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A Technical Perspective on Euphrates-Tigris Basin

1. Introduction

Most of the issues related to water resources such as development of agricultural and industrial water use, increasing population, growing urbanization and contamination of water are global in nature. In today's world, like most others, Middle East countries are facing similar problems. However, especially when it comes to the Middle East, the emphasis is generally placed on the conflictual aspects of water and unrelated events are systematically used to form a picture of a merciless economic and political power struggle. For instance, runoff regulation works provided by upstream reservoirs, which are proven to be hydrologically benefical to all riparian, are portrayed belligerently in some media for speculative purposes.

Water by nature, has always been manipulated for different political ambitions and its political perception is highly ambiguous. Nevertheless, scientific and technological approaches should serve as objective tools and they should illuminate us towards comprehension of the realities. Adaptation of integrated water resources planning concept and improved efficiency in water use are some of those handy tools that would serve as integral parts for finding solutions to current difficulties in our region.

This paper aims to present a perspective analysis of water resources management and allocation issues in the Eupharates-Tigris basin. It then reviews briefly the technical measures to be taken for improving water use efficiency in the irrigation schemes of tne Southeastern Anatolia Project.

2. Water Resources Management and Allocation Issues in the Euphrates-Tigris Basin

The following points concerning water resources management and allocation should be properly addressed:

- The first point is the conflicting data on the irrigable land potential to be fed by the Euphrates and Tigris rivers.

In the framework of enhancement of data availability, this issue is now being discussed by some circles. However, it is not totally new to us. In early 80s, Turkish water specialits proposed a well-defined data collection plan for the basin. Among the data required, actual area of irrigable land potential was of major concern.

- The second point is the concerned parties' focusing solely on the Euphrates river and neglecting water diversion possibilities from the Tigris in order to match demand in the whole Euphrates-Tigris basin.

- The third point relates to the allegations over the causes of water quality changes along the Euphrates river.

These issues are briefly evaluated in the following paragraphs.

2.1. Conflicting Data on the Irrigable Land Potential Fed by the Euphrates and the Tigris Rivers.

When it is referred to the problems of transboundary rivers among riparian countries, the concept is being merely presented as the resource allocation. Whereas, the agreement on a proper water allocation should be based on findings derived from basin-wide planning process and any negotiations should emphasize basin-wide planning as a goal. Such a plan should depend on the collection, interpretation and evaluation of basic data relating to hydrology, climate, soil and other physical and socio-economic factors.

Presence of evident data anomalies in the available records concerning water and irrigable land resources in the Euphrates-Tigris basin is noted several times in various reports and question of data validity is pertinent to the formulation of any firm conclusions. Current levels of extraction of water for irrigation and future plans for development are two major unknowns among riparian.

Table 1 reveals data discrepancies on the existing and proposed irrigation project areas fed by the Euphrates river.

Table1: Conflicting Data on the Total Irrigation Project Areas Fed by the Euphrates in Syria and Iraq (all figures in hectares)

Source:	Country:	Syria	Iraq	Remarks
Official		773,000	1.952,000	-
Kolars		375,000* 397,000	1,294,000 1,550,000	240.000 ha from main, 135,000 from Khabur
USAID Report		320,000	-	-
Anderson		200,000* to 500,000	-	Irrigation from main stream
Beaumont		400,000 to 800,000	-	-

Referring to the given table, a variety of local and foreign experts assert conflictive figures concerning the availability of irrigable land in each riparian country. Since irrigation is the major water consumer, lack of consensus on irrigable land potential is an important issue. Such inconsistent figures can mislead the analysts.

It could be easily seen from the above table that, data consistency and reliability on the land to be irrigated is a major concern for all parties. As a result, more comprehensive work needs to be done to clarify the existing situation. Let's take soil quality. Soils are being classified within six categories ranging from excellent (class 1) to poor (class 4) and to uncultivable (class 6). Among these categories, particularly, class 4 has severe limitations for crop production. Heavy textured soils together with salinity and alkalinity will cause serious difficulties in the process of reclamation and hence will be uneconomical. It is not worthwhile to drain and reclaim such soils. Even after drainage and reclamation, productivity of these soils would be very low compared to lighter textured and better structured soils. Low productive soils, on which low yields are likely to be obtained despite enormous water use, must be removed from irrigation in all riparian countries. Even if only small percentages of lands that are least suited for irrigation are removed from irrigation, water savings will be considerably high.

Agricultural withdrawals from the Euphrates and Tigris that correspond to 70-75 percent of the total consumption are differently accounted for by the parties due to the soil data inconsistency as mentioned above. Since national guidelines being followed by each country for data collection, evaluation and processing are based on different criteria and are not readily applicable to transboundary water courses. Data collection and survey of water and land resources should be jointly performed by the riparian countries in order to acquire a basis for water allocation questions.

2.2. Water Transfer from the Tigris River to the Euphrates

Total quatity of water flow in the Euprates river regulated by large upstream reservoirs is adequate for domestic water supply, industrial growth and agricultural development into the future, but there might still be a problem in matching the supplies to the demands at certain places

and times (e.i., severe drought periods). To this end, the Tigris river diversions seem to be technically, economically and hydrologically appropriate for the following reasons:

(i) Unlike the Euphrates, the Tigris river has several major tributaries in Iraq that enter the Tigris at the left bank from the Zagros mountains at the east. These tributaries are namely: The Greater Zap, the Lesser Zap, the Adhaim and the Diyala. The average annual flow of main stream at Mosul is 23.2 km^3 and the tributaries supply even a larger volume amounting to 29.5 km^3/year. (Beaumont, 1978) The total water resources of the Tigris basin, therefore, amount to 52.7 km^3/year, thus, 1.5 times larger than the annual mean flow of 35,0 km^3 in the Euphrates river.

(ii) According to the balance sheet of water resources versus water uses from the Tigris river prepared by Kolars (1992), the amount of surplus water in the Tigris river is 11.9 km^3/year. In his balance sheet, Kolars accepts the natural flow as 49.2 km^3/year that is less than 52.7 km^3/year given by Beaumont. On the basis of the Beaumont's figure, surplus water amounts to 15.4 km^3/year of which 50 per cent could be transferred to the Euphrates. Topography in the Iranian part of the basin neither precludes the practical possibility of any significant water use there, nor diversion to the other parts of Iran. Therefore, it is unlikely that Iran would be affected as a result of this transfer project.

(iii) In connection with this water transfer project, several authorities on Middle East water issues pointed out the importance of the supporting role of both rivers to each other. Some are quoted as follows:

"Iraq could well make greater use of the discharge in the Tigris. In fact, the Tharthar canal project which at the moment diverts Tigris water into the Tharthar depression, thereby controlling floods, is planned to be extended to the

Euphrates, facilitating therefore the transfer of flow from one river to the other" (Anderson, 1986).

"The Iraqis are also planning to transfer water from Tigris to the Euphrates. The Tharthar canal project presently diverts water into the Tharthar depression, controlling the flood flow of the Tigris. The next stage of the plan is a canal from the Tharthar into the Euphrates, and outlet canals back into the Tigris and Euphrates to channel water as needed into agricultural projects" (Naff, 1984).

"Fortunately for Iraq, however, there is little suitable land in these two countries which could be irrigated by using the waters of the Tigris. As a result, it seems unlikely that serious international problems will be generated concerning the use of its waters, and Iraq will be able to make the fullest use of them for its own needs. This explains whay Iraq is able to divert a significant proportion of the flow of the Tigris through the Tharthar Basin to augment the water resources of the Euphrates" (Beaumont, 1978).

Kolars (1993) makes a different recommendation concerning the route of transfer canal, viz;

"... a canal might be built from the Mosul reservoir or (from a smaller retaining or diversion dam farther upstream) in order to bring a supplemental supply of water to the Euphrates river. Such a canal could run almost straight south following the 500 meter contour to the latter river below the Haditha Dam. This, in combination with water stored in reservoirs on the eastern tributaries of the Tigris might alleviate Iraq's predicted water problems.

Nevertheless, the expense of such ventures should be considered as an international regional item to be shared by all the riparians. Such an idea raises the possibilities of potential basin-wide/regional/cooperation."

Another recommendation made by Beaumont (1991) is as follows:

"On the Tigris the picture is clearer as much less development has occurred, or indeed little is planned outside Iraq. In Turkey, some water use takes place in the Diyarbakır basin, but as yet no major water structure has been built, or seems like to be built in the near future. Leaving Turkey the river flows into Iraq, though for a short distance the boundary between Syria and Turkey is marked by the Tigris river itself. In this area the head waters of the Khabour, the major tributary of the Euphrates are close by, and it would not be too difficult from an engineering point of view to divert some of the waters of the Tigris into the Khabour at this point."

Among above-cited project proposals, the one that links the Tigris to the Euphrates through the Tharthar Valley has already been realized and operative since 1988 (Dhanoun, 1988).

From time to time, it is argued that salinity in the Tharthar depression precludes the transfer of water except in extreme cases (Kolars 1993). However, a by-pass canal to be built at the North of Tharthar depression could transfer the fresh Tigris water directly into the Euphrates, by making use of the existing canal between the Tharthar depression and the Euphrates avoiding rather saline earth formation in the Tharthar lake bed (Figure 1).

While discussing the possibility of linkage between the Tigris and Euphrates rivers, it is interesting to note that the original idea dates back

to the pre-Christian times. It was then thought to link two rivers by the Shatt el Hai canal (McDonald and Kay, 1984).

Above-mentioned linkage of two rivers in our belief, is ethically justifiable as well:

Suppose two transboundary rivers enter into a lower riparian State. One of these rivers receives a large portion of its water from tributaries that run exclusively within national boundaries while the other river is very much susceptible to the demands of upper riparian countries. How ethical would it be for this State to insist on maintaining all it's existing and potential water rights on the latter river that is very much needed and susceptible to depletions, while reserving the surplus water of the former for only itself?

Views of the experts mentioned above hopefully address this question.

2.3. Allegations over the Causes of Water Quality Changes along the Euphrates River

Interpretation can be better made if we define water resources management as "***the art of matching supply of water with demands while controlling the quality.***" In other words, water quality and quantity issues are complementary to each other.

Evidently water resources development projects have created some environmental problems. The goal of ***"no damage to nature"*** while using water resources would not be quite possible. However, sustainable economic development and environmental management can be concordantly pursued to minimize negative effects.

Head waters of Euphrates and Tigris are of high quality and return flow from irrigation will be moderately mineralized containing about 700 ppm dissolved solids and of satisfactory quality for irrigation supply (Lower Euphrates Project). This salinity level is even less than what has been stipulated in the US and Mexico treaty:

Under the terms of a joint treaty signed between Mexico and the United States, the US agreed to reduce the salinity level of water entering Mexico to less than 800 ppm from an average salinity level of 2800 ppm at Yuma desalinization plant (Goldsmith, 1984). Thus, agreed upon salinity level of return flow provided to Mexico is almost equal to the level of concentration to be given by Turkey to its neighbours at full development.

Moreover, return flows from irrigation schemes around Atatürk Dam enter directly to the dam reservoir and are diluted with large amounts of fresh Euphrates water. It is expected that return flows may ultimately total 20 percent or more of the diversions. This return flow is significant and it's clean enough for additional irrigation in the downstream riparian countries.

Kolars (1993) states that:

"Syria may experience relatively little additional trouble regarding salinization from Turkey, but its own soils are notoriously gypsiferous and saline and their proper washing and cleansing could dump oppressive loads of dissolved solids on Iraqi fields."

Although, lack of drainage facilities and properties of soils are the major causes of salinization in arid zones, salinization of soils is solely attributed to quality of irrigation water. In this respect, Kovda (quoted by Goldsmith, 1984) makes the following point:

"It has been always underestimated the importance of the ground water and properties of saline soils ... secondary salinization of soils is attributed mostly to salts of irrigation water, which in fact, are of secondary importance."

Conclusively, an efficient drainage scheme in the Euphrates-Tigris Basin is of great significance and the lack of drainage facilities is a major cause of several environmental problems including salinization.

Water quality issues, as well as quantity, concerning the Euphrates-Tigris basin even under full development is not more serious than any other developed basins such as Colorado, although doomsday scenarios are frequently drawn up for the future.

It would not be fair to blame the water resources development on the headwaters of the Euphrates and the Tigris rivers as the cause of water quality problems in the Gulf. Since the Gulf area would have been under fatal attack of industrial and oil pollution where agricultural contamination remains as a trivial externality. In fact, dumping of highly toxic trace metals and other forms of wastes into coastal and off shore waters by the industrial plants is a very serious environmental problem. Considering the fact that the Gulf countries have not yet reached a comprehensive marine management, we can anticipate even more dubious environmental consequences in the region.

With or without irrigation development, the Gulf area is under persistent attack of industrial pollution, therefore, we should not miss the forest for a tree.

3. Improved Efficiency in the Management of Water Resources

Water management measures that will improve water use efficiency in the Southeastern Anatolia Project (GAP), cover a wide range of actions in several technical and non-technical domains. These are as follows:

a) Re-use of Irrigation Water,
b) Automation of Main Canals,
c) Application of Sprinkler Irrigation,
d) Establishment of Pilot and Demonstration Schemes,

Construction of above mentioned water management facilities are underway in the project areas fed by the Atatürk Dam. Some technical characteristics of the applications are given very briefly in the following paragraphs.

(a) Re-use of Irrigation water

Irrigation systems are equipped with a drainage network to collect and dispose the irrigation outflow in the form of surface runoff from the irrigated areas and seepage flow from the soil. Taking into account the high opportunity cost of water in Urfa-Harran scheme, irrigation return flow is an important resource but quality of it should be carefully monitored and if necessary, improved by blending it with fresh irrigation water. When 143,000 hectares of Urfa-Harran scheme is completed, drainage water available is estimated at about 200 million cubic-meter per year. Of which 120 million cubic-meters from upstream irrigated areas in Urfa-Harran Plain will be recycled in several canals in the lower areas. Wherever possible, captured excess water is diverted to adjacent area with a lower elevation without pumping. However some parts of the scheme, drainage water re-use entails the capturing and pumping of drainage water back into the system. For these purposes pumping stations and several pumping units will be installed. Some degree of flexibility in the design of irrigation scheme was also

introduced allowing staged construction in order to understand and quantify the extent and dynamics of excess water generated within the system more clearly. A very cautious approach, in terms of water quality will be followed in the early stage of project life (see Figure 2).

(b) Automation of Main Canals

The Şanlıurfa Tunnels diverts water from the Atatürk reservoir and represents the headrace system of two major irrigation projects.

- Mardin-Ceylanpınar Irrigation Scheme, and;
- Urfa-Harran Irrigation Scheme that is under construction.

Headrace canal of the Urfa-Harran Irrigation scheme, having a capacity of 120 m^3/s, branches from the tunnel outlet canal a short distance upstream of the Mardin cross regulator.

There is a power plant that will use, the 50 m. fall between the tunnel outlet canal and Urfa-Harran canals. Power generation is subordinate to irrigation and the power plant will be operated as a head regulator to provide the required discharge for the Urfa-Harran irrigation schemes.

Harran-Urfa main canals branch from tailrace canal and supply water to the 150,000 hectares of land, both of them are under construction.

Automation of Harran Canal

The total length of Harran main canal is 122 km and has a capacity of 80 m^3/s at the upstream end and tapers to a capacity of 2,35 m^3/s in the very downstream part.

Upper part of this canal up to 56th km is designed according to the upstream operation concept with constant upstream level gates. The lower part of the Harran canal between km 74 and km 122 is equipped with automatic downstream control gates and medium part from 56th to 74th km is mainly devoted to the storage to render the operation

concepts compatible. This reach is divided into 4 sections with mixed gates. Volume needed for regulation equals to 500,000 cubic meters.

The decision to implement an automated control system is not justified solely on a cost-benefit analysis based on reductions in operating costs only, but also significant savings of water generation achieved at Atatürk Dam have been considered in analysis:

A system simulation model was developed for the Harran Main Canal by GERSAR, France. This model is capable of dealing with canals containing any number of distinct prismatic reaches of different cross sectional shape and roughness. Each reach is bounded by hydraulic structures which may be operated interactively during the execution of the program.

General Directorate of the State Hydraulic Works (DSI) has initiated to develop additional algorithms for application to the automation of canals. DSI signed contracts with a Turkish Consultant firm, Middle East Technical University at Ankara and ASELSAN (Military Electronics Industry) for the supply of electronic equipment in order to implement this program.

DSI's efforts in the canal automation program are currently being developed. Undoubtedly, field experience is required with new equipment to eliminate potential problems (Figure 3,4).

The experience gained in this on-going program should influence the design of future projects.

(c) Application of Sprinkler Irrigation

Around the Atatürk reservoir, several irrigation projects are planned to be constructed by lifting water from the reservoir. For the development of these schemes, in any case, irrigation water must be pumped and the cost of incremental pressure required for sprinkling will be relatively small

in the overall cost of water. Considering this fact in terms of water saving and other physical constraints such as topography and soil conditions, sprinkler irrigation is highly competitive with surface irrigation methods.

Among these several projects, Yaylak Irrigation project is supplied by a short separate tunnel (1.6 km) from the Atatürk reservoir, the Tunnel from which the water is pumped to 555 m is under construction. The command area is 18,300 ha. and pumped discharge is 21 m^3/s. The irrigation network is designed as sprinkler and will be tendered next year. Main canal of this irrigation scheme is regulated by Bival downstream control concept. Algorithm of this control concept is developed by a joint study of DSI, a Turkish consultant and the Middle East Technical University at Ankara. Electronic parts of the System will be manufactured by ASELSAN.

The Bival System of Yaylak main canal regulation guarantees that the maximum discharge can be delivered at any time, as for downstream control systems. Moreover, it minimizes the canal dyking works since the banks need not be horizontal along the total lenght of the reach but only along approximately half. Radial gates are used as control structures and a remote control system is used for gate movement. There are 10 water pools and 9 radial gates. By changing the regulation system from an upstream control system to a downstream control system (Bival), the main canal operation guarantees water saving with no flow through drainage canal.

In order to guarantee the pressure at hydrants, the Yaylak plain is divided into three zones. The first zone is irrigated without pumping system (7,567 ha), the second zone is irrigated with pumping system (7,940 ha) and the third zone is irrigated by a second stage pumping station (2,815 ha).

(d) Contruction of Pilot and Demonstration Schemes

Primary objective of the study is to develop a framework for evaluating costs and benefits of proposed water conservation practices and facilities for operational and future irrigation schemes in target areas. A secondary objective is to identify those forces which influence, at farmer, district, and regional levels, the capacity for achieving increased water conservation and the economic incentives necessary for their implementation.

Based on foregoing considerations, construction of pilot schemes over 3,000 hectare along the secondary canal branching from Urfa main canal is initiated. The project area is divided into 4 units (sub-projects) which can be operated separately and each unit is designed with different levels of sophistication.

Distribution system consist of elevated flumes or pipes including pumping station for sprinkler irrigation, regulation reservoir and other operation devices. On this pilot scheme, the following alternative practices in various aspects will be compared quantitatively:

- Water application methods (surface irrigation versus sprinkler irrigation),
- Operation methods (planned demand, demand, rotation)
- Distribution type (elevated flume-canalette versus low-head and/or high-head pipelines)

4. Conclusion

The complexity of relation between the two legal principles of ***reasonable and equitable utilization*** of transboundary water courses and ***not causing appreciable harm*** to beneficiaries should be challenged by means of well - meditated technical approaches.

To lead a definition on the reasonable and appropriate amount of water each country needs from both rivers, depends upon the availability of

complete and accurate information on land and water resources of the Euphrates Tigris basin, included in a basin-wide plan.

Contrary to what the doomsday scenarios argue, the solutions discussed in this paper hopefully contribute to make the ends meet in the basin.

5. References

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6. Annexes

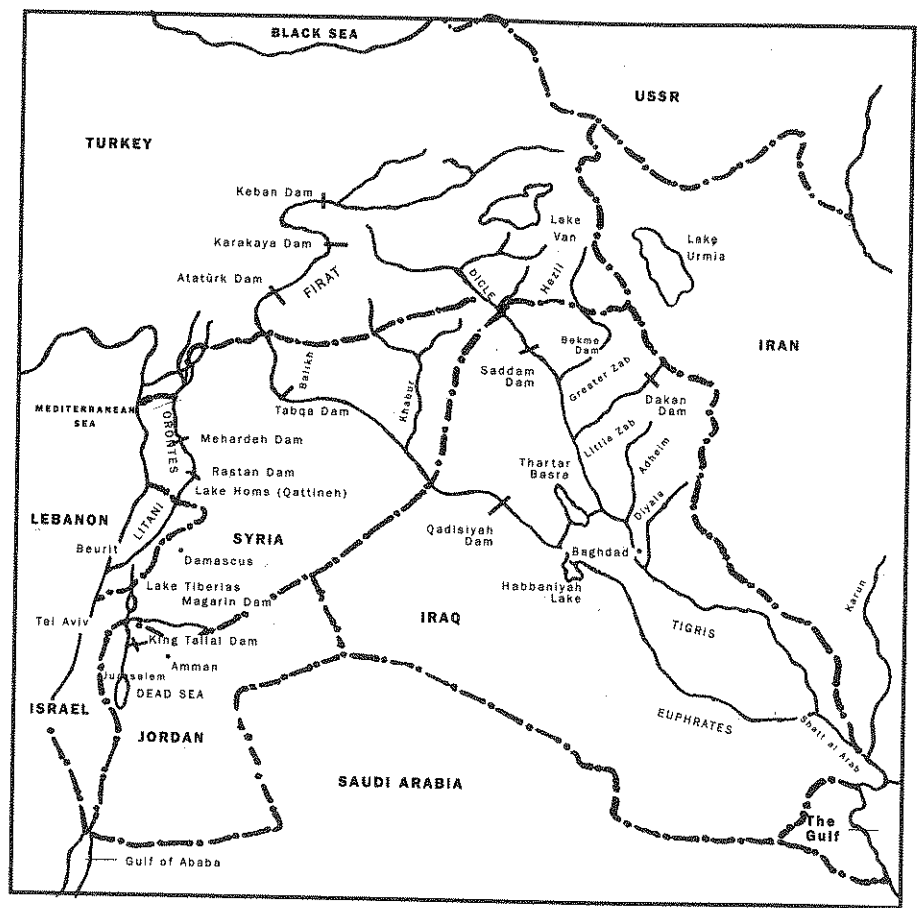

FIGURE 1: MAJOR RIVERS IN THE MIDDLE EAST

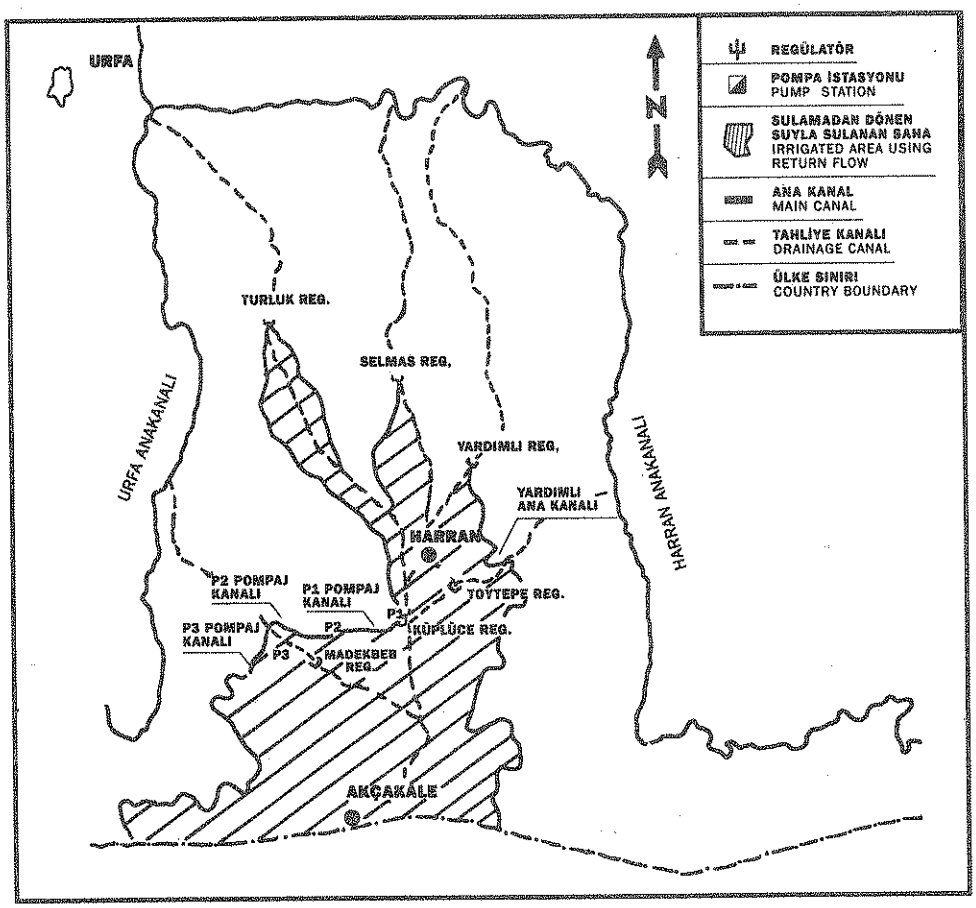

FIGURE 2 : CONJUNCTIVE IRRIGATION BY RETURN FLOW

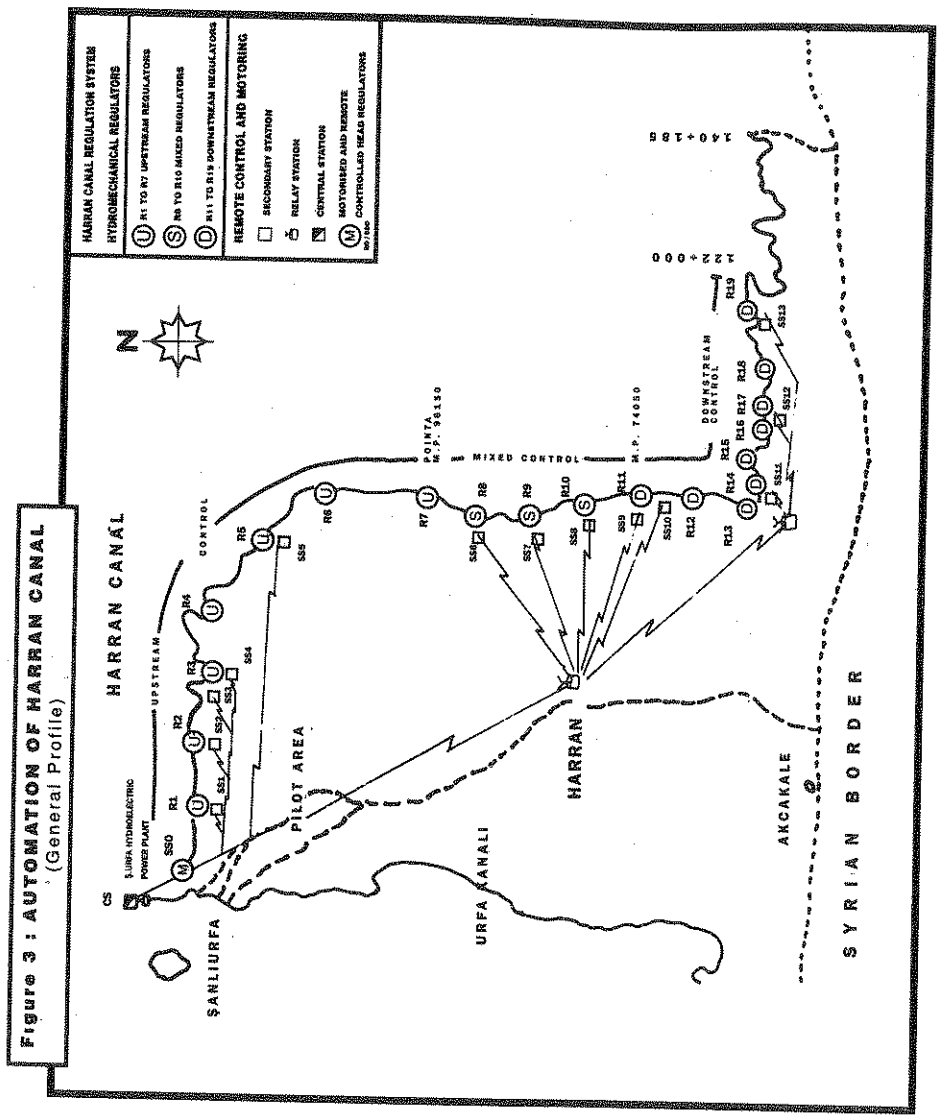

Figure 3 : AUTOMATION OF HARRAN CANAL
(General Profile)

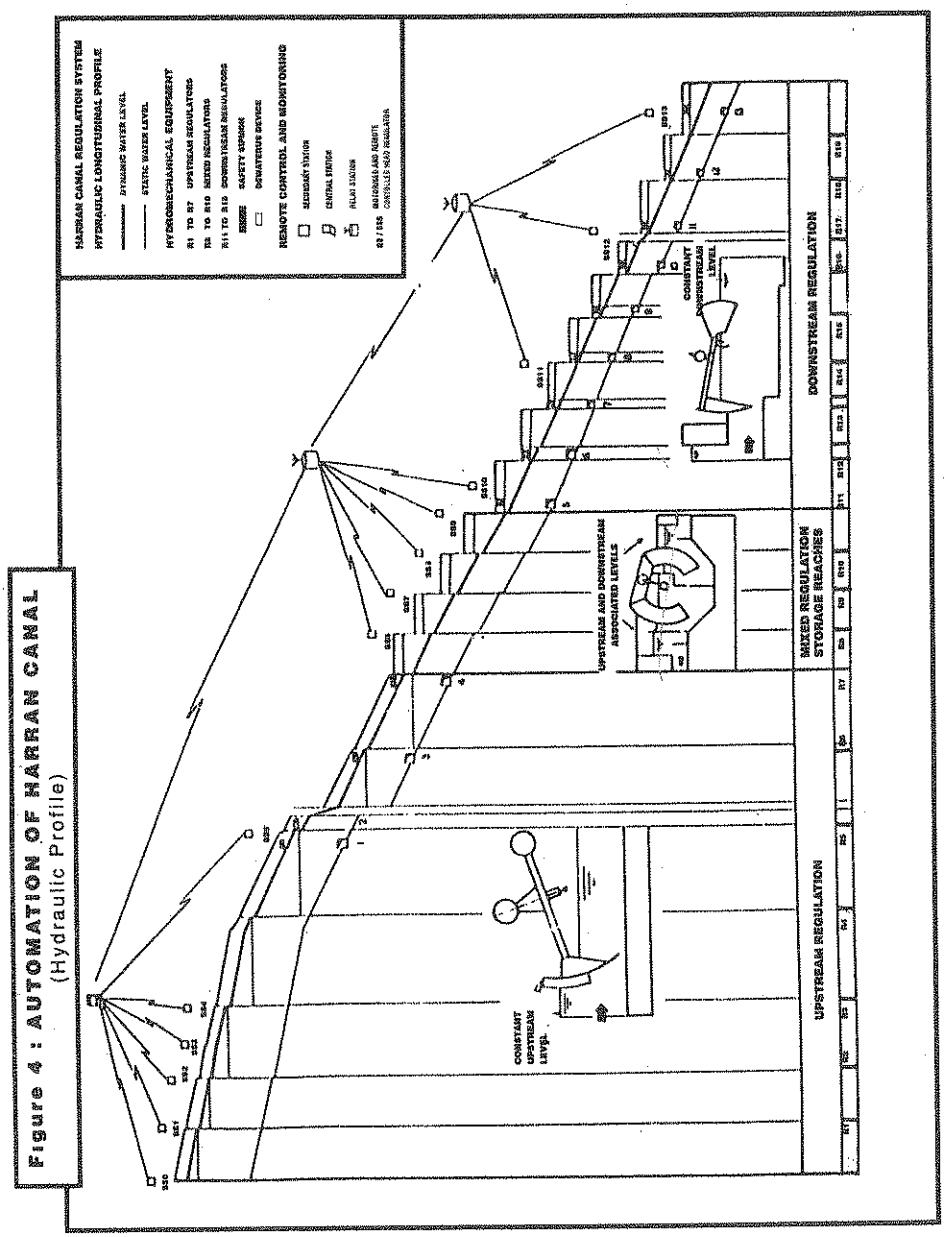

Figure 4 : AUTOMATION OF HARRAN CANAL
(Hydraulic Profile)