

# **STRATEGIC REFORM & MANAGEMENT OF JORDAN'S WATER SECTOR**

By

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does not reflect the position of any office of the U.S. Government.***

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## PREFACE

Jordan's water resources sector has but one problem: Demand exceeds supply. The problem too commonly is viewed within the sector as a Gordian knot, unsolvable and therefore best to be hidden with a liberal application of additional water supplies, i.e., the Disi Water Conveyance and the Red Sea – Dead Sea Water Conveyance mega-projects. This approach would indeed hide the problem for a period of time, at very high cost, but does not untie or solve it. A sustainable solution to the knot will only be found outside the water sector because the solution set is not one-dimensional or one sectoral but indeed is multidimensional across sectors with non-water elements dominating.

This paper will discuss the elements perceived by the author to be essential in starting to solve the problem. However as the author is not Jordanian, it is a given that some elements and some interlinking of elements have been missed. It is hoped the reader will not dwell on these deficiencies but instead benefit from the ideas presented.

The author wishes to thank his many friends, colleagues, and acquaintances that over the years have actively participated in discussions on water in Jordan. However, given the controversial nature of some of the text, names will not be given. The author alone accepts full responsibility for what is written in this document.

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## EXECUTIVE SUMMARY

Jordan's water resources sector has but one problem: **Demand exceeds supply**. However, for Jordan the adequacy of water supplies is less of a problem than weak management and societal adaptive capacities and a distorted incentive structure guiding the use of available supplies. That 63% of fresh water supplies go to agriculture demonstrates a conscious Government of Jordan (GOJ) decision to short domestic and industrial water, regardless of health and economic implications. Also, under-funding water sector institutions and musical chairs top management, other GOJ conscious decisions, directly translate into decreased competency and a demonstration to the public that water is unimportant. Therefore, the public in large part believes water must be plentiful and unworthy of conservation and efficient use. As presented in this document, the water supply constraint ranks in third place as an issue of importance for the water sector.

Correcting deficiencies in the water sector requires a multi-faceted and multi-dimensional approach involving all consumers, everyone in the Hashemite Kingdom. And, it is outside the sector that comprehensive and lasting solutions will be found. Some significant deficiencies in the sector include:

- Weak and decaying water sector institutions
- Weak sociopolitical and organizational adaptive capacity
- Insufficient involvement of non water sector institutions and the public in water sector decision making
- Incentive structures that encourage inefficiency and misuse of water resources
  - Tariff structures that do not cover operations and maintenance, much less capital improvements
  - Tariff protection of non-competitive crops
  - Protection of the historical water use rights of low economic return segments of the national economy
- Inefficient capture and use of existing available fresh water supplies

Donors are willing to help Jordan overcome these deficiencies through rational use of its water supplies for the benefit of the Jordanian citizenry, not for the exclusive benefit of the few. However, it appears to the outsider that these deficiencies are not perceived as important by the GOJ and water institutions. Jordan still sees the major problem as a lack of water, which can be solved by the capture of water from the Disi aquifer and the Red Sea – Dead Sea Conveyor.

If Jordan is unwilling to make the hard choices and begin movement, it risks donor fatigue and withdrawal from the water sector. The onset of this fatigue may be indicated by the difficulty Jordan-Israel-Palestine has faced in raising \$15 million—an inconsequential amount for many donors—to fund the feasibility study for the Red Sea – Dead Sea Conveyor. The ambassador of a donor country recently stated in a public forum that donor perception of Jordan's mismanagement of its water resources is beginning to influence donor commitments to the sector.

***A nation that fails to plan intelligently for the development and protection of its precious waters will be condemned to wither because of its shortsightedness. The hard lessons of history are clear, written on the deserted sands and ruins of once proud civilizations.***

***-Lyndon B. Johnson***

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## ACRONYMS

AWC	Aqaba Water Company
CEO	Chief Executive Officer
CIDA	Canadian International Development Agency
CIF	Cost, Insurance, and Freight
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GOJ	Government of Jordan
GTZ	German Development Agency
IM	Information Management
JEPA	Jordan Exporters Producers Association
JRV	Jordan Rift valley
JVA	Jordan Valley Authority
km	kilometer
m	meter
MCM	Million cubic meters
mm	millimeter
MOE	Ministry of Environment
MPR	Ministry of Public Reform
MWI	Ministry of Water and Irrigation
NRW	Non Revenue Water
NWMP	National Water Master Plan
OAC	Organizational Adaptive capacity
O&M	Operation and Maintenance
PA	Public awareness
PSP	Private Sector Participation
SAC	Social Adaptive Capacity
U.S.	United States
USAID	US Agency for International Development
WAJ	Water Authority of Jordan
WB	World Bank
WUA	Water Users' Association

## **INTRODUCTION**

### **Philosophical Underpinnings**

Advancing competence in the Jordanian water sector needs to happen on two parallel tracks. The first track requires significant effort by the public and political emphasis and the second will come along almost automatically.

*The need for political will, at the highest level, must be emphasized, it cannot be lukewarm or half hearted (as it has been in the recent past<sup>1</sup>) or little change will occur and investments to bring change will have low, if any, return.*

The first track involves the adaptive capacity of Jordanian society.

**Adaptive capacity** is the property of a system that allows it to adjust its characteristics or behavior to expand its coping range under existing stresses, or projected and unexpected future stresses. In practical terms, adaptive capacity is the ability to design and implement effective adaptation strategies, or to react to evolving stresses so as to reduce the likelihood of the occurrence and/or the magnitude of harmful outcomes resulting from stresses. Improvements in adaptive capacity enhance a system's coping capacity and increase its coping range. [5]

Adaptive capacity can be split into two separate but interlinked components. Social adaptive capacity (SAC) is demonstrated by the stability of social relations, the maintenance of social capital (e.g., institutions, decision-making systems, formal and informal networks), and economic prosperity, even during times of environmental stress, all within the legal framework of the operational structure. The organizational and institutional forms of water sector entities managing the operational structure also are on this track and require organizational adaptive capacity (OAC) or resilience. Institution in this context is broader than the water sector organizations. It includes laws and by-laws, regulations, and implementation instructions to define the institutional structure and the incentive system or operational structure faced by water users. Encapsulated within this structure are water tariffs and the subsidies framework. Social adaptive capacity and organizational adaptive capacity comprise the national adaptive capacity.

The second track concerns the resource and its sustainable management. Here the focus will be private sector participation (PSP) to improve management expertise and efficiency and use of technology to improve use of water. But, technology doesn't just have to be water technology, it could be technology that removes or reduces the need for water for a task where water is currently used. A simple minded example is the use of a broom to remove dust from a veranda or driveway instead of using water to wash it away. Both aspects, PSP and technology, will advance or stall depending on track one progress.

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<sup>1</sup> In the past, there was political will at the top and clear guidance that led to the establishment of the Jordan Valley Commission (1973-1977) renamed the Jordan Valley Authority in 1977, and establishment of the Water Authority in 1983 under a temporary law replaced by Law 18 of 1988, and the Ministry of Water and Irrigation in 1992.

Three ingredients are needed to get movement on track one. Favorable political will by those with power to effect change, organizational adaptive capacity and social adaptive capacity. Without social adaptive capacity in sync with the needed change, the more likely change will not happen or society will be destabilized. Currently, neither Jordan's organizational nor social adaptive capacity are developed to a point where society is capable of responding to the worsening water crisis. Unfortunately, the lack of will to engage the public in the debate on the problem increases the likelihood of social stress when a serious drought event occurs.

*The reality of water scarcity in the Middle East is concealed by religious, political and technological myths that create the illusion of plenty. The perpetration of these myths is highly unsustainable. [8]*

National adaptive capacity operates on the structural macro-level with organizational adaptive capacity and on the micro-level, where the capacities of households and individuals are central to adaptation, or social adaptive capacity. Thus, successful adaptation requires coordination across these scales.

There has been no mention of mega-projects, demand management, water use efficiency, or water reallocations. Although all are important, their importance pales when compared to the need for national adaptive capacity. To reiterate, without improvements in adaptive capacity, Jordan will continue to become ever more vulnerable to social unrest as water demands increase and major water supplies are dependent on climate variability.

## Organizations

The water sector institutions include the Ministry of Water and Irrigation (MWI), Jordan Valley Authority (JVA), and Water Authority of Jordan (WAJ). The MWI has umbrella responsibility for water resources management but its authority is constrained by the respective boards of JVA and WAJ, who delegate to it.<sup>2</sup> The JVA is responsible for and has the authority to develop and provide irrigation water in the Jordan Valley. The WAJ has responsibility for and authority to treat and deliver drinking water to customers, collect and treat wastewater from households, and license and monitor wells. Responsibility for treatment and disposal of industrial wastewater belongs to WAJ but the Ministry of Environment has overall responsibility for monitoring and ensuring compliance with legal requirements. Responsibility for monitoring quality of drinking water resides in the Ministry of Health.

The WAJ has corporatized its two largest water distribution and wastewater collection systems. The Aqaba Water Company (AWC) was formed in 2005 and Miyahuna (Amman Water Company) came into existence January 2007. Water supplies accessed by Miyahuna are many and about evenly split between well fields and surface water. WAJ outsourcing of management of all or portions of municipal water and wastewater systems continues with a private company

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<sup>2</sup> MWI is the official body **responsible** for the overall monitoring of the water sector, water supply and wastewater system and the related projects, planning and management, the formulation of national water strategies and policies, research and development, information systems and procurement of financial resources. Its Role also includes the provision of centralized water related data, standardization and consolidation of data. [22]

handling billing and collection in Madaba and AWC holding a management and operations contract for the Wadi Mousa system.

Most non water sector ministries also have an interest in finding a sustainable solution for water problems. Institutions and organizations outside the three water sector bodies need to be actively engaged in water sector reform and in changing the attitude and expectations of Jordanian society. The vested interest of each ministry is paraphrased as follows.

- Industry and Trade and Supplies – water used for less productive uses constrains growth of the industrial sector, which offers much higher economic returns per cubic meter of water used and could be a significant employer of Jordan's youth entering the job market
- Information and Communications Technology – plays a critical role in assisting water sector institutions to identify and use digital technology to improve management of water resources
- Planning and International Cooperation – is charged with liaising with donors and approving plans and program for donor funding, a task to become more difficult as donors see little movement towards better use of water resources
- Interior – in times of severe water stress internal stability comes under threat, a threat better avoided than faced
- Education – children must start developing non wasteful habits of water use at an early age
- Agriculture – as the largest user of water resources must become a part of the solution, by freeing up fresh water for municipal and industrial users by increasing the transition to impaired quality water and reducing groundwater abstractions in the highlands, and not remain a large part of the problem as consumer of the largest portion of fresh water; covered in some detail later in this paper
- Finance – current heavy subsidies to the water sector cannot continue, as the cost of new supplies increases exponentially, continued high subsidies will constrain investments in all development sectors
- Environment – overuse of water results in water logging of soils and causes deterioration of shallow aquifers receiving the excess waters (in both the Jordan Valley and highland areas), improper disposal of wastewaters can negatively impact the environment, over extraction of groundwater results in water quality deterioration and can reduce flow from springs and dry springs, both of which negatively impacts biodiversity – example Azraq Oasis
- Energy and Mineral Resources – pumping, treating, and delivering water is energy intensive and wasted water is an unnecessary load on the energy generation and distribution network
- Social Development – allocation of water to a sector that offers low employment opportunities<sup>3</sup> and shortage of water to the industrial and tourism sectors<sup>4</sup> which offer significantly more job opportunities per cubic meter of water, results in fewer job opportunities for job seekers leading to higher unemployment and increased load on the social safety net
- Higher Education – students must continue to learn about best use and management of scarce water resources, knowledge by young adults of water issues can lead to support for change and it is only by repetition that wasteful habits can be changed

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<sup>3</sup> Agriculture employees 2.8% of over 15 years Jordanian workers and over 50% of the 69,000 agriculture jobs were taken by foreigners in 2005. [12]

<sup>4</sup> The manager of the industrial park in Aqaba has reported lost industrial opportunities because of water shortages.



- Health – shortages of water available for municipal populations, as demonstrated by rationed deliveries, a conscious government choice, leaves the population more vulnerable to epidemic outbreaks of diseases
- Culture – Jordan’s wasteful water culture—habits— must change to one of water conservation and best use
- Justice – if legal penalties against water law violators are not or can not be enforced the hope for improvement in water use practices is seriously compromised
- Awqaf and Islamic Affairs and Holy Places – ensure proposed water use practices conform to Islamic teachings, assist in preparation of water awareness materials and through Friday prayers promote best water use practices
- Municipal Affairs – concerned with obtaining adequate water supplies to ensure the municipality can provide the services needed by citizens; wasteful habits and practices reduce the water available for all
- Public Works and Housing – develops and enforces compliance with building codes to promote efficient water using technology/fixtures for best – non wasteful – uses of water supplies
- Tourism – the second largest generator of foreign currency for Jordan is tourism, but tourists are also very high per capita water users and hotels need to use near state-of-the-art water efficient practices, to include treatment and reuse of greywater
- Non governmental organizations and the citizen on the street also have roles to play in improving management of scarce water resources, on a personal basis, and lobbying for change in policy, regulation, and law.

## **The Problem**

Jordan’s water resources sector has but one problem: **Demand exceeds supply**. Solving this dilemma requires a multi-faceted/multi-dimensional approach involving all consumers, everyone in the Hashemite Kingdom. It is also true that the solution will not be easy; everyone needs to share the pain. Those who are benefiting from business as usual are likely to resist change and need to understand the near- and long-term outcome has a high probability for disaster. Events that could transpire include communities and industries without water, and migration of people from smaller rural communities to the large urban centers, assuming they, the large urban centers, can obtain water in sufficient quantities; and there could be significant social instability.

Groundwater continues to be extracted at rates exceeding recharge; this is called mining. [18] Over time, as aquifers are drawn down, water quality in the aquifer can change. As salt or brackish water enters the aquifer, fresh water storage capacity is lost. This mining will in the medium- and long-term lead to irreparable damage to some aquifers. To date the Dulil aquifer has already been seriously damaged; Hallibat is showing increasing deterioration in water quality; and water quality at Shobak is starting to decline. Groundwater mining is demonstrated by perennial springs going dry, and flow from others continuing to decline. Twenty-two springs in Shobak have gone dry since 1980 and another 47 springs show continued declines in flow. As pumping increases aquifer water tables are drawn below the spring discharge level. [36] Recent newspaper articles<sup>5</sup> reported the Ministry of Agriculture has initiated a study for establishing a

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<sup>5</sup> April 6, 2008 in El Ghad and April 8 in Al Rai.

Regional Agriculture Zone in the Shobak-Petra area because the area has fertile land and abundant water supplies. The article says this is to be a model to be expanded into other areas. It is hoped the Ministry of Water and Irrigation will be involved in the study; the Shobak-Petra area aquifers are being over-pumped and are projected to have severe water quality/quantity problems within the near future. [36]

Groundwater also is the source of summer stream flow; as groundwater is mined, summer stream base flow declines. This is shown by declines in the summer flow of the Yarmouk River. The many wells in the Yarmouk watershed—Syria, Jordan, and Israeli Golan—have reduced the groundwater levels to where summer flows are compromised. How many aquifers are the people of Jordan willing to sacrifice before getting serious about change? It is recognized that shared water resources, both surface and groundwater, required shared solutions. The Nile countries have demonstrated that it is productive to separate the technical issues of water management from more contentious political issues. Recent agreements and establishment of technical committees between Jordan and neighbors indicate the same approach may be gaining momentum here.

A second clear indication of crisis is rationing of household water supplies. A consortium of donors has recently spent about \$250 million to upgrade the Amman water system for continuous household deliveries. To date, 31 districts of 330 are receiving continuous deliveries. Rationing leaves the delivery system vulnerable to compromise by biological pathogens. As water is withdrawn from the system negative pressure, or suction, is created and openings in the pipe system are doorways for entry of disease organisms. The MWI and WAJ Secretary Generals have said continuous deliveries of water are not possible in Amman because of the shortage of water supplies and rationing must continue until the Red Sea Dead Sea Conveyance project is delivering water to Amman. However; Conakry, Guinea and Dakar, Senegal deliver 60 and 69 liters per person per day, respectively, in continuous supply. [29] For Amman, rationing of water deliveries is a conscious choice not a physical limitation. The Ministry of Health should be speaking out about the health implications of rationing water deliveries.

## Solution Constraints

The current environment of Jordan's water sector has several constraints that make action difficult. The *sanctioned discourse* does not permit discussion of reallocating fresh water from agriculture to urban and industrial uses, nor does it permit discussion of options for shutting down wells in threatened aquifers. The sanctioned discourse is controlled from outside the sector, by those of power with special interests, as demonstrated by water sector officials refusing to even discuss such topics. When questioned the response is that those issues are of concern at the highest political levels and if they open the discussion their careers would be at risk. Therefore, it is outside the sector that comprehensive and lasting solutions will be found.

*If, or when, those of power do understand the critical nature of the sector and choose to not act, the future for Jordan is bleak.*

Management under conditions of increasing pressure from supply-demand imbalance requires strong institutions that can handle mounting competition between sectors of society. The institutions must also be capable of balancing socio-economic demands and environmental

sustainability. However, Jordan's water sector institutions stumble from daily crisis to daily crisis, some say there is time in the future to start action, no time today. After all, the National Water Master Plan says all will be in balance by 2020. This is a false assumption; Jordan is in serious crisis now and has no time to wait.

***Leadership, management, and technical capacity*** in water sector institutions are under threat. The frequent change in Minister keeps the institution in a continuing state of flux. Each new minister begins with a struggle to learn the pressing issues while staving off requests and influence exerted by those desiring favors, some outside the law. During this period, work continues as usual but few changes requiring ministerial approval are undertaken; innovation is not possible. All

too often the minister is changed before he has had time to learn the job, much less accomplish anything of lasting value. Lack of a clear consistent institutional vision, almost non-existent human resources management and development capacities, meager salaries and benefits, and higher paying opportunities in the private sector or outside Jordan are creating the conditions for departure of institutional staff and difficulty in hiring competent replacements.

***A key role of public policy is to establish incentives so that private choices are consistent with social welfare.***

The Government of Jordan (GOJ) is not looking at Jordan's water sector in a holistic manner. Too often the focus is on the isolated problem of the day, instead of aspects of a larger continuum of developmental needs for the sector. Thus, there is failure to appreciate how actions to solve one problem impact the solution for other problems in the sector or create problems in another sector; symptoms are treated and not the real causes of problems. What should be a comprehensive strategy for the water sector ends up a series of single focus policies and activities instead of a comprehensive articulation of sector problems that demonstrates understanding. Key strategic areas are being ignored, and isolated actions do not help Jordan efficiently move forward in addressing problems in the water sector. Although a comprehensive water strategy and water policies covering the irrigation, utilities, wastewater, and groundwater sectors were approved by the Council of Ministers in 1997-1998, nothing has been developed in subsequent years. These documents are supposed to be "living" with periodic modifications, updates, and clarifying supplements, none of which have occurred.

Significant subsidies to users result in a ***financial crisis*** in the sector. Money is insufficient for daily operations and routine maintenance. The consequence is that physical infrastructure deteriorates sooner than it should. Rehabilitation takes funds from system expansion and improvement to meet increasing demand. The constant shortage of funds impacts employees' work environment and morale, contributing to flight of the best and brightest.

Jordan's demand exceeds supply problem, quantified in the next section, is exacerbated by an apparent unwillingness to seriously comprehensively discuss potential solutions beyond the capture of additional resources. The Disi Pipeline to bring water from a fossil aquifer in Southeast Jordan and the Red Sea – Dead Sea Conveyance projects are touted as the ultimate solution to Jordan's demand exceeds supply problem. Both will deliver high cost water requiring substantial increases in the water tariff or high subsidies from the central treasury. Blind acceptance of these mega-solutions compounds the problem, water resources abuse continues as aquifers are mined at ever increasing rates. This document takes the position that Jordanian

decision makers outside the water sector do not understand the critical nature of the sector. Assuming this is the case, water sector managers are not doing their full job; a significant component of which is to educate and inform non water sector decision makers. If decision makers outside the sector do understand the critical nature of the problem, and are choosing to do little, the country is in for hard times.

An attempt is made in this document to put forth a comprehensive solution process, with drilling down by sub-sector to illustrative activities and policy measures. The goal is to stimulate discussion and thinking on how to improve water resources management in Jordan. It is hoped the discussions will be followed by action and policy; Jordan does not have time to dally.

As mentioned earlier, one critical requirement for sustainable problem solving is a well developed ***national adaptive capacity***. The adaptive capacity of Jordanian society and its organizations is weak. GOJ sheltering of urban and agriculture water users, through subsidies, from the harsh realities of the sector has inhibited the development of coping mechanisms. Deterioration in water sector institutions has sapped their ability to cope, even on a day-to-day crisis management basis. The crucial deficiency in dealing with water in Jordan is not the scarcity of the natural resource – water – but scarcity of the social and organizational resources needed to adapt to water scarcity.

***That sustainable solutions to the water sector problem will only be found outside the water sector is a constant theme throughout this paper.***

The deficiency in adaptive capacity is also reflected in little apparent understanding that policies for agriculture, trade, energy, real estate, finance, and social protection affect overall economic diversification and often have more impact on water management than many policies championed and implemented by the water sector institutions. [37] Non water sector impacts on water use decision making will be discussed in several sections of this document.

## **PART I. LAYING THE FOUNDATION**

### **Water Supply**

*Jordan today stands face to face with the reality of potentially frightening water shortages. In a largely arid region, even the slightest change in water levels or quality has a significant impact on agriculture, industry, nutrition, and personal health standards. The hard reality is that Jordan is consuming more water than it has available from secure (annually renewable) sources. A water catastrophe is imminent, as groundwater resources will slowly dry up.* Embassy of the Hashemite Kingdom of Jordan, Washington D.C. [13]

Water supply and water demand quantity data is taken from the Ministry of Water and Irrigation National Water Master Plan for year 2005. [21] This document does not attempt to quantify the volume of “green water” used by rainfed agriculture. However, approaches to increase capture and use of this water are discussed in Section IV, Highlands.

Jordan receives an historical average of about 8,500 million cubic meters (MCM) of rainfall per year. 90% of this water evaporates leaving but 505 MCM that is beneficially used as surface water and another 275 MCM that recharges groundwater aquifers. Some of this rainfall provides water for the Yarmouk River, Syria also provides water, from which Jordan receives about 230 MCM per year. Additionally some farmers in the southern Jordan Valley operate desalination plants to treat brackish groundwater for irrigation water production. Reuse of treated wastewater provides about 70 MCM per year. The National Water Master Plan estimates that Jordan has a sustainable long-term average water supply of between 800 to 850 MCM per year.

There is danger in using long-term average rainfall patterns for future water resources planning and availability. A detailed statistical study of rainfall records from 1922-2003 shows a downward trend in annual rainfall, beginning in 1957, for Madaba, Amman and Mafraq rainfall stations. [33] Stations at Amman, mean annual rainfall 275 mm, and Madaba, mean annual rainfall 349 mm, have roughly similar rates of change, which are -1.14 mm and -1.36 mm per/year, respectively. The Mafraq station, mean annual rainfall 165 mm, has a rate of change of -0.49 mm per year. Analysis of the same data set for maximum temperatures shows a significant warming trend after the year 1967 for the summer season with a rate of temperature increase of 0.038°C/year. Analysis of minimum temperatures shows a significant warming trend after the year 1957 for all seasons. [32] Studies such as these should be of interest to policy makers on environment, agriculture and water resources. Due to the relatively low amount of rainfall in the region, the impact of a decline in the rainfalls may result in desertification and drought with serious impacts on water resources and agriculture.

The author finds it unfortunate that the water sector institutions, i.e., MWI, WAJ, and JVA, have not done comprehensive hydrologic analyses of rainfall and stream-flow records; their analyses center on averages. There is no apparent ability in the sector to use historical records to predict drought occurrence or severity, much less do a reasoned analysis of the probable effect of climate change on rainfall distribution and amounts. Predictions are that the region could receive in the future up to 20% less precipitation per year in higher intensity shorter duration storms. Climate change is an important factor that must be considered in water resources management.

A second significant deficiency regarding water supply is limited information on groundwater aquifers. Recharge points are not identified and therefore cannot be protected from damage, nor can opportunities to maximize recharge be taken advantage of. Groundwater monitoring wells are limited and poorly located, typically along highways for easy access; it is not uncommon to find monitoring wells in the drawdown shadow of others nearby. Knowledge of aquifers is so weak that it is not possible to predict with any accuracy how much water remains; water quality deterioration indicates the bottom of the fresh water is being approached in some aquifers.

Table 1 shows how much each of Jordan's classified zones contributes to the total annual rainfall received by the country. It is worth noting the majority of Jordan's average annual precipitation comes in the arid and desert zones, 6,375 MCM or 75%. These areas are most at risk from climate change caused increases in temperature and reductions in rainfall.

Table 1. Jordan classified by rainfall zones, rainfall period 1937-2003 [16]

<b>Classified Zone</b>	<b>Annual Rainfall (mm/yr)</b>	<b>Catchment Area (km<sup>2</sup>)</b>	<b>Area Ratio (%)</b>	<b>Rainfall Volume (MCM)</b>
Semi-humid	500 - 600	620	0.7	425
Semi-arid	300 - 500	2,950	3.3	1,170
Marginal	200 - 300	2,030	2.2	530
Arid	100 - 200	20,050	22.3	2,950
Desert	<100	64,350	71.5	3,425
<b>Totals</b>		<b>90,000</b>	<b>100.0</b>	<b>8,500</b>

## Water Demand

Table 2. Projected Annual Gross Water Demand per Sector including Physical Losses. [21]

<b>Sector</b>	<b>Water Demand, MCM, (%)</b>			
	<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>
Municipal and Tourism	372 (24)	415 (27)	460 (29)	513 (32)
Industry	59 (4)	77 (5)	100 (6)	120 (7)
Agriculture	1,102 (72)	1,072 (69)	1,040 (65)	983 (61)
<b>Total</b>	<b>1,534 (100)</b>	<b>1,564 (100)</b>	<b>1,600 (100)</b>	<b>1,616 (100)</b>

The numbers in the last row for total demand cannot be taken as given. A portion of all Municipal, Tourism, and Industry demands return to the water supply as wastewater. With proper treatment much of this water can be reused and counted a second, third, or more times. However, agriculture, the largest water demand and user returns a small volume of economically usable water to the supply system and its demand alone exceeds the sustainable supply.

## Balancing Supply and Demand

The author's premise is that there is but one point on which to focus to solve Jordan's inefficient use of water resources. Remember the child's game wherein children stand in a circle and hit a ball to each other while trying to keep it in the air? The ball is analogous to the water needing allocation and each child represents the influence exerted by a special interest, the strong can drive the ball in the direction they want. Examples of special interest influence include tariffs established to subsidize certain segments of society—but subsidizing a more well off segment of society [29]—maintaining water shares to less productive economic sectors [34], retaining inefficient organizational/institutional structures [6, 10, 11, 23], and import protection for non-competitive agriculture [8]. Allocated water moves to the relatively more powerful of the special interest groups and some inefficient users belong to and have benefit from more than one special interest group. For example, from the unwillingness to discuss removing water away from highland irrigation (too political) or increase fees, water is considered an entitlement, and the customs protection afforded apples and other non-competitive highland crops is a second benefit received by influential landowners.

*The key to balancing supply and demand is to get right the incentive structure guiding the allocation of available water resources.*

The only way to make water allocation and use more efficient in Jordan is to manipulate the relative power of special interests to change the incentive structure. For example, by increasing the understanding of interest groups, youth being one discussed later, of the critical nature of water management and the need for action now, their power increases relative to those preferring the status quo. A change in relative power can open the window to changes in allocation policy and decisions. Donors must help the non water sector institutions and Jordanian society at large ensure changes are in the right direction. Increasing the social and organizational adaptive capacities will help change the power balance. The old saying that knowledge is power does have merit.

**Action 1.** Collect historical weather data records, some begin in the middle 1800's, and conduct analyses: for a start the study should verify data record accuracy, determine trends, probabilities of annual rainfalls, drought recurrences and severities, and projections of the impact of climate change on water supplies.

**Action 2.** Implement a scientifically based analysis of aquifer information to identify need for and locations of monitoring wells, develop a plan for installing wells needed and collection of data needed to map the aquifers, prepare surface maps of aquifer recharge points, develop and implement protection plans for recharge zones with criteria defining allowable development for each zone, develop plans to increase recharge from rainfall – include a prioritized schedule for implementation of plans.

## **II. WATER SECTOR REFORM**

Jordan's water sector problem, **demand exceeds supply**, is exacerbated by inefficient/ineffective performance by water sector institutions. One way to begin to focus in on a solution set is to divide the problem into smaller digestible bites. Two definable subsets that can be addressed are management and water allocation practices. This section will develop the case for water sector institutional reform and address a solution set by focusing on these two subsets.

### **Need for Reform**

*Many of the water shortages emerging around the world stem from the widespread failure to value<sup>6</sup> water at anything close to its worth. Grossly underpricing water perpetuates the illusion that it is plentiful, and that nothing is sacrificed by wasteful practices. Postel [27]*

The quote perfectly describes Jordan's water crisis. Water to agriculture and domestic users is heavily subsidized, sending the message to users that water is plentiful and not valuable. Consequently, use efficiencies are low, waste is high—cars, paved garage entryways, sidewalks and even streets are cleaned with a running water hose—and water conservation messages disseminated by donor driven programs have yielded little sustained change in use practices.

Jordan's water resources are limited and are posing a serious constraint to national economic development and the social well being of its population. As a consequence of water pricing policies, the operating entities in the sector, the WAJ and JVA, are in deficit financial positions. This is not the preferred state when future increments to water supplies will be increasingly costly. Given these circumstances, a sectoral capacity to provide comprehensive planning and management of national resources is a critical need. Efficient management of water collection and delivery systems infrastructure are essential for Jordan to achieve near optimum benefits from resources development and ensure equitable sharing of scarce water supplies amongst all consumers.

Moving toward more efficient, ecologically sound and sustainable patterns of water use requires major changes in the way water is valued, allocated, and managed. Appropriate pricing, the creation of markets for buying and selling water, and other economic inducements for better water use have a central role to play in easing the transition to an era of water scarcity.

“The efficient use of water and the safe reuse of waste water are the most economical and often the only sources of additional water and, at the same time, the most effective means of controlling water pollution.” [2]

To a large extent, the problem is one of choice and management rather than simply a shortage of water. For example, choices made to use scarce water for irrigation purposes, the poor management of water supply systems (half of the water produced is actually delivered), the

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<sup>6</sup> The difference between value and cost/price is not widely understood. Cost/price is market determined and distorted by subsidies. Value of water in a specific country is a composite number derived from economic, social, environmental and political values wherein distorting variables are identified and corrected for.



inadequate enforcement of regulations, poor coordination among water sector institutions and other agencies and entities, and the lack of effectiveness of the current organizational arrangements of Jordan's water institutions are all factors which need to be addressed urgently in tandem with water resource issues. [23] It is essential the Ministries of Finance and Planning and International Cooperation become active proponents for changing the current choices being made. Budget implications of decisions are not always apparent. Deferring maintenance on large infrastructure, such as water distribution and wastewater collection systems, are hidden future problems and the true costs of such decision making doesn't surface until the systems begin to fail. At this time the Ministry of Finance and the public are faced with an immediate need to find large sums of money for rehabilitation. [37] An example of faulty decision making is in the current news: "A crumbling sewage system in the city of Zarqa, 30km east of Amman, could trigger the spread of diseases on a large scale, according to community leaders and residents." The MWI is estimating it will cost \$275 million to replace the system. [14] Sewer systems do not crumble if they are properly maintained, but lack of maintenance can be costly – as demonstrated.

The Ministry of Water and Irrigation recognizes that new approaches to water resources management are required. It also recognizes that strategies can no longer be fragmented but need to be comprehensive, and that actions require the establishment of realistic goals. These goals have now been identified. As a beginning point of the change process, current senior management of the water sector has established a committee to develop a detailed design for new institutional arrangements and prepare a plan for their implementation. It is yet to be shown that the new emphasis will bring change.

While components of Jordan's water resource problems have been and continue to be extensively researched and documented by many experts, less attention has been paid to the water sector organizations and laws which drive the decision-making and policymaking process.

## Legislation Reform

Table 3 shows the trend in Jordan's water law is towards more institutionalized water organizations with centralized control. Since the 1940's public participation in water resources decision making has not been emphasized but in fact deemphasized. Current laws do not consider public involvement in water sector policy formulation and decision making processes.

Table 3. Development trends in Jordan's water law [31]

Decade	Thrust of legislation
30's	Rules and Prohibitions
40's	Basic institution, Public Participation
50's – 60's	Institutions, Economic development
70's	Decentralized Institutions
80's	Institutional restructuring (JVA, WAJ)
90's	Centralized management through MWI

The changes in legislation thrusts have resulted in a patchwork legal framework wherein ministries and authorities have overlapping responsibility. This results in inaction on contentious

issues—passing the buck. On other matters the legislation is vague, e.g., on the matter of who is responsible to assist farmers in on-farm water management.

A clear legal and regulatory framework defining the role of the private sector vis-à-vis the public sector in water sector decision making is essential to continue moving forward the GOJ desired Private Sector Participation or Partnership (PSP) in commercialisation and decentralisation of water sector institutions. Regulatory authority should reside outside the organizations being regulated. This means it should be located outside the MWI because the MWI will retain responsibility for development and delivery of bulk water supplies to privatized municipalities and farmers associations.

**Action 3.** Conduct a thorough assessment to identify all the entities involved in water resources management and use decision making, their various roles, authorities and legally mandated responsibilities. This should look extensively at the water sector, across all government and include the private sector having a delegated role, e.g., the Royal Society for Conservation of Nature has been delegated responsibility for nature preserves and national parks.

**Policy 1.** An organizational structure for implementing the new water legislation that clearly shows the respective responsibilities of the different administration units in charge of water resources and providing these units with the power to facilitate the proposed restructuring. The policy should consider traditional roles and responsibilities of the various entities in developing the new collaboration enforcing structure.

**Policy 2.** Craft a clear comprehensive legal structure to efficiently and effectively govern the water sector: include clear delegation of authorities and responsibilities and define modes of public participation in decision making. The new law will be the roadmap or foundation upon which a new institution will be built. The new law should fully replace the WAJ and JVA Laws and the MWI by-law.

## **Institutional Reform**

Calls for reform of the sector are not new. A 1987 USAID funded study of the WAJ recommended significant change. Some organizational change did occur but three findings of the study are important and still relevant. [6]

- The organization is over staffed
- There is a lack of organization and delegation or devolution of authority
- Employee evaluations are rather capricious, dependent upon the judgment of individual managers/supervisors

In 1995-1996 CIDA funded a major study that recommended breakup of JVA and WAJ and absorption of the residual pieces by MWI. The process moved forward to the point where the three entities to be impacted agreed on a final plan. The new structure clearly delineated the three main functions of the water sector in Jordan, and how they would be structured. [10,11]

- Planning, Policy, Regulatory and Control Systems – the government would have direct control over these functions
- National Infrastructure – the structure would allow the government to manage the national infrastructure as a national resource while allowing it to be run in a visibly efficient manner and with direct accountability to the government
- Local Distribution and Collection Systems – could be operated on a decentralized basis with appropriate geographic divisions that could gradually move towards individual financial viability, and eventually towards private sector investment and involvement

Shortly after the agreement was formalized with letters signed by the three secretaries general and the minister there was a change in minister and the effort stopped. Where this effort stalled would be a logical starting point for a new institutional restructuring effort.

In August 2007 the Jordan Ministry of Public Reform (MPR) recommended restructuring of the MWI, again calling for the breakup/dissolution of WAJ and JVA. [23]

- Responsibility for developing, amending and implementing strategies and policies is unclear
- There is duplication of responsibilities between MWI and WAJ
- There is lack of coordination at the strategic and execution levels between MWI and the other entities
- Much of the work can be carried out more efficiently and at lower cost by the private sector with a new organization providing regulation and monitoring

After two decades of calls for change in water sector institutions, there remain many weaknesses. Some of the most significant are listed here.

- Significant political interference in hiring and allocation of resources
- Authority for decision making is centralized, no delegation downward or development of successors
- Overlapping authority between the WAJ and JVA and other ministries, but there also are gaps
- Laws and regulations on water supply, usage, and quality are not being adequately enforced
- Underpricing/undervaluing of water resources, prices reflect heavy subsidies and result in wrong allocation decisions
- Human Resource Management Systems are lacking and existing human resources are not being adequately utilized or developed
- Low salaries and Civil Service hiring procedures ensure less competent staff are hired leading to low staff productivity and a downward spiral of competency
- Coordination with other agencies, such as Ministries of Health and Environment, is poor
- WAJ and JVA are operating in significant financial deficit positions

There are a series of fundamental conclusions regarding the institutional model for Jordan's Water sector:

1. There will always be a need for government to retain the capability of carrying out its responsibilities in the water sector through a line ministry and to establish organizational units under the direct control of the line ministry as required.
2. Policy and planning functions properly belong under the control of a line ministry, but the delivery of water services both "wholesale" and "retail", require the ability to operate efficiently with as little direct government involvement as possible, and therefore offer opportunity for private sector participation.
3. International best practices suggest that service functions be separated from regulation, i.e., not reside in the same institution. Regulation should be the domain of government control or input to ensure the monopolistic utility does not abuse its position.
4. In principle, the actual legal regime of these service functions matters less than their ability to be free of the constraints that inhibit their efficient operation. The private sector is often best suited for delivery of services.
5. The government has expressed in general terms, its intent to move toward more commercialization of water services. It is necessary to enact changes in laws and regulations to create greater freedom of action and allow the change process to accelerate.
6. Changes in relationships, attitudes and incentives (institutional cultural change) also will be required to achieve the desired results.

Water Sector Information Management (IM): Definition of a methodological framework for data and information management is needed. The defined system would use data on technical, financial and economical processes to generate information for delivery to decision-makers within the water sector. Structured IM would support the water sector decision making process and thereby allow performance improvement on many levels. In a real sense IM would be the lifeblood of the water sector, connecting water sector relevant data generated everywhere in Jordan to decision makers in Amman. IM should be a centralized service provider to the sector. In restructuring, the temptation to create several IM centers should be resisted. The USAID funded Information Technology Master Plan implementation can be guided to fill this need.

**Action 4.** Use the USAID, CIDA and MPR reports to begin discussion on a new institutional structure for the water sector. Gain commitment from the Minister, Prime Minister and key members of parliament to move forward with the reorganization of the three entities. Procure services of a consulting company to provide significant technical assistance focused on change management, capacity building, and offering advice on the new water law. Draft and approve a new comprehensive water law, one that consolidates responsibility and authority, removes overlaps, and fills gaps.

**Policy 3.** An Information Management framework. The framework should be integral to the water sector organizational structure. IM is focused on service to decision makers at all levels in the sector. To function efficiently it must have centralized management; picture a garden spider sitting in the center of her web, she manages information coming in from each strand.

## Sociopolitical Dynamics

The story of changing social uses of water can be characterized as a spiral movement, swinging between a perceived scarcity of water, and a perceived scarcity of the sociopolitical means required to overcome the scarcity; all the while progressing towards ever-increasing application of social resources to overcome the natural resource scarcity. FAO2000 [15] well describes this process and this source is drawn on heavily for the following discussion.

As the water demand and supply equation becomes more unbalanced, demand increasing exceeds supply, controlling factors can be bifurcated into first-order scarcity, the hard science and numbers describing demand vs. supply, and the second-order scarcity, the sociopolitical ability to find the social tools to adapt water use patterns to balance supply and demand. International consensus describes the three phases of a society's adaption to water scarcity—large-scale engineering, institutional change, and social re-structuring—and the sociopolitical requirements at each stage. These phases will be used to discuss where Jordan currently is along the water resources management continuum and what is needed for Jordan to continue its development progression. The crucial task for society and water managers is to identify the social bottlenecks that stand in the way of new kinds of adaptive measures and to adopt mitigating measures.

### *Large-scale engineering projects phase*

At the first level, the problem is seen as water scarcity, pure and simple. The index indicates a need for more water—or an urgent need to curb population growth or re-structure the economy—stressing large-scale engineering supply-side management. This was the era when Jordan actively constructed dams in the Jordan Valley: Wadi Arab, Ziglab, King Talal, Shueib, Kafrein, Karama and later Mujib, Wala, and Tannour. Extensive well fields were established to exploit groundwater and during this phase aquifer mining began. Demand management and the beginning stages of adaption, the second-order scarcity, were not on the table as society at large was shielded from the growing disparity between available supplies and growing demands. Even though this approach has become increasingly economically infeasible, Jordan is still looking to more dams and the two mega projects to solve water scarcity constraints.

***The water scarcity index is a simple annual amount of renewable water per capita measure.***

The sanctioned discourse on water is controlled by the politically and socially powerful. An observation of water in the American west "...that water flows toward power and money" is equally applicable to Jordan. [28] It is by influencing the powerful that the discussion can be broadened. The sociopolitical adaption process covered in this section requires significant change in the sanctioned discourse, change that can be accelerated by strategic use of information dissemination.

***The most significant special interest driven water allocation is to keep the agriculture sector flush with fresh water.***

The public sector reform process, and broadening the discourse on water, has been hampered by rent-seeking that allows political and business elites to block certain reform policies and manipulate others to fit their own interests; e.g., political leverage used to avoid implementing

steps that harm their interests. Some changes can take place as long as privileges to various political and economic elites remain intact. If Jordan is to move forward, progress is needed in three main areas: public sector performance, public sector accountability, and institutional capacity building. [3] Real progress, not superficial, in these three areas will require reallocation of benefits from the few to the many.

It is part because of the above political dimension that Jordan is still in this phase of development, while some are tentatively trying to advance to the next level as will be discussed below. The GOJ still sees the major problem is a lack of water, which can be solved by the capture of water from the Disi aquifer and the Red Sea – Dead Sea Conveyor. Persevering in this train of thought will lead the country to crisis. Current low-cost water is heavily subsidized for consumers, and the strain is being felt on the central budget. The true cost, speaking only of full costs of operations and maintenance, of these two mega-projects will either bankrupt the government in subsidies or drive residents away from Amman and other delivery points dependent on this costly water.

### ***Institutional change phase***

As demand continued to increase much faster than the ability to generate new supplies, second-order scarcity began to appear as increasing first-order conflicts over water between users at the local and regional level (Azrak groundwater basin) and between countries sharing a common resources (Yarmouk River).

***The index of water scarcity measures end-use efficiency, gaining “more benefit per drop.”***

Supply-side, large-scale engineering solutions no longer suffice to increase the available amount of water and society needs the tools to cope with an increasing absolute scarcity. The solution is to save water by doing more with every drop, i.e. improving end-use efficiency, which is the first stage of demand management. The means to do so are found through changing the water use incentive structure (the rules and regulations, administrative bodies, and economic incentives); in other words, modifying the institutional framework, in order to bring more water-efficient modes of usage into practice.

Jordan is slowly moving in this direction, e.g., the transition to drip irrigation, but continues to delay implementation of incentives and programs to build the social adaptive capacity of Jordanian society. Even the measures to move agriculture to drip irrigation are half-hearted; farmers are encouraged to adopt the technology but no support programs are available to help them use the technology correctly. As will be discussed later, drip irrigation efficiencies are not much better than the levels being achieved under surface irrigation. As time passes without development of higher adaptive capacity, Jordanian society become ever more vulnerable to the recurring drought. This vulnerability is exacerbated by over pumping of aquifers, which reduces the emergency reserve that could be used in the event of a serious extended drought event.

With socio-political adaptive capacity development in step with increasing water supply scarcity, scarcity becomes relative, since the available amount of water depends on social willingness and economic rationality in employing more labor- and technology-intensive, but less water-consumptive, modes of production and use. However, to change such an institutional framework infringes on the vested interests of societal segments that may have become very powerful and

entrenched over time. The potential second-order conflicts lie with the State (trying to impose new regulations and economic incentives) on one side, and previously subsidized large water users on the other side. The management effort at this stage involves transforming an absolute, and therefore by definition unmanageable, scarcity of water, into a relative scarcity, amenable to management. End-use efficiency measures will alleviate the pressure to find more water.

It is possible to build organizational adaptive capacity through regular, sustained exercise. When an organization is proactively engaged in steady, small changes, it will be much better positioned to handle larger external changes when they come. Exercises can be used to build organizational adaptive capacity.

1. **Scenario Planning.** Scenario planning involves a team envisioning possible futures and detailing plans for those futures. The idea is to have possible actions for many situations, so that the organization is prepared for as many outcomes as possible; a flexible creative organization that learns. Scenario plans can help ‘reality check’ statistical forecasts but they do rely on knowledge of the planners. Droughts do happen in Jordan, though there currently is no drought prediction capacity or organized mitigation plan in place. To develop predictive capacity and mitigation scenarios should be a high priority topic for scenario planning.
2. **Cross Training.** A cross-trained organization has multiple perspectives to adapt and improve processes; the organization reaps full benefit from its diversity and different types of knowledge.

Rationalize tariffs and improve collection efficiency: The agriculture sector pays the least for water (when fees are paid), has low returns for each cubic meter used, and with current practices is destroying the heritage of Jordan’s youth. Low prices do not induce an incentive to use resources efficiently resulting in inappropriate crop selections, over applications of irrigation water, and environmental degradation.

Irrigation water provided by JVA is sold at a tariff of 11 – 12 Fils per m<sup>3</sup>. However, private farmers in the highlands who pump water from wells can support water cost of 50 Fils per m<sup>3</sup>. This indicates there is room for adjustment of the water tariffs at JVA. Furthermore, agricultural surveys suggest the low JVA tariff leads to waste of water as it is not an important component in the cost structure of agricultural production in the Jordan Valley. [24]

Current tariffs for potable water do not cover the costs of routine operation and maintenance of the water delivery system. As expensive new sources of water come online, e.g., the Disi Conveyance Project, cost recovery as a percentage of needs will decline. Unless tariffs are adjusted upwards to cover the full costs of operation and maintenance and emergency repairs, the delivery system will remain in the vicious spiral of new construction → deterioration → need for rehabilitation. Demand for water services grows with the Jordanian population and economy. Current high levels of donor support for new construction and rehabilitation relieves part of the burden from the GOJ budget. However, for every new pipeline extension there is an accompanying addition to operation and maintenance costs, costs borne in full by the GOJ. The current Minister of Water and irrigation has initiated a study to develop a procedure for

determining tariffs and to explore new options for subsidies to ensure everyone has access to water.

### ***Large-scale social re-structuring phase***

The new economic disincentives for water-squandering production will pave the way for the logic of the second stage of demand management, namely allocative efficiency.

The problem at this phase is perceived as achieving a quantum-leap in water efficiency by maximizing the economic return on every drop of water mobilized in society. The solution is a conscious effort to redirect water to cities and industries, yielding some 20-70-times higher economic returns from water compared to agriculture. [34] The index of water scarcity measures allocative efficiency.

The second-order conflicts at this stage have to do with agricultural expansion *per se* being no longer an option. Competition for the amount of water diverted to cities and industries is less of a problem because a comparatively small proportion of the water used for agriculture will suffice for those needs. The challenge is to create new jobs in cities and industries to compensate for the stagnating or even shrinking number of jobs in agriculture; and to do this at a time when population is still growing rapidly, and people have justified demands not only for basic livelihoods, but also for better lives more generally. Social resources during this phase are taxed to the utmost, while the supply of social ingenuity may be severely hampered by social conflict.

***“If allocative efficiency is not achieved, it is possible, and even common, to be doing the wrong thing extremely efficiently. It would be much more useful to be doing the right thing, that is, with efficiently allocated water, a little badly.” [26]***

Inter- and intra-sectoral movement of water: Permitting economically driven movement of water between sectors would offer significant encouragement to use water efficiently. It is estimated that the economic returns to water used in industrial and urban domestic consumption are, respectively, about 100 times and 70 times higher than in irrigated agriculture. Industry and tourism also employ many more Jordanians. [34] In 2006, about 56% of all agriculture workers were non-Jordanian, with 89% of permanent agriculture laborers foreign. [12] Jordanian agriculture labor was primarily relegated to seasonal and casual jobs, the non-permanent jobs with lowest pay.

Sector	Return to Water JD/m <sup>3</sup>	Employment per MCM
Agriculture	0.36	148
Tourism	25	1,693
Industry	40	3,777

An approach to encourage water transfers between and within sectors would be the institution of dynamic surface water and groundwater rights schemes. Issuance of a dynamic water right is eminently doable for surface water flows to Jordan Valley agriculture. The annual water right could be allocated on a proportional basis. Each farmer would know his annual right at the start



of the spring planting season, at the end of the rainy season. As the proportion of irrigation water that is treated wastewater increases, the volume of the annual water right would stabilize.

Water rights in the highlands could be initially allocated or tied to the pumping license. As groundwater users associations take over management of the aquifer, the right would change over time as pumping comes into line with long-term sustainability requirements. A water rights scheme would enable the GOJ and other water users to buy wells at a market rate and incur no protests or social disruption. The buy-out option for reducing groundwater abstractions in the highlands is discussed in more detail in the section discussing highland agriculture.

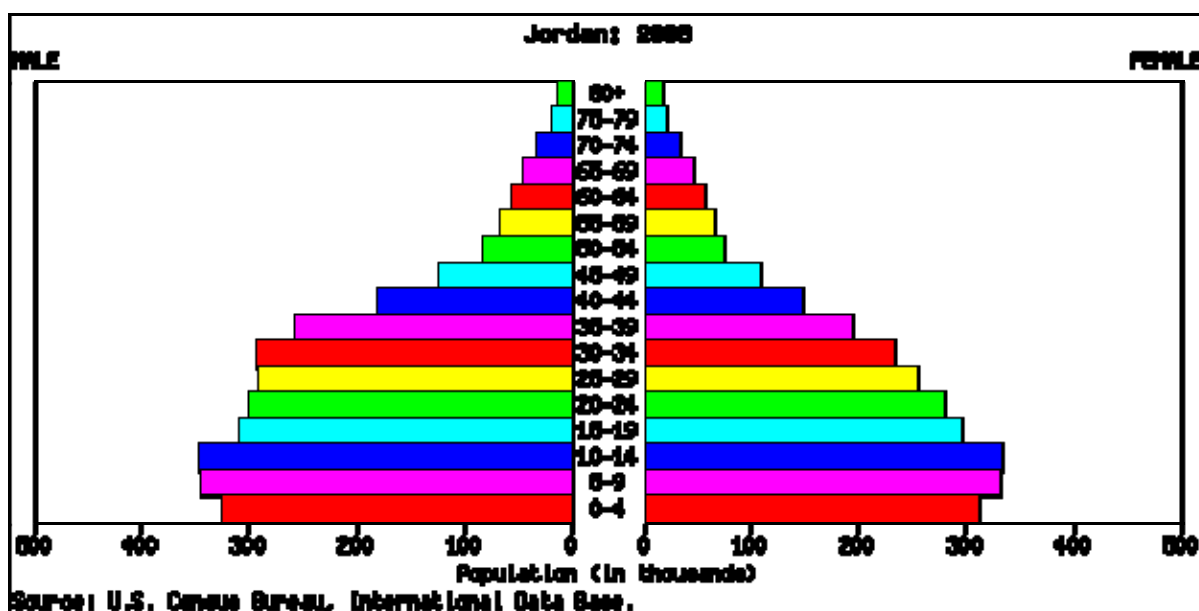
Some do believe that deeming water or water rights to be a commodity is not the best way to encourage inter- and intra-sectoral movement of water. Rather, community water use planning, viewed as similar to land use planning, combined with integrated water resources planning, could be a more socially acceptable approach to accomplish the same goal. Indeed, mutual consultation between those who have a common interest is enshrined in the Qur'an. [1, 38]

***“Those who hearken  
To their lord, and establish  
Regular prayer; who  
(conduct)  
Their affairs by mutual  
Consultation;  
Who spend out of what  
We bestow on them  
For sustenance;”  
(Sūra Shūrā, No. 38) [42:38]***

### **Creating and Sustaining Momentum for Change**

Social adaptive capacity cannot be developed overnight; it takes sustained hard work by a government willing to bring the public into the comprehensive debate on water issues. Simply acquiring knowledge through awareness programs is not sufficient for building adaptive capacity and reducing vulnerability to environmental change. Adaptive learning requires communities and individuals to make use of new understandings of how the world operates via new behavior and plans; they have to do in addition to hearing or seeing. Organizational adaptive capacity is linked to social adaptive capacity because resilient power structures consider the needs of all stakeholders and responding to those needs bring stability.

Changes in the relative power of interest groups can be brought about by increasing the knowledge of the less well informed interest groups who may be supportive of change in the desired direction. A particular useful target group for an information dissemination campaign is young adults. A population estimate for 2006 (Figure) shows 29% of Jordan's population is between the ages of 15- and 29-years.[35] The future for these young adults is immediate enough they can appreciate the impact the loss of the aquifers and general mismanagement of water resources will have on their job opportunities and quality of life. Also, this population group has less to lose (risk) if they speak out against powerful special interests. The below demographic pyramid illustrates the youth bulge that will be most affected by decisions made by special interest groups.



The Ministries of Education and Higher Education can play a role in delivering to future citizens the knowledge they will need to fully participate in decision making on water resources use. Ministries of Municipal Affairs, Culture, Youth, and Awqaf and Islamic Affairs and Holy Places should be involved in crafting and delivering public awareness messages for water conservation and non wasteful water use practices.

**Action 5.** Initiate an awareness/information campaign and capacity building program targeting young adults to focus on the critical concerns facing the water sector. The campaign/program should be personalized so young adults understand the impact on them and know what they can do to make change.

**Policy 4.** Permit water users associations to set a water tariff level sufficient to cover operation and maintenance (O&M) and system capital improvements. The Jordan Valley Authority, as bulk water supplier in the Jordan Valley, should be permitted set a fee sufficient to cover the full cost of delivering water to the associations.

**Policy 5.** Permit groundwater users associations, with regulatory oversight, to control extractions from the aquifer they manage. They have the highest interest in ensuring sustainability of the aquifer and world experience shows they can do a better job than the government.

**Policy 6.** Introduction of dynamic water rights for surface water and groundwater. The right is dynamic because it is not a fixed volume. The volume available for use may vary each season or year as rainfall varies.

**Policy 7.** A mechanism/procedure whereby the tariff structure can be modified outside the Cabinet. Tariffs should be set based on financial needs of water supplying and wastewater collecting entities, i.e., Irbid residents could face a different rate than residents of Amman,

Ma'an or Aqaba. Availability of water to the poor at an affordable price would have to be addressed.

**Policy 8.** Governmental oversight to prevent excessive profit taking is needed when private companies are involved. A regulatory capacity independent of water sector institutions is needed.

**Policy 9.** Irrigation Water Policy article 2, “*Existing areas of irrigated agriculture shall be accorded the chances for sustainability. No diversion of its waters to other uses shall be allowed without providing a replacement source fit for agricultural use unrestricted by health and public health considerations, and unduly hampered by chemical constraints.*” must be rewritten to permit removal of water from land without replacement. [20]

### **III. MUNICIPAL AND INDUSTRIAL WATER USES**

The long-term average water supply deriving from rainfall is 780 MCM. Table 4 shows a year 2020 projected demand from Municipal, Touristic, and Industrial of 633.21 MCM. This demand can be met with existing sustainable fresh water supplies. By recycling treated wastewater for landscape and some industrial uses, fresh water demand can be reduced. Industries are beginning to request assistance and to adopt water conserving ways of doing business, e.g., the manager of Pepsi reports they have reduced their water use by 500,000 m<sup>3</sup>/year by changing processes while production of final product has increased.

Table 4: Projected Annual Gross Water Demand per Sector including Physical Losses. [21]

Sector	Water Demand, MCM, (%)			
	2005	2010	2015	2020
Municipal	366.9	404.5	444.2	493.4
Touristic*	5.53	10.06	16.18	19.87
Industrial	59.51	77.40	99.97	119.94
<b>Total</b>	<b>431.94</b>	<b>491.96</b>	<b>560.35</b>	<b>633.21</b>
Reuse Ratio** (%)	15	16	18	20

\* Includes Landscaping & Losses

\*\* Industrial reuse, source: MWI/WB 2001

#### **Municipal**

Municipalities face two critical constraints: high non-revenue water (NRW) rates and tariffs below the level required for sustained operation and maintenance of the delivery and collection system. Both will be discussed in turn.

But first, municipalities need to transition to continuous delivery of water. Many water leaks do not become apparent until the volume of loss increases, as they would under a continuous delivery system. And, many water conserving devices will only work with a fully pressurized system. Also, continuous delivery will significantly reduce the probability of serious water-borne disease outbreaks. Conakry, Guinea and Dakar, Senegal deliver 60 and 69 liters per person per day, respectively, in continuous supply; why can Amman not go to continuous flow? [30]

Non-revenue water: It is estimated that non-revenue water in municipal water distribution systems exceeds 50%. This is a direct loss in revenue to water companies and WAJ of about JD60 million per year. This loss is estimated to be about evenly split between water physically lost due to leaks in the system and water used but unpaid. Several actions are needed to bring this number down.

1. Building code enforcement, Miyahuna input in the development of new building codes
2. Enforce ban on washing of cars and outside of buildings with water hoses
3. Reduce unaccounted for water

Water utilities in the U.S. and Europe have found that rebate programs to encourage customers to replace high water use fixtures for low water use ones can free up enough supply water to delay for several years the need for new high cost supplies. Comparisons of the cost of rebates vs. the cost to develop new water supplies show the rebate programs can generate increased water supplies at lower cost. To prevent abuse of the programs, installation of new fixtures must be done by installers approved by Miyahuna (licensed plumbers once program is in place and plumbers are available), only approved fixtures will qualify for the rebate, and proof of installation must accompany rebate requests.

Converting districts from rationing water delivery to continuous 24/7 delivery of water shows high water losses after the water meter, i.e., internal to customer premises. Miyahuna has an opportunity to enhance customer relations and decrease water demand by providing technical assistance to customers wishing to reduce their water demand. Water Conservation Survey and Advisory Teams staffed by Miyahuna could provide free surveys of water use for households, advise on water conservation, and serve as a promoter of the rebate schemes.

Public awareness (PA) messages can use quotes from the Quran to encourage the reduction in water wastage. In the example quote, the message to true believers is clear; they should not waste water if they want to stay in Allah's favor. [38] PA messages should be delivered in the schools, mosques, posters in public places and with the water bill. Mass media should be used to the extent practical. PA can be linked to a rebate program, in a real sense an offer of a reward for improved conservation, and should do more than exhort the public to conserve and use water wisely. People need to know what and how they can do in addition to the why.

#### Municipal water tariff:

Establishing a proper municipal tariffs rate structure was discussed in the previous section. For urban areas, the tariff structure must parallel a subsidy program to ensure the poor have access to the water they need. The subsidy must be targeted to benefit the target audience; the current subsidy largely benefits the non-poor. [29] And, a portion of the subsidy cost should be borne by the public sector at large, not entirely by the water delivery entity. By their nature a municipal tariff rate structure and subsidy program are cross sectoral and should involve the Ministries of Health, Finance, Social Development, Municipal Affairs, and Awqaf and Islamic Affairs and Holy Places in their determination and implementation. The Ministry of Energy should be involved because one of the largest operating costs for the water utility is energy for obtaining water, its treatment, and delivery to customers.

***“O children of Adam!  
Wear your beautiful apparel  
At every time and place  
Of prayer: eat and drink:  
But waste not by excess,  
For Allah loveth not the wasters”  
(Sūra A’raf, No. 31) [7:31]***

#### Corporatization:

The current approach, as modeled by Miyahuna, has significant, potentially fatal, weaknesses.

There is no firewalling of finances, aptly demonstrated by WAJ taking 8,000,000 JD from the Miyahuna accounts in December 2007. Without complete control of assets the company will never have the wherewithal to properly expand and improve the system to meet growing needs and expectations of customers. Any surplus accumulated for future large construction projects

are subject to extraction at any time. The Ministry of Finance should be concerned by this practice. By stripping the Miyahuna account, flexibility of operation and funds to react when an emergency occurs are constrained. In the event of an emergency, Miyahuna will have to come to the Ministry of Finance for funds to make up the shortfall.

The Miyahuna has no independence in management of personnel. Salary levels are controlled by the Management Committee and staff can be imposed on the company; nepotism and wasta have full reign. Recent examples, the company has been unable to hire an Information Management Director because it is not allowed by the Management Committee to pay the salary required. The same applied to the Technical Services Director. However in this case Miyahuna was forced to take a WAJ employee who had been passed over in the earlier search process.

Miyahuna operational authority is subject to overrule by the Management Committee. Resistance to going to continuous delivery of water to customers is reported to be because of instructions from WAJ. The Ministry of Health should step into this discussion. Intermittent delivery of water supplies leaves the city open to epidemic outbreaks of disease; recent past events have shown that Ministry of Health credibility suffers when this happens.

For a private sector approach to water utility management to succeed, the above mentioned problems must be solved. Finances must be firewalled, personnel management within the company must be the prerogative of the Chief Executive Officer (CEO), and the CEO must have full operational control of the company. The role of the Management Committee is to select the CEO and monitor performance, not micromanage the company. A private sector majority in the Management Committee would increase the likelihood of company success.

**Action 6.** Public awareness on water conservation linked to rebate programs for switching high water use fixtures for low water use ones, facility/plant inspections/monitoring by regulatory authorities and Miyahuna, and establishment of Miyahuna Water Conservation Survey and Advisory Teams to assist water users to conserve water through leak detection and repair, better use practices, and recommendations for equipment and appliance upgrades. The teams would offer information and advise consumers on the rebate programs.

**Policy 10.** Transition from rationed delivery of water to urban consumers to one of continuous pressurized flow.

**Policy 11.** Require the use of low-flow plumbing fixtures in new construction and in renovation of old construction. Enforce a phase-out plan whereby ability to purchase and import high water use fixtures would be curtailed and over time prohibited.

**Policy 12.** Require inspection of all plumbing and installed fixtures in new construction and renovated old construction and the issuance of a conformation certificate before the structure can be occupied or used. This will reduce the occurrence of leaks in the structure, currently estimated to be greater than 20% of the water supplied.

**Policy 13.** Require installation of greywater systems in high-rise and high-density housing complexes to enable reuse for landscape irrigation. Also require greywater reuse systems at

high volume industrial users where the treated water can be re-injected into the water use stream or used for landscaping. Reuse of water will reduce demand on the water distribution system and reduce load on the sewer system

**Policy 14.** Mandatory certification of all technical staff working in water and wastewater treatment plants. To be phased in as trained staff becomes available.

## **Industrial**

Industries recruited for establishing plants in Jordan should have low water consumption rates, use water conserving equipment, and have in-house (in industrial zone) pre-treatment/treatment, and wastewater or greywater recycling where appropriate. In addition to the Jordan Industrial Estates Corporation, several ministries should be involved in permitting new industries for Jordan, whether in estates or not. The Ministry of Environment should work with the Ministry of Industry and Trade to assess and provide input on the technology to be used and the level of treatment required for the wastes to be generated. The water utility providing water and sewage treatment services to the industry site, and the Ministry of Water and Irrigation, need to evaluate the projected water demand for the industry, with consideration to what the system has available and can provide. The Ministry of Labor should evaluate the types/qualifications of employees needed while considering what the Jordanian labor market can supply.

**Action 7.** Within its service area, Miyahuna Water Conservation Survey and Advisory Teams – provide free surveys of water use for businesses, advise on water conservation, serve as a promoter of the Ministry of Environment’s environment fund revolving loan scheme for purchase of water saving technology and coordinate work with the Ministry of Environment’s Clean Production Program.

## **IV. AGRICULTURAL WATER USE**

It must be reiterated that agriculture is third priority for fresh water use, after domestic drinking water consumers and industrial users are satisfied. This not only is national policy but good economic sense. To soften the shock to agriculture, investments must be made to make its use of water more efficient, both in terms of productive use efficiency (engineering efficiency) and dinars gained per cubic meter of water used (economic efficiency). And, farmers must be assisted in the transition to irrigation with treated wastewater: proper crop selection, use of correct quantities of fertilizer inputs, irrigation practices, and improved post-harvest handling.

*To balance water demand and available sustainable water supply, **fresh** water use by agriculture will have to be reduced, if not eliminated entirely.*

Irrigation remains the single largest user among the water sectors in Jordan, despite government figures indicating water use for irrigation steadily decreased over the past two decades from nearly 80% of total consumptive use in 1985 to 64% in 2002. Projections are, however, that irrigation water use will remain nearly constant over the coming years. This may stem from the statement in the Irrigation Water Policy that “*Existing areas of irrigated agriculture shall be accorded the chances for sustainability. No diversion of its waters to other uses shall be allowed without providing a replacement source fit for agricultural use unrestricted by health and public health considerations, and unduly hampered by chemical constraints.*”[20] The main replacement source envisioned in this statement is treated wastewater, but to date less than 10% of irrigation waters come from this non-traditional source and long-term projections are that only 25% of irrigation demand will be met through reuse in 2020. The commitment of such a large portion of the country’s fresh water to irrigation limits development in other water using sectors. Although agriculture has been a defining feature of the Jordanian identity since pre-Christian times—**for most of this time it was rainfed agriculture**—from an economic standpoint, returns from agriculture represent an ever decreasing proportion of the country’s GDP and today account for only 3%.

### **Agricultural Production Marketing**

Increasing efficiency in irrigated agriculture should be a comprehensive program tackling the many problems impacting the sector. Interlinked factors include the water tariff, procedures for allocating water to farms, water delivery schedules, the agricultural production and marketing system, and agriculture protection via importation duties. A program to reduce water used in agriculture must also look at the other side of the coin, what happens to the crop after it leaves the farm. This discussion will start downstream of water and outside the water sector, with the agricultural production and marketing system.

*Raising water fees must be accompanied by better services to farmer (to increase productivity) and a better marketing environment (to increase economic returns per cubic meter of water used).*

Agricultural production and marketing is a logical place to start because without increases in income farmers will not have the wherewithal to increase investments in their irrigation systems and without additional returns upward adjustments in water tariffs will be strongly resisted. More importantly, farming is a business and like all businesses responds to the incentive system



it faces. Through adjustments to the incentive system, a business sector can be moved in a certain direction.

Several studies by USAID over the last twenty years have shown the Jordanian marketing system to be broken. Produce is purchased in the wholesale market by “weight”, which has been operationally translated as “per packing container”. There is a proposal to change this requirement to purchase by volume of produce, which also will be operationally translated into “per packing container”. Neither of these price schemes offers an incentive or premium to farmers willing to grade by quality, sort by size and conformity, and improve produce transport and handling to increase product quality and shelf life.

Marketing costs represent a considerable portion of total costs, even for the relatively short distances and low-cost methods used to transport produce from the Jordan Valley and highlands producing areas to Amman. These costs are especially high for many vegetables and fruits. For example, in 2003 twelve major crops represented 70% of fruits and vegetables production. The marketing costs ranged from 18% to 44% of the farm gate price; those costs would have been considerably higher if post-harvest product losses had been taken into account. [25]

For exports, the costs are higher still, especially when the costs of obtaining export documents and certificates, international transportation, and obtaining market information are taken into account.

Current Jordanian agriculture policy imposes significant costs on agricultural marketing, through taxes and regulations, which other countries in the region do not impose. Some of these additional costs are:

- Regulation requiring all sales, including exports, to go through municipal markets. That means paying a 4% municipal sales tax, a 4% market tax, a 5% commission agent fee, and a sales tax on the commission of 16%. This requirement also affects producers who wish to sell directly to retailers and bypass the wholesale market, they are legally required to pay.
- In the case of cut flowers, there is an additional 16% sales tax (over and above the two 4% taxes), the commission fee is 7%, and therefore, the tax on the commission fee is also higher. The total cost increment is about 28% for cut flowers.

Current import tariff policy has a strong effect on resource allocation, encouraging resources to move toward crops that represent inefficient uses of water, in terms of income generated per cubic meter of irrigation water: bananas, apples, and grapes. Border protection for these crops is in the neighborhood of 50%, Table 5. In addition, in the case of apples and bananas, it is clear that Jordan does not have a comparative advantage in production. Syria produces apples of equal or higher quality at a much lower price, and Latin American bananas are more competitive than those domestic. To encourage a high-value water efficient species mix for Jordan’s agriculture, tariff protection discouraging import of high-water consuming products should be removed.

Table 5. Agriculture produce customs tariff schedule [8]

Product	Tariff Rate
Apples (June 1 – Oct 31 + 250JD/Ton)	30%
Orange* (May 1 - end February)	35%
Bananas and Plantain + 250JD/Ton	30%
Grape	30%
Grapefruit, Pomelo, Lemon, Lime, Other citrus	30%
Mandarin, Tangerine, Satsuma, Clementine, Wilking and similar citrus hybrids	23%
Apricots, Cherries	28%
Peaches, Nectarines, Plums, Pear, Quince, Strawberries, Papaya	23%
Raspberries, Blackberries, Mulberries, Loganberries	25%
Egg-plant, Celery, Capsicum, Spinach, Tomato, Cucumber, Cabbages and similar edible brassicas, Lettuces, Peas, Beans, Other leguminous vegetables, Garlic	30%
Carrot, Turnip, Cauliflower, Broccoli	23%

\* Tariff protection outside the specified period is 30%

In addition to the duty detailed in the Jordanian customs tariff, goods imported to Jordan are subject to 13% general sales tax based on the value (Cost, Insurance, Freight (CIF) + duty).

Let's summarize some key factors of the current agriculture incentive system:

- wholesale pricing scheme that discourages produce quality,
- high transaction costs – taxes, fees, and obtaining export documents,
- entry barriers to competition – custom duties, fees, and tax protection, and
- subsidized water for irrigation – first 150,000 m<sup>3</sup>/year of groundwater pumped for irrigation is free and Jordan Valley tariff does not cover operations and maintenance.

The marketing system also has significant impact upon the required transition of cropping pattern due to changes in water quality. As the use of treated wastewater increases in the JRV, appropriate crops will change and an efficient marketing system will send signals on what crop offers the highest return to the farmer. Too much of Jordan's agricultural production is supply focused. Grower's produce then search for a buyer; the all too often tomato surplus dilemma.

Production linked tightly to demand through advance sale production contracts is starting to be used; its expanded use needs to be encouraged through a proper incentive structure. Also, Jordan Valley farmers targeting the export market should be assisted through a strengthened association such as the Jordan Export Producers Association (JEPA). The Jordan Valley is a natural greenhouse permitting the production of crops that can reach markets in Europe ahead of other neighbors.

***Marketing system corrections will ripple through to the water sector, e.g., premium pay for quality produce will result in optimal use of water resources (produce quality and water management are directly linked) and result in demand for better water delivery protocols and on-farm distribution systems.***

**Action 8.** Push forward to acceptance and implementation of the draft policy on Agricultural Production and Marketing.

**Action 9.** Support JEPA and other producer associations on forward contracting production, EurepGap certification of farms, and harvest and post-harvest handling.

### **Jordan Rift Valley (JRV) Water Management**

To make the changes in agriculture production happen, there is need for complimentary changes in irrigation water distribution. Current Jordan Valley Authority (JVA) operations protocols were developed when the majority on-farm irrigation system in the Jordan Rift valley was surface irrigation. Surface irrigation is most efficient when large quantities of water are delivered infrequently. Drip irrigation, currently most common in the Valley, requires the exact opposite, low volume applications frequently. The current rotational distribution system requires farmers to build reservoirs, purchase and operate pumps, and leads to over-irrigation with consequent low application efficiencies, about 40%. Application efficiencies for drip irrigation should be near 80%. This approach has severe environmental implications, over-irrigation leads to soil salinization, a recognized growing problem in the Valley, and the many diesel pumps leak fuel and oil, contaminating soil and potentially the shallow groundwater aquifer.

Work with cooperating farmers in the North, Middle, South, and Southern Ghors on better irrigation water delivery scheduling and application volumes demonstrated it is possible to achieve significant savings in water used in irrigation, an easy average 20% saving. [17] Several farmers reported that with water use reductions they had fewer pest problems, higher yields and higher quality produce. Table 6 shows some of the results obtained on farmers fields using their systems as built. It must be mentioned that none of the changes were sustainable. After the project demonstrations ended, farmers reverted to the old way of irrigating; it is less management intensive and therefore least cost. An incentive structure to encourage change did not exist, and still does not exist. It is said that farmers need new high-tech systems to achieve high efficiency. This is false, as the demonstrations in 1998-2000 showed. High-tech equipment is needed when farmers move above the 85% efficiency level; at 40% efficiency it would be a waste of valuable resources.

Table 6. Results from Irrigation Advisory Service crop season 1999/2000

<b>Crop</b>	<b>% Water Decrease</b>	<b>% Yield increase</b>
Cucumber	5-40	0-14
Tomato	10-25	0-11
Eggplant	11-47	13-22
Grape	11	0
Squash	39	3

Water distribution in the JRV needs to transition to a demand system. Under this system the JVA would delivery water on arranged demand to farmers or in bulk to water users' associations

(WUAs) every day. The WUAs would distribute water to their members on a defined priority basis. At critical peak use periods farmers may need to receive water and irrigate every day or two. Preliminary discussions with some JVA staff and the GTZ consultant working with WUAs indicate interest in shifting to the new irrigation water distribution management approach. To be feasible JVA would have to sell water in bulk to WUAs and let the WUA do the distribution to farmer members. JVA has resisted this approach.

Farmers need to understand the true value of water, the cost of water deliveries, the costs and benefits of alternative approaches to water management and that subsidized irrigation water reduces the capital available to properly operate, maintain, and improve the delivery system. This would be a first step towards rationalizing water tariffs and improving collection efficiency. The lack of incentive to conserve distorts the market, another factor leading to inappropriate crop selections. Better enforcement within the agriculture sector would highlight the concept of water as a commodity.

Policy and legislation is needed to permit movement of water between economic use sectors and within agriculture. This would require institution of a dynamic water rights scheme wherein flows are allocated on a proportional basis. A water right would offer significant encouragement to use water efficiently because seasonal water not used could be sold to another user. This is eminently doable for surface water flows to agriculture in the JRV.

<b>Action 10.</b> Restructure JVA to deliver water in bulk and on demand to WUAs.
<b>Action 11.</b> Work with WUAs and JEPA on crop production changes due to changes in water quality – fresh water to treated wastewater – and as production shifts to fulfill demand from forward contracting.
<b>Action 12.</b> Push final approval and support implementation of the two draft policies prepared under a previous USAID funded activity. Develop new policies for JRV irrigation, e.g., issuance of dynamic water rights to JRV farmers; and for agricultural water users in the highlands.
<b>Action 13.</b> Continue use of messages (social marketing) and best practices prepared for farmers but link them tightly with changes in the incentive system.

## Highlands

The Ministries of Social Affairs, Planning and International Cooperation, Interior, Finance, Environment, Health, Justice, and Culture should be actively engaged in water use practices and planning for the Highlands. Aquifers, essentially the only water sources for the area, are being depleted at an alarming rate. When aquifers go dry, what do the people do? Most do not live in an area that will be served by the Disi pipeline. Without water they will migrate to the cities seeking housing and a livelihood. Given the likely mismatch between skills required for urban employment and skills held by a largely rural population, pressure on social support institutions and societal stability will increase.

Enforcement of the Groundwater By-Law: Support enforcement of the groundwater allocation among municipal, industrial, and agricultural users under the National Water Plan. This would help alleviate over-abstraction of ground water resources. A strong public/pumper awareness campaign should be coupled with legal action. A Zaydi scholar from Yemen interpreted this verse from the Koran to mean communities do in fact have a collective responsibility to manage their environment in a sustainable way. He also challenged the widely shared notion that God will readily reverse the damage done by decades of over abstraction. [19] This message can be widely disseminated to the rural community.

*Say: "See ye?—  
If your stream be  
Some morning lost  
(In the underground earth),  
Who then can supply you  
With clear-flowing water?"  
(Sūra Al-Mulk, No. 30)  
[67:30]*

Highland irrigation continues to increase, Table 7, indicating groundwater extractions continue to increase. Though there was a slight decrease in irrigated field crops, this decrease was more than offset by large increases in irrigated tree crops and vegetables.

Table 7. Irrigated crop production in the Jordan highlands, dunums. [12]

Crop/Year	1994	1996	1998	2000	2002	2004	2006	94-06
Tree Crop	143,572	148,721	234,097	238,164	240,900	241,588	241,866	98,294
Field Crop	68,307	48,376	46,063	43,330	41,549	58,035	59,402	-8,905
Vegetable	150,231	113,418	174,415	138,808	164,149	180,348	228,521	78,291
<b>Total</b>	<b>362,110</b>	<b>310,515</b>	<b>454,576</b>	<b>420,302</b>	<b>446,598</b>	<b>479,971</b>	<b>529,790</b>	<b>167,680</b>

The previous quote on consultative decision making, Sūra Shūrā, No. 38 [42:38], coupled with the one immediately above could be used to culturally empower groundwater user associations. Decentralizing management of groundwater would allow local level decision-making by those most impacted by changes in the aquifers. Such a move would require government commitment to work with the associations. In several cases the government is the largest extractor of groundwater, for agricultural as well as for municipal uses, and the government can help moderate the influence of large absentee landlord irrigators.

Encourage Water Harvesting and Rainfed Agriculture: The total long-term average annual precipitation in Jordan is 8,500 MCM. About 75% of this rainfall is in the arid and desert areas of Jordan, the Badia (<200 mm of rainfall per year), Table 1, of which less than 5.2% infiltrates. About 92.5% of this rainfall runs off into salt sinks and/or directly evaporates. Rainfed grain crops such as barley, wheat, and sorghum could be grown, if not for grain production for forage. Modern varieties are more drought tolerant and work is underway on varieties that have higher salinity tolerance. There is a need to develop a large scale watershed management program (water harvesting) to capture more of this water.

A comprehensive program could include promotion of high value natural plants such as herbs, aromatic oils, and medicinals and improved non-irrigated forage — significant use of lost water could be made with improved management. Activities in the rural areas offer an additional benefit of improving economic opportunities available to some of the poorest members of Jordanian society. With USAID support, a 50 hectare pilot for range rehabilitation is ongoing

and is showing significant increase in forage production with an increase in biodiversity in the pilot area.



Range rehabilitation at Tal Ar-Rimah, in the 100 to 200 mm rainfall zone, has shown factor of ten forage production increases with significant increases in site biodiversity and recovery of indigenous Badia plant species.

There are other available options for trapping rainfall for short-term storage, e.g., the use of open mining pits, before it is lost to salt sinks. There are several large, over 1 million cubic meters each, phosphate mine pits near Abiad that are in close proximity to flood flow filled wadis that could be used. Current MWI regulations prohibit storage of water in the pits and require dikes to prevent flood water from entering the pits. If this is part of a long-term strategy, other storage pits could be created by stopping backfilling with spoil, e.g., at the Eshidiya mines. Before adopting this strategy wide-scale an assessment of water quality in the pits would be required and an assessment of potential nearby users. However, some farmers in Abiad are already using rain water trapped in the pits for irrigation of vegetable and forage crops.

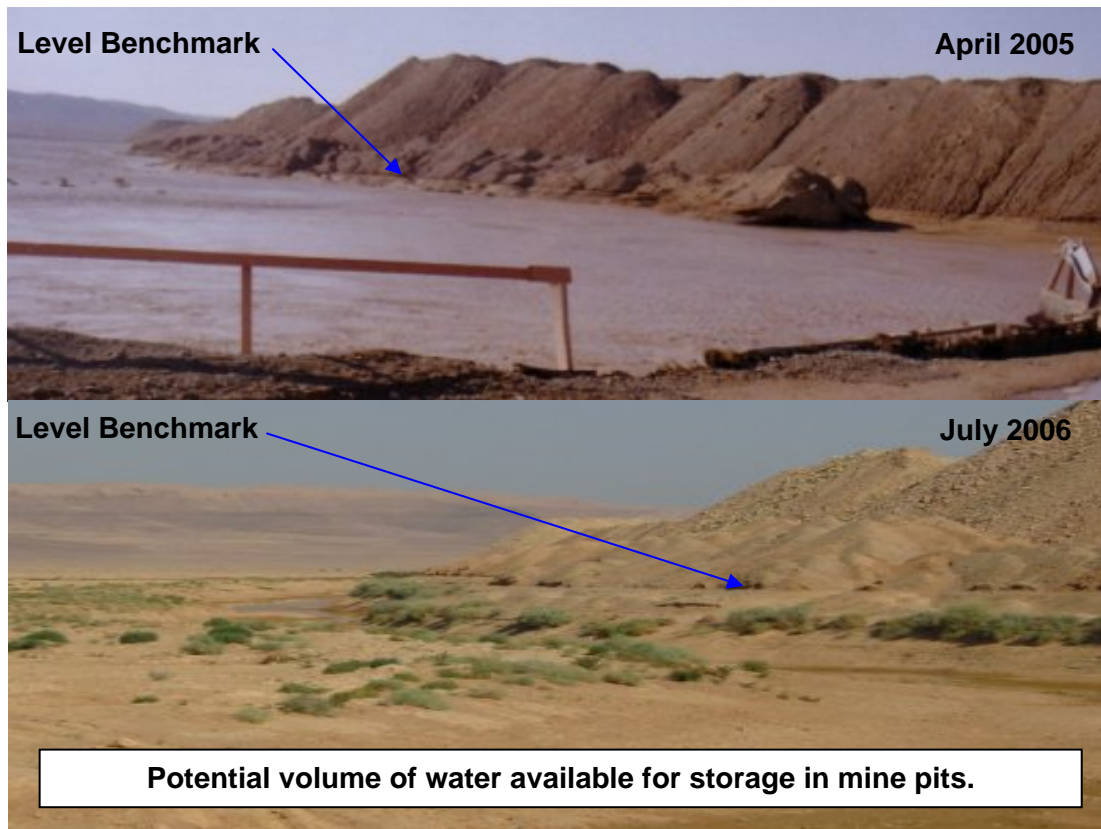


### ***Maximize Aquifer Recharge***

Aquifer recharge with rainfall runoff needs stronger emphasis. In 1997 USAID completed a study identifying a few floodwater recharge zones and completed a feasibility study for implementing a recharge system in Wadi Madoneh. This site was constructed and dedicated in late 2007. There are other low cost methods to increase infiltration through wadi beds at



appropriate locations, such as dams constructed from recycled tires across wadis upstream of the prime recharge zone; a practice used in the American Southwest.



Recharge with treated wastewater, which is permitted by current policy and standards for reuse of treated wastewater, is not being considered as a measure to relieve stress on aquifers and to delay the need for additional supplies from the Disi-Amman Conveyor and the Red Sea - Dead Sea conveyance scheme. Even if it is necessary to “polish” the wastewater with desalination and sterilization it is highly likely to be a more economic option than the two mega-projects.

A Fatwa in 1978 in Saudi Arabia even permits the use of treated wastewater for drinking if the treatment produces a water of high quality. There is no doubt such water can and should be used to recharge aquifers, or even for blending with water treatment plant feed water. This type of blending is used in many countries of the world.

*Impure wastewater can be considered as pure water and similar to the original pure water, if its treatment using advanced technical procedures is capable of removing its impurities with regard to taste, colour and smell, as witnessed by honest, specialized and knowledgeable experts. Then it can be used to remove body impurities and for purifying, even for drinking. If there are negative impacts from its direct use on the human health, then it is better to avoid its use, not because it is impure but to avoid harming the human beings. [6]*

**Socially Acceptable Options:** New Mexico State University recently completed a survey of agriculture in Mafrq governorate. [24] The survey data indicates a possible approach for reducing pumping in that governorate. Of the Mafrq farmers, 33% are 60 years old or older

with 57% over 50 years old. Farmers over 60 (50) years old cultivate 37% (60%) of the irrigated area in production. They pump 36% (61%) of the water extracted by agriculture. Well buyout schemes should target this farmer class. A second class to target for buyout would be the 39% of farmers, 50% of the irrigated land and 39% of the water pumped, who do not depend on farming for their main source of income.

Promote the formation of groundwater basin water users' associations. The associations should include representation from all water users within the basin. Resident farmers deriving a significant portion of their income from farming operations have an interest in sustaining the aquifer and can put in place operational protocols to bring withdrawals into line with safe yields. The influence of special interest groups with power not living in the area, absentee landowners, may make this approach difficult to put into practice. USAID and GTZ are currently funding efforts to establish such user associations in Shobak and Azrak, respectively.

Bedouin and Government Stipend: Though this may be heresy it must be offered as a potential partial solution to poverty in the Badia. First a relevant digression, livestock on the slopes of the Alps in Switzerland became uneconomical decades ago, but tourists still come to see the flocks and herds, and their traditionally dressed tenders, on the slopes in the spring through fall months. The Government of Switzerland made a decision to subsidize farmers to keep them on the land because the returns to the country from tourism exceeded the payout to farmers. Jordan should assess the potential for a similar system where Bedouin herders are paid a stipend by the government. The recipient herder could be linked into a tourist eco-adventure or experience package. Tourist could walk with the flocks, hike the Badia, and sleep under a camel and goat hair tent.

<b>Action 14.</b> Watershed/rangeland improvements to increase capture of rainfall for forages and high value indigenous plants.
<b>Action 15.</b> Water sampling in abandoned mine pits as one component of a feasibility study for water capture and short-term storage.
<b>Action 16.</b> Clear delineation of aquifer recharge zones to be followed by zoning to prevent development that would reduce recharge and watershed measures to enhance recharge. Appropriate recharge enhancement actions taken.
<b>Action 17.</b> Assess the feasibility of a well buyout program beginning with farmers operating at marginal profitability, with a particular early focus on older farmers.
<b>Action 18.</b> Support formation of groundwater users' associations, to include public awareness to heighten general public knowledge of the growing groundwater problems.
<b>Action 19.</b> Public awareness campaigns to inform farmers about their and their children's livelihood if pumping continues as now.
<b>Action 20.</b> Evaluate/assess the potential for a Bedouin experience eco-tourism project.



## **V. CONCLUSION**

“There is evidence the government institutions forming the water sector in Jordan seem to be relatively unprepared to react adequately and in due time to the water balance deficits that have been predicted by insiders to occur towards the end of the 1980's.” [4] This twenty-one year old quote unfortunately still rings true.

Jordan is rapidly consuming its future by mining aquifers to exhaustion and diminishing its capacity to adapt when supplies become tight by letting water sector institutions decay and collapse. To compound the problem, society at large is kept in the dark about the impending crisis, subsidized water is not valued and therefore not worthy of conservation. When crisis happens, a sheltered society will be unable to adapt and instability is a high probability.

Comments by Egyptian minister of water resources, Dr Mahmoud Abu Zeid are applicable to Jordan “There are too many priorities. You look at the situation and you see only priorities. It is a big challenge: we have to maximise our benefit from the water we have – use it more efficiently. Then we have to prevent pollution and also work with our neighbours. In parallel we have to ... limit the birth rate... It is a great challenge and it is hard to know where to begin.” [9]

A path is given in the document. It is hoped it will generate discussion but more importantly, that it will generate action to begin correcting the ills of the Jordan water sector. Jordan would be ill advised to expect donors to be standing by to bail them out of their mismanagement caused misfortune.

***Two closing thoughts, everyone contributes to the problem, everyone must contribute to the solution.***

***And finally, don't pass up today's opportunities while waiting for tomorrow's dreams.***

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## ANNEX A. SUGGESTED ACTIONS

**Action 1.** Collect historical weather data records, some begin in the middle 1800's, and conduct analyses: for a start the study should verify data record accuracy, determine trends, probabilities of annual rainfalls, drought recurrences and severities, and projections of the impact of climate change on water supplies.

**Action 2.** Implement a scientifically based analysis of aquifer information to identify need for and locations of monitoring wells, develop a plan for installing wells needed and collection of data needed to map the aquifers, prepare surface maps of aquifer recharge points, develop and implement protection plans for recharge zones with criteria defining allowable development for each zone, develop plans to increase recharge from rainfall – include a prioritized schedule for implementation of plans.

**Action 3.** Conduct a thorough assessment to identify all the entities involved in water resources management and use decision making, their various roles, authorities and legally mandated responsibilities. This should look extensively at the water sector, across all government and include the private sector having a delegated role, e.g., the Royal Society for Conservation of Nature has been delegated responsibility for nature preserves and national parks.

**Action 4.** Use the USAID, CIDA and MPR reports to begin discussion on a new institutional structure for the water sector. Gain commitment from the Minister, Prime Minister and key members of parliament to move forward with the reorganization of the three entities. Procure services of a consulting company to provide significant technical assistance focused on change management, capacity building, and offering advice on the new water law. Draft and approve a new comprehensive water law, one that consolidates responsibility and authority, removes overlaps, and fills gaps.

**Action 5.** Initiate an awareness/information campaign and capacity building program targeting young adults to focus on the critical concerns facing the water sector. The campaign/program should be personalized so young adults understand the impact on them and know what they can do to make change.

**Action 6.** Public awareness on water conservation linked to rebate programs for switching high water use fixtures for low water use ones, facility/plant inspections/monitoring by regulatory authorities and Miyahuna, and establishment of Miyahuna Water Conservation Survey and Advisory Teams to assist water users to conserve water through leak detection and repair, better use practices, and recommendations for equipment and appliance upgrades. The teams would offer information and advise consumers on the rebate programs.

**Action 7.** Miyahuna Water Conservation Survey and Advisory Teams – provide free surveys of water use for businesses, advise on water conservation, serve as a promoter of the Ministry of Environment's environment fund revolving loan scheme.

<b>Action 8.</b> Push forward to acceptance and implementation of the draft policy on Agricultural Production and Marketing.
<b>Action 9.</b> Support JEPA and other producer associations on forward contracting production, EurepGap certification of farms, and harvest and post-harvest handling.
<b>Action 10.</b> Restructure JVA to deliver water in bulk and on demand to Water Users' Associations (WUA).
<b>Action 11.</b> Work with WUAs and JEPA on crop production changes due to changes in water quality – fresh water to treated wastewater – and as production shifts to fulfill demand from forward contracting.
<b>Action 12.</b> Push final approval and support implementation of the two draft policies prepared under a previous USAID funded activity. Develop new policies for JRV irrigation, e.g., issuance of dynamic water rights to JRV farmers; and for agricultural water users in the highlands.
<b>Action 13.</b> Continue use of messages (social marketing) and best practices prepared for farmers but link them tightly with changes in the incentive system.
<b>Action 14.</b> Watershed/rangeland improvements to increase capture of rainfall for forages and high value indigenous plants.
<b>Action 15.</b> Water sampling in abandoned mine pits as one component of a feasibility study for water capture and short-term storage.
<b>Action 16.</b> Clear delineation of aquifer recharge zones to be followed by zoning to prevent development that would reduce recharge and watershed measures to enhance recharge. Appropriate recharge enhancement actions taken.
<b>Action 17.</b> Assess the feasibility of a well buyout program beginning with farmers operating at marginal profitability, with a particular early focus on older farmers.
<b>Action 18.</b> Support formation of groundwater users' associations, to include public awareness to heighten general public knowledge of the growing groundwater problems.
<b>Action 19.</b> Public awareness campaigns to inform farmers about their and their children's livelihood if pumping continues as now.
<b>Action 20.</b> Evaluate/assess the potential for a Bedouin experience eco-tourism project.

## ANNEX B. SUGGESTED POLICIES

<p><b>Policy 1.</b> An organizational structure for implementing the new water legislation that clearly shows the respective responsibilities of the different administration units in charge of water resources and providing these units with the power to facilitate the proposed restructuring. The policy should consider traditional roles and responsibilities of the various entities in developing the new collaboration enforcing structure.</p>
<p><b>Policy 2.</b> Craft a clear comprehensive legal structure to efficiently and effectively govern the water sector: include clear delegation of authorities and responsibilities and define modes of public participation in decision making. The new law will be the roadmap or foundation upon which a new institution will be built. The new law should fully replace the WAJ and JVA Laws and the MWI by-law.</p>
<p><b>Policy 3.</b> An Information Management framework. The framework should be integral to the water sector organizational structure. IM is focused on service to decision makers at all levels in the sector. To function efficiently it must have centralized management; picture a garden spider sitting in the center of her web, she manages information coming in from each strand.</p>
<p><b>Policy 4.</b> Permit water users associations to set a water tariff level sufficient to cover operation and maintenance (O&amp;M) and system capital improvements. The Jordan Valley Authority, as bulk water supplier in the Jordan Valley, should be permitted set a fee sufficient to cover the full cost of delivering water to the associations.</p>
<p><b>Policy 5.</b> Permit groundwater users associations, with regulatory oversight, to control extractions from the aquifer they manage. They have the highest interest in ensuring sustainability of the aquifer and world experience shows they can do a better job than the government.</p>
<p><b>Policy 6.</b> Introduction of dynamic water rights for surface water and groundwater. The right is dynamic because it is not a fixed volume. The volume available for use may vary each season or year as rainfall varies.</p>
<p><b>Policy 7.</b> A mechanism/procedure whereby the tariff structure can be modified outside the Cabinet. Tariffs should be set based on financial needs of water supplying and wastewater collecting entities, i.e., Irbid residents could face a different rate than residents of Amman, Ma'an or Aqaba. Availability of water to the poor at an affordable price would have to be addressed.</p>
<p><b>Policy 8.</b> Governmental oversight to prevent excessive profit taking is needed when private companies are involved. A regulatory capacity independent of water sector institutions is needed.</p>
<p><b>Policy 9.</b> <u>Irrigation Water Policy</u> article 2, “Existing areas of irrigated agriculture shall be accorded the chances for sustainability. No diversion of its waters to other uses shall be allowed without providing a replacement source fit for agricultural use unrestricted by health and public health considerations, and unduly hampered by chemical constraints.” must be</p>

rewritten to permit removal of water from land without replacement.
<b>Policy 10.</b> Transition from rationed delivery of water to urban consumers to one of continuous pressurized flow.
<b>Policy 11.</b> Require the use of low-flow plumbing fixtures in new construction and in renovation of old construction. Enforce a phase-out plan whereby ability to purchase and import high water use fixtures would be curtailed and over time prohibited.
<b>Policy 12.</b> Require inspection of all plumbing and installed fixtures in new construction and renovated old construction and the issuance of a conformation certificate before the structure can be occupied or used. This will reduce the occurrence of leaks in the structure, currently estimated to be greater than 20% of the water supplied.
<b>Policy 13.</b> Require installation of graywater systems in high-rise and high-density housing complexes to enable reuse for landscape irrigation. Also require graywater reuse systems at high volume industrial users where the treated water can be re-injected into the water use stream or used for landscaping. Reuse of water will reduce demand on the water distribution system and reduce load on the sewer system
<b>Policy 14.</b> Mandatory certification of all technical staff working in water and wastewater treatment plants. To be phased in as trained staff becomes available.