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Based on an International Expert Consultation, Baghdad, Iraq, 24 February - 1 March 1979

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TABLE 3 Irrigation and Drainage Projects Financed by the Bank in Western Asia as of December, 1978

Country	Project	Credit/Loan Number	Credit/Loan Amount (Million of US $)	Area covered	Year of effect-iveness	Estimated percentage of completion
1. Afghanistan	Khanabat Irrigation I	C-248	15.0	26 000	1972	40
2. Afghanistan	Khanabat Irrigation II	C-778	22.0	15 000	1978	--
3. Egypt	Nile Delta Drainage I	C-181	26.0	400 000	1970	80
4. Egypt	Upper Egypt Drainage I	C-393	36.0	125 000	1973	50
5. Egypt	Upper Egypt Drainage II	C-637/L-1285	50.0	210 000	1977	20
6. Egypt	Nile Delta Drainage II	C-719/L-1439-40	66.0	420 000	1978	--
7. Egypt	Fruits and Vegetables	L-1276	50.0	71 000	1976	15
8. Egypt	Agricultural Develop.I	C-830	32.0	75 000	Not yet	--
9. Iraq	Lower Khalis Irrigation	L-878	40.0	46 000	1973	15
10. Iran	Dez Irrigation (2 phases)	L-247-594	63.0	57 000	1959	100
11. Jordan	N.E. Ghor Irrigation I	C-498	7.5	2 760	1975	85
12. Syrian Arab Republic	Malikh Irrigation	C-469/L-975	73.0	41 000	1974	10
13. Turkey	Ceyhan-Aslantas Multipurpose	C-360/L-883	74.0	97 000	1974	80
14. Turkey	Corum-Cankiri Rural Develop.	L-1130	75.0	13 000	1976	40
15. Turkey	Irrigation Rehabilitation	C-281	18.0	50 000	1972	90
16. Turkey	Seyhan Irrigation II	C-143/L-587	24.0	48 000	1969	85
17. Yemen	Tihama Development I	C-376	21.2	17 000	1973	65
18. Democratic Yemen	Wadi Hadramout	C-615	7.0	1/	1976	--
19. Democratic Yemen	Wadi Tuban Agr.Develop.	C-768	5.2	1 755	Not yet	--
Total			704.9	1 716 000		

1/ Study on underground resources

Part VII

COUNTRY CASE STUDIES

Water Resources in Iraq

M. M. Badry, M. S. Mehdi and J. M. Khawar

INTRODUCTION

This study dealing with water resources in Iraq is based on project reports prepared by foreign consulting firms and papers produced by the Central Statistics Organization, the Ministry of Irrigation, the Ministry of Agriculture and Agrarian Reform and some other state organizations. Some recent studies, in particular the first stage of the General Scheme for Water Resources and Land Development in Iraq prepared by the Ministry of Irrigation in 1975, also have been used. This study examines the utilization of water resources of both the Tigris and Euphrates rivers within the territory of Iraq. Long-term utilization of water resources up to the year 1995 covering agricultural and other requirements has also been discussed.

WATER RESOURCES

The Tigris and the Euphrates rivers constitute the main water resource of Iraq. The mean annual flow of the Euphrates River at Hit, based on extended observations, is estimated at an average of 30 billion cubic metres within a range of fluctuations between 10 and 40 billion m^3 depending on the cycle of wet and dry years. The mean annual flow into the Hammar lake is about 10 billion m^3 during the flood period. After diverting the water across the Warrar regulator upstream of the Ramadi barrage, the Habbaniya lake regulates the water storage between Hit and Hindiya city. The annual flow of the Euphrates river has been considerably affected by the construction of the Keban dam in Turkey and the Tabqa dam in the Syrian Arab Republic in 1973. The filling of the reservoirs of both dams started in the same year, causing considerable water shortage in Iraq. The annual flow of Euphrates river during the flood season from March to July is estimated at 60 to 70 percent of the total annual flow. Its lowest flow is during the period from August to October at 180 to 230 m^3 per second or a total of 2.5 billion m^3, which is 9 percent of the mean annual flow.

The mean annual water flow of the Tigris river as it enters Iraq from Turkey is 31.5 billion m^3. The mean annual flow generated inside Iraq at the confluence of the Diyala river with the Tigris river is 27.9 billion m3 (Greater Zab 14.2 billion m^3, Lesser Zab 7.4 billion m^3, Al-Adhaim 0.7 billion m3 and Diyala 5.6 billion m^3). Thus, the mean annual total flow of the Tigris river develops to 59.4 billion m^3. The Tharthar reservoir has been operative since 1958. By absorbing the extra water discharge upstream of the Samarra barrage it protects Baghdad from floods. The amount of water accumulated in the Tharthar lake between 1959 and 1972 is estimated at 108 billion m^3. In the beginning of December 1973, the volume stored in the Tharthar depression (reservoir), excluding losses due to evaporation, was 65 billion m^3. Two other reservoirs have been constructed in the Tigris basin, i.e., Dokan on the Smaller Zab and Derbendi Khan on the Diyala river. These two reservoirs regulate the flow into the Tigris, taking into account irrigation, flood protection and electricity needs. Most of the Tigris water south of the Diyala river confluence is used for irrigation. Part of it flows into marshes and natural depressions on the right bank of the river. On the left bank of the Tigris basin, between Kut and the Tigris-Diyala confluence, a series of marshes and swamps have formed from the waterflow originating in the Iranian hills along the eastern frontier. Some of this water flows into the Tigris and Shatt Al-Arab.

The Teeb, Dewarege and Shehabi river waters are highly saline and thus of limited use. In the flood season, the Karkha river flows into the Hur Al-Hewaiza, but it is not possible to use this water for agricultural purposes. The water flowing into Hur Al-Hewaiza is not taken into account in the present study of water resources in Iraq. But the waters which flow into Shatt Al-Arab are important in quality and quantity.

Good quality subterranian water has been found at the foothills of the mountains in the northeast of the country and in the area along the right bank of the Euphrates. The aquifer in the northeast of the country, having an estimated sustained dishcarge between 10 and 40 m^3/sec., lies at depths of five to fifty metres. Its salinity increases towards the southeast of the area till it reaches between 0.5 and 1 mg/litre. The aquifers on the right bank of the Euphrates river, trapped between gypsum and dolomite at depths increasing towards the west, where water is found at 300 m depth (at Abu-Al-Jeer), have an estimated total discharge of 13 m^3/sec. In the western part of that area the salinity of the water is only 0.3 mg/litre compared with 0.5 to 1 mg/litre in the eastern sections. In other areas of the country good quality ground water is quite limited because of high levels of salinity. In summary, the total river water resources of the country are estimated as under:

Source and location	Quantity (billion m^3)
Euphrates at Hit	30
Tigris river at Fatha	43
Adhaim river at Enjana	6
Diyala at Sudour	5.5
Teeb, Dewarege and Shehab	1
Al-Karkha	6.3
Karoun river	24

PRESENT WATER RESOURCES UTILIZATION

Regulation of the River Water Course

Barrages, canals, dams and reservoirs such as Dokan and Derbendi Khan on Tigris river tributaries and the Habaniya reservoir on the Euphrates help control the utilization of annual water flows. On the Lesser Zab river 80 to 85 percent of the flow is controlled. On the Diyala river the mean control is 45 to 55 percent. The Ramadi dyke, the Warrar and Majara regulators and Hur Abu-Debis control the Euphrates water course. The regulation of the water stored in the Habbania lake allows 5 to 15 percent of the Euphrates river water to be utilized. The recently completed Tharthar-Euphrates canal allows the use of water stored in the Tharthar lake. There are several other important constructions which help regulate water courses inside Iraq such as the Hindia barrage, Al-Meshkab, Al-Abu, Al-Shamia, Akeka and Al-Hafar on the Euphrates, Debis on the Lesser Zab, the Diyala weir on the Diyala river and the Samara dyke and Al-Kut on the Tigris river. These infrastructures control water upstream, store water for irrigation networks and increase water depth in rivers to facilitate navigation. The annual quantity of water released in the Euphrates between Ramadi and Naseria is 3 to 4 billion m^3, while it is about 23 billion m3 in the Tigris between Samara and Al-Kurna. However, as mentioned above, the Keban dam in Turkey and Tabqa dam in the Syrian Arab Republic have adversely affected the flow and availability of water in the Euphrates river basin in Iraq and have created additional difficulties for control and regulation of the river flow within the country. The characteristics of these dams are spelled out as under:

	Normal operation level	Dead storage level	Storage		
			Gross	Live	Dead
	(Metres above sea level)		(billion m^3)		
Keban dam and reservoir in Turkey	845	813	30.7	16.3	14.4
Tabqa dam and reservoir in the Syrian Arab Republic	300	285	11.9	7.3	4.6
Total	-	-	42.6	23.6	19.0

The operational details of the two dams, the reservoir filling programme and the discharge have still to be agreed upon among Iraq, the Syrian Arab Republic and Turkey. The failure to agree so far on the riparian issues involved has had serious consequences for the agricultural economy of Iraq due to reduced water supplies and irregular course of the river.

Flood control is an important aspect of regulating the watercourse of the river, through passing high-frequency flood discharge which is between 0.01 to 1.0 percent. Although at present there is only limited control on floods, after the construction of the Dokan and Derbendi Khan dams (Tigris river), infrastructure works for the purpose are in progress, specifically the Samarra dyke and Tharthar regulator. The Ramadi dyke, Warrar regulator, Al-Majara and Abu-Debis depression are the main flood control works being executed on the Euphrates river.

Water Resource Use for Irrigation and Drainage

Modern irrigation systems were introduced in Iraq during the years 1911 to 1914 with the construction of Hindiya barrage on the Euphrates river followed later on by the Kut barrage on the Tigris river during the 1937-1939 period. In the beginning of the 1950s other important projects such as Ramadi dyke and Habbania lake on the Euphrates river, Samarra dyke and Tharthar regulator on the Tigris river, Dokan dam on Lesser Zab and Derbendi Khan on the Diyala river were executed. Many pilot projects for reclamation of agricultural lands affected by salinity due to the lack of adequate drainage, were also undertaken. For example, pilot experimental stations were established at Dujaila, Al-Amara, Dewerege and Al-Musaib. The main irrigation projects of that time were only concerned with meeting irrigation requirements through constructing main head regulators without considering drainage aspects and comprehensive planning for the agricultural area. In 1969 the situation changed with the establishment of the Ministry of Irrigation, which was to execute irrigation projects in coordination with State Organization for Soil and Land Reclamation, under general directives of the High Agricultural Council.

During the 1981-1985 development plan, the Ministry of Irrigation envisages to improve and regulate irrigation and drainage schemes and to start new schemes over an area of 600 000 misharas in the northern region and 2 750 000 misharas in the central and southern regions 1/. This will allow the development of existing schemes and an expansion of 22 percent of the land under cultivation. The construction of drainage networks is expected to benefit an area of 4 750 000 misharas, representing a 32 percent growth over 14 million misharas of the existing area. The major irrigation and drainage schemes in the Tigris basin are Ishaqi, Kirkuk, Adhaim, Middle and Lower Diyala, Eastern Gharraf, Dalmaj, Badra Jassan and Middle Tigris. In the Euphrates basin the major schemes include Saqlawiya, Abu Ghraib, Hilla-Diwaniyah and Iskandariya-Mahaweel. Table 1 shows the land area to be irrigated in different river basins in the year 1995.

Most irrigation systems do not fulfill the necessary engineering requirements due to the lack of land levelling and to inadequate water distribution and drainage systems which cause waterlogging. This situation results in important water losses and increases salinity levels in the soil, ultimately rendering it unfit for crop cultivation. Surveys and studies have revealed that 64 percent of all irrigated lands suffer from salinity problems and 43 percent of these lands are in need of basic leaching. Experiments have indicated that field drainage of 20 to 40 percent of applied water is of a suitable order for the purpose of removing salinity from the soil. Lately, several drainage water collectors and pumping stations were constructed in a number of irrigation projects. Also, field drainage systems were constructed, e.g., in the Radwaniya project, Khalis project and in sugarbeet growing areas. It is observed that the drainage water presently discharged into the Tigris and Euphrates rivers increases the salinity of the river water and may ultimately make it unsuitable for irrigation.

Irrigation Duties

The present water requirements for irrigation have been estimated in a report on water utilization prepared by experts of the Ministry of Irrigation. Mean water duties were calculated for different winter, summer and perennial crops in cubic metres per mishara according to different irrigation rates and seasons and for various climatic zones. After the construction of irrigation systems, regulation

1/ One mishara = 0.25 hectare

TABLE 1. Area Planned to be Irrigated in Different River Basins in Iraq in the year 1995

River basin	Net area of irrigation system (Million misharas)	Utilization of irrigated areas: Annual irrigated area (Million misharas)	Utilization of irrigated areas: Intensity of cultivation (Percentage)	Total water allocation: Irrigated lands (Thousand m^3 mishara)	Total water allocation: Annual irrigated lands (Thousand m^3 mishara)	Existing irrigation requirements (Km^3)
1. Euphrates	5.63	4.21	118.1	2.7	3.6	15,560
2. Tigris (total) Comprising:	9.74	8.87	121.2	3.0	3.4	29,397
2.1 Above Samarra barrage	3.15	3.15	115.3	2.6	2.6	8,131
2.2 From Samarra barrage to Kut barrage	5.24	4.67	126.1	3.0	3.4	15,326
2.3 Below Kut barrage	1.35	1.05	118.3	4.0	5.2	5,450
3. Shatt Al-Arab region	0.42	0.42	156.0	5.6	5.6	2,373
Total/ Average	15.79	13.50	121.4	3.0	3.5	46,835

Source: Documents of the ECWA Regional Water Conference of the Countries of Western Asia, Baghdad, 11-16 December 1976

of river runoff across barrages for additional transmittal of discharge becomes necessary. The additional volume of water may be used to expand irrigated agricultural lands. At present, the irrigated area in Iraq is more than 16 million misharas, of which 6 million misharas are in Euphrates basin.

Water Supply and Sewerage

Total water requirements consist of requirements for domestic, industrial and agricultural purposes; the latter include gardens and pastures. The water requirements for human use and sewage for different regions of the country have been estimated in Table 2 and total water requirements of the regions in the different seasons are reproduced in Table 3.

TABLE 2. Water Requirements for Consumption and Sewage in Different Areas of Iraq, 1975

(Million cubic metres)

Description	Northern region	Central region	Southern region	Total
Total	395	1 139	646	2 180
Of which:				
Sewage water	105	532	336	773
Water consumption	290	607	310	1 207

TABLE 3. Total Water Requirements in Different Seasons and Zones in Iraq, 1975

(Million cubic metres)

Region	Winter	Summer	Perennial
Northern	550 - 1 650	1 550 - 2 300	2 300 - 3 200
Central	750 - 2 100	1 900 - 3 100	3 700 - 4 550
Southern	950 - 2 200	2 000 - 3 100	4 300 - 4 800

Mean-weighted irrigation duties depend on the areas cropped seasonally. Estimates according to river basins are given in Table 4.

TABLE 4. Mean-weighted Irrigation Duties according to Crop Season in Different River Basins in Iraq

(Thousand cubic metres per mishara)

Type of Crops	Euphrates basin		Tigris basin		Shatt Al-Arab		Gross rate	
	Net	Gross	Net	Gross	Net	Gross	Net	Gross
Winter crops	1.08	1.93	1.08	1.93	-	-	1.08	2.00
Summer crops	3.40	6.08	3.46	6.54	-	-	3.44	6.36
Perennial	3.96	7.08	4.00	7.55	4.35	8.20	4.03	7.41
Average	2.10	3.76	1.80	3.40	4.35	8.20	1.95	3.63

In determining gross irrigation rates, water losses are assumed to be 33 to 43 percent of the net irrigation duty on the farm and in field canals, and 25 to 30 percent in the main and secondary canals, depending on the season. These gross irrigation duties do not allow for additional transit discharges. The tentative water balance in the Euphrates river ranges between 6 to 7 km^3 and in the Tigris river between 3 and 5 km^3. At present, the annual water requirements for human use are 2.18 km^3, of which 1.21 km^3 are consumed and 0.97 km^3 are returned to the rivers.

Water Requirements for Electric Power

The power generating capacity of hydro-electric stations in Iraq is at present underutilized. Hydro-electric stations need to be developed to harvest the potential energy from river flows. According to 1972/73 data, the cost of generating power by a gas and thermopower station is between 1.59 and 3.29 Fils/kWh, while the cost of hydro-electric power at the Samarra Station (installed capacity 84 Mw) is 0.36 Files/kWh. Water requirements for generating the present level of power in the country are estimated to be 1.76 billion m^3. By 1995 it will reach 7.42 billion m^3.

Fisheries

Inland water bodies - rivers, lakes and reservoirs - cover at present 4.5 million misharas, which yield an annual fish harvest of about 35 thousand tons. It is noted that there are five public sector basins covering an area of 560 thousand misharas and a few private basins covering an area of 620 thousand misharas, exclusively meant for fisheries. The annual quantity of unreturnable fructified water for fisheries is about 20 million m^3.

Navigation

In the past few years cargo transportation by rivers decreased sharply due to neglect of navigation and shallow river depths because of increased water use for irrigation. At present navigation routes do not meet established requirements. Of the 3 000 km of total navigable river length, only 803 km between Baghdad and Basrah are used, and during the low water period cargo transportation is stopped. Actually, only a few boats engage in cargo transportation during the flood period.

Quality of Water Resources

The volume of returned water from irrigation and sewerage is not very significant and amounts to only 2.3 km^3 and 1.0 km^3 per year, respectively. On the whole, river waters are clean and may be used for all domestic purposes and pisciculture, except at the lower reaches of the Euphrates, downstream of Shinafiyah and Shatt Al-Arab where salinity becomes quite high.

PROSPECTS OF WATER RESOURCE UTILIZATION BY 1995

Projections show that availability of irrigable land will be far in excess of the potential irrigation water supply by the turn of the century. There will be more irrigable land and less irrigation water than at present. This would be due to the increased utilization of the Tigris and Euphrates waters by Turkey, the Syrian Arab Republic and Iran. The present river water resources of Iraq are 106 km^3/year, of which about 80 km^3/year (the effective water resource) come from the Euphrates upstream of Hit and the Tigris downstream of Baghdad (at the Diyala confluence). The rest (26 km^3/year, which is not an effective resource) is contributed by the border rivers Teeb, Duwairaj, Karkhal and Karoun. The effective water supply of the twin rivers at 50, 75 and 90 percent levels of probability is calculated at 77.5, 64.0 and 53.2 km^3/year,respectively. Since evaporation losses from reservoirs would be about 10 km^3/year, water resources available for various uses would be 67.5, 54.0 and 43.2 km^3/year. Given this situation, Iraq is developing various alternatives for water use in the long term. Present water use and two alternatives in the long term (1995), as adopted by Iraq, are shown in Table 5.

TABLE 5. Present and Planned Water Resource Utilization in Iraq

(Km^3 per year)

Purpose	Present (1975)	1995	
		Alternative I	Alternative II
Irrigation	39.53	52.1	46.8
Domestic	0.58	3.5	3.5
Industrial	0.45	1.9	1.9
Power generation	1.76	7.4	7.4
Pisciculture	0.03	2.6	2.6
Total	42.35	67.5	62.3

WATER RESOURCE UTILIZATION IN RIPARIAN COUNTRIES

About 70 percent of the waters of the Tigris and Euphrates rivers originate outside the territory of Iraq. Thus, any expansion in water use in riparian countries will reduce the supply to Iraq, especially in the Euphrates basin. To understand the situation, the effects of two alternative water use programmes as projected to the year 1995 in these countries were examined. Under each alternative two variants were considered, depending on cropped areas and water duties as shown in Table 6. The data show that by 1995, the Euphrates water resources in Iraq are likely to decrease to almost one-half to one-third of the present availability.

TABLE 6. Alternative Water Withdrawal Programmes from the Euphrates River in Turkey and the Syrian Arab Republic in 1995

Alternative	Country	Area (Hectares)	Water duty (M^3/ha)	Water need (Km^3)
I-a	Turkey	600 000	11 000	6.8
	Syrian Arab Republic	545 000	14 000	7.0
	Iraq	-	-	16.2
I-b	Turkey	700 000	11 000	7.6
	Syrian Arab Republic	830 000	14 000	10.1
	Iraq	-	-	12.3
II-a	Turkey	600 000	15 700	8.9
	Syrian Arab Republic	545 000	18 600	8.9
	Iraq	-	-	12.2
II-b	Turkey	700 000	15 700	10.0
	Syrian Arab Republic	545 000	18 600	9.0
	Iraq	-	-	11.0

Notes: Evaporation losses are 1.8 and 1.4 km^3/year in Turkey and the Syrian Arab Republic, respectively.

Alternative I is for low water duty and alternative II is for high water duty.

About 50 percent of the Tigris waters originate in Iraq and the rest flow from Turkey and Iran. So far, no definite plans of major water withdrawal in these countries are known. Present withdrawals are estimated at 2 km^2/year.

RIVERFLOW REGULATION AND FLOOD CONTROL

To overcome a probable water shortage by 1995, Iraq has engaged in the construction of a network of major reservoirs to store water for various economic uses. The construction of the Tharthar-Euphrates canal and the Tharthar-Tigris canal would improve interbasin utilization of water resources. In 1975, a scheme to operate the reservoirs has been worked out for different river basins as shown in Tables 7 and 8.

TABLE 7. Alternatives for Storage and Reservoir Operations in the Tigris River Basins Upstream of the Samarra Barrage, 1995

(Km^3 per year)

Alternative	Reservoir group	Live storage	Evaporation losses	Guaranteed water 1/
1	Dokan + Tharthar	44.0	4.9	37.5
2	Dokan + Tharthar + Mosul	38.7	5.4	51.8
3	Dokan + Tharthar + Mosul + Bakhmah	58.9	5.5	39.6
4	Dokan + Mosul	13.3	0.7	25.3
5	Dokan + Mosul + Bakhmah	20.4	0.8	33.3
6	Fatha	19.3	1.6	32.4
7	Dokan + Mosul + Bakhmah + Fatha	39.7	2.3	40.4

1/ Including water consumption upstream of the Samarra barrage.

Table 7 shows that alternative 7, which does not include Tharthar lake, is the best one as it provides 40 km^3/year of live storage and incorporates better flood control and more of power generation.

TABLE 8. Storage and Reservoir Operation in Diyala and Euphrates River Basins in Iraq, 1995

(Km^3/year)

	Reservoir group	Live storage	Evaporation losses	Guaranteed water
	DIYALA			
1	Derbendi Khan	2.5	0.1	3.7
2	Hemrin	2.3	0.1	3.2
3	Total for Derbendi Khan + Hemrin	4.8	0.2	4.7-4.9
	EUPHRATES			
1	Haditha	7.5	0.9	-
2	Habbaniya	2.7	1.3	-
3	Total for Haditha + Habbaniyah	10.2	2.2	9-12 (Alternative I)1/ 6.9 (Alternative II)1/

1/ Total water consumption in Turkey and the Syrian Arab Republic assumed at 16.2 km^3/year and 12.3 km^3/year for alternatives I and II, respectively.

FLOOD CONTROL MEASURES

Reservoirs in Tables 7 and 8 were developed to meet water requirements in the country and not for flood control purposes. For example, at the Iraqi-Syrian borders, floods of 13 500 cubic metres per second are possible in the Euphrates basin. The Haditha dam which operates basically for irrigation purposes would be able to reduce this peak to 12 500 cumecs. Thus, it is necessary either to widen the Warrar and Majarrah canals and increase the capacity of their regulators or to raise the level of the levees on both banks of the river to accommodate more than 3 000 cumecs additional flow. Upstream of the Samarra barrage, floods of the Tigris have a probability of 0.01 percent to reach a magnitude of 37 500 cumecs yielding 72 km^3 of water. A flood magnitude of 25 700 cumecs yielding 52.8 km^3 of water has a probability of 0.1 percent. Thus, it is necessary to (i) utilize the additional storage capacities of reservoirs, (ii) create greater storage space in reservoirs upstream of Samarra before the flood period, in coordination with the operations scheme of Tharthar lake and (iii) keep in view the possibility of floods in Diyala and Udhaim rivers.

Storage analysis indicates that the Dokan, Bakhma and Mosul reservoirs are capable of reducing floods to 28 000 cumecs (0.01 percent probability) and to 17 300 cumecs (0.1 percent probability), yielding 40 km^3 and 22 km^3 of water upstream of the Samarra barrage, respectively. If Diyala and Udhaim floods would take place simultaneously with those of the Tigris, then it would be necessary to direct the floods of the Tigris to the Tharthar lake. Therefore, the capacity of the Tigris-Tharthar canal needs to be increased to carry these discharges. Studies show that the Dokan, Bakhmah, Mosul and Tharthar reservoirs are in a position to accommodate floods for 200 to 300 years; not affecting the guaranteed water supply up to the year 1995.

ECONOMIC WATER MANAGEMENT

So far, water management in the country is planned on an annual basis. The water of the wet season (March, April and May) is stored to meet requirements of the dry season. However, this operation does not ensure an efficient use of river waters because it operates on the basis of a 90 percent probability which gives a very low water expectation. Therefore, there should be a shift towards long-term water

storage, where water of above average wet years is carried to dry years, thus guaranteeing a regular flow. The present live water storage in the country is about 12.8 km^3. Theoretically, it can be expanded to 82.9 km^3, which is the annual average water supply in the rivers. It is also possible to harness additional water resources, which include 0.6 km^3/year from left bank tributaries of the Tigris and Shatt Al-Arab between Kut and Basrah and 2.6 km^3/year of return water upstream of Samarra in the Tigris basin. In water management studies undertaken in Iraq re-use of return water from industries, thermal power houses, domestic use and pisciculture is taken into consideration. It is not possible, however, to account for the waters of the Karoun river, water resources of the Western Desert and return water within the Mesopotamian plain and Shatt Al-Arab region.

MAIN FEATURES OF WATER MANAGEMENT PLANS

The study of the first stage of General Scheme of Water Resources and Land Development in Iraq showed a need for planned execution of a complete set of irrigation projects, including:

(i) construction of regulators, headreaches and long-term storage reservoirs,

(ii) improvement of operation of the Dokan and Derbendi Khan reservoirs,

(iii) reconstruction and improvement of major canals and regulation of river flows in coordination with major reservoirs,

(iv) construction of barrages on rivers to guarantee required water level at intake points and

(v) construction of structures needed for regulation of water levels of the Diyala river downstream the Hemrin dam and in the Tigris and Euphrates rivers downstream the Samarra and Fallujah barrages, respectively.

The following projects should be given high priority within the next five to ten years:

(i) completion of Hemrin, Haditha and Mosul dams and reconstruction of Dokan and Derbendi Khan headwork structures,

(ii) completion of Tharthar-Tigris canal and reconstruction of Tigris-Tharthar canal and its regulator,

(iii) reconstruction of Warrar and Majarrah canals and their regulators.

The Tharthar-Tigris canal will help desalinize the lake water and will meet irrigation water requirements in southern Iraq. The Tharthar-Euphrates canal will remove the water deficiency in the Euphrates basin. Moreover, once the Turkish and Syrian reservoirs are filled, floods would increase and it will become necessary to reconstruct the associated structures of the Hannaniyah and Abu Dibbis lakes. The same applies to the Diyala river if the construction of Hemrin dam would be delayed and in the Tigris basin when the Tharthar lake will be filled. In order to avoid flood risks, it is necessary to take precautionary measures and provide necessary solutions as follows:

(i) Ascertaining the operational relationship of reservoirs in the context of irrigation, power generation and other aspects of the national economy.

(ii) Preparing mathematical models for ensuring an adequate water quantity and quality in the Tigris and Euphrates river basins, because of water storage in reservoirs outside the country.

(iii) Making projections of river basins' sedimentary deposits and their effect on water level in canals and at intake points.

(iv) Making socio-economic studies for regulation and diversion of water to the Hammar lake.

(v) Establishing a hydrometeorological network covering different basins.

(vi) Allocating available water resources fairly among riparian states.

(vii) Lining of canals to reduce conveyance losses (estimated at 5.0 km^3/year).

(viii) Introducing modern irrigation methods to reduce field and seepage losses (estimated at 5.0 km^3/year).

(ix) Re-using return water after the salt balance is reached in the soil. The water volume involved in this case is likely to be 10 km^3/year.

(x) Making use of research to reduce evaporation losses from reservoirs. These losses are estimated to reach 11.0 km^3/year by 1995.

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Salinity Problems and Land Reclamation in the Arab Republic of Egypt

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INTRODUCTION

Egypt has a population of about 40 million persons and a land area of about one million Km^2. Nearly 96 percent of this area is barren desert. The remaining 4 percent, concentrated mostly in the Nile Valley and the Delta, is intensively cultivated. The irrigated areas have a population density of 1 320 persons per Km^2. The area under cultivation is about 6.5 million acres, of which about 1 million acres are newly reclaimed. Very few areas are cultivated outside of the Nile Valley. The western desert oases, a chain of depressions in the western desert extending northward from the west of Quena to Wadi Natraun, are irrigated from newly drilled artesian wells. These areas are known as El Wadi El Gadid, meaning the New Valley.

The Nile is the main source of irrigation water with an average concentration of 200 ppm of dissolved salts. The total amount of water used for irrigation is about 54 billion m^3 at Aswan with an average duty of 8 000 m^3 per acre. The country is almost rainless, with the exception of the Delta and the northern coast along the Mediterranean, where annual rainfall does not exceed 200 mm. The average rainfall is 150 mm and is unevenly distributed over the winter months. Crops having low water requirements such as barley, figs, olives and some vegetables are grown on the rainfed coastal strip.

EXTENT OF SOIL SALINITY

Since the dawn of history, agriculture in the Nile valley has always been influenced by the Nile. Since ancient times, the basin system of irrigation has been practised by the Egyptians. This system ensured leaching of salts and effectively prevented the ground water table from rising. In the beginning of the nineteenth century, due to the need for intensification of agriculture, a series of water control works were constructed on the Nile with a view to providing year round irrigation. This resulted in widespread waterlogging and salinization. Salinity became a serious problem by the second half of the nineteenth century and has increased since as a result of expansion of irrigation.

The saline soils, although scattered all over the country, predominate mainly in the northern sector. The 1960 soil survey of the areas to be reclaimed under the High Dam Project revealed that about 375 000 acres were salt affected in the eastern part of the Delta, 150 000 acres in the middle of the Delta, 100 000 acres