THE WATER RESOURCES MANAGEMENT PROGRAM IN JORDAN

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Jordan

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1. Introduction

Water is one of Jordan's scarcest resources, it originates from precipitation within and outside the country. Average rainfall ranges from 600 mm/yr in the northern uplands to less than 50 mm/yr in the east and south semi desert areas. Rainfall occurs between October and May, and is at its height between December and March when 80% of the rainfall occurs. Average annual volume of rainfall within Jordan is estimated at 8500 million cubic meters (McM) and with high evaporation losses the annual yield is only about 1120 McM with 245 McM in the form of groundwater and 875 McM in surface flow, half of which forms the flow of the Yarmouk River on the border between Jordan and Syria.

The distribution , frequency and intensity of rainfall renders about 94% of the area of the country a contiguous stretch of arid and semi-arid terrain with no potential for rain fed agriculturel, and the winter flows in rivers and wadis are generally of a flashy nature with large seasonal and annual variations. Over 40% of the flows are in the form of short storm runoffs which occur about five months in the year. Annual base flows originating from springs vary by about 15 to 20 percent within a return period of five years. Years of drought are not unfamiliar and three such years occur in a cycle of ten years with varying intensities of shortage.

2. Characteristics of Water Use and cost

The limitations on the water resources of Jordan are likely to have a significant impact on the social and economic development of the country. Because the Government and the people are well aware of the scarcity of the resource, water usage is generally low and suppressed.

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Compared to other countries with comparable levels of economic and social development, Jordan stands in the forefront of efficient and conserving users of water.

Water uses in the country are made to "satisfy" the municipal and industrial requirements, and the requirements for the production of food through irrigated agriculture. However, the water quantities that Jordan allocates to "satisfy" the user's needs is hardly enough to "pacify" such users through a drought year in a developed country. Further, the cost that Jordan incurs to develop its water resources and put them to benificial use is high by any standard. Given the limited financial resources of the country, the burdens are heavy and the performance is no less than good.

The population of Jordan has a relatively high birthrate and the country accomodated over the past forty years of Middle East turbulance a high proportion of displaced people and refugees. About ninety percent of all population live in the northwest quadrant of the country, and by 1975 came to consume all the nearby underground water and springs by pumping them to use for mainly municipal purposes. By 1981 municipal water had to be transported from remote areas some 80 Kilometers away with adverse environmental impact, and more recently, surface water has been pumped, treated and transported from the East Ghor Canal below sea-level in the Jordan Valley to over 1000 meters above sea level to supply towns and cities in the uplands with municipal water including the capital city of Amman.

The cost of delivery of water to city limits under these schemes is about 70 cents per cubic meter divided equally between capital cost recovery and operation and maintenance cost. When adding the lost development oppurtunity to the area of the source the schemes cost to the country are magnified. More important, however, is the impact such schemes will have on population distribution and on rural development. There is, however, no visible other possibility to meet the future municipal water demands of Jordans population but to pump and transport more of the Jordan Valley water resources for this purpose.

Fortunately, water transported from the Jordan Valley to cities in the uplands is not all depleted. Plans have been drawn up and expensive projects were and are being built to recycle that water after municipal uses and appropriate treatment, blending and regulation for use in irrigation of arable lands in the Jordan Valley. The return of such recycled water occurs by gravity flow, and power will shortly be generated from the scheme.

Naturally, agriculture remains the main user of water, and care has been taken since the early seventies to make irrigation systems more efficient with the Government investing handsomely in water resources development and in pressure pipe distribution networks and regulation devices. The farmers responded enthusiastically by equally hansome on-farm investiments in drip irrigation systems and in modern farming practices that saved on water losses, increased the yields per unit area and improved quality of the produce.

All this has not been without cost; to the Government, the cost per cubic meter to recover the capital cost of infrastructure at 10% interest stands at about 25 cents, and to the farmer the added capital cost recovery per cubic meter is about 10 cents for the drip system. The cost of maintenance of the systems and of water delivery to the farms is about 5 cents. The financial cost of one cubic meter of irrigation water adds up to about 40 cents and enables the farmer to produce about 10 pounds of vegetables on the average.

The future cost of development of water resources is likely to be higher than the cost that has been incurred by the Government already. This is due to the distances and elevations of the consumers locations from those of the **resources**, and because of the future requirements for treatment of brakish water, and of construction cost escalation.

3. Water Requirements

Definition of water "requirements" in Jordan is made in the reverse. Whereas in many countries requirements are defined and water resources are called upon to satisfy them, the case in Jordan starts with the limitations on water resources and users are called upon to set their patterns of use to stay within the constraints of available resources. Obviously such a criterion is not workable forever.

Under these circumstances and constraints it is not possible to look ahead with any degree of reliability beyond the turn of this century. The time we have left until then must bring about economic means for desalting brakish or sea water to enable the country to maintain an acceptable level of growth. This is not meant to leave the impression that we are without problems in the next dozen years, but the problems we are likely to face are not insolvable.

For the year 2000, the municipal and industrial share of water for the East Bank population has been set at 247 McM . This allocation is based on the criterion mentioned above with a total per capita daily share a modest 120 liters further reduced by losses in the conveyance systems and by the degree of efficiency of water use. The irrigation allocations for agriculture in the East Jordan Valley (including southern Ghors and Wadi Araba) have been set at 590 McM in the year 2000. Provided the overall irrigation efficiency is improved to a level of 75 percent, this allocation could allow a cropping intensity of 128 percent over a total area of about 50,000 hectars of which 36000 hectars are in the East Jordan River Valley, 12000 ha in the southern Ghors and 2000 ha in Wadi Araba. When this is all accomplished the share of irrigated land per capita in the East Bank will be one in a hundred hectar to produce his or her food for a period of seven months.

Because of the allocations made to municipal water, the above allocation for irrigation in the Jordan Valley can not be secured without the re-use of municipal water after appropriate treatment and blending with fresh water. The quantity of re-cycled water amounts to 115 McM by the turn of the century all to be used in the East Jordan Valley, forming about 23% of its water allocation. The remainder of its share comes from the Yarmouk River, the Zarqa River and the side Wadis of the east escarpment.

4. Government Development Effort

To meet the requirements of growth and development, the Jordan Government exerted an impressive effort to develop the Water Sector. Under its successive plans since 1973 dams were built, deep wells drilled, water treatment plants and major pumpstations were constructed, and an elaborate system of pipe conveyance and distribution was installed.
Following is a brief review of the past and planned efforts:

Jordan Valley Irrigation Projects.

The Jordan Valley Irrigation Projects were conceived, designed and built in accordance with the Master Plan prepared in 1955 for the Jordan Valley development, which plan was compatible with regional arrangements for water allocation and use. The Valley development has been going on for the past 25 years and the following have been accomplished.

a- Stage I Projects (1961-1980)
These projects were initiated by the construction of the East Ghor Canal (EGC) and its irrigation and drainage networks. The source of irrigation water is the Yarmouk River and by 1965 about 12000 ha were perenially irrigated below the 70 Km long EGC from Yarmouk waters by surface methods. By 1969 the EGC was extended by 8 Kms to cross the Zarqa River and 2000 more hectars were added to the gravity irrigation system but were irrigated only in winter from the EGC.

The Valley development was resumed in 1973 with an integrated social and economic development approach. Projects were implemented in the sectors of water resources development, irrigation and drainage, village and rural development, agricultural services and farmers organization. During the years of the seventies, the King Talal Dam was built with a live storage capacity of 48 McM, and 8300 hectars of new land were added to the irrigated areas in addition to securing perenial irrigation for the 2000 ha of 1969. Of the above new areas 4000 ha are below the EGC which was extended southward for a distance of 18 Km, and depend on the water supply from the Yarmouk between October and April and on the King Talal Dam for the remainder of the year. The rest of the new are (4300 ha) are located above the EGC or away from it and depend on side Wadis for their water supply.

The irrigation networks in the new areas are all pipe networks that deliver water to the farmgate at 3 atmospheric pressures, and efficient on farm drip irrigation systems were adopted by farmers; as a result, the overall irrigation efficiency in these areas is now between 70-75 percent.

b- Stage II Projects (1982-Present)

Jordans attempts to build the Maqarin Dam on the Yarmouk River were revived in 1975 and were stalled in 1981 after all preparations were completed to have the construction start. Under the scheme, and in addition to an increase in the irrigated area, projects were included for the supply of municipal and industrial water to 90% of Jordan's population who live in the northwest quadrant of the country. Despite the adverse circumstances of the past, Jordan maintains high hopes to have the dam built. With this in mind, Jordan proceeded to build the following projects:

- Construction of Wadi Arab Dam with a storage capacity of 17 McM, 7 of which would regulate the flow of Wadi Arab to irrigate 1250 ha of which 400 are new lands, and 10 McM will be pumped to it in winter from the EGC for later use in municipal water supply to the capital city of Amman. The scheme was completed in 1985.

- Raising of King Talal Dam to increase its storage capacity to 82 McM and the diversion of desert catchments to the catchment of the dam. Additional water would come from the return flows of used municipal water in the greater Amman area. The project is due for completion in early 1987.

- Extension of the EGC by 14.5 Km and the construction of pipe irrigation network for about 6000 ha of new land. Until enough stored water is made available, this area will be irrigated only for one winter season between October and April, from primarily Yarmouk water.
  The Project is due for completion in mid 1987.

- Construction of the Deir-Alla-Amman domestic water project to pump Yarmouk water from the EGC at Deir Alla to Amman over a total head of 1350 meters and a distance of 40 Km. The project capacity is 45 McM per year.

- Underground water exploration which made it possible to supply the Governorate of Irbid in the north with domestic water from underground sources in Wadi Arab.

- Wadi Arab-Irbid domestic water supply project to lift the ground water over 700 meters head to the city of Irbid with a delivery capacity of 20 McM per year.

- Sewerage networks and conveyance systems and sewage treatment plants for all cities in the Jordan River catchment on the highlands. Treated affluent flows back to the Zarqa River, Wadi Arab and other side wadis for re-use in irrigation of the Jordan Valley .

- South of the Dead Sea, the first stage of the Southern Ghors Irrigation has been completed and 4700 ha have been added to the area irrigated by pressure pipe networks.

The size of Government investments on the stage II projects amounted to about ⅀ 550 million over a period of five years.

c. Stage III Projects (1985-1995)

Water resources development projects for the next ten years focus on economic storage of water that otherwise goes unused to the Dead Sea, on further exploration of ground water and on replacing networks of water distribution to maximize water use efficiency. Care has been taken to introduce advanced systems of water management and controls. Projects to be implemented include the following:

c-1 In the Jordan Valley

- The construction of Karama Dam to store the surplus surface runoff of the eastern escarpment. The EGC is the primary collection and conveyance system . Geotechnical investigations have recently been contracted to determine the technical feasibility of maximum storage. The yield of this dam will be allocated to M&I water and to irrigation and to provide perenial irrigation to the 14.5 Km extension of the EGC.
- Small dams each on Wadis Yabis, Kufranja and Rajib and a re-regulation dam on the Zarqa River. These projects are yet to be studied for technical and economic feasibility.
- Pumping of winter water from the EGC to Wadi Arab to compensate for the depletion of Wadi Arab base flow caused by abstraction of underground water for municipal use in Irbid.
- Replacement of surface canal irrigation networks for a total are of 14000 hectars built between 1961 and 1969. The first component replaces 6000 ha will start next month, and the other components will start next year.

- Installation of automation systems for management of irrigation water. The computer system and software packages will be completed next year.

- Mukheiba-Amman Domestic Water Project to pump 26 McM of water from Mukheiba wells to Amman to help meet the requirements of municipal supply in 1991.

c-2 - In the Southern Ghors
The diversion of Wadi Mujib flow to help meet the industrial water requirements in Safi and to expand the irrigated area to about 12000 hectars.

- The construction of Tannur dam on Wadi Hasa the yield of which will be used for the same purposes as above.

- The construction of Rumeil dam on Wadi Walla and Nukheila Dam on Wadi Mujib both with modest yields to augment the above resources.

c-3 - In Wadi Araba
The development of groundwater resources to irrigate about 2000 hectars in the region.

c-4 Outside the Jordan Rift Valley Projects will focus on updating of investigation for ground water in the east and south Badia and desert, and on water spreading techniques in those areas.
Other projects will continue to replace the old water distribution networks, and to expand the distribution systems to villages yet unserved with domestic water. Advanced systems of automation will be installed for proper management of the municipal and industrial water systems, and maintenance facilities will be upgraded and expanded.

c-5 Training

Training of personnel is being conducted continuously inside Jordan through training centers and overseas under programs of cooperation with other countries. These programs aim at making available comptent personnel to operate and maintain the modern installations of the water systems.

In conclusion I hope that this brief presentation on the Water Resources and their management in Jordan makes a contribution to the project being undertaken by the Center for International and Strategic Studies, and, as I express my thanks to the Center and my appreciation of this opportunity to participate, I look forward to further contribution in the future.