribute substantially to Jordan's total water resources, and despite heavy investment in the construction of storage reservoirs, there are still opportunities for further investment in surface water facilities.

In order to enhance the surface water resources, the Ministry of Water and Irrigation is implementing a comprehensive monitoring and assessment program for surface water quantity, quality, and uses, as well as establishing an integrated development and conservation program to increase the potential of surface water development in Jordan.

Since the surface water resources are extremely limited, the Ministry will optimize the development and use of this resource through supply-enhancing measures, including surface and subsurface storage, minimizing losses by surface evaporation and seepage, soil and water programs, and protecting surface water supplies from pollution.

The Ministry is also pursuing the development of sustainable management plans for surface water systems in the Jordan Valley, conversion of open canal systems to a pressurized pipe system, giving priority to modernizing and upgrading systems, and precedence to water projects which make significant contributions to meeting rising municipal and industrial demands.

VII - Conclusion

It can be concluded that the link between water scarcity and the competition among sectors is a serious threat. Jordan is now a source of water conflict among sectors because of the rapid population growth, climate changes, limited water resources, and other causes. At present, the challenge that faces Jordan that it cannot depend exclusively on surface and groundwater to satisfy the growing demand for water various uses. It is important that water shortages must be dealt in a manner to bridge the gap between supply and demand. Accordingly, Jordanian's

leaders addressing several actions, implementing different policies to support this goal, and are planning more for the future.

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