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THE EFFECT OF REUSE OF WATER FOR AGRICULTURE ON THE ARAB-ASIAN SOCIETY: A NEW INTERDISCIPLINARY MODEL FOR UNDERSTANDING A DEVELOPMENT PROBLEM

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THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE EFFECT OF REUSE OF WATER FOR AGRICULTURE ON THE ARAB-ASIAN SOCIETY: A NEW INTERDISCIPLINARY MODEL FOR UNDERSTANDING A DEVELOPMENT PROBLEM

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

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THE EFFECT OF REUSE OF WATER FOR AGRICULTURE ON THE ARAB-ASIAN SOCIETY: A NEW INTERDISCIPLINARY MODEL FOR UNDERSTANDING A DEVELOPMENT PROGRAM

APPROVED BY

DISSERTATION COMMITTEE

ABSTRACT

Because of the continuing changes in the society and the demand of development, the arid countries of the Arab-Asian region faces a serious water shortage problem. This dissertation analyzes the problem projecting the likelihood of its solution in view of the current trends as well as the technological measures used in dealing with it. Then this study offers an alternative solution in the technology of wastewater reuse for agriculture, a rich source of water that is currently being wasted in the region.

In order to try to insure the efficient transfer of wastewater reuse technology into the society, the author sets up an interdisciplinary model for approaching this development problem. This approach is based on an important new conception of the term development. In this study, the author has redefined development as the on-going interaction process between water (other resources), society (demographic, socio-economic, and social organization), environment (pollution), and technology. In other words, water adequacy, its technological solution and impact,

interdisciplinary problem, built into the on-going system of interaction in the development process.

This dissertaion then postulates the potential social impact of wastewater reuse technology for irrigation programmed from the start to overcome societal constraints. It perceptually compares two alternative futures in the development process for the region: 1) The future development process <u>without</u> wastewater reuse as extrapolated from the present on-going interaction process, and 2) an alternative future <u>with</u> wastewater reuse derived from the present on-going interaction process. To substantiate these impacts the author uses two historical scenarios from the U.S.A. and Mexico and the Delphi-technique. The impacts are conceptualized as two dimensional: 1) The societal constraint resolution, and 2) the resultant social impact.

This study establishes that wastewater reuse technology will have beneficial impacts on social concerns in the region and that successful diffusion of the technology depends on putting high priority on resolving societal constraints at the rural level in the programming of that technology. In other words, water problem in the region is an integral part of a system of interaction in the development process.

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CHAPTER I

INTRODUCTION

A. The Problem

Water is the most significant scarce resource in the region of the Arab-Asian countries: Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Syria, Saudia Arabia, the United Arab Emirates (UAE), the Yemen Arab Republic (North Yemen), and the Yemen's People's Democratic Republic (South Yemen). See Figure A.1*. The water shortage in these countries has recently become more than just a problem with water, it has become a significant developmental problem. Two major changes in the region within the last three decades mainly account for the increasing significance of the water problem.

First, within the last three decades all the countries have started to work for greater development.

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*A refers to figures and tables in Appendix A.

However, development requires adequate water;[1] water adequacy in terms of quality as well as quantity is necessary for developing the domestic, industrial, recreational, and agricultural sectors of society.

Second, the discovery of vast amounts of oil in the region has brought about abrupt, societal changes--demographic, social structural, and socio-economic changes--which, in turn, have caused an unprecedented demand for water, thereby putting added pressure on the already limited water resources, especially in the domestic and agricultural sectors. Industrial water usage, though increasing, is at present still at an insignificant level since industry is not yet a salient force in the region. Only the oil producing countries report data on industrial water usage, with Iraq claiming the highest percent for industry (only 5%).[2]

In 1977, the United Nations Water Conference (UNWC) warned in reference to the Arab-Asian countries that "because of the extreme importance of water resources for the future of the region, it is imperative that measures be taken now to conserve and develop this resource in the most efficient and economic manner for the highest and best use of all nations."[3] This statement is already dated, and the problem with water development remains a crucial issue.

B. The Objective

This dissertation will explore the potential impact of an increase in the water supply on the Arab-Asian society. The objective here is limited to the effect of the reuse of domestic wastewater for agricultural production. Food production is emerging as a central issue presently causing considerable concern in the region.[4] Moreover, the development of the agricultural sector is basic to all further developments. As Reid has noted the overall development of a country depends on that country's "ability to feed its own people."[5] In order to develop this sector augmenting the water supply for irrigation is a necessity.

Furthermore, the technology of reclaimed sewage will also affect the domestic sector: besides augmenting the water supply for irrigation, the technology, by definition, reclaims polluting sewage from the domestic sector, thereby protecting the quality of the domestic environment. Providing the people with a healthy environment is as basic for the overall development of the region as providing food.[6]

Thus, the technology of wastewater reuse has the potential for alleviating two basic developmental problems for the society in the Arab-Asian region:

1. By providing more food--the agricultural sector--
2. By providing a cleaner environment--the domestic sector.

Sewage is an important source of water which is presently being wasted in this region. Although the technology to reclaim sewage is available and has been diffusing rapidly and successfully in other parts of the world where water is short (see Chapter 2, Part II-D), in this region only Kuwait currently has a small experimental treatment plant for wastewater reuse (see Chapter 2, Part I, C-3). However, wastewater reclamation becomes much more attractive for the region when it is considered that sewage is 99.9 percent water, while the purest of sea water is only 96.5 percent,(7) and that much effort and money have been devoted to the conservation of saline water in this region, while relatively nothing has been done about the reclamation of sewage.

What could the Arab-Asian Society be like with the technology of wastewater reuse? The impact of a technology on the Arab-Asian Society depends on the "environment" in which that technology is transplanted. The environment consists of everything outside the technology relevant to its transfer and adaptation. In the process of transfer and adaptation, technology interacts with a cluster of systematically interrelated variables existing in its environment. The environment, in a broad sense, is that on-going developing system of interaction existing in the region between the water supplies, the characteristics of society--demographic, social structural, and socio-economic--, the quality of the environment in terms of pollution, and the other resources available--especially energy resources. As in any introduction of technology, the technology of waste-water reuse may encounter "barriers" from its environment. The society may or may not adapt to the demand of the technology. The technology may solve the water problem and/or it may create spin-off problems. Technological solutions are never completely without problems, nor are they always the right answer. For example, building the dam over the Euphrates in Syria provided the country with the needed electricity, water, and with a beautiful lake deep inside its vast desert land (Lake Asaad); but it also prompted the controversy between Syria and Iraq over the reduction of the amount of water coming down to Iraq and the reduced fertility of the land on the banks of the river downstream caused by the silting upstream. Referring to these problems caused by technological solutions, Reid notes that "it has been observed by sanitary engineers for several decades, that water plant designs based on current developed countries practice which do not take into account local conditions are doomed to failure."[8] In other words, even though water is a necessary factor for development, it is not a sufficient one. There are other factors in the development process--societal, environmental, and resource factors--, that have to be taken into account if the technology of wastewater reuse is to accomplish its intended purpose, that of aiding in the development of the countries.

Accordingly, to estimate the impact the strategy of this dissertation is first to analyze the developing system of interaction already existing in the region and to speculate on future trends in development <u>without</u> wastewater reuse technology. On the one hand, understanding the context of where the technology will be transplanted helps program the technology and direct its future path; for if one wants to control the result and guide the process of transfer and adaptation, one must work from an anticipated outcome.[9] On the other hand, the developing system can then be evaluated against an ideal system of interaction, a basic developmental goal that each socially stable and secure society cherishes and seeks first to accomplish. The basic characteristics of the ideal system are:

1. Adequate per capita food production that provides a food-security for the countries.

2. Adequate clean water that keeps pace with societal needs,
3. Clean environment that enhances the well being of the people.

The ideal system of interaction provides a standard for evaluating the developmental process in the region without wastewater reuse technology.

No doubt, there are other ideal models suited for developed countries; but for this region, underdeveloped as it is presently, this is a priority model to guide the development process. The ideal system is derived from historical experiences of the developed countries and from the warning signals of the contemporary world. Agriculture was the strategy of development in the U.K., the U.S.A., and Japan. The initial economic and social developments of these countries began with the initial development of agriculture, which, in due course, provided the marketable agriculture surplus to buy raw material for their industry and to provide food for their industrial workers.[10] However, these industrially developed societies are caught presently with severe pollution problems, thereby providing a "demonstration" and a warning to the underdeveloped world to be on guard against polluting its own environment in its drive for development.

C. The Conceptual Framework and Theoretical Background

Several investigators in the last decades have studied the relationship between technology and society and forecasted the impact of the one on the other; among these are Kahn and Wiener,[11] Gilfillan,[12] Baker,[13] Ogburn,[14] Reid,[15] Meadows,[16] Schumacher,[17] Colwell,[18] Wenk,[19] Bright,[20] and others. Certainly such investigation was the theme of the 70's. It was the major theme of at least three of the decade's early "best sellers:" Future Shock by Alvin Toffler,[21] The Greening of America by Charles Reich,[22] and Pantagon of Power by Lewis Mumford.[23] Similarly, it has been the "theme of the international conferences of Human Environment (1972), Population (1974), Food (1974), Industrialization (1975), Employment (1976), Human Settlement (1976), Water (1977), Desertification (1977), Primary Health Care (1978), and Climate (1979)."[24]

However, no one thus far has used the interaction system approach to explain or predict the impacts. Typically and traditionally, the impacts or the effects are assessed with one as the dependent variable and the other as the independent variable. The approach of this dissertation provides a new perspective from which to assess the potential impact of wastewater reuse technology. The perspective here is based, in a broad sense, on the interaction between water (other resources), society, technology, and the environment on-going in the region.

To bring the crucial parameters into perspective and allow for a comprehensive view of all the processes in their interactions, the parameters are presented in a model (Figure 1.1). This model provides a highly general conceptual framework relevant to understanding the problem. In the model, the four parameters are conceptualized as the constituents of a developing system. The system develops through time with the tempo dependent on the extent of the changes in the parameters. Usually the change is steady and incremental; occasionally, however, a fundamental change, or what Kuhn[25] calls a "new paradigm," occurs, leading to a reconstruction of the structural relationships in the system.

For instance the incident at Harrisburg, Pennsylvania, in the Three Mile Island nuclear plant on March 28, 1979, illustrates clearly the intricate interactions. That incident instigated a disruption and a disarray in the community. It prompted a re-evaluation of available energy resources, it called into question the safety factor due to the dissipation of nuclear isotopes in water and in the atmosphere, and it shed doubt on the cherished economic value of growth. The

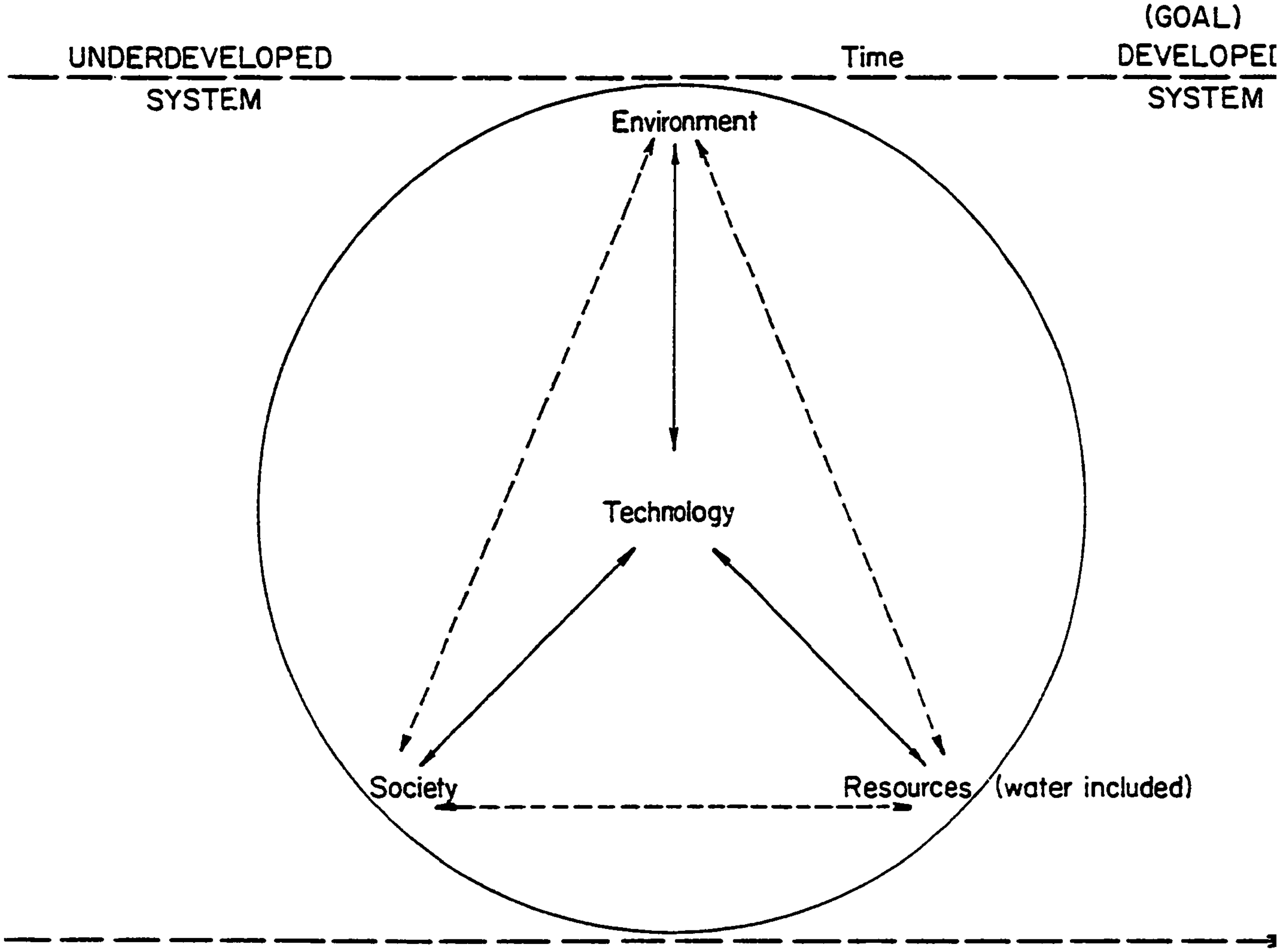

FIGURE 1.1. The Developing Interaction System

incident dramatically illustrates that problems of technology, society, resources, and environment are enmeshed; that technology is an integral part of a system of interaction; and that technology which can give man comfort, could also destroy him. Although this example was an extreme one, the lesson of the incident is significant: technology is at once a technical, societal, environmental, and a resource problem.

The approach of this dissertation is also new in another respect; no one so far has used the construct "development" to mean an on-going process of interaction between water (and other resources), society, environment, and technology. A schematic representation of this approach is:

Development: Society/Resources/Environment/Technology

The typical traditional use of the term development denotes the concept only as an economic and a social aspect of a national activity. Figure 1.2 depicts the conceptual relationship between the on-going system of interaction and the development process and provides a new general model of inquiry to structure the process of investigation from this interdisciplinary perspective.

This general framework of conceptualization in the dissertation was guided first by the increased

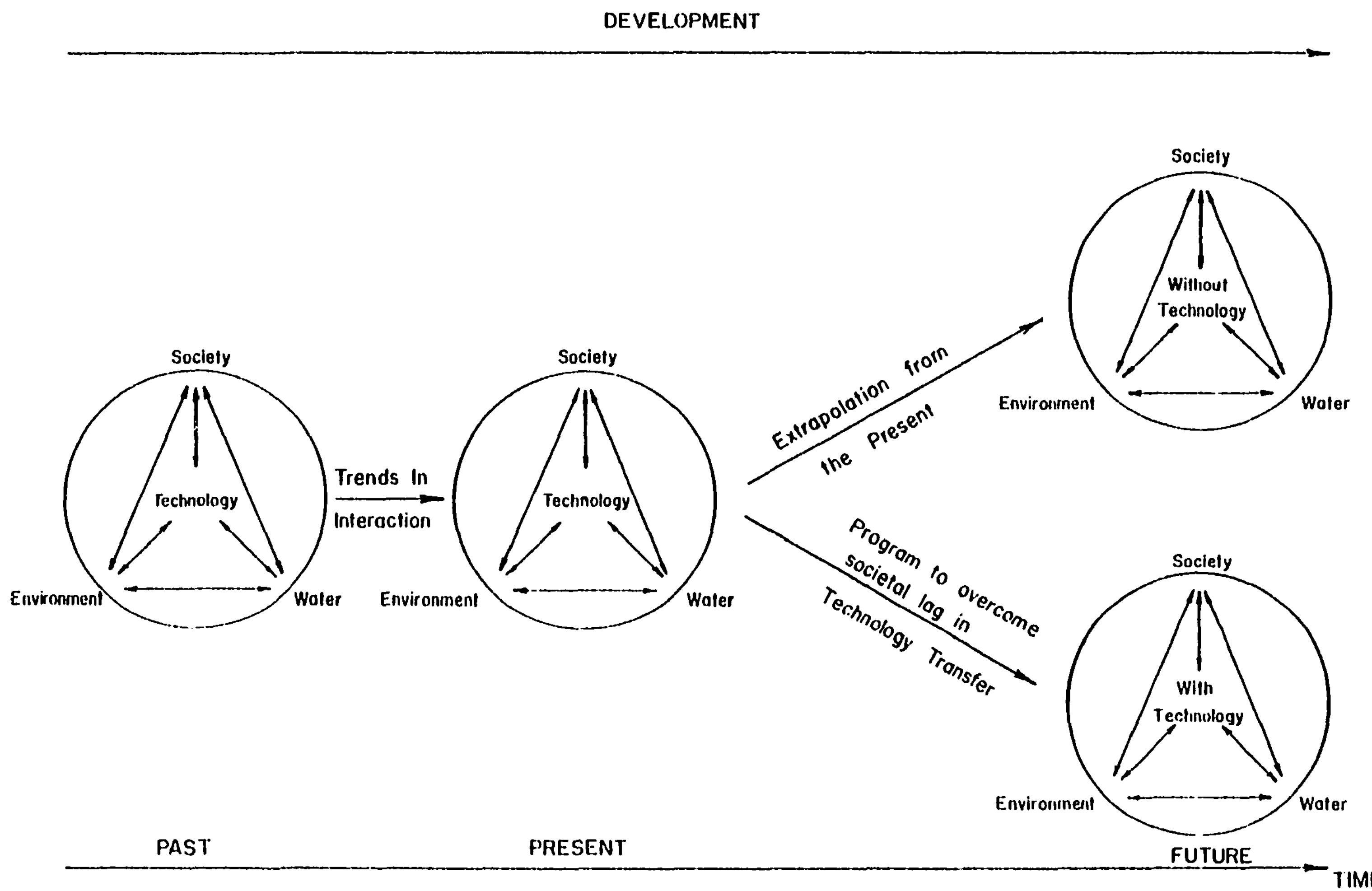

Figure 1.2. A Model Synthesizing the Research Procedure and the Conceptual Framework.

recognition that "development is a multi-dimensional concept that encompasses not only economic and social aspects of national activity but also those related to population, the use of natural resources, and the environment,"(26) and second by the general concern over unwanted social and environmental consequences of technology.

This approach is viable. It provides guidance for policy decisions and allows for future control of the outcome of the technology. It reveals:

First, the pattern of development for the existing system of interaction and its future outlook--How the system is working <u>without</u> adequate water.

Second, the future needs for water--the deficit and the need for other water resources.

Third, the anticipated societal constraints in the path of technological transfer and adaptation--to help formulate a soft program that will take these anticipated societal lags and the potential spin-off problems into consideration.

The potential impact of reclaimed sewage for irrigation will then be assessed on the basis of an empirically demonstrated <u>need</u> for the technology and on the basis of the potential impact of a <u>directed</u> technology.

D. The Definition of the Main Variables

For the purpose of this dissertation the following definitions hold for the main variables:

Technology of wastewater reuse: refers to the collection of domestic wastewater, its treatment, and then its diverting for irrigation purposes.

Society: refers to the population characteristics and trends--the demographic, socio-economic, and social structure.

Social structure: refers to the norms that order the relationships between the people.

Water: refers to the adequacy of water in terms of quality and quantity.

Agricultural development: refers to the per capita food production and fiber production.

Environment: refers to the quality (pollution) of air, soil, and water.

Resources: refers to water--both surface and underground--, and to energy.

E. The Data Collection and the Procedure

This study can by no means analyze the whole complex of interdependence for all the factors involved; rather it will place emphasis on a number of empirically demonstrated leading variables. The data has been gathered from various sources: pertinent national reports, UN agencies--ECWA, FAO, UNESCO, ECOSOC, UNEP, UNIDO, WHO, WMO--, the World Bank, and experts on the area.

A word of qualification is necessary at this point. First, the data here is limited to the post oil era--these countries and UN agencies have only recently begun to compile statistical information. Even now the statistics are fragmentary and still in their infancy. Second, not all the countries have all the needed information; and, therefore, whenever there is no information from the region to lean on for analysis, a surrogate country is sought.

The findings from this study on the potential impact of water reuse for irrigation will then be put into further verification and sifting. The potential Social Impact Index arrived at from this study of the development process in the region is checked and compared with two historical scenarios from two types of societies--the U.S.A. and Mexico. The historical scenarios check whether these two societies felt the impacts in the Index when they developed the water resources for irrigation. The Delphi-technique will be used to verify further the Impact Index and also to rank the impacts according to the likelihood of each occurring.

The emphasis throughout this dissertation is on the developing interacting system in order to evaluate the potential social impact of wastewater reuse technology for irrigation. However, for analytical purposes, the analysis will begin with the current water situation in the region and the benefits of water reuse technology in combating water shortages (Chapter II), to be followed by a general description of the societal trends (Chapter III), and by a description of the trends in agricultural production (Chapter IV).

CHAPTER II

WATER IN THE REGION AND THE LOSSES IN WATER RESOURCES WITHOUT REUSE OF WASTEWATER

PART I. WATER IN THE REGION

A. Meteorological Characteristics: Rain and Evaporation

The Arab-Asian countries occupy an area of 3.7 million Km^2 located in the western section of Asia. Except for the mountain ~ange in northern Iraq and the Syrian and the Lebanese heights, the region falls predominantly in the arid zone as shown in Figure A.2.

Generally, rainfall of less than 10 inches per year is classified as arid, whereas 10-25 inches per year is semi-arid; and in excess of 25 inches is moist, humid or wet.[27] Table 2.1 shows the annual mean precipitation in each country of the Arab Region. Most of the countries receive less than 10 inches of precipitation per year.

TABLE 2.1

Average Annual Rainfall in the

Arab-Asian Countries

Country	Annual Precipitation (Inches) *	Section of Country
Iraq	7	Central portion
	40	North
Jordan	20	Wastern Highlands
	8	South and East deserts
	<10	Most of Jordan
	>14	13%
Kuwait	Rarely exceeds 5/year	
Lebanon	39	Average
Oman	4.5	Average
Qatar	2.5	Average
Saudi Arabia	2	Average
	6	North
Syria	30	Mountains
	~ 2	East and Southeast

Source: Countrys' Reports prepared by ECWA countries for UN Water Conference, 1977.

*1 inch = 2.54 centimeters.

The World Meteorological Organization (WMO) also places the region in the lowest category receiving water.[28] WMO divides the surface of the earth into seven zones according to the deviation from normality in annual precipitation. The Arab region falls in the zone of most deviation, as shown in Figure A.3.

Added to this shortage of rainfall is the extremely high evaporation rate as shown in Table 2.2. This high evaporation rate drains the soil of water.

TABLE 2.2

Average Annual Evaporation in the Arab-Asian Countries

Country	Average Annual Evaporation (Inches)*
Iraq	84
Kuwait	80
Lebanon	9
Oman	40
Qatar	90
Saudi Arabia	70
Syria	15

Source: Meteorological Bulletins of the countries, 1975.

*1 inch = 2.54 centimeters.

Comparing the two tables of precipitation and evaporation reveals the debit in the hydrological cycle in the region. The comparison is pictorially depicted in Figure 2.1. The figure clearly shows the extremely low level precipitations relative to evaporations in the countries of the region. Except for Lebanon and to a certain extent Syria, the countries suffer from very high debit in the hydrological cycle. The hydrological cycle refers to the continuous exchange of water through precipitation and evaporation. The water resource of any region depends on the annual water budget which expresses the balance in the hydrological cycle. In the water budget, the annual increment of rainfall is the credit, whereas the annual increment in evaporation is the debit.(29) The adverse water situation in the region is highlighted when its water budget is compared with the water budget of the world as a whole. Contrary to the region of the Arab-Asian countries, the world as a whole is bestowed with a credit in its water budget. Of the 21 percent falling on land, only 13.4 percent is lost as a result of evaporation, leaving 7.6 percent credit to run off in the rivers of the world and through the ground.(30)

Thus, by any standard, the region is arid and, consequently, the shortage of natural fresh water

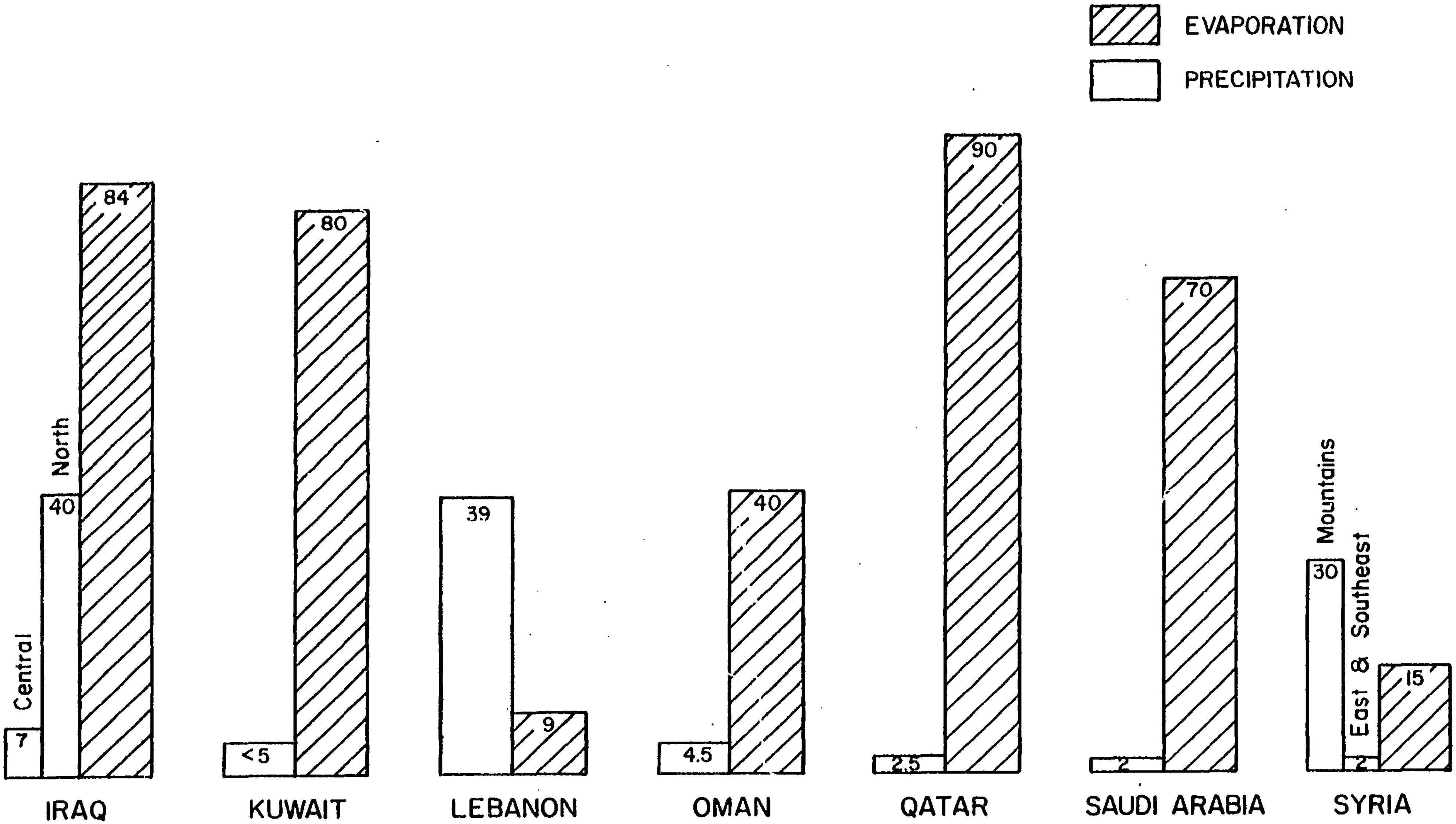

Figure 2.1. Annual Precipitation and Evaporation in the Arab-Asian Countries. (Inches)

Source: Data from Table 2.1 and 2.2.

resources is there to stay. Fresh water consists of surface water (lakes, rivers, and streams) and ground water (including only water which can be made available through pumping or drainage).

B. Surface and Underground Water (fresh)

Only few countries in the region have perennial rivers flowing: Syria, Iraq, Jordan, and Lebanon. Table 2.3 shows the major rivers in these countries.

TABLE 2.3

Major Rivers in the Region

Name of River and Country	Catchment Area (KMS)	Length (KM)
Euphrates (Iraq) Euphrates (Syria)	241,000	1875
Tigris (Iraq)	253,000	1718
Tigris (Syria)	Not Available	50
Jordan (Jordan)	6,000	Not Available
Litani (Lebanon)	2,168	170

Source: ECWA-UN. E/ECWA/42/Rev. 1. 26 April 1978. Report of the ECWA Regional Preparatory Meeting for UN. Water Conference.

The surface run-offs for the rest of the region are either negligible or at best seasonal. In Kuwait, Bahrain, Qatar, and in parts of other countries in the region no measurable surface run-offs occur. In Saudi Arabia and

Yemen, surface run-offs occur, depending upon the duration and the intensity of rainfall. Such run-offs usually occur in the dry wadis and often do not reach the sea because of evaporation and infiltration into wadi elluvium. Data for such flows is scanty. All in all, approximately, 75% of the surface water is in Iraq, 15% in Syria. Table 2.4 shows the lack of surface water in the Gulf area.

TABLE 2.4

Annual Surface Water Potential

(Million m^3/Year)

Country	Annual Surface Water Potential
Bahrain	Negligible
Iraq	80,000
Jordan	850
Kuwait	Negligible
Lebanon	3,800
Oman	10
Qatar	Negligible
Saudi Arabia	2,200
Syria	32,000
UAE	160-270
Yemen (YAR)	N.A.
Yemen (PDRY)	1,500

Source: Country Reports to the Regional Preparatory Meeting for the United Nations Water Conference, December 1976.

Thus, the surface water in the region is extremely scarce, and the countries depend mostly on underground water for the fresh water supply (for Ground Water see pp 87-90)

C. Technologies to Combat Water Shortage in the Region

Technological measures at all levels have been used in the region to alleviate the water shortage problem. These measures may be classified into two categories: Traditional and modern.

1. Traditional Technology

Palm trees. Palm trees have always been part of life in the Arab-Asian countries. Besides providing the inhabitants with food (dates), palm trees have been recognized as a method of conserving soil moisture.

Water spreading. The water spreading technique has been used in Syria, Lebanon, Jordan, and Iraq. It consists of diverting and rerouting flood waters over areas adjacent to the main stream, thereby increasing the moisture content of the soil and, as a result, raising the productivity of the land.

Erection of terraces. Terraces have also been in use in the region for a long time, especially in Lebanon, Syria, and Jordan. Terraces serve two purposes: 1) they prevent the erosion of soil by climatic condition, and 2) they increase the moisture in the soil, a sure way to raise productivity.

Homemade cisterns. In modern terminology, this method may be called rain harvesting. In this method each family digs a pit, 6-9 meters deep and about 2 meters in diameter, into which rain from the roofs of the buildings is directed. These devices are useful in the small rural communities during the scorching summers when the village spring practically dries out.

2. Modern Technology

Two up-to-date technologies are used in the region to augument water supplies. These are the building of dams and the desalting of brackish water and sea water.

Dam building. As anywhere else, dams in the region are erected to control floods, to store water for future use, especially in irrigation, and to recharge underground water.

Iraq has been a pioneer in the construction of dams in the region. Recently Jordan, Saudi Arabia, and Syria have come to realize the significance of the erection of dams. Currently, Iraq has four huge reservoirs in existance and is planning for 5 more in the next decade or so.[31] The existing dams are:

(1) Habbaniyah Lake (in Western Iraq) consisting of a depression which was originally a mean to control flood waters from the Euphrates, but has been used lately for irrigation as well, with a capacity of $3.28 Km^3$,

(2) Dokan Dam, a concrete structure measuring 116m high with a capacity of 6.8Km^3 on the small Zab River (a tributary of the Tigris), and established to regulate the flow of the river, control floods, generate electric power, and irrigate,

(3) Darbindikkan Dam, a rock-dirt structure on the upper Dayala River, 128m high, capacity 3Km^3 built to guard against flood, supply water for irrigation, and generate hydro-electric power,

(4) The Tarthar Project, one of the most important projects in flood control in Iraq with a 85Km^3 capacity and a water level 65m above sea level.

In Jordan, several dams have been constructed, and others are still under consideration. Table A.1 lists the dams already constructed.

One of the most recent and largest dams in the region is the Euphrates Dam in Syria. It is an earthen dam 4,500m long, 60m high, 512m wide at the base and 9m wide at the top. The main purposes of the dam is the irrigation of land and the generation of electricity.

Saudi Arabia is a relative newcomer to the field of dam construction. Yet, much progress has been achieved since 1971 when the first dam was constructed. Table A.2 lists existing dams and their characteristics.

Desalination. Desalination, mainly distillation, as a source of water supply in the region, has come to the forefront in recent years. In fact, this region, because of Saudi Arabia and Kuwait, is today a world leader in terms of the abundance and size of distillation plants. Plants processing fifty million gallons a day are common now in both countries. Saudi Arabia will soon be commissioning a plant on its east coast with a 200 mgpd capacity, making it the largest such plant in the world.[32]

Other Gulf countries of the region are also heavily involved in producing fresh water from the sea. Table 2.5 lists the capacity of distillation plants in operation and under construction in the region.

TABLE 2.5

Capacity of Distillation Plants in Operation and Under Construction

Country	Plants in operation (mgpd)*	Under Construction (mgpd)
Bahrain	5.7	16.1
Kuwait	80.0	40.0
Oman	1.8	--
Qatar	7.3	13.0
Saudi Arabia	275.0	125.0
United Arab Emirates	1.5	NA

Source: Preparatory Meeting, Baghdad, December 1976.

*1 mgpd = 3785.m^3/pd

3. Experiments

Unconventional water technologies are also being experimented within the region. Although efforts in that direction are limited and do not go beyond the experimental stages, they do deserve mentioning.

Weather Modification. Saudi Arabia is experimenting, along with the U.S. Bureau of Reclamation, with rain making by cloud seeding.[33]

Iceberg Towing. Saudi Arabia and France have already established a joint venture for the purpose of towing icebergs from the South Pole to Saudi Arabia. Although technically feasible, this process is expensive. It is estimated that a cubic meter of water extracted from an iceberg reaching the coast of Jeddah will cost the Saudis about $2.40, which is equivalent to about $10 per 1000 gallons, at least five times the current cost of distilled sea water in the region.[34]

Underground water recharge. Qatar has recently been experimenting with groundwater recharge using desalinated water. If successful, they plan to begin large scale operations using water recharging. South Yemen also has been spreading aquifers by using a series of ditches.[35]

Drip irrigation. In environmentally controlled agriculture, Kuwait and the UAE are using drip irrigation on a limited scale.[36] Drip irrigation consists of stretching a perforated hose alongside a row of plants, with water flowing into it.

Canal lining. To decrease water losses and alleviate the problem of soil salinity and water logging, Iraq has started a large scale canal scheme. Canal lining calls for lining the inside of the canal with cement or plastic material.

Remote sensing. Saudi Arabia and Yemen Arab Republic are incorporating remote sensing technology by satellite (lansat) in their exploring ground water resources and monitoring weather phenomena.[37]

Wastewater reuse. Kuwait is currently experimenting with wastewater reuse to irrigate shrubs and bushes. Effluent from the treatment plant is used in irrigating some shrubberies and trees along the streets outside the city limits.[38]

There are other technically feasible processes which have not been tried in the region. Evaporation reduction and water conveyance are such examples. In evaporation reduction organic material such as alcohol is spread over water surface to prevent sunrays from penetrating into water, thus reducing evaporation. Water conveyance uses plastic collapsable bags filled with water, perhaps at a river mouth. These bags are towed by ships to certain coastal areas where water supplies are scarce.

Thus, the region's water needs have encouraged the contemplation of exotic solutions to the water shortage, such as the towing icebergs from the antarctic to Saudi Arabia. However, it is clear that wastewater reuse is not given the proper attention. Wastewater reuse could be a key element in developing agricultural resources in the region and augmenting domestic water supplies. Section II of this chapter analyzes such water reuse as a water resource for the future of the region.

PART II. WASTEWATER REUSE: THE WATER RESOURCE FOR THE FUTURE OF THE REGION

Despite the efforts to alleviate the water shortage, the region is still severely short on water. An available source of water in reclaimed wastewater is, however, being wasted, abused, and remains still untapped in the region. With the available level of wastewater treatment technology, wastewater in the region can be reclaimed and reused, thereby securing a certain source of water for irrigation and possibly useful for some other water demands.

A. The Amount of Water Recovered by the Technology

It is estimated that 80% of the domestic effluent is recoverable by the current technology.(39) However, due to the various constraints in the region, such as climatic conditions and inefficiencies, it is assumed here that only 50% can be recovered. Using the domestic water consumption of 1976[40] as a base, Table 2.6 calculates the benefits in water supply and arable land by domestic wastewater reuse. For the whole region and for each country, this table estimates the increased amount of water supply and the irrigated land available from this rennovated source. The table shows that a new 1,009.5 million cubic meters (266,508 million gallons) of water and an additional 83,793 irrigated hectares (206,968 acres) will be lost without wastewater reuse.

B. The Benefits of the Technology of Wastewater Reuse

Domestic wastewater reuse also has the following advantages:

(1) It is economical. The single strongest argument for reuse of wastewater for irrigation is to be found in the cost of treatment. The economy of recycling wastewater will become apparent when compared with the cost of desalting sea water. (Desalination by distillation is now a well-established method for combating water shortage in the oil producing countries of the region.)

The cost of distilled water in Saudi Arabia and Kuwait is about $2/1000 gallons.[41] It goes without saying that for the non-oil producing countries of the

TABLE 2.6

Amount of Increased Water and Irrigated Hectares

by Domestic Wastewater Reuse

Country	Domestic* (mm^3) (1)	Annual** Water Reclaimed (mm^3) (2)	Water*** Per Hectare (CM) (3)	2:3 (Hectares) (4)
Iraq	580	290.0	15,950	18,182
Jordan	40	20.0	8,600	2,325
Kuwait	75	37.5	60,000	625
Lebanon	94	47.0	10,850	4,331
Saudi Arabia	830	415.0	10,100	41,089
Syria	400	200.0	11,600	17,241

* ECWA, Report of the ECWA Regional Preparatory Meeting for UN Water Conference, 1976.

** 50% of domestic water.

*** Abou-Khaled, Potentials of Land and Water Resources in the Arab Countries, FAO, 1977.

**** Average for the region.

mm^3 Million cubic meters.

CM Cubic meter = 264 gallons.

Hectare 10,000 M^2 = 2.47 acres.

region--Jordan, Lebanon, the two Yemens, and to a certain extent Syria--the cost will be much higher.

On the other hand, the cost of secondary treatment, which is more than adequate for irrigation purposes (removing 100% suspended solids, 85% BOD, 20% nutrients), the cost is about $.10/1000 gallons on the scale of 2mgd.(42)

Secondary treatment is a well-established and standarized process. The unit cost of $.10/1000 gallons may, therefore, be applicable to the region of Western Asia. But to be on the safe side and account for inefficiencies, a unit cost of $.25/1000 gallons may be assumed. To provide a higher level of treatment is neither needed at this level of usage, nor in line with the United Nations principle of 1958, which states that "No higher quality water, unless there is a surplus of it, should be used for a purpose that can tolerate a lower grade."(43)

Using the comparison cost analysis, Table 2.7 computes and compares the estimated cost of the amount of reclaimed water by secondary treatment with the estimated cost of the same amount by desalination. The table clearly reveals that it is more economical to use wastewater recycling to combat the shortage in irrigation, rather than to use desalinated water. Desalinated water costs at least eight times the cost by recycling. This ratio is much higher for the non-oil producing countries.

TABLE 2.7

Cost Comparison Between Secondary Treatment and Desalination and the

Saving to the Region by Water Reuse for Irrigation

Country	Secondary Recycled Treatment (Million Gallons)*	Cost: Desalination $2/1000 gallons (Thousand Dollars)***	Cost: Secondary Treatment $.25/1000 gallons (Thousand Dollars)****	Savings Desalination Secondary Treatment (Thousand Dollars)
Iraq	76,560	153,120	19,140	133,980
Jordan	5,280	10,560**	1,320	9,240**
Kuwait	9,900	19,800	2,475	17,325
Lebanon	12,408	24,816**	3,102	21,714**
Saudi Arabia	109,560	219,120	27,390	191,730
Syria	52,800	105,600**	13,200	92,400**
TOTAL	266,508	533,016	66,627	466,389

* Data converted from column 2 in Table 2.6.

** Jordan, Lebanon, and to a certain extent Syria, cost is much higher than oil-producing countries.

*** Source: (1) Desalination in Saudi Arabia, Presented at UNWC Mar del Plata, Argentina, March 1977.

(2) The State of Kuwait's Fresh Water Needs. December 1976.

**** Source: DeCook, J.J. "Reuse of Wastewater in Desert Regions". in Conference on Alternate Strategies for Deserts Development. Sacramento, California, May-June 1977.

Furthermore, an additional few cents/1000 gallons worth of coagulants achieves substantial improvement in water quality, making it fit for a much wider use including recreation and ground-water recharge.[44]

(2) Consumes little energy. Wastewater secondary treatment is an energy-saving process. This fact again becomes apparent when compared with the energy consumption of desalination. Fuel and electricity costs for secondary treatment are 1.6 cents/1000 gallon.[45] For distillation, it costs $.48/cubic meter, which is $1.81/1000 gallons.[46] Because of concern over oil shortages and energy saving, energy efficiency is a crucial factor. It is more economical, therefore, in terms of energy consumption, to use secondary wastewater treatment for irrigation than to use desalinated sea water.

(3) Provides nutrients. Secondary effluents are rich in the basic nutrients, namely nitrogen and phosphorous. Using reclaimed sewage for irrigation purposes will do away with the needs for fertilizers, thereby saving the farmers substantive expenses.

(4) Generates sludge residue. The residual sludge from the treatment plant is an excellent soil conditioner, which is also rich in nutrients.

(5) Treatment plants can be conveniently located. Contrary to desalination plants, which should be located along the coastal area, wastewater treatment is not site

specific. The distribution of plants can be planned according to the distribution of human settlements. In rural areas, where the villages are too small to afford waste treatment plants, several villages can cooperate to have one central treatment facility, the effluent from which can be reclaimed to irrigate the farmlands of their communities.

(6) Controls pollution. The development of wastewater reuse technology in the region is fully justified from another point of view than that of combating water shortages. The unregulated sewage in the region is polluting the environment, ground and surface water, thereby providing suitable conditions for the breeding of the hosts of parasitic diseases and endangering aquatic life. Therefore, the argument for wastewater reuse which would solve this problem is compelling.

C. The Wastewater Treatment Technology

A description of the technology of wastewater treatment is now in order.

In general, there are three basic types of treatment: primary, secondary and tertiary (advanced).

Primary treatment consists of the removal of suspended solids from effluents by plain sedimentation (Gravity settling). About 40% of the suspended solids is precipitated. Usually settling is aided by the addition of certain types of chemicals (organic or inorganic) known as coagulants. The function of these chemicals is to build up large size flocs from colloidal particles and, thereby, facilitate their settling. By using this technique, removed suspended solids could reach 70%.

The aim of secondary treatment is to remove dissolved organic matter using a wide array of microorganisms, the most important of which are bacteria. This could be done in many ways. But the most common one is the activated sludge process which has been in use for over seventy years.

The activated sludge process consists of bringing together primary effluent and bacteria in an agitated tank in the presence of oxygen. Within 4 to 6 hours detention time, soluble organic matter is consumed by bacteria. Part of the consumed organic matter is then utilized in the production of new cells. The remainder is oxidized to CO_2 and H_2O. The treated effluent then overflows to a settling tank where solids agglomerate and settle. The settled flow is rich in active bacterial cells. Most of it is returned to the aeration tank to keep the process operating; the rest is pumped to waste or further treatment.

Advanced or tertiary treatment is a polishing process for previously treated effluent. The aim is to increase the level of purification a few extra percentage points. However, removal of these few points can be very costly because there is no one single process that can achieve this. Rather, it involves a series of successive processes each for one or more types of contaminants.

Contaminants in secondary effluent of treated sewage consist of: Suspended solids, plant nutrients, non-biodegradable organic substances (refractory), inorganic salts, and micro-organism cells (mostly bacteria). All in all, their concentration in the effluent is less than 0.1% (1000 mg/l). Yet, their removal is expensive as has been mentioned.

D. The Diffusion of the Technology of Wastewater Reuse World-Wide

The Arab-Asian region will not be a pioneer in the adoption of wastewater reuse. Wastewater reuse programs have been applied in various sections of the world and for all levels of water usage: Agricultural, industrial, recreational, and even potable usage. Appendix B reviews and examines briefly the major wastewater reuse programs from the perspective of technology transfer, i.e., the global evolution of the technology at the stage of broad practical application and the local adaptation or diffusion or acceptance of the technology.(47)

In all the cases of wastewater reuse cited, water supply became scarce relative to the demand and wastewater reuse paid off. The cases clearly show the interaction between society, water, and environment, with technology as the solution. The technology of wastewater reuse stabililized the economic and social life of the local communities and alleviated also the pollution problem.

In the region of the Arab-Asian countries, the same symptoms currently exist: Shortages of water supply, expanding economy, and a rapid rise in water demand. Water supply is scarce relative to the demand and that scarcity is threatening the economic and social life of the rural communities. The need is real to consider seriously the reuse of domestic effluent for irrigation.

Moreover, the governments in this region do not seem to be against sewage reuse for agriculture. This conclusion is based on the responses to a questionnaire on wastewater reuse, which is the subject of Part III.

PART III. ATTITUDES OF THE REPRESENTATIVES OF REGIONAL GOVERNMENTS TOWARD WASTEWATER REUSE

Realizing that it is doubtful whether the technology transfer will come about without the governments' patronage and guidance and that it is the national governments that have the means--especially the financial resources--to deal with the whole dimension of the problem--this dissertation turned to representatives of the governments to assess the attitude on the possibility of adopting the wastewater reuse technology for their countries. After all, "The over-all direction of historical movement will still be difficult to forecast due to the power concentrated in individuals such as 'heads' of governments."(48)

To determine the attitude of men of government, questionnaires were circulated to the delegates of the governments of the region attending the Water Regional Conference, held in Saudi Arabia, January 1979, sponsored by ECWA of the United Nations. The twelve countries participating were: Lebanon, Syria, Jordan, Iraq, Saudi Arabia, Kuwait, Bahrain, Oman, North Yemen, South Yemen, United Arab Emirates, and Qatar. The six questions of the questionnaire relate to the affective dimension of attitude (the first question) and the behavior dimension of attitude (the last five questions).

The questionnaire:

1. Do you approve of wastewater recycling for your country? YES NO
2. Would you recommend it for domestic usage? YES NO
3. Would you recommend it for industry? YES NO
4. Would you recommend it for agriculture? YES NO
5. Would you recommend it for recreation? YES NO
6. Would you use it at your home? YES NO

All of the experts of the goverrments were for wastewater reuse (affective). But when came to usages (behavior), all were for reuse in industry and agriculture, and none for reuse in thier own homes. Three were for reuse domestically; however, two of these disapproved of reuse in recreation. On the other hand, of the nine delegates in disfavor of reuse domestically, four shifted in favor of reuse in recreation (see Table 2.8).

TABLE 2.8

Frequency Distribution of the Governments of the Region Attitude Toward Wastewater Reuse

Question	Reuse Category	Yes	No
1	acceptance	12	--
2	domestic usage	3	9
3	industry	12	--
4	agriculture	12	--
5	recreation	5	7
6	ones home	--	12

CHAPTER III

THE SOCIETAL TRENDS IN THE REGION

The purpose of this section is to describe the social setting of the Arab-Asian countries.

Until the last two decades, the social structure of the Arab-Asian countries was predominantly traditional and largely based on the teaching of Islam. The social order was well integrated, with long-standing norms controlling the behavior and the interrelationships. These norms were largely ascriptive, particularistic, and diffused. One's status in society was, with little qualification, inherited. One did not earn it, one was born to it. The families that were political were also those economically powerful landed groups. Interpersonal behavior was regulated by detailed normative rules whose validity had for centuries remained largely unchallenged. It was a social order based on the patriarchal family and the absolute authority of the father; obedience to the elderly was a sacred rule, and the breaking of the rule elicited the wrath of the community. Women were usually kept within the house, and if they did go out they were heavily veiled (customs that became associated with the religion, though are not the teaching of Islam). It was a structure based on the traditional communalism of the village, the tribe, or the extended family.

This social structure, though still pervasive, is slowly but steadily changing. The social changes are manifested only in the urban centers. Why is this social structure which for centuries has been stable and normatively integrated changing? Its sanctity seemed to be so far unquestioned. If it had not been, we would not have in these Islamic societies today almost the same social order that existed centuries ago.

The discovery of vast reservoirs of oil in the region was the resource paradigm that triggered the change. Oil and the revenues from oil created new conditions. The structural-functionalists, such as Parsons[(49)] and Durkheim,[(50)] tell us that the traditional society (Gemeinschaft, mechanical) which was functional in the past was rendered dysfunctional under the new circumstances. The structure of the Islamic society became a constraint and inefficient in performing the multi-purposed specialized activities that emerged. The traditional extended family, the cornerstone of the traditional society, did not have adequate means to prepare its members to occupy the emerging roles. In sociological language, functional differentiation requires structural differentiation.

Currently, critical structural transformation is underway--from the traditional to a structure associated with a developed modern rational type of society (Gesellschaft, Organic). Typically the social structure of a modern society is based on the division of labor, on specialization, where social cohesion is a function of complementary roles. Such a society adheres in its behavior to the norms of achievement rather than ascription, to universalism rather than particularism, and to specificity rather than diffuseness, to use Parsons' pattern variables. These pattern variables are the norms, the laws, the role expectations, that provide prescriptive standards of action. The norms of the modern society thus encourage competition, aspiration, hard work, individuality, material rewards, mobility, and rationality. Today, the urban social structure of the Arab-Asian countries is far from this description. It is far from being organic. But the change is in this direction.

Here are brief summaries of the social changes currently on-going in the region:

(1) Altered Opportunity Structure. The oil altered the occupational opportunity. The nature of the

labor market has changed. Within a short period of time important changes in the economy led to gross changes in the occupation structure. Increasingly economic activities took place outside the home. The new market sought and valued the professionally qualified and the skilled. Education became the "credential property" of the man; and formal education flourished. Table A.3 shows the diversification in the labor market with and without oil. In the table, two countries are used for comparative purposes: Saudi Arabia (with oil) and South Yemen (without oil). This table shows the development in Saudi Arabia between 1970 and 1975, and compares that with the situation in South Yemen. The table reveals the decline in the significance of the traditional agricultural and bedouin's life in Saudi Arabia, and the rise in the importance of non-traditional employment, especially construction, industrial production--mostly related to oil--, and public services. By contrast, in South Yemen, a country without oil, the economically active population is still predominantly in the traditional agricultural sector.

(2) Expansion of Education. Massive free formal eduction is underway, especially in the oil producing countries. Table A.4 shows the expansion of formal education from 1970 to 1975. The table shows

clearly that the younger generation are much more often literate than the older ones for both males and females, with the males having the upper edge.

Furthermore, the policies of the national governments are accelerating the process of educational expansion. Currently in Saudi Arabia and Kuwait, any aspiring student who wishes to continue his higher education, at home or abroad, can receive generous financial support from his or her government up to and even beyond the expenses of schooling. Such a policy is having its effect. Table A.5 computes the ratio of students in secondary and higher education for the year 1975, with those enrolled in 1970. The ratio shows an increase several times in the higher education during this period; that ratio is, once again, higher for the oil producing countries. The increase in higher education cannot be attributed to the increase of the population factor only. Table A.6 computes the ratio of the population for the same period (1970-1975). Relative to the education ratio, the population ratio is low and the variance is small. The population ratio ranges from 1.12 (North Yemen) to 1.34 (Kuwait), while the secondary education ratio ranges from 1.1 (Lebanon) to 8.9 (Oman), and for higher education it ranges from 1.0 (Bahrain) to 3.0 (Saudi Arabia).

Thus the school is becoming another great socializing agent besides the family. The family still has its influence, but learning, just as economic activities, is increasingly taking place outside the home.

(3) Georgraphic mobility. Everett Lee once remarked that a geographically static society is a socially static society.[51] And certainly the society of the Arab-Asian region is not currently socially static. The discovery of oil created income disparities which set in motion abrupt shifts in population. Table A.7 shows the per capita income distribution in the region. The region includes the richest country in the world (Kuwait) with per capita income reaching in 1975, $11,640 (compare with U.S. per capita income of $5,834 for the same year),[52] and one of the poorest countries in the world (North Yemen) with per capita income as low as $180 for 1975. Kuwait's per capita income is 65 times that of North Yemen. Such a disparity will do doubt attract labor. Labor was "pulled" away, so to speak, from underneath the umbrella of the extended family and the local communities and on to the new opportunities in the oil producing country. From the statistics available for the year 1975, 17.5% of Bahrain were foreigners, 52.5% of Kuwait, and 59% of Qatar.[53]

Furthermore, there is also short distance migration, i.e., internal--within a country--migration. rurals and those without specific skills are increasingly migrating to the outskirts of the capital city. In the words of Alvin Toffler, "We are witnessing a historic decline in the significance of place to human life. We are breeding a new race of nomads, and few suspect quite how massive, widespread and significant their migrations are."[(54)] The traditional nomads, however, move with the extended family keeping their own norms, values, and customs. The values directing the mobility of the traditional nomads are basically altruistic and for the benefit of all. Not so with the current population movements. The values directing this mobility are economic; they are based on self interest, where contractual agreements, not traditional norms, control interrelationships. The contracts adhere, supposedly, to the norms of achievement, specificity, and universalism.

This geographic mobility is creating far reaching social consequences.

(a) Homogenizing the people of the region. The continuous reshuffling of the people is providing a built-in mechanism for homogenizing the population in the region. By draining the non-oil producing countries of this skilled labor, the oil producing countries are changing the texture of the population. To have 52.5% of Kuwait and 59% of Qatar be non-nationals is not an insignificant number. Then during the vacation season, the direction of mobility is reversed.

Labor returns home, and people from the oil producing countries spend their leisure time in the non-oil producing countries--Lebanon, Syria, and Jordan.

The twentieth century advances in the technology of transportation are also aiding the process. Currently, air transportation is a major infrastructure connecting the countries of the region.

(b) Redistribution of income. Geographic mobility is also providing a built-in mechanism for redistributing income. Through this mechanism, the rise in income in the oil producing countries is spilling over to the rest of the region. Labor returning periodically brings their savings to their home countries, and vacationers from the oil-producing countries spend their money in the host country. Jordan, for example, reports one million dollars for its budget comes from its nationals working in the oil-producing countries.

(c) Expansion of the woman's role. A final consideration for the effect of mobility involves the working woman and her commitment to a career. Geographic mobility is affecting the female's traditional structural role. Occupational opportunities in the oil producing countries are incorporating the females. Women are being sought to occupy mostly teaching positions in the oil-producing countries. Women, mostly single, are leaving their communities in greater numbers to join the labor market in the oil-producing countries. The roles they occupy are mostly limited to teaching. No statistics are currently available on the number of females presently with careers in the oil producing countries. But they are there and in high demand. Although her participation in the labor force is restricted to a few occupational roles, the image of a career woman away from her local community is certainly a different image from that of a woman confined to a home under the supervision and protection of the family. It is a small, but a significant step, in blurring the demarcation lines and the boundaries of sex roles.

(4) Increasing population. Other social changes in society are demographic. In all the countries of the region the population is increasing, (see Table A.6). The region is experiencing a high birth rate. Table A.8 shows the birth rate and the death rate for the year 1970 and 1975--not much change. The birth rate for the year 1975 ranges from 33 per 1000 for Lebanon to 51.1 per 1000 for Kuwait. This is a high birth rate, one of the highest in the world. (Compared with the U.S. birth rate of only 14.9 for the year 1974).[55] On the other hand, the death rate ranges from 6.1 for Kuwait to as high as 25 per 1000. Though for some countries the death rate is still high, in general, the death rate in the region is getting lower. (Compare the death rate in the U.S. for 1974 which was 9.2.)[56]

Consequently, the regional population is relatively young. Table A.9 shows the age distribution in the countries. In 1975, in all the countries of the region, around 50% of the population was under 15 years old. At the same time, the percentage of 65 years and older was relatively small, ranging from 1.6% (Kuwait) to close to 5% (Lebanon). (Compare that with U.S. which had almost 27.1% of its population under 15 years old and 10.5% of them 65 years and over in 1975.)[57] This distribution in age structure is significant for the region. It means that the bulk of its population is under 15 and will be ready to enter the labor market, which the countries so desperately need, in the coming years. It means also that the elderly are still an insignificant minority and that they have not surfaced yet as a social problem, as is the case presently in the industrialized societies. Separate institutions for the elderly are virtually non-existant, and the traditional norms of taking care of the elderly by the extended family are still prevalent. It is not socially acceptable to do otherwise. What will happen when their number increases is now mere speculation.

(5) Better health programs and services coupled with more nutritious food. These two factors largely account for the growth in population. The combination

led to a longer life expectancy and a decline in infant and child mortality. In Table A.10, health practice, indicated by the number of persons per physician and per nurse, shows an improvement between the years 1960 and 1975; the ratio of patients to physicians had lessened during this period, and concommitantly life expectancy between 1960 and 1975 had increased in a range of 6 years (Lebanon) to 9 years (Kuwait), and with an average increase of 7.8 years. Undoubtedly, then there is a definite effect on life expectancy and the child mortality rate by having more physicians and nurses in the countries, as is shown in Table A.11. The table ranks the countries according to health practice and compares the ranking with life expectancy. The comparison shows that the fewer the number of patients to physicians, the higher the life expectancy. A computed Pearson moment correlation between health practice and life expectancy of -0.6 indicates that people living in countries with better health practice live longer. For instance, Kuwait which currently has the highest life expectancy (67) in the region has the fewest number of persons per physician (1,140) while Yemen, which has the lowest life expectancy (45) is ranked the highest as to the number of persons per physician (26,440).

(6) The diffusion of mass communication. This is another significant socializer currently encroaching on the role of the family. Each country has its own television station; and the satellite is bringing events around the world instantaneously to the remote villages in the region. Information from any source, the capital city and otherwise, can penetrate fast and reach any destination or locality in the region. Values, norms, customs, and various aspects of foreign cultures are continuously being flashed on the television screens for entertainment, advertisement, and various other purposes. Thus, the local culture is no longer immune from being penetrated by other cultures. Even before the era of television, Lehrner[58] as early as 1963, noted that the pace of change had been immensely accelerated by the coming of mass media (radio and movies). These mass media, he observed, have come onto the world stage along with many mass-produced consumer goods which have altered the imagery of ambition out of all keeping with the traditional limits. This observation by Lehrner is manifested in the increase in foreign imports recorded by the countries of the region for the year 1975, over the year 1968. Table A.12 depicts the increase; the ratio comparing the imports in these two years goes as high as 30.1 (Oman). Clearly, the region is increasingly becoming a big consumer on the world

market. The new wealth along with the diffusion of mass communication, especially the television, has opened the area wide for world-wide economic speculation and trade activities.

The role of television in transforming the social structure cannot be underestimated. The significance of television as a socializer has been confirmed by several studies. The studies by Bandura and Walter are worth mentioning. They exposed nursery school children to different kinds of models with different patterns of behavior (aggressive and nonaggressive), which had different kinds of consequences for the models (rewarding and punishing). The results indicate that children who observed aggressive models responded to subsequent frustrations with considerable aggression, much of which immitated the observed behavior, whereas equally frustrated children who have observed models displaying inhibited behavior tend to match the non-aggressiveness of the inhibited model.[59] This is an important finding. The child internalized the norm of proper conduct through exposure to a movie film. No one told the child what was wrong and right in behavior; the mere observation was enough to internalize the norm.

Television is important from another social aspect. Observation does not require skill or literacy;

one does not have to be literate to observe; and, therefore, happenings around the world are no longer the exclusive privilege of the rich minority and the educated.

(7) Greater disparities between rural and urban standards of living. This social trend is a consequence of the above-listed changes. The on-going changes in the society of the region are stopping at the urban level and are not penetrating the rural communities. The rurals are living in the unreality existing in the region. The prosperity all around is contrasted with the extreme poverty in the villages. Village life is a paradox. It is in desperate impoverishment in a region of plenty. Today a large number of villages maintain a way of life that was "appropriate" before the oil era. The old rural institutions are not changing, and the constraints of class hierarchy and the settled village life are still intact. And the villagers are not adapting to the new situation. The crucial thing is to release the individual energy so long held back by rigid social customs and hierarchical forms. However, the young and the ambitious who are realizing the new realities are leaving the rural communities. "And civil servants are hesitant to accept work in rural areas."(60)

Moreover, the public policies are not helping. The polarization of development efforts toward meeting the needs of growing urban centers is further widening the gap between urban and rural centers in the standard of living.[61] There is no proper balance or social equity in the distribution of public services between the rural and urban areas. The extreme segregation in favor of urban centers is having its impact. The rurals lag behind the urbans in income, education, health, and other aspects of social and economic life.

(8) Wider generation gap and increasing the polarization of two ways of life. The people are increasingly being stratified into those who move to seek new job opportunities (The Mobile), and those who are left behind maintaining the status quo (The Immobile). The rural exodus is ravaging the rural social fabric, breaking down the village communities; families are shattered for the same reason. For the Mobile, new relationships replace the ties of tradition, custom, religion and respect. The new situation threatens him with the possibility of unemployment and a sense of inadequacy in education and skill where these qualifications for the individual are becoming increasingly valuable. On the other hand, for the Immobile, among other things, the prospect of old age insecurity poses as a threat for the future.

(9) Other social changes. No doubt there are other on-going social changes, such as a trend toward lessening religiousity and a trend toward more civil

disobedience (deviancy), but there are no statistics on that, and they do not seem to be significant social issues in the Hobbesian sense. One plausible explanation, is that the mobile get into a new type of social organization, related to work, bureaucracy, etc. that controls the social order. This one needs further research for confirmation.

These are the major changes in the social life currently taking place in the Arab-Asian region. However, while many aspects of social life are changing and at an accelerating rate, many aspects remain basically unchanged:

(1) The persistent traditional economic structure (Organizational Lag). The society of the region has not experienced yet a major change at the organizational level. This aspect of social life shows a reluctance to change. There is an attitudinal reluctance on the part of the young to take courses for technical training. Manual labor has a low value. High school students go to the universities, rather than technical schools. There are no local nationals to fill the emerging technical roles. This shortage of technical manpower represents a significant obstacle to the transition from the traditional to the developed society.[62] Additionally, outside experts are brought in to do the work. A report by the United Nations[63]

states that expatriates are being utilized not so much to train nationals as to fill vacant posts and carry out day-to-day work. Substantial development projects are usually undertaken by foreign consulting firms while national engineers are not given the chance to acquire practical experience and organizational skill. A lack of qualified manpower will remain one of the main barriers which could slow the process of development. Manpower strategy has not been conceived yet as a national policy to channel talents and abilities for a specific national goal. Without the government initiative, it is difficult to perceive that this aspect of society will change fast enough to meet the challenge of development, at least not on a large scale.

(2) Rural institutional lag (Implied in the foregoing discussion). Though the extended rural family is disintegrating due to the flight of young men from the rural communities, socio-economic activities in the village are still conducted on family basis. With the young and the ambitious leaving and the authority of the elderly still persisting, the rural areas are deteriorating at an accelerating rate. The family cannot buy modern farming equipment to replace labor, nor is there an organization among farmers for the sharing of water or equipment. And "farmers are usually not willing to accept new farming methods and techniques unless

they are convinced of their value."[64] Government initiative is needed to coordinate the farmers; otherwise the persistence of the norms of the traditional family and the rural social hierarchy will continue to be the barriers to the farmers' community coordination.

This is the social situation in the Arab-Asian countries. In general, the region is in a stage of rapid transition, organizing and disorganizing, and the style of life is changing; in short, it is modernizing.

But, is the region really developing? How is the scarcity of water interacting with these on-going societal changes and trends? Water adequacy is not an absolute phenomenon. Water adequacy is relative to the demand by society. And the demand is not static; demand for water varies depending on these on-going social processes and trends. The next chapter analyzes the trend in agricultural production in the region. Agricultural production is an empirical manifestation of the developmental impact of the interaction between water adequacy and the on-going societal changes. In this arid region, agricultural production is dependent on irrigation.

CHAPTER IV

AGRICULTURAL PRODUCTION IN THE REGION

The Trend in Per Capita Food Production

Agricultural production in the Arab-Asian countries lags behind the region's increased demand for food. Table 4.1 reveals the decline in the per capita agricultural output. The annual change in the per capita food production serves as a useful indicator of the strength of a country's agricultural economy. As a minimum, increase in food production should match the increased demand for population growth. Ideally it should go beyond the average 3% increase in population due to the rise in income, and the necessity to provide a more nutritionally adequate diet. Instead, in this region, the output is declining below the minimum.

This alarming trend is creating a great concern in the region. The Arab-Asian countries are the highest per capita food importers in the world.[65] Table A.13 depicts the acceleration in agricultural purchases in the region. In a decade (1965-1977) the region's food imports increased seven times. Table 4.2 ranks the countries according to each country's ratio

TABLE 4.1.

Index Numbers and Annual Change of Food Production Per Capita in Selected Arab-Asian Countries, Selected Years (1969-71 = 100) (Percent)

Country	Index (Percent)					Annual Percentage Change	
	1970	1975	1976	1977	1978	(1969-71)-1978*	1978 - 1977
Iraq	99	70	83	71	84	-4.3	18.3
Jordan	79	74	75	63	61	-7.0	- 3.3
Lebanon	99	91	86	84	83	-3.4	- 2.2
Syria	88	139	158	141	147	5.7	4.3
Saudi Arabia	103	100	86	90	88	0.4	- 2.3
YPDR	92	110	108	102	98	0.2	- 3.0
YAR	85	108	98	93	91	-1.6	- 2.2

*Exponential

Source: UN-ECWA/FAO. Agriculture and Development, May 1979.

TABLE 4.2.

Rank Order of Countries According to Ratio Increase in Agricultural Imports (1977/1961-65)

Rank	Country	Ratio Value*
1	UAE	60.5
2	YAR	36.5
3	Oman	14.9
4	Bahrain	13.8
5	Saudi Arabia	11.7
6	Qatar	11.3
7	Iraq	7.8
7	Syria	7.8
9	Kuwait	6.6
10	Jordan	6.1
11	Lebanon	3.3
12	YPDR	2.1

Sources: Ranked from Table A.13

$$\text{*ratio value} = \frac{\text{Import 1977}}{\text{Average Import 1961-1965}}$$

of increase in food imports during this time interval. The ratio goes as high as 60 times. Concern over food imports is a recent one happening in the late 70's. Previously, the agricultural sector was not given the priority it actually deserved. Instead, nonagricultural developments were emphasized. The oil producing countries considered it marginal and only recently has a dramatic change in attitude taken place.(66) Currently, "food security" is becoming a major issue and the concept of "self-sufficiency" in food is being questioned. The countries are depending more and more on foreign countries to feed their people. Table 4.3 shows that the per capita self-sufficiency ratio for the major food commodities is dropping in all the countries of the region, and that food output thus far does not seem to pacify this concern; on the contrary, the food production situation is getting worse.

Irrigation vs. Dry Farming in the Region

It is clear that farming in the region is now unproductive. The yield is unstable and poor. In order to increase the quality and amount of the yield, irrigation is a necessity. However, water is not currently adequate to meet the demand for such irrigation. Only 30% of cropped land is perennially irrigated.(67)

In the region fresh water is used for irrigation. There are three major sources from which irrigation water

TABLE 4.3.

Annual Change in Per Capita Consumption and Self Sufficiency for Major Food Commodities in the Region of the Arab Asian Countries, 1970-1977

Commodity	Self-Sufficiency Ratio (Percent) 1970	1976	1977	Growth Rate 1970-1977	Per Capita Consumption Growth Rate 1970-1977
Wheat	69	54	39	- 4.2	4.0
Rice	24	13	15	-13.6	2.6
Pulses	92	90	98	- 0.7	6.0
Sugar	8	6	5	- 6.2	4.6
Vegetable Oil	50	64	37	- 1.7	-0.3
Red Meat	58	55	50	- 1.8	1.3
Poultry Meat	81	36	38	- 4.7	16.1
Hen Eggs	78	67	74	- 1.5	3.8
Milk	65	60	56	- 2.3	2.4
Fish	101	99	99	- 0.6	-0.4

Source: ECWA-UN/FAO. Agriculture and Development, May 1979.

originates; rivers and springs, floods, and underground water. In the countries of the northern subregion, by far the major share of irrigation is from canals which divert water from a major river (Euphrates, Tigris, Khabour, Orontes, Litani, Jordan) as well as a number of smaller rivers of local importance. Such canal networks are major undertakings constructed and managed by the governments, with the water being used by individual farmers.(68) Table A.14 shows the annual quantity and sources of water used for irrigation.

As expected, in the region as elsewhere, the yield of the crop is higher when irrigated than when rainfed. Table A.15 compares the average yield of selected crops in irrigated and rainfed sectors in the various countries in the region. The table demonstrates clearly the advantages of irrigation.

Comparison in Food Production in the Irrigated Land Between the Countries in the Region and Outside Countries

According to the United Nations' Food and Agricultural Organization (FAO), the yield of irrigated land in the region is disappointing when compared to that achieved by other countries. The yield in the other countries is 2.5 to 3.0 times higher.(69) This observation by FAO is confirmed in the conclusion, presented in Table A.16, by the Kuwait Institute of Economic and Social Planning in the Middle East. The table compares Iraq, a leading agricultural country in the region, with some selected countries from around the world. Except for Turkey in the tobacco production, Iraq ranks the lowest in agricultural production for all the crops and across all the years.

The depressing results of irrigation could have been avoided had the farmer been exposed to and trained to use modern technologies, such as drip or spray irrigation, as opposed to flooding his land with water. Thus, the poor water management by unknowledgeable farmers and the institutional lag led to logging and salinization of the soil.(70) Salinity and water logging normally occur together. When soil becomes water logged, dissolved salt precipitates on the surface of the soil as the water evaporates. This actually occurred in Iraq and the Euphrates valley of Syria, where large areas of irrigated land went out of cultivation due to water logging and salinity.(71)

Nevertheless, there is potential for improvement in agricultural production. Expansion in irrigation development and rehabilitation of land that has gone out of cultivation will alleviate the problem of low agricultural production in the region and will increase the returns to the farmer for his labor.

The big problem is that the fresh water in the region is not enough to meet the potential demand for irrigation. Table 4.4 compares the water demand for irrigation and the potential available supply by the year 2000 and computes the shortages of water for selected countries in the region (Syria, Jordan, Iraq). These countries must obviously look for a new source of water to satisfy the needed future requirements of irrigation.

Water reuse provides such a resource. The computation in Table 2.6 in Chapter II shows that 1,009.5 million cubic meters of new water will be reclaimed, and an additional 83,793 irrigated hectares will become available by the technology of domestic wastewater reuse.

However, the salinity and logging problem in Syria and Iraq shows that low agricultural production is not only a water shortage problem, but also a societal problem; that water, though a necessary factor, is not sufficient for agricultural development; and that the outcome of the technology depends on the processes of transfer and adaptation. In short, agricultural development is an on-going process of <u>interaction</u> between the parameters of society, water and other resources, environment and technology existing in the region. The current low level of production is leading to farm exodus. Table A.17 shows the drop in labor in

TABLE 4.4.

Future Water Shortages for Irrigation in Selected Countries of the Arab-Asians by the Year 2000

Country	Water Use Per Irrigated Hectare* (CM)	Future Irrigation *x10^3 (Hectare)	Future Agriculture Demand*x10^3 (CM)	Potential Water for Agriculture x10^3 (CM)	Shortage for Irrigation***** x10^3 (CM)
Iraq	15,950	4400	70,180,000	52,100,000**	18,080,000
Jordan	8,600	140	1,204,000	580,000***	624,000
Syria	11,600	1250	14,500,000	11,800,000****	2,700,000

*FAO/ECWA, <u>Agriculture and Development</u>, 1979.

**Baghdad Council, <u>Country Report</u>, 1976.

***Kingdom of Jordan, <u>Five Year Plan 1976-1980</u>, National Planning.

****Syrian Arab Republic, Prepared by Safadi, C., <u>Water Resources in Syria</u>, 1974.

*****Computed. (Future Agricultural Deman-Potential Water Available).

the agricultural sector. Loss of labor means a further loss in agricultural production, because in these under-developed countries, agriculture is still labor-intensive.

The next chapter analyzes the development process in the region: How the interaction system is developing in the agricultural sector, and how the interaction system is developing in the domestic sector. The two sectors are interrelated and are only separated for analytical purposes. The information analyzing the interaction will have implications for programming the technology and assessing its impact on the society of the region (see Chapter 1).

The forthcoming analysis of the interaction is viewed in a time perspective. It leans on the past to explain the present, and extrapolates that to the future (see Figure 1.2). As Mumford says, "If we do not take the time to review the past, we shall not have sufficient insight to understand the present, or command the future."[72]

CHAPTER V

THE DEVELOPING SYSTEM OF INTERACTION IN THE REGION BETWEEN WATER, SOCIETY, TECHNOLOGY AND ENVIRONMENT:

THE AUTHOR'S OWN PERSPECTIVE OF ASSESSING THE POTENTIAL IMPACT OF A TECHNOLOGY ON SOCIETY

This chapter analyzes the development process--the on-going interaction--in the Arab-Asian countries. The focus is on how the societal changes and lags are interacting with water adequacy in terms of quality and quantity, the environment in terms of pollution, and the technology in the region. Part I analyzes the process in the domestic sector while Part II analyzes it in the agricultural sector.

PART I. THE INTERACTING SYSTEM IN THE DOMESTIC SECTOR

A. Population Pressure and Domestic Water

A major factor constraining the quality and quantity of domestic water is the exponential growth in population. It is leading to excessive water demand relative to the available supply. There is no dispute to the proposition that other things being equal, the more people, the more the demand for domestic water. An exponential growth in population requires, at a minimum, similar exponential increase in domestic water supply.

In all the countries of the region the population is on the rise (Table A.18). Like most developing countries, the annual average growth in the population is around 3%, and the projection is for continued growth until the closing of the twenty-first century or the start of twenty-second century. Then a stationary population is expected (Table A.19). Such a conclusion is based on a study of the region by the World Bank. According to the World Bank, if the present regional population growth continues, the population by the end of the twenty-first century will be several times its present level. Table 5.1 computes the ratio of the hypothetical stationary population predicted by the Bank to the current population. The ratio ranges from 3.0 (Lebanon) to 7.0 (Kuwait).

There is no reason to believe that such a projection will not come about. The norms of society and religion support such an increase; "Children and money are the ornaments of Life" is a sacred saying. Moreover,

TABLE 5.1.

Comparison of Hypothetical Stationary Population Over Current Population

Country	Hypothetical/Mid-1976 (Millions)	Ratio
Democratic Yemen	9/2	4.5
Iraq	65/12	5.4
Jordan	11/3	3.7
Kuwait	7/1	7.0
Lebanon	9/3	3.0
Saudi Arabia	48/9	5.3
Yemen	26/6	4.3

Source: Compiled and computed from the World Bank, etc. The World Bank, August 1978, _World Development Report, 1978_, Washington, D.C., pp. 106-107.

government policies will not limit this growth. In fact each country has its own national policy to encourage the continued population growth by various means. For example, Kuwait provides a cash bonus to a family for each additional child born. This policy has had its effect; Kuwait is now experiencing a 6.5% growth rate, the highest in the region (see Table A.18). The incentive for the increase is due to the need for labor. The countries of the region are underpopulated and severely limited on manpower, especially in the oil producing countries. Even Lebanon complains of shortages[(73)] in skilled labor and professionals due to the brain drain to oil producing countries and others. Jordan is facing a similar situation. According to the projection of the Industrial Regional Advisor for the United Nations Industrial Development Organization (UNIDO),[(74)] the outflow of labor from Jordan is becoming so crucial that Jordan's development activities are already suffering from these shortages and it will not be long before Jordan has to import labor. For instance, several existing electrical establishments which UNIDO visited currently face difficulties in recruiting and in retaining the required manpower.

These demographic facts are constraining the water supply. Assuming that the population will more than double by the year 2000, which the World Bank has projected (Table A.19), and assuming that the continued current per capita consumption, the domestic demand for water, will more than double by the year 2,000, Table 5.2 computes the expected increase in domestic demand for water by the year 2000 due to this population growth factor. The society faces a challenge to meet the domestic water requirements because of this specific factor alone.

B. Socio-economic Trends and Domestic Water

The continued present per capita amount of domestic water consumption is used to illustrate the magnitude of the increase in domestic water requirements due to the population increase factor. It is, however, unrealistic and oversimplified. Domestic water requirements vary widely in time and place. Even within one country the variance in domestic water's per capita consumption at any point in time can be quite wide. In Saudi Arabia, for instance, the daily per capita domestic water consumption is 60 litres in Jedda, 160 litres in Riyadh, 87 litres in Dharan, and 40 litres in Ras Tannura.[75]

Domestic water requirements depend, also, on hosts of other various social factors. Besides price, the United Nations[76] lists three social factors as major influences on domestic water per capita demand:

TABLE 5.2.

Domestic Water Demand by Year 2000 Assuming Current Level Per Capita Water Consumption

Country	Current (1976) Domestic* Usage (Million m^3)	Current (1976) Pop.** ($x10^6$)	Current (1976) Per Capita Consumption (Usage/Pop) (m^3)	Future (2000) Pop.** ($x10^6$)	Future (2000) Domestic Usage Current Per Capita x Future Pop. (Million m^3)	Future (2000) Minimum Domestic Increase, Assuming Future - Current Domestic Usage
Iraq	580	12	48.3	25	1,207.5	627.5
Jordan	40	3	13.3	5	66.7	26.7
Kuwait	75	1	75.0	2	150.0	75.0
Lebanon	94	3	31.3	5	156.5	62.5
Saudi Arabia	830	9	92.2	19	1,752.2	922.2
Syria	400	8	50.0	15	750.0	350.0
TOTAL	2019	36	56.1	71	4,082.9	2,063.9

*Report of the ECWA Regional Preparatory Meeting for UN Water Conference. Baghdad, Iraq, 11-16 of December 1976.

**The World Bank, World Development Report, 1978, Washington, D.C., August 1978, pp. 106-107.

1. The income level of inhabitants
2. The customs and traditions in water use.
3. The facilities supplying the water to users.

The presumption of the continued present per capita water demand hence presupposes a ceiling on the on-going social changes in the region. It assumes, among other things, that per capita income has leveled off, that the existing pattern of water usage will not alter, and that the current domestic water delivery service will not change. In short, it assumes a static society, but the society of the region is far from being static.

In the following analysis, four water-related societal variables indicative of the standard of living or socio-economic factors--are examined in the region, and their interrelationships with domestic water are described:

1. Per capita income
2. Pattern of domestic water usage
3. Water delivery
4. Wastewater disposal

These variables are interrelated and separated only for analytical purposes. Domestic water usage is not given a separate heading since it is significantly related to all of the other variables and will be included in the discussion.

Water rates are excluded from the analysis. Usually rates are used to cut domestic water consumption. But water is first an indispensable resource; it is not a luxury item subject to the rules of the market. Second, water is supposedly a public domain, which means there is nowhere else to get it. Third, the cost cannot be set too high, prohibiting the poor from buying it.

Therefore, a purposeful cut in water consumption for domestic purposes can result in only a slight saving, hardly significant in comparison with total family expenditure. In other words, water demand relative to price is inelastic (Figure 5.1).

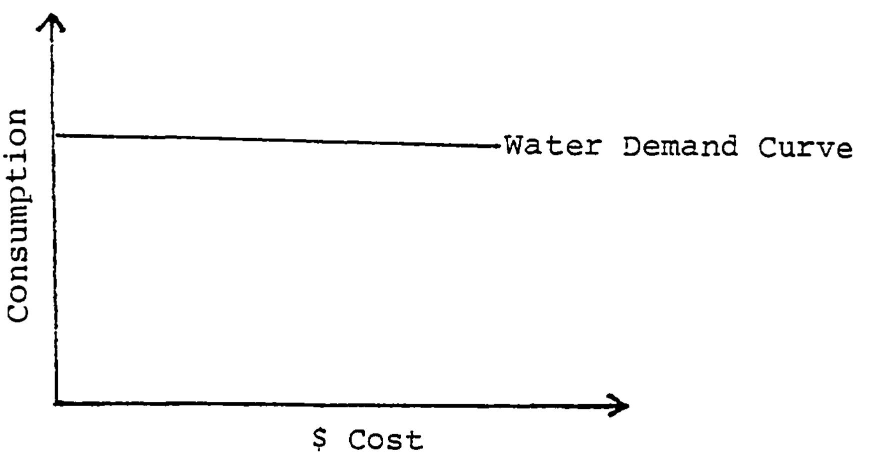

FIGURE 5.1. Inelastic Water Consumption Relative to Cost.

(1) Per capita income and domestic water consumption. In the Arab-Asian region income is on the rise. Table A.20 shows the annual rise in national per capita income within the region. The table reveals the extreme disparities between these countries in the growth of national and per capita income. The annual percent gain in per capita income goes as high as 51.7% for Saudi Arabia and as low as 4.2% for South Yemen. However, despite these great disparities, the per capita income in all the countries shows an upward trend. Table A.7 of Chapter III compares the per capita income in 1970 with that of 1975. The per capita income more than doubled in most of these countries. The ratio goes as high as 8 times for Oman. Table 5.3 lists, in time series, the annual per capita income in the region as a whole. Figure 5.2, plotting the data, shows no abatement in the rise of the per capita income. The per capita income is rising at an accelerating rate. Additionally, per capita income abruptly rises after 1973, the year that triggered the sharp rises in the oil prices.

This upward trend in per capita income will most likely continue. Oil prices continue to rise, and so will the revenues of the countries.

Per capita income is a major influencing factor in domestic water demand and consumption. It is important for at least two significantly interrelated reasons.

TABLE 5.3.

Construction and Per Capita Income in the Region

from 1960 to 1975

Year	Construction Million U.S. $	Per Capita Income U.S. $
1960	308	289
1961	330	305
1962	333	327
1963	405	333
1964	440	364
1965	500	382
1966	554	404
1967	590	411
1968	671	431
1969	716	455
1970	745	475
1971	929	606
1972	1114	711
1973	1898	1167
1974	2290	1937
1975	2905	2301

Source: Compiled from ECWA-UN. Statistical Abstract of the Arab World. First Issue, Amman, Jordan, 1977.

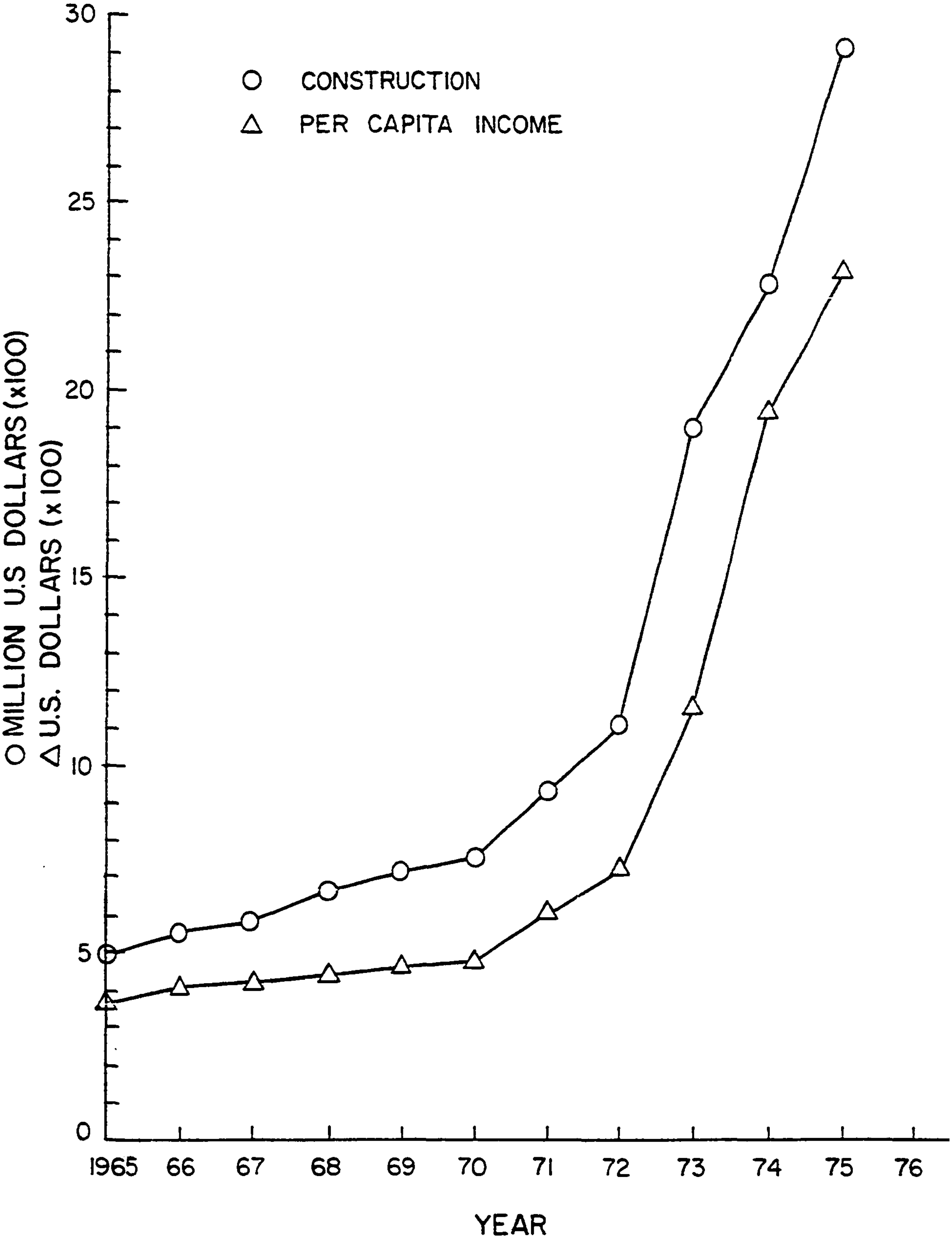

FIGURE 5.2. Time Series of Construction and Per Capita Income in the Arab-Asian Region.

First, the rise in income provides the people with purchasing power to build more and more modern houses. Construction is used here to indicate housing development. Table 5.3 lists, in time series, the annual construction in the region as a whole. The graph plotting the annual per capita income in Figure 5.2, also plots the annual construction for comparative purposes. The rise in annual construction is also not abating, and like the per capita curve, the construction curve rises sharply upward in 1973 and thereafter, thereby indicating the strong relationship between income and construction.

Construction of modern housing is important in water demand. For one thing, the type of housing is related to water consumption.(77) Modern housing is equipped with flushing toilets, bath and/or showers among other things. Akron(78) estimates that a typical bath uses 20 gallons*, showers 5 gallons per minute using 1/4 inch pipe, and toilet flushing 113 gallons/capita/day. Reid(79) estimates a bath to be 80 gallons/capita/day for the largest users, and 96 gallons/capita/day for toilet flushing. Whatever the estimates, the quantities are a measure of the expected increase in water consumption due to the addition of these equipments to the homes. Compare that with per capita daily consumption in Ras Tannura, Saudi Arabia, which is currently 40 litres or 10 gallons.

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*1 gallon = 3.785 litres

Furthermore, continued construction in housing is important for another reason; it gives the people room to spread out, thereby reducing the density of housing. Density of housing is related to per capita water consumption. There is no data from the region relating density of households to water consumption. But such data is available from other countries. White and Bradly report that such a relationship does exist in Kenya, Uganda, and the United Republic of Tanzania.[80]

Second, with the rise in income, water use multiplies. The rise in income is providing the people with the means to buy desired modern appliances, such as washing machines and dishwashers. Even North Yemen, the poorest country in the region is purchasing these water-consuming appliances.[81] No statistics are available from the region on the quantities actually purchased, but these modern conveniences are increasingly being purchased. Again to quote Reid and Akron,[82]

Item	Reid (Gal.*/ capita/day)	Akron (Gal./ capita/day)
Dishwasher	15	16.5
Laundry	34	11
TOTAL	49	27.5

* 1 gallon = 3.785 liters

Thus, the addition of these items increases the demand for water. In Kenya, the estimate of water consumption due to a higher income is shown in the variance of water consumption between low income group and a higher income group. For the low income group domestic water consumption is as low as .35 gallons/capita/day (1.3 liters/cd); while the domestic water consumption for the high income group is 165 gallons/capita/day (624.5 liters/cd).[83]

While income allows for the purchasing of these modern housing equipments and appliances, these additions to the life style will not operate without adequately flowing domestic water. Obviously, then, these on-going purchases increase and will, in turn, increase even more the demand for domestic water up to and beyond the rise due to the population factor. In addition, these purchases are cumulative, in the sense that they are domestic capital investment, and their effect on water requirements, is therefore, cumulative.

(2) Water delivery facilities and domestic water consumption. Another societal criteria for the standard of living and related to domestic water consumption is the facility used in the region to supply domestic water. The facility supplying water to domestic users is a major factor influencing the level of domestic water demand. It relates to the convenience of the location of the domestic water supply. The impact on domestic usage due to the convenience of water supply may be 5 to 10 times as much water.[84]

WHO surveyed the water supply facilities in the region.[85] The findings are summarized in Table 5.4. The table lists the water supply services in 1970 and

TABLE 5.4.

Community Water Supply--Comparison of Services, 1970 and 1975

	Urban Population Served												Rural Population With Reasonable Access				Total			
	By House Connections				By Public Standposts				Total Urban											
	1970		1975		1970		1975		1970		1975		1970		1975		1970		1975	
Country	N'000	%	N'000	%	N'000	%	N'000	%	N'000	%	N'000	%	N'000	%	N'000	%	N'000	%	N'000	%
Bahrain	154	91	195	95	15	9	10	5	169	100	205	100	46	94	50	100	215	99	255	100
Iraq	3,600	65	6,900	98	966	18	118	2	4,566	83	7,018	100	300	7	462	11	4,866	51	7,480	66
Kuwait	120	18	496	50	280	42	495	50	400	60	991	100	--	--	--	--	400	51	991	89
Qatar	120	94	152	99	8	6	2	1	128	100	154	100	24	75	30	83	152	95	184	97
Saudi Arabia	1,164	82	1,050	55	256	18	800	42	1,420	100	1,850	97	2,410	37	4,000	56	3,830	49	5,850	64

Source: WHO. Regional Office for the Eastern Mediterranean. The Attitude of WHO and Its Activities in Water Resources Development in ECWA Countries. Prepared for the Regional Preparatory Meeting for the UN Water Conference. November 1976.

1975 for both rural and urban areas for selected countries in the region. It is apparent from the table that:

First, there are levels of accessibility to sources of water supply (connection, public standpost, and nonaccessibility).

Second, that the overall trend is for more accessibility. (In all the countries, the percent of population served is higher in 1975 than in 1970).

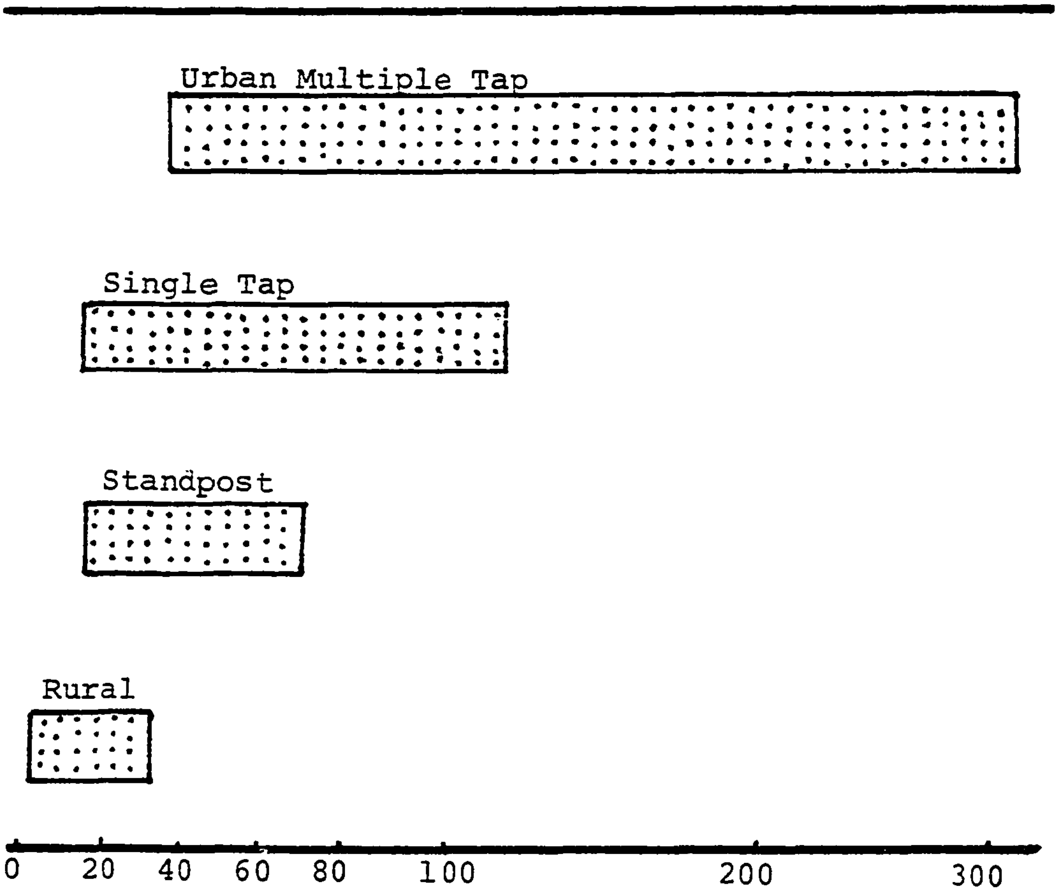
Third, that in all the countries the rurals lag behind the urbans in domestic water accessibility in both years, 1970 as well as 1975.

Of course, in many rural areas and in some urban areas having no such accessibility, water may have to be hauled from a distant well or spring, and this will no doubt lessen domestic water consumption.

There is no data from the region to indicate the relationship between the level of accessibility to sources of water and water consumption. However, the United Nations provides a guiding diagram of the range of the per capita domestic water consumption in relation to the users level of accessibility to sources of water supply (Figure 5.3). The figure clearly depicts a direct relationship between per capita domestic water consumption and levels of accessibility.[86]

Also the U.S. Department of Health has estimated the effect of the type of water delivery services on

FIGURE 5.3. Range of Daily Domestic Use, Per Capita.



Source: ECWA-UN. Document E/CONF. 70/CBP1. Water Resources Assessment. July 2, 1976.

domestic water per capita consumption in the United States households.(87) The U.S. estimates are consistent with the U.N. guiding diagram:

Households	Gallons*/capital/day
With One Hand Pump	10
With one pressure faucet at the kitchen	15
With hot and cold running water, in the kitchen, laundry and bath	50

*gallon = 3.785 liters

Accordingly, the trend in the region for easier accessibility of domestic water supply to the users is another indicator in the rise of the standard of living in the region which is increasing the per capita domestic demand for water and which will increase it up to and beyond that increase due to the population growth factor.

The rapidly rising domestic per capita demand for water due mainly to these on-going socio-economic changes and the population growth is overtaking the water supply and exacerbating further the scarcity of the domestic water problem. In general, the countries of the region are all experiencing underground water depletion. Wells, which were until recently the main source of fresh water for the region, especially for the oil producing countries, are drying out. The increase in demand is overdrafting the available potential supply. Table 5.5 shows the known quantities in the region and the deteriorating qualities of underground water in certain countries. In addition, the underground water depletion is affecting springs and fountains, such as Khouta Springs in Syria, the main source of fresh water for Damascus.[88] Figure 5.4 depicts the impact of societal trends on the available water supply in the region.

(3) The wastewater disposal service and domestic water supply. This is another societal criterion in the standard of living which is affecting domestic water supply. Pressure exists on water resources from the societies' prevailing pattern of wastewater disposal.

WHO studied the sewage collection system in the region. Only four countries provided the World Health Organization with the needed information--Iraq, Oman, Qatar, and Saudi Arabia. WHO's statistical findings are presented in Table 5.6. The table shows that:

First, like the water delivery system, there are various levels of sewage disposal in the region (sewage system, septic tanks, buckets, and no collection facility).

Second, except for Qatar, which claims 100% sewage collection service, the wastewater situation is clearly posing a health hazard threatening the communities of these countries; only 4% of the population in

TABLE 5.5.

Groundwater Sources in the ECWA Region

Country	Production	Quality	Remarks
Bahrain	1199 Mcm/y[1]	Deteriorating	Water tables drop markedly
Iraq	126 Mcm/y	200-3000 mg/l	Well administrated by the Government
Jordan	165 Mcm(1975)	High	Subject to contamination
Kuwait			
Rawdhatain		300-1300 mg/l	
Other Fields	130 Mcm(1974)	2500-5000 mg/l	
Lebanon	50 Mcm/y		Estimated regularly
Oman	650 Mcm/y	200 mg/l	
Qatar			
Northern part		500-2000	
Southern part	50 Mcm/y	2000-5000	
Saudi Arabia			
Eastern part	1723 Mcm/y	350-820 mg/l	28,000 wells
Wajid aquifer	100 Mcm/y	530-820 mg/l	
Minjur aquifer	460 Mcm(Storage)	Good	Level dropped 45mm (During 1956-68)
Saq aquifer	N.A.	High	
Tabouk aquifer	N.A.	Good-very bad	
Syria	1600 Mcm/y	Good-fair	Depleted due overdraft
UAE	270 Mcm/y		
Yemen Arab Republic	N.A.		
Yemen People's Democratic Republic	350 Mcm/y		

1/: Safe yield.

N.A.: Data not available.

Source: ECWA-UN. Baghdad Meeting, 1976.

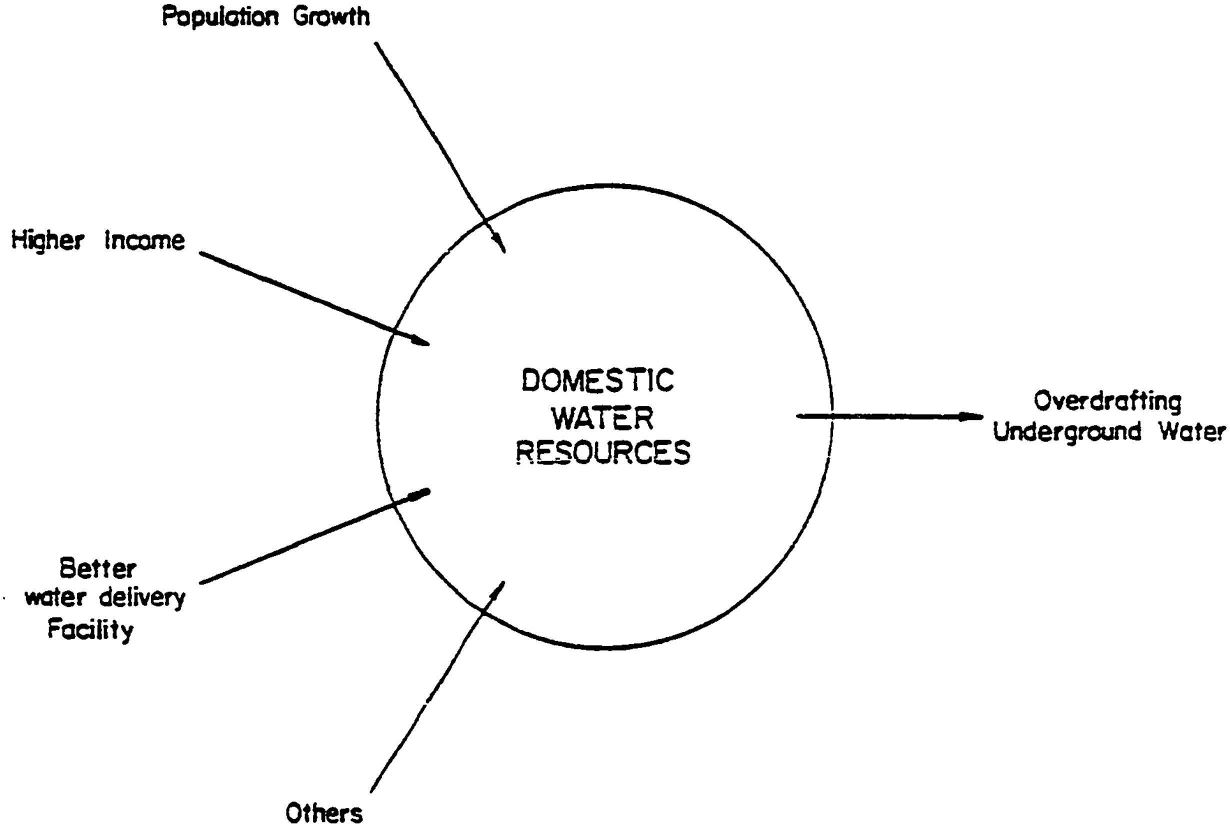


FIGURE 5.4. Societal Developments and Water Supply and Demand.

TABLE 5.6.

Excreta Disposal - Comparison of Wastewater Disposal Services, 1970 and 1975

	Urban												Rural With Adequate Disposal				Total			
	Connected to Public Sewerage Systems				Household Systems				Total Urban											
					Pit Privy, Septic Tank		Buckets													
	1970		1975		1970	1975	1970	1975	1970		1975		1970		1975		1970		1975	
Country	N'000	%	N'000	%	N'000	N'000	N'000	N'000	N'000	%	N'000	%	N'000	%	N'000	%	N'000	%	N'000	%
Iraq	212	4	300	4	4,270	5,000	--	--	4,482	82	5,300	75	20	--	30	1	4,502	47	5,330	47
Oman	--	--	10	14	20	30	13	30	33	100	70	100	--	--	50	5	--	--	120	12
Qatar	10	8	108	70	112	45	6	1	128	100	154	100	5	16	36	100	133	83	190	100
Saudi Arabia	150	11	500	26	800	1,250	--	--	950	67	1,750	91	700	11	2,500	35	1,650	21	4,250	47

Source: WHO. The Attitude of WHO and Its Activities in Water Resources Development in ECWA Countries. November 1976.

Iraq have sewers, and though sewage access increased 42% between 1970 and 1975, the 4% remained unchanged during this period, indicating a rise in population. The increase in service was, therefore, off-set by the increase in population.

Third, the impact of the population factor is highlighted in the urban situation. The adverse effect is specially shown in the Iraqi urban case. The population served increased from 4,270,000 in 1970 to 5,300,000 in 1975, i.e., an increase of 18%, yet the percentage of urban population served dropped from 82% to 75%. In urban areas, the increase in sewerage service did not match the sharp rise in urban population, and the wastewater service percent fell below the 1970 level.

Fourth, there are great disparities in the wastewater disposal services between the urban and rural centers for both years, 1970 and 1975. Only 1% in rural Iraq has adequate sewer facilities. The ratio of urban to rural sewage service for the year 1975 is 75 times better in Iraq, 20 times in Oman, and 3 times in Saudi Arabia.

However, in all the three countries, the disposal services are far from satisfactory. More than half of the total population has no sewage collection facilities.

Moreover, the situation is no better in the other countries of the region. World Bank conducted a study of the sewage collection system in Syria. According to this study, the service levels throughout Syria--in terms of house-connection for sewage--are relatively high, except for residents outside the planning limits of the major cities. However, the sewage collection systems in the cities are old and need to be replaced. There is no sewer maintenance; consequently, the system is in poor condition. The Demascus system is several centuries old.(89)

Similarly, in Jordan, the sewage facilities are inadequate. Only 1500 homes have sewer connection in Amman. The rest of Amman and the country have either septic tanks or have no facilities to dispose of their sewage.(90)

In Kuwait, only 10% of the population have sewers, the rest use septic tanks.(91)

In Lebanon, the cities have sewers.(92) However, the outskirts of Beirut are inhabited mainly by squatters--refugees from the South, in addition to the rural migrants. Public sewage service is non-existent within the squatters' domain.

This all adds up to the fact that in the region the state of sewage collection systems demands an urgent overall reconstruction. In general, the sewage collection systems in the region are either old, inadequate, or non-existant.

Moreover, there are no sewage treatment facilities in any country in the region except for a small treatment plant in Baghdad and an experimental plant in Kuwait. The untreated sewage is dumped into rivers, seas, or wadis, and thus contributing to water-borne diseases and fish kill. In Syria, for instance, widespread use of the streams for irrigation of small agricultural plots is common. Along the Quwaik River (which is polluted with untreated sewage) and particularly around Aleppo, the use of stream flows for contact irrigation by farmers located downstream contributes to a high incidence of waterborne diseases and causes considerable losses in crops. During the dry season, the river is practically undiluted raw sewage, creating serious health problems, which periodically reach epidemic proportions.[93]

The fate of the Barada River is no better. This river which crosses the ancient city of Damascus and which attracted poets and literary men in the past has become dangerously polluted. The river is in fact the main sewer of the city.[94]

In Baghdad, the treatment plant can accomodate no more than one-third of the effluent from the connected homes. The treatment plant has the capacity of

7 1/2 MGD. The waste from the city sewage is about 30 MGD. This means, that some 20 MGD of untreated raw sewage by-passes the plant flowing into the Tigris, a major source of water supply for Baghdad and other smaller towns along the sides of the river.[95]

These are typical instances in handling the sewage in the region. In addition to being scarce the surface water is becoming heavily polluted. And the practice is already effecting the three regional water bodies: the Arabian Gulf, the Mediterranian, and the Red Sea. The coastal areas of these bodies of water are presently dangerously polluted so that marine life is seriously threatened.[96]

Thus, though water is extremely scarce in the region, the behavior of society is aggrevating the prolem. For one thing, the domestic wastewater is too good to throw away; it is a loss in water resources, and mismanagement of this vital resource. For another thing, the proximity of wastewater disposal to the people poses a pollution threat to their environment and to their usable fresh water--surface and underground. In this arid region, disposal of wastewater without further use should be the <u>last</u> alternative. Such water commonly cannot be discharged into streams because in a desert region streams are ephemeral and their assimilative capacity is negligible, and surface disposal is an unhealthy practice because of the danger of polluting the ground water reservoir, which is likely to be the sole source of fresh water supply. Consequently, wastewater which should be a water resource asset to the region, with a positive value, is currently a debit: Polluting the water, the environment and posing a serious health hazard to the community.

C. The Social Structure and Domestic Water

(1) Institutional and organizational lag in domestic water and wastewater management and control. This is another societal characteristic exacerbating the domestic water problem. Usually sewage is incorporated weakly within the local municipal authorities and not given the proper attention it actually deserves. The countries have no pollution control legislation to ensure the protection of the existing sources of water supply. In other words, there are no laws of discharge or effluent standards, and there is not enough water to dilute the sewage.

(2) Lack of skilled labor. Not one country has a national training program for technical operation or maintenance of the water delivery system or its sewer system. This is leading to real losses in domestic water due to leakage and evaporation and to a threat to domestic water quality from the cracked sewer system.

(3) Lack of comprehensive control over all the fresh water resources. Traditional rights and norms in water consumptions persist. For example, mosques have their water and land (Waqf) and that is expected to continue. The people own their wells. Consequently, efficient control of domestic water poses as a special problem; control is practically impossible without an accurate monitoring of water usage by private users.

Conclusion: Consequently, in the region, while the domestic demand for water is rising due to demographic and socio-economic developments, conventional sources of fresh water are declining due to the institutional lag which is leading to overdraft, losses in leakage and evaporation, and pollution.

This water and wastewater situation is affecting society. Water is intermittently delivered, if at all for several days; and the pollution poses as a health hazard to the people. The level of domestic water supply in quantity and quality effect health standards in two ways: (a) the quality of drinking water has a direct effect on health; (b) the amount and quality of water available for bathing and cleaning have a significant indirect effect upon health conditions.

Society's reaction. In turn, the society of the region is reacting to this health threatening situation. Among other things:

1. Water bottling is a flourishing business, diffusing and penetrating fast all over the region.
2. Many homes set the rhythm of their life and activities around the off-and-on water availability: Laundering at night, filling jars, etc. when water is available.
3. People drill their own wells.
4. People illegally divert the water to their homes or break the water pipes.[97]
5. And the region is innovating the exotic technological solutions to the water shortage.

It is a system of interaction between water, society, environment, and technology. Figure 5.5 depicts the interrelationship.

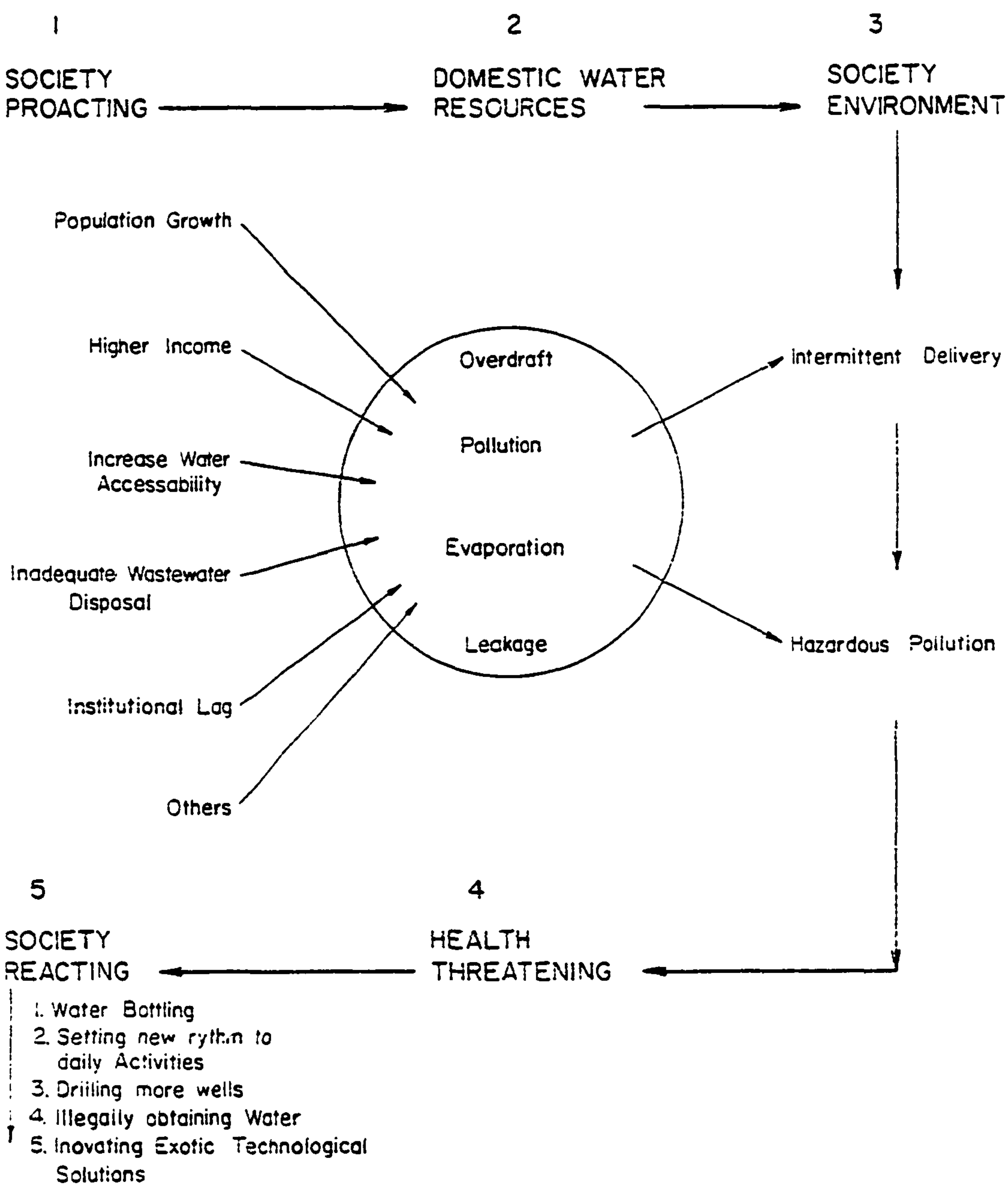


Figure 5.5. The Interaction Between Water, Society, Environment, and Technology in the Domestic Sector in Arab-Asian Countries

PART II. THE INTERACTING SYSTEM IN THE AGRICULTURAL SECTOR

Chapter III points to the lower trend in per capita food production, to the need for a new source of water to irrigate the land and boost production, and to the present soil degradation in water irrigation projects due to the farmers' ignorance of modern irrigation technology and due to the institutional lag. This rural situation is having far-reaching social consequences and a significant impact on the development of the region as a whole.

One of the significant social processes currently witnessed in the region is the accelerating outflow of rural people from their settlements to the urban centers. The villagers are abandoning their villages in greater numbers and heading towards the already overpopulated cities. Within the last two decades, the population has been rapidly shifting from predominantly rural to predominantly urban. In Iraq, for instance, in 1957 about two-thirds of the population lived in the rural areas. Since then the ratio of rural to urban dwellers has been steadily reversing. Today nearly two-thirds of the Iraqis live in urban centers.[98] Another illustrative instance is the rapid drop in the population of two Syrian villages: Bab and Saphire. In 1970, they had a population of about 90,000. In 1976 the number dropped to about 20,000.[99]

These are extreme examples, but the overall trend in the region is in that direction. Table A.21 shows that the ratio of urban to rural population is steadily rising.

This massive shift in population is significantly related to the deterioration in the agricultural sector; the trend, in turn, is having a significant social impact on both rural and urban settlements. The forthcoming discussion analyzes:

1. The state of rural settlements and mobility.
2. The state of urban settlements and urbanization.

(1) The state of rural settlements and mobility. The farmer can no longer meet the bare subsistence of his living. The yield of his farm is too little to feed him, his family, poultry, and livestock. Old-fashioned farming that is dependent on weather conditions is precarious and no longer profitable. Income is probably the most useful quantifiable measure to manifest the extent of rural poverty. A comparison of the per capita income between urban and rural populations will shed some light on the farmer's relative standing. However, statistics on urban and rural income are seriously lacking.[100] Agricultural vs. non-agricultural income

provides a reasonable substitute. Table 5.7 reveals the rural-urban income disparities in 3 selected countries: Democratic Yemen, Oman, and Yemen.

The table shows the "relative deprivation" of the farmer in the three countries, and that gap is widening. The seriousness of the disparities is reflected in the depressed ratio of the per capita agricultural income to non-agricultural income, which goes as low as 1.5% with a high of only 23.7%.

Rural income vs. gross national product (GNP) is another means to show the situation of the farmer. Two countries are selected for the analysis: Syria and Iraq. Table A.22 compares these two measures for each country; again the ratio is low and in favor of non-agricultural income.

No data is available on the age and sex of rural migrants, but the information from Iraq reveals that the rural migrants are predominantly male, between the ages of 15 and 60. This means that the young are migrating, and the old and the females are left behind in the rural settlements (see Table A.23). This flight of the young male labor from the rural settlements will no doubt cause social problems and a further deterioration of these rural areas in addition to a further decline in agricultural production.

TABLE 5.7.

Rural-Urban Income Disparities in Democratic Yemen, Oman, Yemen

	GDR Per Head 1975			GDP Per Head Annual Growth Rate 1969-1975	
	Non-agricultural	Agricultural	Agricultural/ Non-agricultural Income Per Head	Non-Agricultural	Agricultural
Country	(Dollars)		(Percent)	(Percent)	
Oman	6975	103	1.5	35.4	- 0.9
Yemen (North)	419	99	23.7	23.4	15.4
Yemen (South)	416	49	11.7	6.7	5.6

Source: UN-ECWA. The current situation and prospects of rural development in selected countries of the ECWA region, November 21, 1978. Compiled on the basis of international sources.

(2) The state of urban settlements and urbanization. In each country of the region the urban population is growing at a faster rate than the country's total population. This trend is revealed in Table A.24. The table compares the rate of urban growth with the rate of population growth for each country. The rate is consistently higher at the urban level.

The urban population growth rate of the region is among the most rapid in the world. The world as a whole is urbanizing at a rate of around 4% annually, while in the Arab-Asian countries the rates reach 6%.(101)

The main feature of urban growth in the countries of this region is the dominance of "primate cities," as opposed to "urban balance." In the primate city pattern the urban population is concentrated mainly in one city. Only two countries in the region have two big cities of almost the same size. These are Syria (Damascus and Aleppo) and Saudia Arabia (Riyadh and Jeddah). But even in these two countries, as elsewhere in the region, the capital is the primate city. The high population growth of the cities is due to the natural increase in city inhabitants and to the influx of rural migrants. The factor of rural-urban migration assumes an important role because the countries are experiencing a "one step" rural-urban migration pattern.

Rurals are by-passing small and middle-sized cities and migrating directly to "the primate city," making the population growth in these cities reach a high rate. In a city like Baghdad which already includes 30% of the Iraqis (population 3.5 million) the increase rate is around 6%.(102) This means that the population will double every 12 years. Similarly, Beirut contains almost 40% of Lebanon's population and under normal conditions receives ten to twelve thousand rural migrants annually.(103) The same situation applies to other major cities in the region.

As a result more water is consumed in these cities, thus further constraining the city's limited water supply. For example, in Beirut, population growth is causing a major water supply problem. On the national television news on June 23, 1979, the Lebanese minister of water complained about the "loss" of water on its way to the houses--calling it a "water robbery." He warned of a serious impending water shortage in Beirut and the possibility of a major cutback in domestic water delivery. Already water is being delivered intermittently. He also said that the winter of this year had been dry and that the ten new wells which the municipality had opened were already dry. Now, a search for a new source of water is underway. (An example indicating the serious vulnerability of the region to non-stable meteorological conditions).

But rural migration is more than a mere increase in urban water consumption. In addition, it is creating a haphazard expansion of the primate city, which in turn is complicating the water problem in the city. Because there is virtually no effective control mechanism, program, or institution to direct the flow of the migrants and limit the expansion of the cities, the primate cities are chaotically and increasingly expanding.

This type of urbanization, among other developments, such as the recent independence of the countries from foreign occupation, has caused strains on the house-stock and inflated the prices of the capital city houses beyond the means of a great number of migrants.[(104)] The rural migrants inevitably have taken shelter by building temporary houses (using poor material) in the outskirts of the city, and their houses have virtually no services (roads, water, sewage disposal, and electrical facilities.[(105)]

Lack of connected water and sewage disposal is certainly an environmental pollution problem and a health hazard for the urban community. The possibility of the outbreak of a water-borne disease (such as chlorea or typhoid) becomes imminent. There have been incidents of such outbreaks.[(106)]

The policy of not providing services beyond the city limits in order to discourage the settlement of the migrants is not having its effect. The rurals are still increasingly migrating, and the primate cities are still hapazardly expanding. The problem is more pronounced in the old cities: Beirut, Damascus, Baghdad, and Aleppo. (Aleppo has already realized the ineffectiveness of this policy, and the health hazard threat that such a policy might entail to the urban community--100,000 migrants encircle the city. Aleppo is contemplating reversing its policy by extending water services beyond city limits).[107]

An important factor that has been ignored in the countries of the region is the relationship between city planning and rural planning. There are practically no promotional actions at the national level to direct the flows of rural migrants or their activities within the country, and the rural migrants are not offered a better alternative in their local rural community. In the region as a whole, the rural areas continue to be neglected in relation to urban development, and as the gap continues to widen between rural and urban communities rather than to narrow,[108] rurals will more than likely continue to migrate and congregate on the outskirts of the city.

Urbanization as it is being currently practiced in the region is a social and a water problem at both the rural and urban level, creating, among other things, shortages of agricultural workers in the villages and an influx of unskilled, unemployable labor in the capital city.

Finding a new source of water to irrigate the farmland must be a major priority for the region along with providing domestic water and waste water services for the total population, rural as well as urban.

However, the experience in Syria and Iraq shows the interaction between water, technology, society, and environment as a system. Ground water projects intended to increase the yield of land by irrigation instead led to some land going out of cultivation and a loss in production. The experience of Iraq and Syria strengthens the argument for appropriate technology; that technology which can be solution under certain conditions, can also be disastrous under others. The technology will not develop the system if any of the system's parameter (society, water, and environment) lags behind.

In the region, the governments construct and manage the water projects, but it is the individual farmer who uses the water. Clearly the governments have a crucial role to play in guiding the farmers in addition to providing water. This guidance, however, is lagging in the region, thus making water <u>use</u> a serious additional constraint on agricultural production besides water shortage, and the loss of labor.

CHAPTER VI

CONCLUSION ABOUT THE INTERACTION SYSTEM: EVALUATION OF THE DEVELOPMENT PROCESS AND THE TECHNOLOGY OF WASTEWATER REUSE

PART I. EVALUATION OF THE DEVELOPMENT PROCESS

Is the pattern and the trend in the interacting system congruent with the basic goals of society?

Despite the considerable potential and opportunities for development in the Arab-Asian region brought about by the oil revenue and the concommitant modernization and rise in the per capita income, the scene of the seventies has been dominated by some grim facts.

The core problem is the lack of adequate water; water is necessary for agriculture and domestic usage. In other words, without adequate water, these two sectors will simply not develop. However, the trends in society--demographic, population movement, socio-economic and the social structural lag--compounded the problems in both sectors. The two sectors are basic to development and are generating, in turn, adverse impacts on the society, environment, and water dimensions of development.

(1) The agricultural sector. The realization of the historical role of agriculture in the process of modern economic development should have made agriculture in the region an initial strategy for developing the economy, and should have been a reason for making successful development in agriculture a matter of serious national consideration. What happened in the region is contrary to this strategy.

To begin with, the water is scarce and not adequate for irrigation. To boost agricultural production, the rural community was provided with piecemeal and ineffective programs which led to the degradation of the farm soil. Therefore, the provided water was not a sufficient factor for agricultural development. There were other necessary societal factors which were not taken into account in the adopted programs. The poor traditional farmer was not fit to implement successfully the demand of modern irrigation technology. Furthermore, according to a U.N. report,(109) the lagging agricultural institutions themselves were not qualified to give effective management and guidance necessary for the rural communities in terms of finance, coordination, and education. In short, the technology did not fit the environment, or more specifically, the social structure of the environment.

Moreover, the lack of water for irrigation and the ineffective irrigation programs themselves led, in turn, to a labor exodus, thereby, constraining even more the limited water supply in the rural and urban settlements, compounding the problem of agricultural production, depriving the rural community of its young labor, increasing the disparity between rural and urban communities, and conjesting even more the big cities with squatters.

The wastewater disposal practice is further exacerbating the food problem. First, the agricultural sector is losing a good source of water for irrigation. Second, the wastewater, disposed off without treatment, except for a small treatment plant in Baghdad, is polluting the conventional sources of water--surface and underground. Marine life is threatened. In Beirut, for instance, fish which were plentiful a few years ago (3-4 years) are at present hard to catch. Fish is now a luxury commodity and the price beyond the means of most people. It is the most expensive meat on the market.

Currently, the constraint on agricultural development is not environmental. Harsh environment is not an insurmountable problem any more. There are techniques for environmental control. Enough evidence is now available that agricultural development in the city states of the Gulf is technically possible.[110] In the agricultural sector the issue basically pertains to:

1. Water: The possibility of increasing water resources for irrigation purposes.
2. Society: The improvement of the irrigation system's efficiency.

In other words, the major constraints on food development are societal and the water resources. The society acts as an intervening variable, so to speak, between the water development itself (technology) and the goal of developing food.

The development and the proper management of water and wastewater resources are obviously crucial to boost food production.

(2) The domestic sector. It is a universally accepted principle that an adequate supply of water for drinking, personal hygiene, and other domestic purposes, and an adequate means of wastewater disposal are essential to public health and well being. WHO

headed safe water supply and disposal of excreta in its list of priorities in basic sanitary measures.[111] In this region, however, vast number of people, most of them living in rural areas, do not currently have access to a safe and convenient source of water, and where they do have they normally lack satisfactory sewage disposal facilities.

The data shows that a great number of the population have either inadequate piped water service (intermittent services) or are being supplied with unsafe water, or both. Intermittent delivery generally results in unsafe water, since periodic drops in water pressure permit the entrance of subsoil water through leaky pipes. Intermittent delivery also means that water is unavailable in adequate amounts to meet personal requirements for much of the time. Where no piped water is easily available in adequate amounts, people turn to sources that are likely to be unsafe and thus expose themselves to such water-borne diseases as cholera, typhoid fever, amoebic dysentery and the diarrhoial diseases. The wastewater discreta services do not fare any better. In fact, the data shows that the discreta services lag behind the water delivery itself; and, in both, water supply and disposal services, the rural lags behind the urban.

The magnitude of the relationship between health and improved water supply and sanitation remains uncertain. But a relationship does exist. A survey[112] has been done of the findings of twenty-eight empirical studies in various parts of the world on the association between water supply, disposal of excreta, and health. It suggests that a significant relation does exist between an adequate, safe, and convenient source of water and the incidence of water-borne and water-related diseases. The studies provide evidence, particularly for diarrhoial diseases, that a water supply outlet closer to the user is generally associated with lower infection rates and that villages with a piped water supply tend to have a lower incidence of a number of water-related diseases. There are also reports from the region documenting the existence of water-borne diseases. Malaria is still widespread in at least three countries--Oman, North Yemen, and South Yemen; so is bilharzia, and other water-borne diseases.[113]

In the domestic sector, like the agricultural sector, the issue basically pertains to:

1. Water: The possibility of increasing the water resources for the domestic sector, and
2. Society: The improvement of domestic water delivery and disposal system.

In other words, the major constraints on the provision of healthy environment are the societal ones and the water resources. To maintain good health, the development and the proper management of water and wastewater resources must obviously be central.

The Interaction Between Water and the Society in the Region

The two constraints on development and their interrelationships in the region require special attention.

The characteristics of the social structure are manifested in the water resources' management and control. A report by the United Nations[114] states that in most countries of the region, water resource activities and responsibilities are divided among numerous agencies without adequate institutional infrastructure to coordinate and without an adequate link to an overall societal goal. Legislation also lags behind modern water management techniques and perpetuates an undesirable fragmentation of administrative responsibilities. There are also sometimes cases of incompatibility between a legal provision of a national character and regulation emanating from regional or local authorities, or between a traditional right and the state's role in controlling water resources.[115] For instance, drilling for water is conducted by the owner of the land without the governments' enforcing the law of licensing and without submitting data to the governments of the amount pumped. Many families own their wells, though water is supposedly a public domain. Such was the norm in the past, and new legislation is not easily enforced or supervised. This situation creates the problem of ownership of the water, the problem of overdraft, the problem of control, and the problem of the enforcement of the enacted laws. The countries are now actively reviewing the legislation rules, regulation, customs, decrease, ordinances, and other measures of control in the water resource field. However, Kuwait is at present the only country in the region with a national water policy in effect. Indeed, even there the policy does not cover such an important matter as sewage effluent. Iraq and Saudi Arabia currently have the matter under consideration.

All this adds up to the fact that the two constraints, water and societal trends and characteristics are still the persistent problems and that the vicious circle of their interactions continues unabated. Meanwhile, food production and the quality of the environment continue to deteriorate.

Such is the on-going situation in the Arab-Asian region. The problem remains a significant one. Piecemeal solutions are not sufficient; merely providing water does not solve the pollution problem. Moreover no technological solution will be effective under the existing characteristics and on-going trends of the rural society (see Figure 6.1).

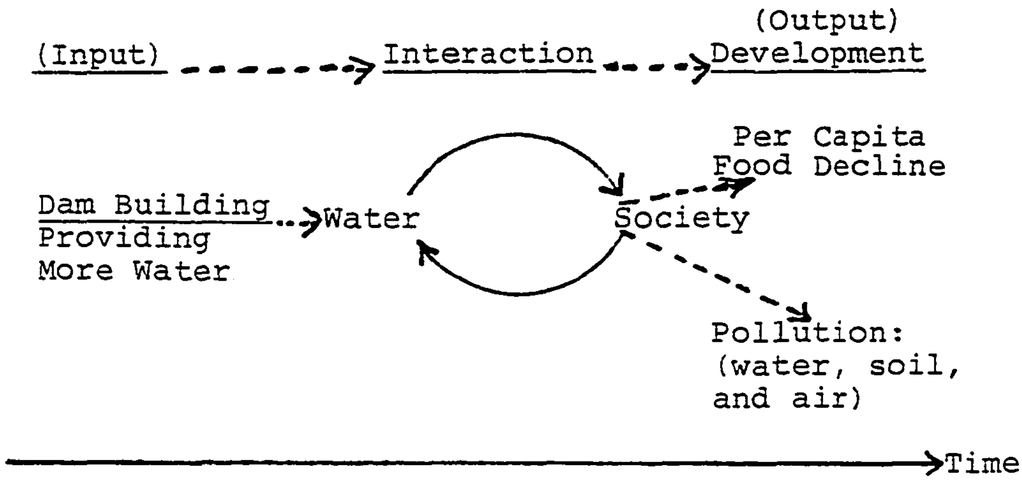


FIGURE 6.1. Incongruent Relationship Between System of Interaction in the Region and the Development Goals.

The Future Outlook

In all probabilities the situation will continue to deteriorate. It is difficult to foresee a resolution forthcoming. On the contrary, the situation is expected to worsen in view of the accelerating population growth, urbanization, and industrialization. The countries will need soon to increase water supply in order just to keep pace with the expected increase in population. Domestic water requirements must also increase; likewise, agricultural requirements must also increase to feed the additional people. Thus, more competition on water is expected. Inevitably, deficiencies in both sectors will further decrease the per capita food production and further increase the pollution problem. Successful technological solutions for water are ultimately contingent on the characteristics of the social structure and the control of the spiraling growth in population, and both are unlikely to change in the near future. It is difficult to foresee that this well-established social order, which persisted for centuries, can be transformed unless the governments themselves take the initiative. It took the Religious Wars of the Seventeenth Century to transform the West to its present form,[116] and it took the famous Communist Revolution of 1917 to transform Russia. And it is difficult to foresee that the old adage value of having more children will easily alter.

Such is the prospect for the future. A continued interaction between factors in society, in water, in the environment, and the technology is culminating in a decline in per capita food production and a deterioration in the quality of the environment. A schematic representation of the interaction would be:

> Per Capita Food Decline: Societal Lags and Changes/Inadequate Water/Inappropriate Technology/Soil Degradation

At least, the following propositions can be drawn, other things being equal, from the trends on-going in the interaction system:

The more population, the more water requirements for domestic consumption and for irrigation, and the more overdraft from the water supply.

The more water consumption, the more wastewater disposal, and the more pollution.

The more polluted the water and the more overdraft, the less the conventional sources of water will be safe for use (overloading beyond their assimilative capacity), and, therefore, the less the water supply.

The less water supply for irrigation, the more urbanization.

The more urbanization, the more soil degradation.

And so on. It is a system of interrelationships, and the system itself is in a state of imbalance with the region's goal of development. In other words, the structure of the interrelationships is dysfunctional.

Accordingly, to develop the region, a program is needed that will take care of:

1. The societal problems, or constraints, the social structure and population growth.
2. The water scarcity problems.
3. The water delivery problem.
4. The wastewater disposal problem.

The forthcoming section analyzes an alternative future and a potential for the region: A future <u>with</u> the technology of wastewater reuse for irrigation. The data shows that none of the measures, though helping, take seriously the capacity of wastewater reuse technology to restore the balance to the system of interaction. The most valuable property, i.e., water renewal, is being touched on by an experiment in Kuwait. The analysis ends with a list of principles to help overcome the anticipated societal lag in the technology transfer and adaptation.

PART II. THE TECHNOLOGY OF DOMESTIC WASTEWATER REUSE

The Arab-Asian region needs to adopt the technology of wastewater reuse. The present inadequacy of water is a pressing problem; pollution is another pressing problem; and food production decline has become a survival problem. All these problems are related, and all will be partially alleviated if the technology of wastewater reuse is adopted and the transfer is successful. By definition, the technology through wastewater treatment removes the pollutants from the wastewater and makes it fit for reuse, thereby augmenting the water supply in agriculture and reducing the health hazard due to wastewater pollution in the domestic sector. Desalinated water, iceberg towing, and other means of acquiring new sources of water to augment the water supply in the region can then after use be extended into further use, not necessarily for drinking, although that is possible, but for irrigation and recreation (Figure 6.2).

Table 6.1 relates water resources to water utilization with emphasis on the conservation of water resources

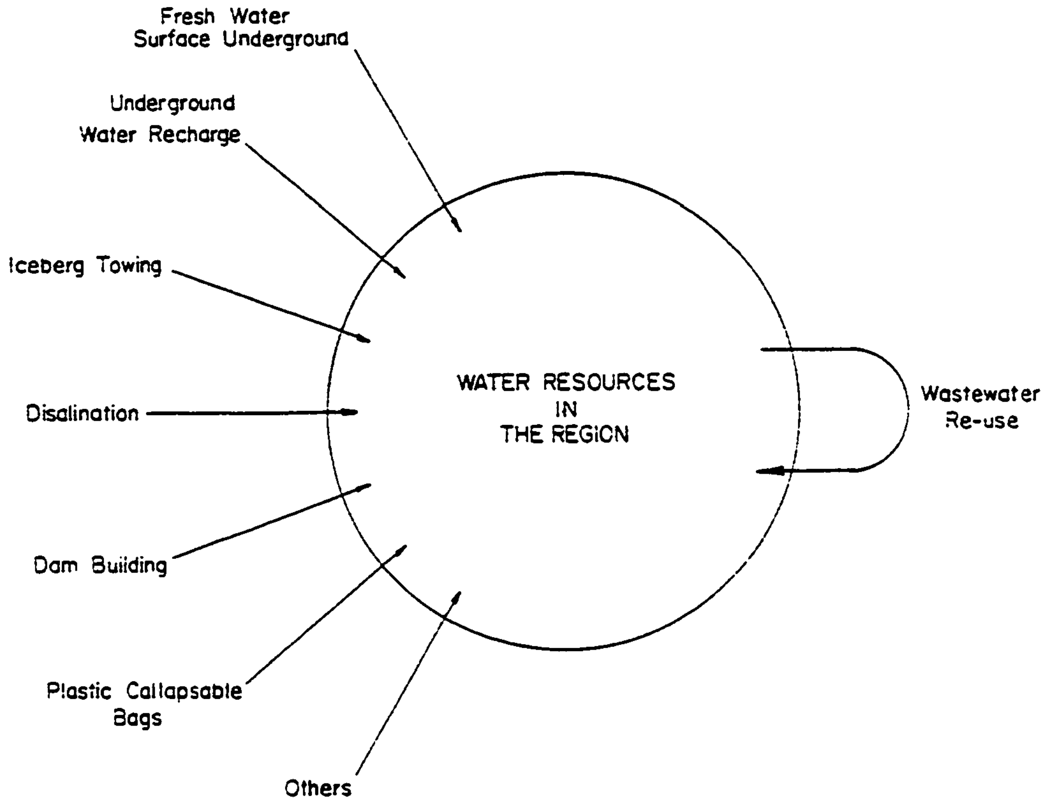


Figure 6.2. Conservation of Water by Reuse.

by reusing nutrient rich domestic wastewater for agriculture. The table estimates the prospective amount of additional water for irrigation and subsequent additional irrigated land, for selected countries in the region, by the year 2000 due to domestic wastewater reuse. It takes into consideration each country's projected population growth, level of urbanization, and likely improvement in the sewerage system determined by the per capita G.N.P. The table shows that the prospective increase in irrigated land from water reuse, relative to existing irrigated land may in some cases be substantial, especially in the oil producing countries of Kuwait and Saudi Arabia. The two countries currently depend heavily on the expensive desalinated water for their water supply and do not employ water reuse technology.

The water reuse estimated in the table is conservative. The potential is much higher, if one considers that the reclaimed water might go as high as 80% rather than the 50% projected, and that the higher income and the changes in the standard of living will likely increase domestic water consumption beyond the estimated per capita figured in the table. Figure 6.3 provides a prospective and a suggested direction for development of water reuse technology in the region.

However, just the need for the technology is not enough for its successful transfer. The degree of success depends on the degree of the fit between the "environment"

Table 6.1.

Summary of the Prospective Relationship Between Population Growth, Urbanization Sewerage System, Reclaimed Domestic Wastewater for Agriculture, and Irrigated Land by the Year 2000.

Country	Population						Urban Wastewater Resource						Reuse Processing by Year 2000		1975 Existing Irrigated Land of the Cultivated (Thousand Hectares, Percentage)	% Additional Irrigated Land by Year 2000 Over Existing Irrigated Land
	1975			2000			1975			2000						
								7* Sewered			Sewered					
	1* Total (Thousand)	2* % Urban	3* Population Growth Rate Yr. 70-75	4* Total (Thousand)	5* % Urban Assumed	Number (Thousand)	6* Total Domestic Vol. (mm^3)	%	Vol. (mm^3)	9* Total Domestic Vol. (mm^3)	10* % Sewered	Vol. (mm^3)	50% Volume Wastewater Reclaimed For Agriculture (mm^3)	11* Additional Land Irrigated (Thousand Hectare		
Iraq	11,124	64.9	3.2	25,000	80.0	20,000	580	4	23.2	1303	85	1107	553.5	34.7	2,895 (41)	1%
Jordan	2,700	56.0	3.3	5,000	78.0	3,900	40	N.A.	N.A.	74.1	70	51.9	26.0	3.0	31 (9)	10%
Kuwait	990	88.3	6.2	2,000	90.0	1,800	75	8* 10	7.5	151.5	95	143.9	72.0	1.2	.7 (100)	171%
Lebanon	2,557	64.9	3.0	5,000	80.0	4,000	94	N.A.	N.A.	183.8	80	147.0	73.5	6.8	68 (20)	10%
Saudi Arabia	8,930	20.7	2.4	19,000	50.0	9,500	830	26	215.8	1765.9	90	1589	794.5	78.7	190 (21)	41%
Syria	7,350	47.3	3.3	15,000	60.0	9,000	400	N.A.	N.A.	816.3	75	612	106.0	26.4	625 (11)	4%

Source:
1* Table A.6
2* Table A.21
3* Table A.24
4* Table A.19
5* Estimates based on Table A.24
6* Table 2.6
7* Table 5.6
8* UNEP/ECWA. Report of the Joint UNEP/ECWA Region, November 1977.
9* Per capita domestic water consumption, 1975, multiplied by population, 2000.
10* Percent estimates according to relative rank in GNP per capita, Table A.20.
11* CM/hectare, Table 2.6.
12* ECWA/FAO. Agriculture and Development. May 1979/No. 2, P. 52.

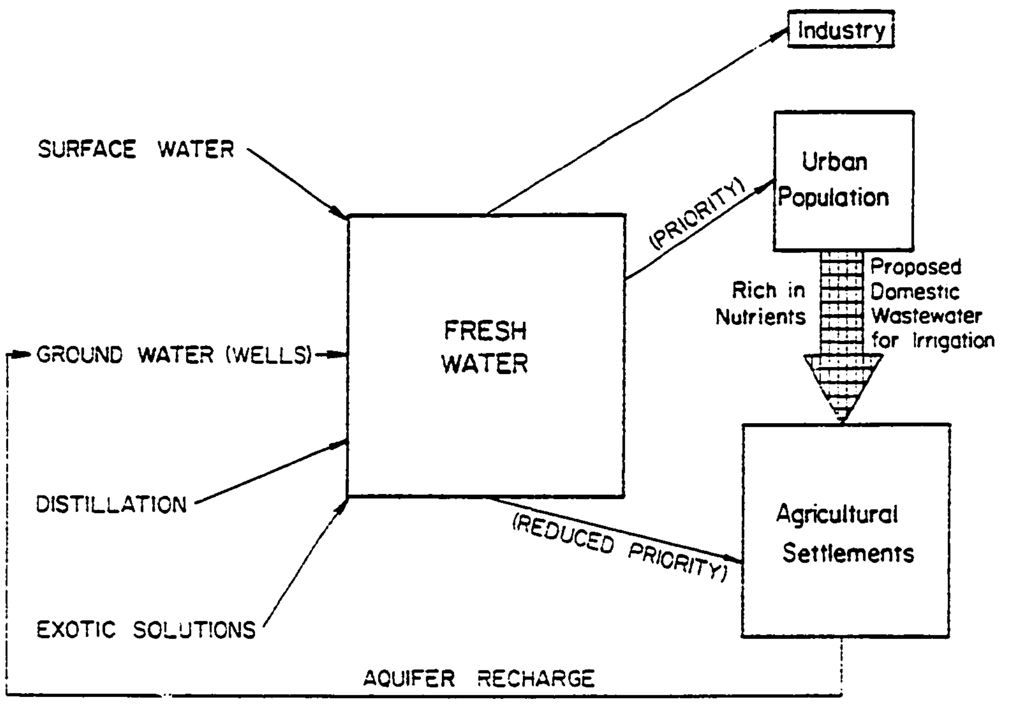


Figure 6.3. A Modified Water Resource/Utilization Model.

and the technology. To control the outcome of the technology, one has to work from the anticipated societal constraints. The experience in irrigation projects shows that there will be social structural constraints or "barriers" in the path of the technology transfer. Therefore, to insure success, these societal constraints have to be overcome in the program itself. Fortunately, the technology of wastewater reuse for secondary treatment, in addition to being economical, is also simple. Thus, the technology is technically feasible in the region. In other words, the technical constraints, or the demands of the technology in terms of skills are not prohibitive. However, the infrastructure for the collection and distribution of wastewater reuse is expected to be prohibitive for the poor countries, such as South Yemen, and will demand financial assistance from the richer countries in the region.

The Principles of the Program

Accordingly, the technological program must include not only the hardware of the technology, but also the software or services institutions. Institutions refers here to the norms, rules of conduct, and the generally accepted way of doing things.

(1) The program should include a provision to reach the people. The public must be aware of the dimensions of the water problem and be made to realize

that the technology is necessary in the face of the ever-mounting population and its demand for water, wastewater services, and food. This support is important, because the participation then will stem from need recognition. In other words, the participation will stem from a sense of value. To reach the mass of the people, effective means of communication must be recommended in the program. The mass communications available in the region is but one means. More than one technique should, of course, be used.

(2) The program should contain basic recommendations for the necessary legislation, including the allocation of funds and the apportionment of responsibility for operation and administrative decisions. In other words, planning ought to include new institutions, local and inter-local. These institutions are necessary for implementation. The problem of creating an adequate institutional infrastructure should be kept constantly under review, and consideration should be given to the establishment of efficient authorities to provide the proper coordination. The data from the region show that inept and inadequate operation and management and the lack of an effective administrative machinery and technical staff have been a problem. Old-fashioned organization structures fail to meet the modern demands for efficient operation, supervision, and financial support.

(3) The program should include appropriate measures for the provision of training courses. In the region, the shortage of technical manpower constitutes a bottleneck to any successful development and represents a serious obstacle in the transition from a traditional to a developed society.[117] The program should concentrate on exposing farmers to the new technology and training them to modern farming practices, and optimum use of irrigation, reducing the illiteracy rate, and exposing them to farming industry. The measures should adhere to universalistic standards that will enhance the norms of achievement rather than ascription, specificity rather than diffuseness.

(4) It should include a provision for law enforcement to bring legal actions against violators. In other words, there should be willingness to impose discipline. This is an important measure to ensure that the roles and the duties are carried out. Having been dependent for centuries on limited laws, the countries find it difficult to enforce newly enacted laws in the communities.

(5) It is necessary to have a system of fact reporting and data collection which imposes the necessity of bookkeeping, a feedback, of the actual operation of the technology and marks the progress achieved.

(6) And the experience in other countries[118] and in the region shows that local participation in decision making is highly recommended.[119] Local participation will rally support behind the program. The participants will become the "reference group" or a point of reference to the other members of the community for evaluating their own behavior.[120] All societies have a built-in resistance to change, and an inclination to maintain the status quo.[121] This is especially true in the Arab-Asian countries, due to the inertia of centuries of stagnation. The local participation is a strong means to exert influence on the rest of the community to adapt itself to the needs of the technology. Local population can feel the program is their own and can take pride in seeing the program operate properly. However, there is always the danger that influential local leaders might use the program to entrench their own power and perpetuate the status quo.

(7) A provision to ascertain social equity in public social services should also be included to decrease the great disparity between the urban and rural standard of living. Besides being a moral issue, this provision is important for the success of the technology transfer. This is a complementary input and refers to the quality of the neighborhood; it refers to public services in health, education, and sanitation. The report shows that rural living in the region is much inferior to urban living. This is true in the quantity and quality of public services provided, in the

educational opportunities, and in many other aspects of socio-economic life. Such a disparity will not attract qualified labor, or ebb the flow of rural migration. It will make it difficult, therefore, for qualified people to opt to live in rural communities, and this will, in turn, certainly adversely affect the success of the technology transfer. After all, the first goal of wastewater reuse technology is to boost the production of rural areas, and this will not come about without the skilled labor in those areas.

(8) The program must include a provision to deal with the expected major expansion in the population. This is a profound and formidable problem for the future of the region. The current exponential population growth will hinder all efforts to increase food supply, and the "Malthusian" problem will stand as a prospective possibility in the not too distant future.

(9) Technically and administratively the program should require the incorporation of water and wastewater as a system. It should also require the construction of numerous sewage treatment plants strategically distributed all over the region, villages included. Adjacent villages can be grouped together, because of the economy of scale. The distribution is beneficial for both the urbans and the rurals, but it is also

technically and economically a good strategy. According to Sumner,[122] for sewage, there is normally little to be said in favour of providing long lengths of unproductive sewer merely to centralize sewage treatment at one site; and as a general rule sewers should not be extended much beyond the area they serve (not more than 10 miles except where there are special circumstances). However, in certain cases, the build-up of the networks necessary for the implementation of wastewater reuse for irrigation may be prohibitively expensive to justify the costs. In these special cases, it will be, probably, technically and economically a better strategy to use hydrofarming. In hydrofarming, nutrient-rich water is contained in a tank or a lagoon and is used to grow certain crops or fish and the yield is much higher than if the water is fresh or used to irrigate the land.

These are the principles to be included in the program. It is an integrative program cutting across a multitude of dimensions implicit in the interaction between water, society, environment, and technology. It is geared specifically to eliminate societal obstacles in the path of technology transfer and adaptation. Thus, what sounds like a technological problem is certainly more than that.

Under such a programmed implementation of wastewater reuse technology for irrigation, what would the Arab-Asian Society be like? Chapter VII postulates the potential impact that the technology more than likely will have on the Arab-Asian Society.

CHAPTER VII

THE SOCIAL IMPACT OF THE PROGRAMMED WATER REUSE TECHNOLOGY FOR AGRICULTURE ON THE ARAB-ASIAN REGION

Assuming the implementation of the programmed domestic wastewater reuse technology for agriculture, what can the region expect? What are the potential impacts?

In assuming the implementation of the technology of wastewater reuse for agriculture, we are, of course, assuming also the implementation of the prerequisites for the technology: (1) a domestic freshwater delivery network, and (2) a sewage collection and disposal network.

These networks are technological prerequisites for the implementation of the technology of wastewater reuse. The forthcoming hypothesized impacts are contingent upon the assumed build-up of these extensive networks for freshwater delivery, wastewater collection and disposal. The impacts of this implementation of wastewater reuse for agriculture are summarized in a table (see Table 7.1). Thus, as the table

Table 7.1

A Summary of the Hypothesized Potential Impacts of the Implementation of Wastewater Reuse Technology for Agriculture on the Arab-Asian Society

Impact No.	Prospective Impacts--Hypotheses
	A. Primary Impacts:
1.	Increase food production
2.	Provide cleaner environment
	B. Secondary and Tertiary Impacts:
1.	Transform the social structure
2.	Raise per capita income of the agricultural communities: (1) Induce rural housing development (2) Alleviate rural drop in manpower (3) Alleviate the burden of rural woman (4) Bring improvement in the rural social sciences (5) Equate the distribution of income
3.	Induce the establishment of new agricultural settlements around urban centers
4.	Change the pattern of geographic mobility: (1) Correct the spatial maldistribution of population (2) Reduce urban problems
5.	Integrate urban and rural settlements, particularly around urban centers
6.	Increase population growth
7.	Reverse the trend in the composition of the rural family
8.	Alter religious values which frown upon sewage
9.	Make "the desert bloom"
10.	Create a new way of life

shows, the technology could be the paradigm that may restructure the interaction system currently ongoing in the region and may help develop the region so as to resolve problems of social concern specifically significant to the region.

The Structure of the Impacts. It is helpful to start the discussion of the hypothesized impacts with the structure of those impacts. In general, the programmed technology of wastewater reuse will have direct effects (primary) and indirect effects (secondary, tertiary, etc.). These effects will be either backward-linked or forward-linked. For instance, in backward-linked effects, the increase in the demand for tools and equipment to irrigate and farm will raise their price, increase the profits of the manufacturer, inside and outside the region, and incite him to enlarge his business, thereby producing at a lower cost (economy of scale). Similarly, in the forward-linked effects, the farmer whose earning will increase may invest in the food industry, or in some other agrobusiness.

These transactions involve people (transactors) and have societal implications. Therefore, it will have ramifications and cumulative consequences on the social structure of society, the stratification system and many other aspects of social and economic life.

The effects or impacts also include the costs. The costs are part of the effects and the counterpart of benefits.

They represent the capital that must be invested in order to obtain the desired benefits. However, the costs will be excluded from the evaluation of the impacts:

First, it has been concluded in this report that the adoption of wastewater reuse, per se, is very cheap; it adds little (a few cents/1000 litres) to the costs of treatment and discharge which the countries must practice if they are to meet the standard set by the United Nations. The UN Water Conference [123] endorsed a recommendation by the UN Conference on Human Settlements which considered the availability of potable water to all the population of the world a priority, and recommended that such a development should be completed by 1990; the Water Conference also recommended that 1981-1990 be declared a Drinking Water Supply and Sanitation Decade. This recommendation by the UN is a constraint for the poor countries. It requires an expensive transportation system to collect and discharge the wastewater; financial assistance to build this network from the rich countries in the region will be necessary.

Second, the significance of the costs in project analysis should compare with the benefits. However, in water developments, most of the social benefits that are desirable are intangible and therefore not quantifiable. In addition, there are short term benefits, and long term benefits, and not all of these benefits can be taken into account. Under these circumstances, it is not valid to compare the benefits with the costs.

Third, the evaluation of the technology should not, in the first instance, be based on net returnability (profit). Admittedly, these are important criteria in the evaluation, but the decision for investment should be based on the priority of need. Water development in the region is needed for survival. It is vital to increase regional food production so as to reduce the vulnerability of the region to future emergencies; such as, the possibility of food embargo or the eventual depletion in oil and the oil revenues. Thus, while currently it is more economical to import food rather than develop water for food production, water development for food production is a necessity that does not require economic justification.

Fourth, the region has the funds available.[(124)] In other words, financing the project is not a regional constraint. Although the poor countries will need the assistance of the rich countries in the region.

The impacts are evaluated on the basis of a comparison of two hypothetical alternative situations for the future of the region, drawn from the currently existing situation:

1. The region without the technology.
2. The region with the technology.

Figure 7.1 shows the scheme of the comparison.

The forthcoming analysis provides an analytical list of the potential social impacts of the programmed technology of water reuse for agriculture on the Arab-Asian Society. The

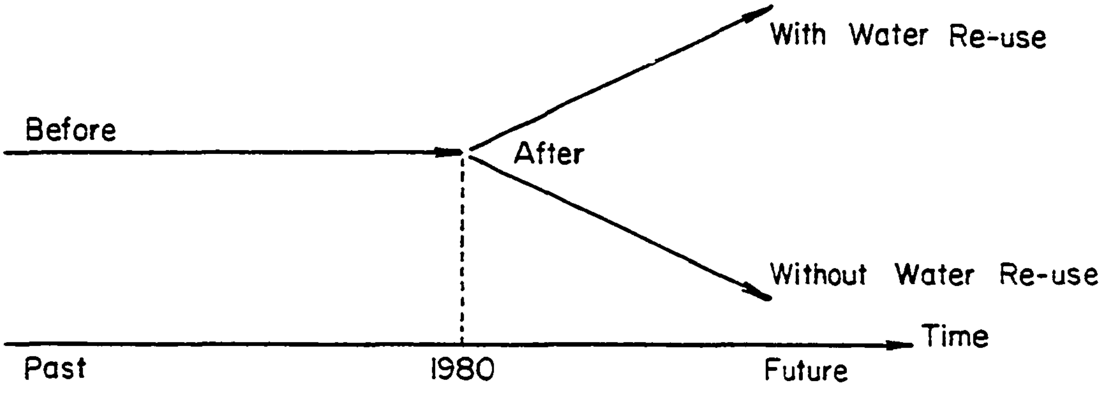


FIGURE 7.1. A scheme Structuring the Evaluation Process of Two Alternative Futures.

list is derived by perceptually evaluating the two alternatives for future interaction processes in the region:

1. Future interaction process extrapolated from the presently existing development process <u>without</u> water reuse for agriculture.
2. Future interaction process branched from the presently existing development process <u>with</u> water reuse for agriculture.

A. Primary Impacts (Physical Resources, Environment)

These are the primary benefits, the immediate reasons why it is necessary to transfer the technology to the region originally.

(1) Increase food production. Food production with the technology will be higher than it would be without it.

There is no doubt that irrigation produces higher output than dry farming (see Table A.15). The technology will provide more and better quality water for irrigation (carries nutrients). The region will also have a better chance of introducing agriculture to areas, especially close to urban centers, which have hitherto been dry, desolate, and barren. (a) More land will be reclaimed. (b) Massive reforestation will halt desertification. (c) The growing of shrubs will provide an important and nutritious source of fodder for livestock and wildlife, while helping to hold moisture and reduce erosion.[125] The many social concerns over "food-security" and "self-sufficiency" in food will consequently have a better chance of being resolved with the introduction of wastewater reuse technology. However, though the technology will increase regional food production, it may not completely solve the region's food dependency. The problem of self-sufficiency in food production has the ptotential to worsen in view of the current rate in population growth which may cause a further decline in per capita food production.

(2) Provide cleaner environment. The technology by corollary will provide more and better quality water for domestic usage (continuous, connected, not contaminated with sewage). This means a significant reduction in water-borne diseases. This disease reduction will also boost food production. Achievement of labor is obviously improved when the laborer is freed from water-borne diseases and no longer

periodically sick and operating on a fraction of energy and efficiency. In addition, the technology will render surface water clean; marine life will, therefore, be saved, thereby providing more food.

B. Secondary and Tertiary Impacts (Social Organization, Norms and Values, Other Social Indicators)

The technology of wastewater reuse will generate a succession of social effects, crucial for the development of the region in general and the rural communities in particular. These hypothesized social impacts are difficult to put a value on, yet they are of social concern, and undeniably significant in the interaction process of development. The technology will:

1. Transform the social structure. The technology will induce a social structural transformation in the rural communities. This refers to the organizational structure, to the norms and the rules that govern or order the interrelationships between people.

The project will demand total control over water and wastewater by the government; it will require allocation and decisions to be made, since what will be required is beyond what is available. The technology will also bring in an assertion of the national authority to the far isolated villages. The internal community authority structure would weaken once "external" officials from the state government have intervened as higher authority for adjudicating disputes and appointing water-control officials.

Thus, by providing an organizational infrastructure for community water supply and sanitation, the technology will also be restructuring the authority in the local community. New power will be created over and above the traditional family authority and the local hierarchy.

The new power will coordinate and control; it will restrict the freedom of users. Water will be no longer exploited and polluted without penalty. The control over water and wastewater forces the establishment of priorities in use, title, coordination, legislation, and in jurisdiction.

The new system of organization will be organic, in that it will adhere to rationalization of water distribution, clarification of rules, formalization of rights and centralization of authority. Whether the allocation favors equal or discriminatory distribution is another matter. But the scarcity of water and the need for control and allocation of wastewater will demand rational organization and comprehensiveness, not to be left up to the traditional informal arrangements and unwritten laws. It will necessitate the incorporation of rules, laws, and legislation about water into a united written form of legislation. Submission will be to the new laws, rather than the traditional norms.

Thus, to implement and operate the program, the government will inevitably assert control over the rural communities and centralize the authorities. The new authority will have to schedule water, to administer record-keeping, and time-reckoning. It is said that the earliest exercise of government arose from the need to manage water. [126] Wittfogel, investigating the relationship between irrigation and society was led to formulate his theory of the Hydraulic Society, in which irrigation necessitates centralized control, bureaucracy, and other features of civilization. Hunt observed and expressed the same idea. Hunt states that when there are population pressures on water, a situation arises under which centralization of authority is adaptive to reducing conflicts. [127] Thus, institutionalized organization became necessary as soon as cooperative efforts were undertaken to harness water for a common purpose.

While there will be centralization of authority, there should also be local integration. Since local labor can operate it, the adoption of the technology will act as a catalyst to stimulate a community organization infrastructure. The communities are not set to work at the corporate level. The work is conducted at the kinship level--on family basis. The program should cut across family lines, facilitating their coordination and integration.

These developments will eventually have implications on the class structure of the rural communities. The technology will blur the lines of stratification based on the family's location in the status hierarchy. Individual achievements, individual initiative, and labor will become important values. The poor will benefit the most. The water will provide them with the opportunity to increase productivity; equity in water services and disposal services will free them from diseases that also hinder their productivity. Further, their will be new employment opportunities. Also, the availability of credit facilities, marketing, and agricultural extensions (provided by the government as part of the program, or free enterprise attracted by the new opportunities) will provide the poor with the means to realize his potential. The poor will become more competitive with the technology than would be possible without it.

Without the technology, rural poverty perpetuates itself. For instance, there is an obvious interaction between poverty and deficient diet, on the one hand, and production, on the other. Wastewater reuse technology will be a measure that will break the vicious cycle. Consequently, the rigid social stratification system will loosen. There will be vertical mobility. Some people will climb up and some will descend the ladder of stratification.

However, the transformation in the social structure could also go the opposite direction if the program is not effectively implemented. There is the possibility that those with power will use the program to strengthen even further their dominance. Under this alternative hypothesis, the rich will get richer; the class structure will become more defined, and the poor will benefit the least though per capita agricultural income will increase.

2. Raise the per capita income of the agricultural communities. Rural communities will then have a greater capacity to produce, while at the same time, the social conditions which formerly inhibited production (such as the stratification along family lines) will be disrupted, further enabling the rural community to increase productivity. Farmer's production will no longer be exposed to natural calamities, especially droughts; the technology will provide insurance against such situations. The farmer will, therefore, become less vulnerable to water vulnerability. The technology will provide him with a dependable and assured source of supply.

This higher rural income will induce other subsequent social effects that will help close the disparity between rural and urban communities' life style;

(1) It will make schemes for housing development more feasible in the rural communities.

(2) It will alleviate the rural drop in manpower. Labor especially around urban centers will be induced to stay on the farm rather than migrate to the cities, which will mean higher rural productivity.

(3) It will help alleviate the burden of the rural women. The rural woman, who currently spends a considerable time hauling water, will be a major beneficiary.

The improved housing will eliminate the water collection journey.

(4) It will bring improvements in the social services available for the rural population. To guage the ability of the rural community to adapt to this radical change the program must ascertain the aspiration of the population, e.g., their expectation for the future of their children. This will bring changes in the educational facilities available, health, and other social services. This expected change is not a consequence of the technology, *per se*, but a necessary consequence, under the assumption of successful technology transfer.

(5) It will help equate the distribution of income. The higher rural income means, in effect, that in the region there will be a more equitable distribution in income. The rise in income in the region due to oil revenue stopped at the urban level, or was diverted outside the region. The technology should affect the direction of the flow of money, channeling some to the rural areas. Money paid for food imports will be diverted to the rural community; assuming that the farm labor will be local. However, if the skilled labor will be imported, this particular benefit to the rural area will be lost.

A more equitable distribution of income is not only beneficial to the poor farmers, but also to the region as a whole. This refers to the behavior of the economic transactors (the people). If the income benefit from the technology is distributed primarily to the poor, it will be spent locally; if, on the other hand, it only increases the wealth of the already wealthy, it will not generate substantial economic transactions. The dispersion of income should generate a succession of income in the rural as well as the urban centers, in agricultural and non-agricultural areas. It will generate economic activities such as food industry, marketing, credit transactions, and changes in the mode of production. Thus, the dispersion in income should induce structural shifts in the region's economy that will stimulate the future development and economic growth of the region and create exchange activities within the region rather than outside. Again this benefit will be lost to the region, if the patronage, the skilled labor, and the specialized manpower come from outside the region. And again, it must be reestated, that the technology may benefit only the rural few already wealthy if the program is not effectively implemented.

In short, the higher rural income from the technology will subsequently raise the standard of living of the rural people, and lessen the disparity between the two types of settlements, rural and urban.

3. Induce the establishment of the ideal new agricultural settlements around the urban centers. New settlements will be a great benefit for countries who plan to settle their bedouins. (Saudi Arabia is similarly settling the bedouins using fresh water).[128] Wastewater reuse technology will accelerate the process and save the high

quality water for domestic usage. It is said in this regard that water settled the Southwestern part of the U.S. and the "water resources activities in relation to settling the semi-arid Southwest may be viewed as an example of planned growth."(129)

4. Change the pattern of horizontal (geographic) mobility. The technology will generate two-way mobility, especially around large urban centers, instead of the one-way flow--to the big cities. It will tend to end the "push" from the village and the "pull" to the city. In the Arab-Asian region agriculture is labor-intensive; and the prospective agricultural prosperity will create the conditions that will induce farmers to stay on their farms and will most likely also attract unemployed labor in the urban centers. However, the exodus of labor will increase from villages not benefiting from the technology.

Subsequently, this change in mobility pattern will induce other impacts:

(1) Correct the spatial maldistribution of population. The technology should induce the growth of small cities and towns around urban centers. It will bring about a dispersion of population, instead of their cluster and concentration in the primate cities.

(2) Reduce urban problems. By decentralizing the population, especially around urban centers, the technology of wastewater reuse should help ease the population pressure on the big cities and help solve many urban ills and social

problems. Along with the rise in the total income in the region due to oil, has come the rising population, over-crowded cities, and shanty towns or squatters choking in poor environmental sanitation. The technology will ease these problems. Thus, while the technology will service the rural communities, especially clustered around urban centers, it will also service the city.

5. Integrate urban and rural settlements, particularly around urban centers. The technology will end much of the isolation of rural areas and bring down some of the boundaries of the rigid compartmentalization along rural-urban lines. It should help to create economic transactions between the two settlements with exchanges of people, goods, and services. This exchange, necessary to establish the program, will in all likelihood generate small businesses (middle men) on the roads connecting the two centers, thereby cementing further the rural-urban raltionship. However, the technology may increase the isolation of outlying rural settlements, unless the distribution of wastewater from urban areas reaches these rural villages, or unless these villages already generally grouped around water supplies form successful wastewater cooperatives. The extention of waste-water reuse from the urban centers generally is not feasible in view of the costs. But the improvements in environment, living conditions, and production, provided by local co-operatives of wastewater reuse, may help encourage local villages to stay in their communities. The increased attention

given to agriculture will enhance the occupation of farming and the local cooperative may capitalize on the farmer's attachment to his land and make it rewarding for him to remain in his local community; thereby, helping stem the accelerated on-going movement to urban centers.

6. Increase population growth. The technology will increase the birth rate, decrease the death rate, and further the rise in population. These effects will be generated basically by the elimination of water-borne diseases. Because currently agriculture in the region is labor-intensive, children are economically valuable. However, in the long run this might turn out to be a disbenefit, if agriculture becomes machine-intensive. The problem will become how to get enough land. When machinery takes over labor, the scheme of continued land parcelling over generations to children in large families will become uneconomical. Thus, in the long run rural population growth may present a dilemma. The way out of this is to control the birth rate.

There will be a bitter debate and struggle over birth control because the old morale and religious injunctions that support a high fertility will persist to resist such practice. However, it seems likely that with intensive educational programs birth control will then be practiced despite religious opposition. In the western world, although all religious groups opposed such practices at first, they changed their views to conform to the changing conditions, holding that the limitation and spacing of births are morally obligatory.[130]

7. Reverse the existing trend in the composition of the rural family. In rural settlements around the urban areas the technology should decrease rural labor exodus and restore the balance to the structure of the rural families at the level of age and sex. The rural migrants are mostly young males. However, the opposite may occur for rural areas not benefiting from the technology.

8. Alter the religious values which usually frown upon sewage. Sewage will be perceived as a valuable water resource and the acceptance will stem from a sense of value. The attitudinal objection to sewage usage has already been overcome; Kuwait which is entirely a moslem country has already started using its sewage for agricultural purposes.

9. Ideally, the technology will help "Make the Desert Bloom," around large urban centers, adorned with greeneries and lakes for boat riding, fishing, and simply for picnicing. Certainly, one cannot put a value on such aesthetic and recreational benefits. However, the priority is for agriculture.

10. Create a new way of life. In a way, the introduction of the programmed wastewater reuse technology to agricultural settlements is asking for a new culture, a new community. New values will emerge: values of planning, organization, rationality, individuality, competition, and specialization. In short, values will be fit for the rural development, and the increase of food; whereas, the alternative is the accelerated dependence on the outside to feed the people.

The scenario of impacts could go on. As Kahn[131] says, there is no completeness or finality without many more volumes of work, if in fact there ever is completion.

There must be a reservation about the word will. Obviously, no one can claim absolute knowledge of tomorrow. The word will should always be read as though preceded by "more than likely." Moreover, it should always be kept in mind that the likelihood is determined by comparing two hypothetical alternative futures for the region: (1) the region without wastewater reuse, (2) the region with wastewater reuse for agriculture.

In short, the wastewater reuse technology which will provide more water for agriculture, will tend to restore the balance in the region's system of interaction. The interrelationships between society, water, and the environment will be restructured to become more congruent with the goals of the Arab-Asian people and their aspiration for greater development, and will resolve partially, problems of social concern.

However, all these benefits may be altered if population increments overtakes the social benefits increments, and if the program does not resolve the social structural constraints. It all depends on a planned program of application and how effectively it will be implemented. Water adequacy is only an initial necessary factor. The program must take account of the anticipated interaction in the region between society, water, environment, and the technology.

The next chapter subjects these hypothesized potential impacts of the technology of wastewater reuse for agriculture in the Arab-Asian region to verification.

CHAPTER VIII

VERIFICATION OF THE POSTULATED SCENARIO

The previous chapter postulates a potential scenario for the impact of water reuse for irrigation on the Arab-Asian society, assuming a successful technology transfer and adaptation. The scenario was deduced from the region's developing and on-going system of interaction between water, society, environment, and technology. The deduction of the scenario from the interaction system stems from the author's own conceptual synthesis of the process of development and the interaction system along the time perspective.

This chapter subjects those postulated impacts in the scenario to verification and further substantiation using two historical scenarios for comparison, as well as the Delphi-technique. The Delphi is also used to determine the likelihood and ranking of these derived potential impacts.

A social Impact Index is constructed of items based on the hypothesized impacts and is used to check against the historical experiences and as the questionnaire for the Delphi.

PART I. THE HISTORICAL SCENARIOS

Two historical scenarios on the effect of the increase in water for irrigation are drawn from two societies:

1. One derived for the U.S.A. from the search of the literature.

2. One derived for Mexico both from the search of literature and from interviews.

The question being asked is: What happened to the American and Mexican societies when water was increased for irrigation? The historical information is perceived as substantial evidence, a demonstration of what actually happened under a comparable situation. Appendix C contains the historical impacts of water development for irrigation in these two societies.

How do the historical scenarios compare with the findings of the study?

The comparison between the Social Impact Index--an itemized list of the potential impacts derived from this study--and the historical scenarios is summarized in Table 8.1. The table checks each impact for the U.S.A. and Mexico according to whether it actually happened (+), did not happen (o), the opposite happened (-), or a combination happened (+ and/or o and/or -).

TABLE 8.1.

Comparison Between the Potential Social Impact Index With What Historically Happened in the U.S.A. and Mexico When Water was Increased for Irrigation

Item No.	Social Impact Index--Future, potential impact derived from this study, of increase water for irrigation by reuse, Arab-Asian countries	Historical Impact Water Increase for Irrigation* U.S.A.	Mexico
1.	Increase food production	+	+,o
2.	Provide cleaner environment	+,-	+
3.	Integrate and coordinate the rural population	+	+,-
4.	Emerge new values: values of rationality, individual competition, specialization, etc.	o (values prior)	o
5.	Increase rural per capita income	+	+
6.	Improve rural housing	+	+
7.	Build new agricultural settlements	+	+
8.	Abate rural drop in manpower	+ (when only labor-intensive)	+
9.	Increase rural social services--clinics, schools, etc.	+	+
10.	Reduce the disparity in living standard between rurals and urbans	+	+,o
11.	Flourish business between urban and rural centers	+	+
12.	Generate two-way mobility instead of only to cities	+	+
13.	Reduce urban problems	N.A.**	N.A.*
14.	Increase birth rate, decrease death rate	+	+
15.	Enhance farmers' education in modern farming	+	o,+
16.	Increase rural population size	+,o	+
17.	Enlarge rural family	+	+

TABLE 8.1(continued)

Item No.	Social Impact Index--Future, potential impact derived from this study, of increase water for irrigation by reuse, Arab-Asian countries	Historical Impact o Water Increase for Irrigation*	
		U.S.A.	Mexico
18.	Alleviate the burden of rural women	N.A.**	N.A.**
19.	Enhance rural family integration	N.A.**	N.A.**
20.	Alter religious taboos which frown on sewage	N.A.**	N.A.**
21.	Farmers will use treated sewage for irrigation	+	+
22.	Provide eventually lakes for recreation--people will enjoy	+	o
23.	Agriculture will become machine-intensive	+	+,o
24.	Assuming agriculture become machine-intensive, rurals will then accept birth control	+	o
25.	Will halt desertification	N.A.**	N.A.**

*See Appendix C.

**N.A. means not available.

In general, the historical evidence of these scenarios confirms the findings of this study. The table shows that the increase in water for irrigation played a predominant role in the two countries. Water development increased food production, improved health standards, centralized political control and social organization, integrated the rural economic activities, but also created conflict by threatening the local power structure establishment, enhanced employment opportunities, vitalized the economic and agrobusiness life of rural communities, redistributed income, increased rural-urban infrastructure, increased and dispersed population, and it increased the size of the rural family as well as other effects (see Appendix C).

In addition the table compares the impact of water development on the two types of societies. The table depicts the effect of the variation in societal characteristics and constraints on the impact--quality and quantity. In other words, the impacts varied between the two because of the differences in the "environment" in which the water development was implemented, i.e., due to the interaction in the development process within each country. The water projects cleaned the environment in both countries, but also had a subsequent impact of polluting the environment in the U.S.A. because of the high development in the chemical technology. The water development integrated and organized the rural communities, but it was more effective in the U.S.A. where people accept more readily the change, i.e., local adaptation was less of a problem; the water development disrupted the law and order in Mexico in the Hobbesian sense several times. And the water development increased rural family size and structure in both countries, but no longer has this effect in the U.S.A. because farming is no longer labor-intensive. The flow diagram (Figure 8.1) in a general way shows the variation in the impact due to the variation in societal characteristics.

PART II. THE DELPHI TECHNIQUE

A. Description of Delphi

The Delphi method has been extensively developed by Olaf Helmer (1966) and others at the RAND Corporation.[132] It is a technique used to combine and refine the opinions of a panel of experts in order to establish a judgment based on the merging of the information collectively available to those experts. The method is a consensus-oriented procedure. What distinguishes it from an ordinary polling procedure is the feedback of the information gathered from the panel of experts and the opportunity that the panelists are allowed for modifying

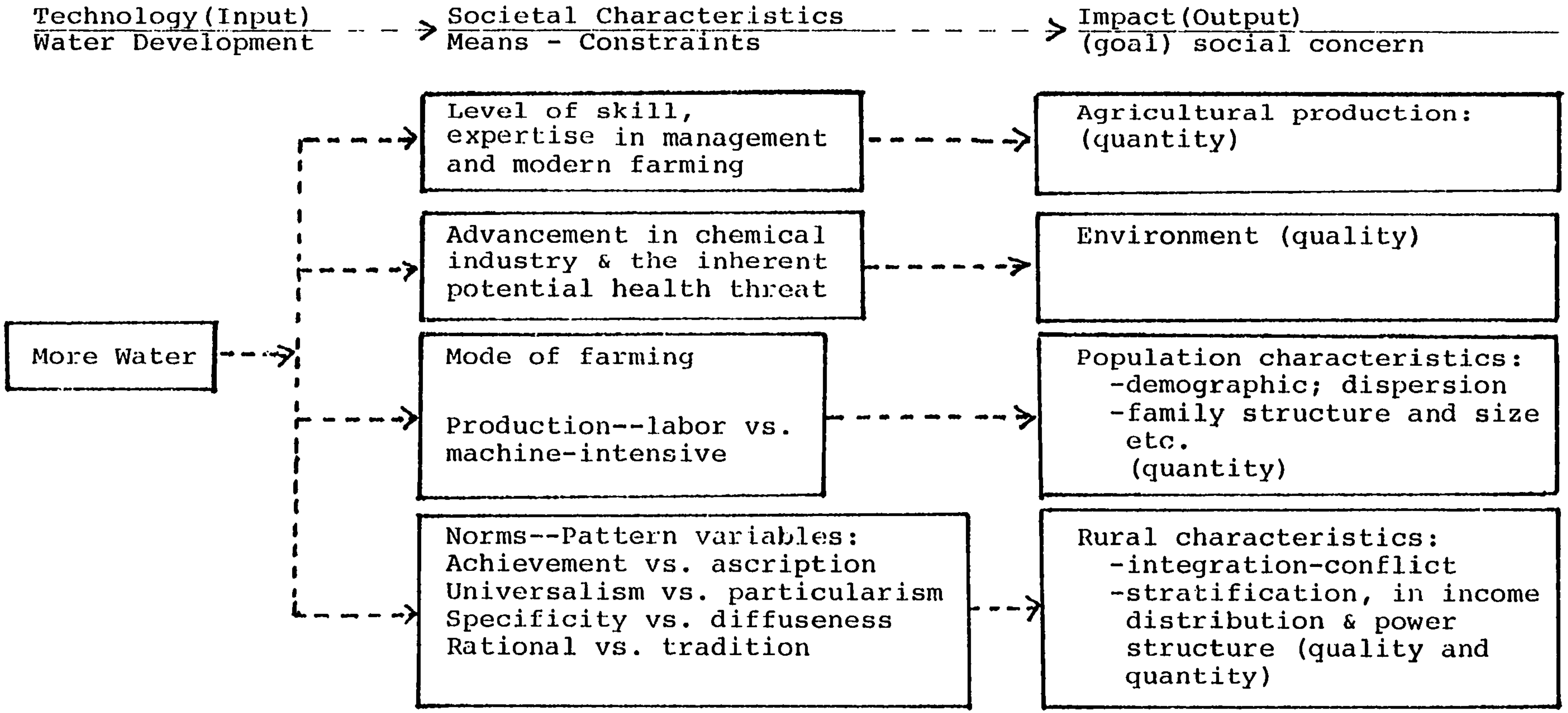


FIGURE 8.1. A Flow Diagram of the Variation in the Water Development Impact Due to Variation in Societal Characteristics

their reactions to the collective views of the group. No direct interaction between the panelists, however, is permitted.

For this study, a panel of eleven experts was formed. Those experts were selected on the basis of two criteria: (1) expertise--each has a special characteristic of competence in at least one of the following areas: rural sociology, economics, water treatment, planning, agriculture, environment, and/or engineering--, and (2) working experinece in the area. The list of panel members is presented in Appendix D.

B. Conduction of the Delphi

Two rounds of questionnaires were sent to the Delphi-panel.

First Iteration: A questionnaire was sent to the eleven selected panelists. The questionnaire consisted of the items of the Social Impact Index derived from this study as the hypothesized potential impact of wastewater reuse for agriculture in the Arab-Asian society. The panelists were asked to check whether they agree, are undecided, or disagree that the implementation of the technology in the Arab-Asian countries will entail each stated impact (see Appendix D). Table 8.2 shows the frequency distribution of the Delphi-panel responses to the questionnaire.

TABLE 8.2.

Frequency Distribution of the Delphi-Panel Responses to Likelihoo

of Impacts to Occur in the First Round of Questionnaire

Item No.	Social Impact Index Items	Frequency Distributior Agree	Undecided	Disagr
1.	Increase food production	11	-	-
2.	Provide cleaner environment	10	-	1
3.	Integrate and coordinate the rural population	4	1	6
4.	Emerge new values: values of rationality, individual competition, specialization, etc.	6	3	2
5.	Increase rural per capita income	10	-	-*
6.	Improve rural housing	5	4	2
7.	Build new agricultural settlements	7	2	2
8.	Abate rural drop in manpower	9	2	-
9.	Increase rural social services--clinics, schools, etc.	7	2	2
10.	Reduce the disparity in living standards between rurals and urbans	6	4	1
11.	Flourish business between urban and rural centers	8	2	1
12.	Generate two way mobility instead of only to cities	2	6	3
13.	Reduce urban problems	11	-	-
14.	Increase birth rate, decrease death rate	4	5	2
15.	Enhance farmers' education in modern farming	7	3	1
16.	Increase rural population size	8	2	1
17.	Enlarge rural family size	2	4	5
18.	Alleviate the burden of rural women	9	-	2
19.	Enhance rural family integration	9	2	-

TABLE 8.2(continued)

Item No.	Social Impact Index Items	Frequency Distribution Agree	Undecided	Disagr
20.	Alter religious taboos which frown on sewage	6	3	2
21.	Farmers will use treated sewage for irrigation	10	1	-
22.	Provides eventually lakes for recreation--people will enjoy	8	-	2*
23.	Agriculture will become machine-intensive	5	3	3
24.	Assuming agriculture becomes machine-intensive, rurals will then accept birth control	3	3	5
25.	Will halt desertification	8	2	-*

*One missing.

The responses to the first iteration reveal:

First, similar to the hypotheses postulated in this study and to the historical scenarios, there will be societal constraints in the region in the path of the technology transfer and these constraints will not be readily resolved by merely adopting the technology. The agreement is less among the panelists on the likelihood of changing values and transforming the social structure, enhancing local integration, increasing urban-rural interaction, and accepting birth control.

Second, these unresolved constraints may subsequently hinder impact of social concern. Though the agreement is high that the technology will increase rural per capita income, the agreement is low that it will raise the standard of living of the farmer, improve the rural housing, generate two way mobility, increase birth rate and decrease death rate, and reduce the disparity in standard of living between rurals and urbans.

Second Iteration: The structure of the second round questionnaire was developed from responses to the first round and from the historical scenarios. The primary purpose of the second round of the questionnaire distributed to the Delphi-panel was:

First, to determine and rank the likelihood of the impacts contained in the Index.

Second, to provide feedback information to the panelists in case they consider it necessary to modify their opinion on the previous round. The panelists were provided with: (1) summary information of the historical scenarios, and (2) the frequency distribution of the responses to the first round of the questionnaire. In addition, the panel was told that the technology will be programmed to overcome societal barriers.

However, in the second iteration, impact items related to societal constraints were isolated from the questionnaire as a separate part. Accordingly the structure of Impact Index was conceptualized as a construct of two dimensions:

1. The dimension of the societal constraint resolution (impact). (See Appendix D, Second Iteration questionnaire, Part I.)
2. The dimension of the resultant social impact. (See Appendix D, Second Iteration questionnaire, Part II.)

The rationale for this structure is to locate the barriers to successful technology transfer and further determine the opinion of the panelists on the likelihood of the impacts on the region from such technology given the existing circumstances. Such a structure hopefully more relates to practical planning and policy makers decisions.

The panelists were asked to forecast for the period prior to the year 2000 on the likelihood of the impacts contained in each dimension, by weighing each impact as to whether its likelihood is high, medium, low, has no chance, or whether the opposite will occur (see Appendix D).

The Delphi method is applied here in order to determine the likelihood of and to rank the items in the Index according to the values of the Factor Likelihood Coefficient (FLC). The experts' competence, knowledge, and experience in the area is used to assist in the ranking process. Also the weighted ranking technique identifies the different likelihood values for each impact in the Index.

The Weighted Ranking Method

First, a matrix is formed (see Appendix D, Table D.2). The experts represent the matrix columns (j), and the social impacts represent the matrix raws (i). The entries consist of the "weights" that each expert scores the impacts (W_{ij}). The Factor Likelihood Coefficients (FLC) is equal to the sum values for an individual impact, divided by the sum values for all the impacts in the Index. In mathematical terms

For Part I: $$FLC = \underline{X} = \frac{\sum_{j=1}^{11} W_{ij}}{\sum_{i=1}^{12} \sum_{j=1}^{11}}$$

For Part II: $$FLC = \underline{X} = \frac{\sum_{j=1}^{11} W_{ij}}{\sum_{i=1}^{14} \sum_{j=1}^{11} W_{ij}}$$

where: FLC = Factor Likelihood Coefficient

W_{ij} = Weight of i-th impact by j-th expert

i = A subscript denoting the i-th impact

j = A subscript denoting the j-th expert

Each impact then has an FLC value. The total values of the FLC equal to 1. The ranking of the Impact Index, therefore, is based on the FLC values.

Table 8.3 and Table 8.4 give a summary information of the Delphi-panel response to Part 1 of the second round questionnaire regarding the likelihood and the ranking of the societal constraint resolutions. Similar to the historic scenarios, the tables clearly show that the constraints in the social structure at the rural community level should be given high priority in programming the technology. The panelists rank these constraints with low likelihood of being resolved prior to the year 2000 even with a programmed technology.

Table 8.5 and Table 8.6 summarize the Delphi-panel response to Part II of the second round questionnaire regarding the likelihood and the ranking of the resultant social impacts. The likelihood and the ranking are low for many of the major social concerns. The implication for policy makers is to give special attention that these desirable impacts are realized in programming. Despite the relatively high grading by the panelists on the likelihood of higher per capita rural income and higher agricultural production, they give low grading to the likelihood of raising the living standard of the rural communities and increasing rural employment opportunities.

TABLE 8.3.

Likelihood of Resolving Societal Constraints by the Year 2000--Frequency Distribution, FLC, Rank, Likelihood (Panel Response to Second Round Questionnaire Part I)

Impact No.	Social Constraint Resolutions	Frequency Distribution High =5	Medium =4	Low =3	No Chance =2	Opposite Will Occur = 1	Total Scores	Average Score	FLC	Rank	Likelihood
	A. Individual and Family Level Constraints										
1.	Farmers will become skilled in modern farming	1	4	3	3	-	36	3.3	.073	10	Low
2.	Farmers will accept treated sewage for agriculture	2	6	3	-	-	43	3.9	.087	6	Medium
3.	Rurals will more accept individual achievement rather than inherited status	-	-	9	2	-	31	2.8	.062	12	No Chance
4.	People will accept eating crops irrigated with treated sewage	3	7	1	-	-	46	4.2	.093	4	High
	B. Rural Community Level Constraints										
5.	Rural class hierarchy differentiation will decrease	4	1	2	3	1	37	3.4	.075	9	Low
6.	Rural communities will become more organized and integrated	2	2	7	-	-	39	3.5	.079	8	Low
7.	Rural life will become more controlled and organized by the central government	-	5	1	5	-	33	3.0	.067	11	No Chance
	C. (Central) Government Level Constraints										
8.	Government will provide the mechanism to effectively train needed manpower	4	6	1	-	-	47	4.3	.095	2	High
9.	Government will build the distribution network necessary for sewage collection and delivery	6	1	4	-	-	46	4.2	.093	4	High
10.	Government will enforce water allocation laws	6	3	2	-	-	48	4.4	.097	1	High
11.	Government will build agricultural "new towns"	3	2	6	-	-	41	3.7	.083	7	Medium
12.	Government will provide new rural social services--schools, clinics--equal to urban services	3	8	-	-	-	47	4.3	.095	2	High
	TOTAL						494		1.00		

TABLE 8.4.

Rank and Likelihood of Resolving the Constraints by the Year 2000, Delphi-Panel Response to the Second Round Questionnaire--Part I

Rank	Societal Constraint Resolutions	Likelihood of Resolving Constraints
1.	Government will enforce water allocation laws	High
2.	Government will provide new rural social services--schools, clinics--equal to urban	High
2.	Government will provide the mechanism to effectively train the needed manpower	High
4.	Government will build the distribution network necessary for sewage collection and delivery	High
4.	People will accept eating crops irrigated with treated sewage	High
6.	Farmers will accept treated sewage for agriculture	Medium
7.	Government will build agricultural "new towns"	Medium
8.	Rural communities will become more organized and integrated	Low
9.	Rural class hierarchy differentiation will decrease	Low
10.	Farmers will become skilled in modern farming	Low
11.	Rural life will become more controlled and organized by the central government	No chance
12.	Rurals will accept more individual achievement than inherited status	No chance

TABLE 8.5.

Likelihood of Resultant Impact Occurring by the Year 2000--Frequency Distribution, FLC, Rank, Likelihood(Panel Response to Second Round Questionnaire, Part II)

Impact No.	Resultant Social Impacts	Frequency Distribution: High =5	Medium =4	Low =3	No Chance =2	Opposite Will Occur = 1	Total Scores	Average Score	FLC	Rank	Likelihood
	A. Individual and Family Level										
1.	Women will have easier life (no more water hauling)	3	3	2	3	-	39	3.5	.068	8	Low
2.	Rural per capita income will increase	9	-	-	1	1	48	4.4	.084	1	Medium
3.	Rural housing will improve	1	8	-	2	-	41	3.7	.071	6	Low
4.	Rural family will reintegrate	7	-	-	2	2	41	3.7	.071	6	Low
5.	Rural family size will increase	-	-	4	7	2	26	2.4	.045	14	No chance
6.	Public will accept treated sewage lakes for recreation	1	4	5	1	-	38	3.4	.066	11	Low
	B. Rural Community Level										
7.	Rural manpower loss will abate	7	1	1	2	-	46	4.2	0.080	4	Medium
8.	Rural population will increase	7	2	1	-	1	47	4.3	.082	3	Medium
9.	Rural employment opportunities in agro-business will increase	2	2	6	-	-	38	3.4	.066	11	Low
10.	The community environment will become cleaner	5	3	3	-	-	46	4.2	.080	4	Medium
	C. Nation Level										
11.	Countries will develop self-sufficiency in food production	5	5	1	-	-	48	4.4	.084	1	Medium
12.	The disparity in standard of living between rural and urban settlement will reduce	2	4	3	2	-	39	3.5	.068	8	Low
13.	Rural-urban interaction will increase(business activities, mobility)	4	2	1	4	-	39	3.5	.068	8	Low
	D. Subsequent Impact										
14.	Urban problems will ease	4	1	1	5	-	37	3.4	.065	13	Low
	TOTAL						573		1.00		

TABLE 8.6.

Rank and Likelihood of Resultant Impacts by the Year 2000, Delphi-Panel Response to the Second Round Questionnaire--Part II

Rank	Resultant Social Impact	Likelihood of Resultant Impact
1.	Countries will develop self-sufficiency in food production	Medium
1.	Rural per capita income will increase	Medium
3.	Rural population will increase	Medium
4.	Rural manpower will abate	Medium
4.	The community environment will become cleaner	Medium
6.	Rural housing will improve	Medium
6.	Rural family will reintegrate	Medium
8.	The disparity in standard of living between rural and urban will reduce	Low
8.	Rural-urban interaction will increase (business activities, mobility)	Low
8.	Women will have easier life (no more water hauling)	Low
11.	Public will accept treated sewage lakes for recreation	Low
11.	Rural employment opportunities in agro-business will increase	Low
11.	Urban problems will ease	Low
14.	Rural family size will increase	No chance

Finally, Table 8.7 and Table 8.8 present a full summary of the above information for the first and second dimensions of the impact of wastewater reuse to substantiate the findings of the study. These two tables combine the historical scenarios and the results of both rounds of the Delphi.

Table 8.7.

Summary Combining the Historical Scenarios and Both Rounds of the Delphi in Relation to Societal Constraint Resolutions

Const. No.	Societal Constraint Resolutions	First Round Response Resolution Will Occur (Frequency Distribution)			Historic Experience + = occurred o = no occurrence - = opposite occurred		Second Round Response-- Likelihood of Resolving the Constraint by Year 2000 (Frequency Distribution)						
		Agree	Unde-cided	Dis-agree	U.S.A.	Mexico	High	Medium	Low	No Chance	Opposite Will Occur	Rank	Like-lihood
	A. Individual and Family Level Constraints												
1.	Farmers will become skilled in modern farming.	7	3	1	+	o,+	1	4	3	3	-	10	Low
2.	Farmers will accept treated sewage for agriculture.	10	1	0	+	+	2	6	3	-	-	6	Medium
3.	Rurals will more accept individual achievement rather than inherited status.	6	3	2	o (prior)	o	-	-	9	2	-	12	No Chance
4.	People will accept eating crops irrigated with treated sewage.	-	-	-	N.A.	N.A.	3	7	1	-	-	4	High
	B. Rural Community Level Constraints												
5.	Rural class hierarchy differentiation will decrease.	-	-	-	- (class emerged)	o	4	1	2	3	1	9	Low
6.	Rural communities will become more organized and integrated.	4	1	6	+	+,-	2	2	7	-	-	8	Low
7.	Rural life will become more controlled and organized by the central government.	-	-	-	+	+	-	5	1	5	-	11	No Chance
	C. (Central)Government Level Constraints												
8.	Government will provide the mechanism to effectively train the needed manpower.	-	-	-	+	+	4	6	1	-	-	2	High
9.	Government will build the distribution network necessary for sewage collection and delivery.	-	-	-	N.A.	N.A.	6	1	4	-	-	4	High
10.	Government will enforce water allocation laws.	-	-	-	+	+,-	6	3	2	-	-	1	High
11.	Government will build agricultural "new towns."	7	2	2	+	+	3	2	6	-	-	7	Medium
12.	Government will provide new rural social services - schools, clinics -	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]

Table 8.8

Summary Combining the Historical Scenarios and Both Rounds of the Delphi in Relation to Resultant Social Impacts

Impact No.	Resultant Social Impacts	First Round Response Impact Will Occur (Frequency Distribution)			Historic Experience + = occurred o = no occurrence − = opposite occurred		Second Round Response Likelihood of Impact Occurring by Year 2000 (Frequency Distribution)						
		Agree	Undecided	Disagree	U.S.A.	Mexico	High	Medium	Low	No Chance	Opposite Will Occur	Rank	Likelihood
	A. Individual and Family Level												
1.	Women will have easier life (no more water hauling).	9	0	2	N.A.	N.A.	3	3	2	3	−	8	Low
2.	Rural per capita income will increase.	10	−	−	+	+	9	−	−	1	1	1	Medium
3.	Rural housing will improve.	5	4	2	+	+	1	8	−	2	−	6	Low
4.	Rural family will re-integrate.	−	−	−	N.A.	N.A.	7	−	−	2	2	6	Low
5.	Rural family size will increase.	2	4	5	+	+	−	−	4	7	2	14	No Chance
6.	Public will accept treated sewage lakes for recreation	8	0	2	+	o	1	4	5	1	−	11	Low
	B. Rural Community Level												
7.	Rural manpower loss will abate.	9	2	0	+,o	+	7	1	1	2	−	4	Medium
8.	Rural population will increase.	8	2	1	+,o	+	7	2	1	−	1	3	Medium
9.	Rural employment opportunities in agro-business will increase.	−	−	−	+	+	2	2	6	−	−	11	Low
10.	The community environment will become cleaner.	10	−	1	+,−	+	5	3	3	−	−	4	Medium
	C. Nation Level												
11.	Countries will develop self-sufficiency in food production.	11	−	−	+	+,o	5	5	1	−	−	1	Medium
12.	The disparity in standard of living between rural and urban settlement will reduce.	6	4	1	+	+,o	2	4	3	2	−	8	Low
13.	Rural-urban interaction will increase (business activities, mobility).	8	2	1	+	+	4	2	1	4	−	8	Low
	D. Subsequent Impact												
14.	Urban problems will ease.	11	−	−	N.A.	N.A.	4	1	1	5	−	11	Low

CHAPTER IX

SUMMARY, CONCLUSION, AND POLICY RECOMMENDATIONS

A. SUMMARY

In analyzing the water shortage in the arid region of the Arab-Asian countries, this dissertation has projected the likelihood of its solution in view of the current trends in society and the demand of development, as well as the technological measures used in dealing with it. This study has offered an alternative solution to the water problem in the technology of wastewater reuse for agriculture, a rich source of water that is currently being wasted in the region, and it has hypothesized the prospective potential impacts of its implementation on the Arab-Asian society.

The method of the investigation has been directed by the author's own conception of the term development. The term development was redefined to mean an on-going interaction system between water (other resources), society, environment, and technology. Thus, the water problems, in terms of adequacy, technological solutions and impacts, was viewed as an integral part of a development process and, therefore, as an interdisciplinary problem.

The following is a brief summary of what has been done:

The "introduction" defines the water shortage problem in the Arab-Asian region and its significance in the development process, especially in the agricultural and domestic sectors. The conceptual framework of the dissertation in which water is perceived as an integral part of a redefined development process is presented, along with the proposition for the implementation of wastewater reuse for agriculture.

Chapter two describes the water resources as they exist currently without wastewater reuse technology. It details the sources of water now in use and the technologies being adopted to try to increase the water in the region. This chapter also briefly describes the efficiency of wastewater reuse technology and its advantages over other technologies presently being used. In addition, the responses by technical experts representing governments in the area to a questionnaire are presented to determine their attitudes on wastewater reuse.

Chapter three discusses the lags and the changes in the social structure and demographic and socio-economic trends. It illustrates how the oil industry has been the paradigm in the region for impact on the on-going development.

Chapter four describes the trends in per capita agriculture production, the concept of self-sufficiency in food, the trends in food imports, and the need to augment water supplies for agriculture in order to boost food production.

Chapter five details the interaction between water, technology, society, and the environment in the development process for the agricultural and domestic sectors in the region. It also describes the present urban and rural water delivery and wastewater disposal systems within the countries.

Chapter six evaluates the interaction system and draws conclusions about the future of the system without wastewater reuse. Then it analyzes wastewater reuse and estimates up to the year 2000 for selected countries how much will be gained in the water supply and irrigated land, given the on-going interaction system.

Chapter seven postulates the potential impacts on the Arab-Asian society, assuming the successful implementation of the technology of wastewater reuse for agriculture in the region. These hypothesized impacts have been drawn by perceptually comparing two alternative development processes in the region--the region without wastewater reuse and the region with it.

Chapter eight verifies the hypothesized impacts using historical experiences in Mexico and the U.S.A. with increased water for irrigation and using the Delphi-technique for projecting the likelihood of the impacts' occurring in the region by the year 2000.

B. CONCLUSIONS

This study has reached certain conclusions about the water problem in the region, about the implementation of wastewater reuse for agriculture, and about the potential impact of its implementation on the society of the region. These conclusions have been drawn from the four levels of analysis in the study: Regional, Wastewater Reuse Implementation, Historical Scenarios, and the Delphi.

Regional

From the regional analysis the study reveals three main points:

(1) The problem of water is expected to worsen in the future in view of the characteristics of the interrelationships in the interaction system. Societal trends--such as population growth, higher per capita income, rural to urban migration, and deterioration of rural areas--coupled with societal lags in terms of the social structure and its inadaptability to technological solutions are in general increasing the demand for water, depleting the groundwater supplies, polluting the surface water, and hampering efforts to achieve technological solutions.

(2) Consequently, the development process is moving in the wrong direction--away from self-sufficiency in food and the maintenance of a healthy environment.

(3) The societal constraints, rather than economic or governmental ones, are adversely affecting technological solutions and leading to a decline in per capita food production and self-sufficiency. A well thought-out program addressing these societal constraints will be necessary for the technology to succeed.

Wastewater Reuse Implementation

Analysis of the wastewater reuse application in the region reveals four main conclusions:

(1) Wastewater reuse for agriculture has the potential for substantially increasing the additional irrigated land by the year 2000, especially in the highly urbanized countries. The more urbanized the country, the more viable wastewater reuse becomes.

(2) The oil producing countries stand to gain the most from such technology, because of their increased dependence on the expensive desalination process. Secondary effluent for agriculture will extend the use of desalinated water and provide richer and a more economical water source for irrigation than desalinated water. Thus, the more desalination, the more viable wastewater reuse for agriculture becomes. Moreover, these oil producing countries will gain the most because the population is rapidly clustering in the main cities, or city states.

(3) The governmental technical experts surveyed were in total agreement on wastewater reuse for agriculture.

This conclusion is significant. It means that those in power to make decisions are not opposed to the adoption of the technology and, therefore, are themselves no constraint on the implementation of the technology.

(4) Wastewater reuse for agriculture could be a paradigm for impact on the development process. It may restructure the interaction of the existing system. By providing more water for agriculture and cleaner environment, the technology has the potential of partially alleviating several current social problems, such as increasing the poor farmer's per capita income, subsequently raising the standard of his living, abating the rural to urban migration, and closing the disparity in the standard of living between rurals and urbans.

Historical Scenarios

The historical scenarios reveal two major points:

(1) The adaptability of the society to technology transfer is directly related to the success of increased water for irrigation. The social impact of increased water for irrigation depends to a large extent on the adaptability of society it is introduced into. The inadaptability of the Mexican society to the change caused conflict. The powerful rural Mexican elite fought to keep their privileges in water allocation and violence broke out. Such was not the case in the U.S.A. where the society adapted more readily, abiding by the new laws and avoiding violent conflict.

(2) Programming the irrigation project is necessary to overcome societal constraints and obtain positive results. In Mexico, the "ejido" project brought positive results only after the increased water for irrigation was programmed.

Delphi

The responses of the two iterations by the Delphi panelists provide the basis for four main conclusions:

(1) The Delphi-panel's consensus is that the societal constraints at the rural level--individual and community--have a low likelihood of being resolved by the year 2000. This projection is indicative of the inadaptability of the rural society.

(2) The panel's consensus is that the governments in the region are no constraints on the implementation of water reuse technology for irrigation.

(3) The consensus is that rural population growth, as a possible problem for the future, will not be readily resolved, because rurals will not accept birth control.

(4) And, finally, the Delphi-panel's consensus is that the technology has a high likelihood of abating the drop in manpower, but a low likelihood of improving the standard of living for the farming community and benefitting the poor farmers by the year 2000, even though the rural per capita income may increase. This projection implies that others than the poor will benefit from the technology and that the

status quo of inequality will be maintained, or even reinforced.

The Delphi projection highlights the anticipated societal constraints in the path of the technology transfer in the region. The inference from this projection is that the characteristics of the rural community are similar to the Mexican and not the American rural community. It confirms the finding of this study and the historical scenarios that a well thought-out and effectively implemented program is necessary to overcome the anticipated societal constraints.

C. POLICY RECOMMENDATION

Although several governments are engaged in many activities related in one way or another to the improvement of water supplies, it is hoped that this study has called attention to the unsatisfactory state of water, both urban and rural, in the Arab-Asian region. The magnitude of the water problem and its significance for the development of the countries demand much more public attention. The current proportion of emphasis will not be enough to correct the worsening situation, even in the near future, in view of the characteristics of the interaction in the development process on-going in the region.

This study is a call to develop the region on a strong foundation, i.e., on the priority for adequate food and a healthy environment. But it is also a caution to give prior consideration to water development, without which there will be no food and no healthy environment.

This study calls attention to the potential loss to the region without the adoption of wastewater reuse technology. It evaluates the significant implications of wastewater reuse for the socio-economic development of the region and the promise that such technology offers for alleviating the problems of food, water, and pollution.

This study also calls for a transformation of the dysfunctional lagging institutional structure in the rural communities in favor of a more efficient structure, congruent with the goal of development and conducive to technological solutions. For it is clear that the rural social system is ineffective. It cannot compete in the existing world market, and it is in need of guidance, assistance, protection, etc. If the food development in the region is of value, and there is no doubt that it is, then the existing social structure lags behind the demand of the technologies available for efficient food development. Efficiency in food production cannot rely on the random activities of people governed by rigid traditional norms and hierarchy. It requires instead rational, individual competition and adaptability to change.

Because the historical scenarios and the consensus of the Delphi-panel confirm the findings of this study that the societal constraints will not readily be overcome, these constraints should, therefore, be given priority in programming technological water projects for irrigation.

In its most forthright statement, this study is a call to take into consideration the interaction between water, society, technology, and environment in water development and in developing the future of the region. The design of such an interdisciplinary model has been the underlying theme throughout this dissertation.

The following diagram (Figure 9.1) gives a final perceptual representation of water adequacy, its technological

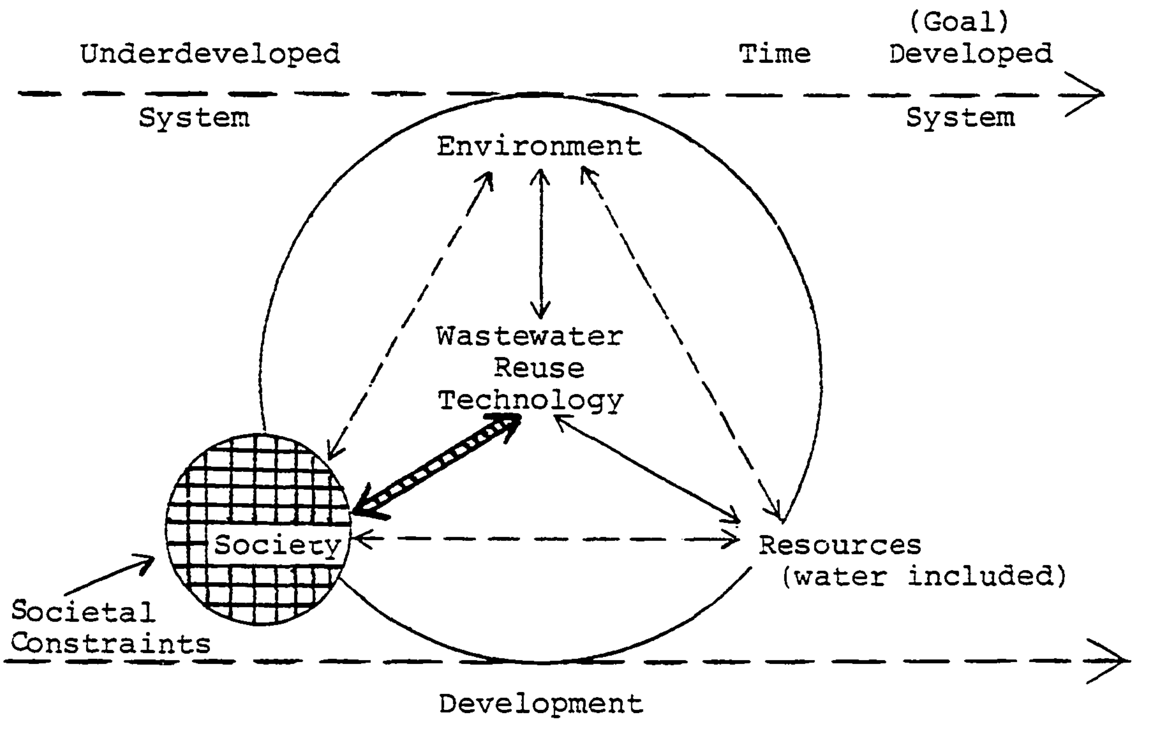


Figure 9.1. Wastewater Reuse Technology as an Integral Part of an Interacting System in the Development Process.

solutions, and impacts as integral parts of an interacting system in the development process; it shows the significance of giving attention to the societal constraints prior to the implementation of the wastewater reuse project. It is hoped that this model will provide a first step toward solving the water problem in the Arab-Asian region, as well as providing a useful interdisciplinary approach for other development problems in the future.

Hopefully the theoretical point of view of this research will have application to future research, and this study of the region will instigate other studies in this area related to the significant problem in the region's water and will induce further research into segments of the programs and the conclusions of this research.

FOOTNOTES

[1]World Health Organization (WHO). Reuse of Effluents: Methods of Wastewater Treatment and Health Safeguards. Technical Report Series, No. 517, World Health Organization, Geneva, 1973.

[2]Economic Commission for Western Asia (ECWA). Report of the ECWA Regional Preparatory Meeting for UN Water Conference, Baghdad, 1976.

[3]United Nations' Report of the United Nations Water Conference. Mar del Plata, Argentina 14-25, March 1977, E/Conf 70/29, p. 63.

[4]Economic Commission for Western Asia (ECWA/Food and Agricultural Organization (FAO). Food Security in the ECWA Region: Analysis of Production and Consumption Problems. E/ECWA/AGRI/79/1, March 1979.

[5]Reid, George W. "Technology Transfer, Adaptation, and Utilization." Appropriate Methods of Treating Water and Wastewater in Developing Countries. G. Reid and Kay Coffey (editors), The University of Oklahoma, Norman, Oklahoma, 1978, p. 25.

[6]Kubursi, Atif A. and Sayed. Economic and Social Council-United Nations. Induced Innovation and the Role Agriculture in Economic Development. A Case Study of Egypt and Syria. McMaster University, Canada, September 1977, p. 1.

[7]McCarty, Perry L. "Research and Development of Reuse Water," Water: Development, Utilization, Conservation. Roma K. McNickle (editor), Western Resources Papers, 1963. University of Colorado Press, 1964, p. 58.

[8]Reid, G.W. "Technology Transfer, Adaptation, and Utilization." Ibid. P. 37.

[9]Jantsch, E. Technological Forecasting in Perspective. OECD, 1967.

[10]Kubursi, Atif A. Ibid. P. 1.

[11]Kahn, Herman and A.J. Wiener. The Year 2000. Macmillan, New York, 1967.

[12]Gilfillan, S.C. The Sociology of Invention. Supplement, San Francisco Press, San Francisco, 1971.

[13]Baker, W.O. "The Dynamics of Science and Technology," Technology and Social Change. Eli Ginsberg (ed.), Columbia University Press, New York, 1964.

[14]Ogburn, W.F. Social Change, Dell Publishing Co., 1966.

[15]Reid, G.W. "Technology Transfer, Adaptation, and Utilization." Appropriate Method of Treating Water and Wastewater in Developing Countries. University of Oklahoma.

[16]Meadows, et al. Limits to Growth. Universal Books, New York, 1975.

[17]Schumacher, E.F. Small is Beautiful. Harper and Row, New York, 1973.

[18]Colwell, T.B. "Some Implication of the Ecological Revolution for the Construction of Value." Human Values and Natural Science. New York, 1970.

[19]Wenk, Edward. "The Social Mangement of Technology," Science for Technology. Atlanta, 1971.

[20]Bright, J. Technological Forecasting for Industry and Government. Prentice Hall, Engelwood Cliffs, 1968.

[21]Toffler, Alvin. Future Shock. Pan Books Ltd., London, 1971.

[22]Reich, Charles A. The Greening of America. Random House, New York, 1970.

[23]Mumford, Lewis. The Pantagon of Power. Harcourt, Brace and Jovanovich, New York, 170.

[24]Economic and Social Council-United Nations. The Study of Interrelationships Between Population, Resources, Environment and Development. E/1979/75, June 1979.

[25]Kuhn, T.S. The Structure of Scientific Revolution. University of Chicago Press, Chicago, 1962.

[26]Ibid. P. 4.

[27]Office of Saline Water, Dept. of Interior USA, Desalination Research and the Water Problem. Publication 941. Washington, D.C., 1962.

[28]WMO. Casebook on Hydrological Network Design Practice. No. 324, Geneva. April 1978.

[29]United States, Department of Interior, Geological Survey. A Qualitative Hydrologic Appraisal of the Yemen Arab Republic from Landsat Images. Reston, Virginia, 1976.

[30]WMO. Casebook on Hydrological Network Design Practice. No. 324, Geneva. April 1978.

[31]Economic Commission for Western Asia (ECWA). Report of the ECWA Regional Preparatory Meeting for the UN Water Conference. E/ECWA/42/Revised, Baghdad, Iraq, 1976.

[32]Albar, Allawi F. Desalination in Saudi Arabia. Presented by United Nation Water Conference, Mar del Plata, Argentina, 1977.

[33]Arab Water World, Arab Water World. July-August 1977. Published by METATO Co., Beirut.

[34]Ibid.

[35]Ibid.

[36]FAO. Regional Office. Protected Vegitable in Kuwait. Ministry of Public Work, Department of Agriculture, Kuwait, 1976.

[37]Grolier, Maurice J., Gordon C. Tibbitts, Jr., and Mohammad Mukred Ibrahim. A Qualitative Appraisal of the Yemen Arab Republic from Laurat Images. Open File Report. United States, Department of Interior, Geological Survey. Washington, D.C., 1976.

[38]Kuwait, Government of. Country Report Presented at Baghdad Meeting of the ECWA member countries, 1976.

[39]Reid, George. Sanitary Design and Water Resource, 1977.

[40]Report of the ECWA Regional Preparatory Meeting for UN Water Conference, 1976.

[41(a)]Desalination in Saudi Arabia, presented at the UNWC Mar del Plata, Argentina, March 1977.

[(b)]The State of Kuwait the Role of Desalting Technology in Providing Kuwait's Fresh-water Needs, December 1976.

[42]DeCook, K.J. Reuse of Wastewater in Desert Regions in Conference on Alternate Strategies for Deserts Development, Sacramento, California, May-June.

[43]World Health Organization. Reuse of Effluents: Methods of Wastewater Treatment and Health Safeguards. Technical Report Series, No. 517. WHO, Geneva, 1973, P. 8.

[44]Journal Water Pollution Control Federation. Vol. 40. Anonymous, JWPCF, April 1968, published by Water Pollution Control Federation, Washington, D.C.

[45]Jacob I. Bregman, "Membrane Processes Gain Favor for Water Reuse," Environmental Science and Technology, Vol. 4, No. 4, April 1970, p. 269.

[46]U.N. Water Conference, Proceeding, Vol. 1, Part 3, p. 1027, Pergamon Press, 1978.

[47]Barb, C.E. and Cook, A.R. "Technology Transfer in Paratransit: Case Study," Interpretation of Five Leading Programs, January 1979.

[48]Jantsch, E. Technological Forecasting in Perspective, p. 38, 1967.

[49]Parsons, Talcott. Social System. Free Press, Glencoe, Illinois, 1951.

[50]Durkheim, Emile. Division of Labor in Society. Free Press, Glencoe, Illinois, 1949.

[51]Lee, Everett. "Migration in Relation to Education, Intellect, and Social Structure." Population Index, 36 (October-December 1970), pp. 437-44.

[52]U.S. Department of Commerce/Bureau of Economic Analysis. The National Income and Product Accounts of the United States. 1929-74. Statistical Tables. A Supplement of the Survey of Current Business. U.S. Government Printing Office, Washington, D.C.

[53]Economic Commission for Western Asia. Demographic and Related Socio-Economic Data Sheets for Countries of the Economic Commission for Western Asia. No. 2, Beirut, 1978.

[54]Toffler, Alvin. Future Shock. Pan Books Ltd., London, 1971, P. 76.

[55]U.S. Department of Commerce/Bureau of the Census, Statistical Abstract of the United States, (97th edition) U.S. Government Printing Office, Washington, D.C., 1976.

[56]Ibid.

[57]Ibid.

[58]Lehrner, Daniel. The Passing of Traditional Society. The Free Press, Glencoe, Illinois, 1963.

[59]Bandura, Albert and Richard H. Walters. Social Learning and Personality Development. Holt, Rinehart, and Winston, New York, 1963.

[60]ECWA-UN. The Current Situation and Prospects of Rural Development in Selected Countries of the ECWA Region. 21 November 1978.

[61]FAO/ECWA-UN. Agriculture and Development. May 1979.

[62]Ibid.

[63]ECWA-UN. Study on Manpower Training Needs and Problems in the Fields of Water Resources Development in the ECWA Region. Beirut. 78-2297. December 4, 1978.

[64]Ibid.

[65]Kubursi, Atif A., Ibid.

[66]Ibid.

[67]ECWA/FAO. Agriculture and Development, May 1979.

[68]Ibid.

[69]FAO. Salinity, The Baghdad Seminar, Irrigation and Drainage. Paper No. 7, Rome, 1972.

[70]FAO, Ibid.

[71]ECWA/FAO. Agriculture and Development. 1979.

[72]Mumford, Lewis. The Myth of the Machine. Vol. 1, Harcourt, Brace and World, Inc., New York, 1966, P. 13.

[73]Lebanon Panel Discussion, National Television, June 18, 1979.

[74]Kassab, Najim K. "Identification of Manufacturing of Electrical Equipment in Jordan." Joint ECWA/ UNIDO. 79-24-21, February 1979.

[75]United Nations, Department of Economic and Social Affairs. Natural Resources/Water Series. No. 3 ST/ESA/38, New York, 1976, p. 193.

[76]Ibid. P. 56.

[77]Ibid.

[78]Reid, George. Water Supply and Sewage. Revised edition, Lecture Notes. University of Oklahoma, 1976.

[79]Ibid.

[80]White, G.F., D.J. Bradly and A.U. White. Drawers of Water: Domestic Water Use in East Africa. University of Chicago Press, Chicago, 1972.

[81]Columbia Broadcasting System. Sixty Minutes. September 2, 1979.

[82]Reid, George. Water Supply and Sewage. University of Oklahoma, 1976.

[83]White, Ibid.

[84]United Nations. Natural Resources, Water Series, No. 3.

[85]WHO. Regional Office for the Eastern Mediterranean. The Attitude of WHO and Its Activities in Water Resources Development in ECWA Countries. Prepared for the Regional Preparatory Meeting for the UN Water Conference. November 1976.

[86]ECWA-UN. Water Resources Assessment. Document E/CONF. 70/CBPI. July 2, 1976.

[87]U.S. Department of Health, Education and Welfare, Public Health Service, Individual Water Supply System: Recommendations of the Joint Committee on Rural Sanitation. Revised Ed. Publication No. 22, Washington, D.C. 1950.

[88]Safadi, M. Water Resources in the Syrian Arab Republic, Ministry of Labor and Water Resources, Damascus, 1974.

[89]World Bank, Syrian Arab Republic Water Supply and Sewage Report. Report No. 1566-SYR. September 1977.

[90]UNEP/ECWA. Report of the Joint UNEP/ECWA Mission on Human Settlements Technology in the ECWA Region, November 1977.

[91]Ibid.

[92]Ibid.

[93]World Bank. An Appraisal of an Aleppo Water Supply Project. Report No. 1542-SYR, June 1977.

[94]International Bank for Reconstruction and Development. Appraisal of the Damascus Water Supply Project. Report No. 106a-SYR, May 8, 1973.

[95]UNEP/ECWA. Report of the Joint UNEP/ECWA Mission on Human Settlements. Technology in the ECWA Region, November 1977.

[96]UNEP. Final Act of the Kuwait Regional Conference on Plenipotentiaries on the Protection and Development of the Marine Environment and the Coastal Areas. Kuwait, 15-23 April 1978.

[97]Lebanon National Television. June 25, 1979.

[98]UNEP-ECWA. Report of the Joint UNEP-ECWA Mission on Human Settlements. Technology in the ECWA Region, 77-1369, November 1977.

[99] World Bank. Report No. 1542-SYR, Appraisal of an Aleppo Water Supply Project. June 1977.

[100] ECWA-UN. The Current Situation and Prospects of Rural Development in Selected Countries of the ECWA Region. 78-2054. November 21, 1978.

[101] ECWA-UN. E/ECWA/Pop/WG. 12/BP. 11. November 2, 1978. The Planning of Arab Cities--A Case Study of Beirut, prepared by Marwan Mahsen.

[102] ECWA-UN, The Planning of Arab Cities--A Case of Beirut, prepared by Marwan Mohsen. E/ECWA/WG. 12 BP. 11, November 2, 1978.

[103] Lebanon National Television Panel Discussion on Housing in Lebanon, Weekly program "Fale," June 18, 1979.

[104] Lebanon National Television, Ibid.

[105] UNEP-ECWA-UN. Report on the Joint UNEP/ECWA Mission on Human Settlement Technology in the ECWA Region. November 1977.

[106] The World Bank, Ibid.

[107] Ibid.

[108] Attar, M.S., Forward, Agriculture and Development. ECWA/FAO, Joint, May 2, 1979.

[109] Economic Commission for Western Asia. Joint ECWA/FAO. Agriculture Division. Food Security in ECWA Region: Analysis of Production and Consumption. E/ECWA/AGR/79/1, 79-2471. March 1979.

[110] FAO. Regional Office, UN. Protected Vegetable Production in Kuwait. Ministry of Public Works, Department of Agriculture, Kuwait, 1976.

[111] Thapalyal, Lalit. "Water, Source of Life." WHO Features. Geneva, Switzerland, July 1976.

[112] Saunders, Robert J. and J.J. Warford. Equity with Responsibility in the Village Water Supply. A World Bank Publication Summary.

[113] ECWA-UN. The Current Situation and Prospects of Rural Development in Selected Countries of the ECWA Region. 21 November 1978. 78-2054.

[114] Economic Commission for Western Asia. ECWA-UN. Second Regional Water Meeting (30 December 1978 to January 3, 1979).

[115] United Nations Water Conference (UNWC). Mar del Plata Conference, Argentina, March 1977.

[116] Weber, Max. The Protestant Ethic and the Spirit of Capitalism. Talcott Parsons (translator). Scribner, New York, 1952.

[117] Economic Commission for Western Asia. ECWA-UN. Study on Manpower Training Needs and Problems in the Field of the Water Resources Development in the ECWA Region. 78-2297. Second Regional Water Meeting, preliminary report, 30 December 1978-3 January 1979.

[118] WHO. Public Health Papers. No. 23. Urban Water Supply Conditions and Needs in Seventy-Five Developing Countries. Geneva, 1963.

[119] ECWA-UN. The Current Situation and Prospects of Rural Development in Selected Countries of the ECWA Region. 78-2054. 21 November 1978.

[120] Stafford, James E. and A. Benton Cocanougher. "Reference Group Theory," Selected Aspects of Consumer Behavior. Prepared by National Science Foundation, NSF/RA 77-0013. pp. 361-370.

[121] Reid, G. "Technology Transfer, Adaptation, and Utilization." Ibid.

[122] Sumner, J. "Regional Approach to Integrated Wastes Management Planning," Problems in Community Wastes Management. WHO. Public Health Papers. No. 38. 1969.

[123]UN Water Conference (UNWC). Report of the UN Water Conference. Mar del Plata, Argentina 14-25 March 1977. E/Conf 70/29.

[124]Schultzberg, Gunnar. "Management of Rural Water Supplies." Carl Widstrand (editor). Water and Society. Part I, The Social and Ecological Effects of Water Development in Developing Countries, Pergamon Press, Oxford, 1978, p. 339.

[125]Guigg, Philip W. Water. The Essential Resource. International Series Number Two. National Audubon Society, New York, December 1976.

[126]Wittfogel, K.A. Oriental Despotism. Yale University Press, 1957.

[127]Eva Hunt and Robert Hunt. "Irrigation, Conflict, and Politics: A Mexican Case." Irrigation Impact on Society. Theodore E. Downing and McGuire Gibson (eds.). University of Arizona, 1974.

[128]Al Khatib, Abdyl Basit-FAO Team Leader. The Seven Green Spikes 1965-1972. Riyadh: The Kingdom of Saudi Arabia, Ministry of Agriculture and Water, 1974.

[129]Fogel, Martin M. "Comments on the Symposium from a Hydrological Perspective." Irrigation's Impact on Society. Theodore E. Downing and McGuire Gibson (eds.). The University of Arizona, Tucson, 1974. p. 168-171.

[130]Davis, Kingsley. "The World's Population Crises." Contemporary Social Problems. Robert Merton and R.A. Nisbet (editors). Harcourt, Brace and World, Inc., New York, 1961, pp. 291-323.

[131]Kahn, Herman. The Year 2000. A Framework for Speculation on the Next Thirty-Three Years. Hudson Institute. MacMillan, New York, 1967.

[132]Wheelwright, S.C. and S. Makridakis, S. Forecasting Method for Management. John Wiley and Sons, 1973.

BIBLIOGRAPHY

1. Albar, Allawi F., Desalination in Saudi Arabia. Government of Saudi Arabia. Presented by United Nations Water Conference, Argentina (1977).

2. Al Khatib, Abdul Basit. The Seven Green Pikes 1965-1972. The Kingdom of Saudi Arabia, Ministry of Agriculture and Water, Riyadh (1974).

3. American Water Works Association. 95th Annual Conference Proceedings. Minneapolis, June 8-13, 1975, American Water Works Association, Denver (1975).

4. Baker, William O., "The Dynamic of Science and Technology," Technology and Social Change. Eli Ginzberg (ed.), Columbia University Press, New York and London (1964).

5. Bandura, Albert and Richard H. Walters. Social Learning and Personality Development. Holt, Rinehart and Winston, New York (1963).

6. Banco Nacional De Comercio Exterior. "Latin America in Perspective--Economic and Social Conditions in Mexico," Comercio Exterior de Mexico, S.A. Vol. 25, No. 5, pp. 172-177, Mexico, D.F. (May 1979).

7. Barb, C.E., Jr. and A.R. Cook. "Technology Transfer in Paratransit: A Case Study." Interpretation of Five Leading Programs, For publication in the Proceedings of the 58th Annual Meeting of the Transportation Research Board, Washington, D.C. (January 1979).

8. Bright, James R. (ed.). Technological Forecasting for Industry and Government. Methods and Applications. Prentice-Hall, Inc., Englewood Cliffs, New Jersey (1968).

9. Cecil, Lawrence K. (ed.). Water Reuse. Chemical Engineering Progress Symposium Series. No. 78, Vol. 63, American Institute of Chemical Engineers, New York (1967).

10. Cecil, Lawrence K. (ed.). Complete Wate-Reuse. Industry's Opportunity. Institute of Chemical Engineering, EPA-Technology Transfer, New York (1973).

11. Columbia Broadcasting System (CBS). U.S.A. "Sixty Minutes," (September 2, 1979).

12. Culp, R.L. and G.M. Wesner. Handbook of Advanced Wastewater Treatment. 2nd edition, van Nostrand Reinhold Co., New York (1978).

13. Cummings, Ronald. Water Resources Management in Northern Mexico. Resources for the Future, Inc., Washington, D.C. (1972).

14. DeCook, K. James. "Reuse of Wastewater in Desert Region." Conference on Alternative Strategies for Desert Development and Management. May 31-June 10, 1977, Sacramento, California (1977).

15. Davis, Kingsly. "The World's Population Crises". Contemporary Social Problems. Robert K. Merton and R.A. Nisbet (eds.). Harcourt, Brace World, Inc. PP. 291-323, New York (1961).

16. Downing, Theodore E. and McGuire Gibson (eds.). Irrigation's Impact on Society. The University of Arizona Press, (Anthropological papers of the University of Arizona, No. 25), Tucson, Arizona (1974).

17. Durkheim, Emile. Division of Labor in Society. George Simpson (translator), Free Press, Glencoe, Ill. (1949).

18. Food and Agriculture Organization of the United Nations (FAO). Potentials of Land and Water Resources in the Arab-Asian Countries, by Abou-Khaled, Rome (1977).

19. Food and Agriculture Organization of the United Nations (FAO). Protected Vegetable in Kuwait. Ministry of Public Work, Dept. of Agriculture, Kuwait (1976).

20. Food and Agriculture Organization of the United Nations (FAO). Salinity, The Baghdad Seminar, Irrigation and Drainage. Paper No. 7, Rome (1972).

21. Food and Agriculture Organization of the United Nations (FAO), Water Laws in Moslem Countries, by D. Caponera, Rome (1973).

22. Freedman, Ronald. "American Studies of Family Planning and Fertility: A Review of Major Trends and Issues," Population and Society. Charles B. Nam (ed.), Houghton Mifflin Company, Boston (1968).

23. Gilfillan, S. Column. The Sociology of Invention. Supplement. San Francisco Press, San Francisco (1971).

24. Guigg, Philip W., Water. The Essential Resource. International Series Number Two. National Audubon Society, New York (December 1976).

25. Hawley, Amos H., "Community Power and Urban Renewal Success," The American Journal of Sociology. Vol. 68, pp. 422-431, University of Chicago Press, Chicago, Illinois (1976).

26. Huisman, L., Groundwater Recovery. Winchester Press, New York (1972).

27. Ingram, Helen M., Patterns of Politics in Water Resource Development. A Case Study of New Mexico's Role in the Colorado River Basin Bill, No. 79. The University of New Mexico (1969).

28. International Bank for Reconstruction and Development. Appraisal of the Damascus Water Supply Project. Report No. 106a-SYR, Washington, D.C. (May 8, 1973).

29. Jantsch, E., Technological Forecasting. In Perspective. Organization for Economic Cooperation and Development(OECD), Paris (1967).

30. Johnson, Rich. The Central Arizona Project 1918-1968. The University of Arizona press, Tucson, Arizona (1977).

31. The Jordan Times. Amman, Jordan (April 20, 1977).

32. Jordan, Kingdom of. Five Year Plan 1976-1980. National Planning, Amman (1976).

33. Kahn, Herman. The Year 2000. A Framework for Speculation on the Next Thirty-three Years--Hudson Institute. MacMillan, New York (1967).

34. Kaisi, A.A., Rural-Urban Migration in Iraq. Kuwait Institute of Economic and Social Planning in the Middle East, Kuwait (1971).

35. Kuhn, T.S., The Structure of Scientific Revolution. University of Chicago Press, Chicago (1962).

36. Kuwait, The State of. The Role of Desalting Technology in Providing Kuwait's Fresh-Water Needs. Kuwait (December 1976).

37. Laszlo, Ervin and James B. Wilbur (eds.). Human Values and Natural Science. Gordon and Breach Science Publishers, New York (1970).

38. Lebanon National Television. Panel Discussion. Beirut (June 18, 1979).

39. Lebanon National Television. Panel Discussion on Housing. Beirut (June 18, 1979).

40. Lebanon National Television. Minister of Water and Electricity, The Problem of Water in Beirut. Beirut (June 25, 1979).

41. Lee, Everett. "Migration in Relation to Education, Intellect, and Social Structure," Population Index. 36, pp. 437-44, (October-December 1970).

42. Lehrner, Daniel. The Passing of Traditional Society. The Free Press, Glencoe, Ill. (1963).

43. Lewis, W. Cris, et al., Utah State University Foundation. Regional Economic Development: The Role of Water. Prepared for the National Water Commission, National Information Service. Accession No. PB 206372. Springfield, Va.

44. Llewellyn-Jones, Derek. Human Production and Society. Pitman Publishing Corp., New York (1974).

45. Loehr, R.C., Pollution Control for Agriculture. Academic Press, Inc., New York (1977).

46. McNickle, Roma K. (ed.). Water: Development, Utilization, Conservation. Western Resources Papers, 1963, University of Colorado Press (1964).

47. Meadows, Dennis L., Donella H. Meadows, Jorgen Randers, and William W. Behrens, III. The Limits to Growth. 2nd Printing, Universe Books, New York (1975).

48. METATO Co., Arab Water World. Beirut (July-August 1977).

49. Mock, John E., Science for Society. Proceedings of the National Science Conference held at Atlanta, Georgia, October 12-14, 1970, Georgia Technology Commission, Atlanta, Georgia (1971).

50. Mumford, Lewis. The Myth of the Machine. 2 Vols. Harcourt, Brace and World, Inc., New York (1966,1970).

51. National Science Foundation. Selected Aspects of Consumer Behavior. NSF/RA 77-0013. U.S. Government Printing Office, Washington, D.C. (1977).

52. Ogburn, William F., Social Change with Respect to Cultural and Original Nature. Dell Pub. Co., New York (1966).

53. Olsen, M.E., The Process of Social Organization. Holt, Rinehart and Winston (1968).

54. Parsons, Talcott. Social System. Free Press, Glencoe, Ill. (1951).

55. Pollak, Franklin S. (ed.). Resources Development. Frontiers for Research. Western Resources Paper. University of Colorado Press, Boulder (1960).

56. Pregman, Jacob I., "Membrane Processes Gain Favor for Water Reuse," Environmental Science and Technology. Vol. 4, No. 4, p. 269 (April 1970).

57. Rakstis, Ted J., "The Poisoning of Michigan," Reader's Digest. Vol. 115, No. 689, pp. 104-108, Pleasantville, New York (September 1979).

58. Reich, Charles A., The Greening of America. Random House, New York (1970).

59. Reid, George W., "Technology Transfer, Adaptation, and Utilization." Appropriate Methods of Treating Water and Wastewater in Developing Countries. George Reid and Kay Coffey (eds.), University of Oklahoma Press, Norman (1978).

60. Reid, George W., Water Supply and Sewage. Lecture Notes (Revised edition), University of Oklahoma Press, Norman (1976).

61. Safadi, M., Water Resource in the Syrian Arab Republic. Ministry of Labor and Water Resources, Damascus (1974).

62. Saunders, R.J. and J.J. Warford. "Village Water Supply: Economics and Policy in the Developing World," Equity with Responsibility in Village Water Supply. A World Bank Publication Summary, Washington, D.C.

63. Schumacher, Ernst Fredrich. Small is Beautiful. Harper and Row, New York (1973).

64. Smythe, William E., Conquest of Arid America. Revised ed., The MacMillan Co., New York (1905).

65. Stevens, L.A., Clean Water: Nature's Way to Stop Pollution. E.P. Dutton, New York (1974).

66. Toffler, Alvin. Future Shock. Pan Books Ltd., London (1971).

67. Ueda, Kozo. Report on Revised Estimates of Population by Urban and Rural in Iraq for 1957-1980. UNOTC, Baghdad (1970).

68. United Nations. Groundwater Storage and Artificial Recharge. Document ST/ESA/13 (1975).

69. United Nations. Report of the UN Water Conference. Mar del Plata, Argentina, 14-25 March 1977, E/Conf. 70/29.

70. United Nations Department of Economic and Social Affairs. The Demand for Water: Procedures and Methodologies for Projecting Water Demands in the Context of Regional and National Planning, Natural Resources/Water Series, No. 3, ST/ESA/38, New York (1976).

71. United Nations Economic and Social Council. The Study of Interrelationships Between Population, Resources, Environment and Development. Report of the Secretary-General. E/1979/75, 79-15392, 3285S(E) (6 June 1979).

72. United Nations Economic Commission for Western Asia (ECWA). Agriculture and Development. No. E/ECWA/AGREB/11, Beirut (May 1979).

73. United Nations Economic Commission for Western Asia. Conservation of Water. Document E/ECWA/Sem. 1/33 (October 1977).

74. United Nations Economic Commission for Western Asia (ECWA). The Current Situation and Prospects of Rural Development in Selected Countries of the ECWA Region, 78-2054 (21 November 1978).

75. United Nations Economic Commission for Western Asia (ECWA). Demographic and Related Socio-Economic Data Sheets for Countries of the Economic Commission for Western Asia. No. 2, Beirut (1978).

76. United Nations Economic Commission for Western Asia (ECWA). Desalination Application in Western Asia. Document E/ECWA/Nr/Conf. 3/7.

77. United Nations Economic Commission for Western Asia (ECWA). Induced Innovation and the Role of Agriculture in Economic Development. A Case Study of Egypt and Syria. By Sayed and Atif Kubursi. McMaster University, Canada (September 1977).

78. United Nations Economic Commission for Western Asia (ECWA). The Planning of Arab Cities. A Case Study of Beirut, Prepared by Marwan Mahsen. No. E/ECWA/pop/WG. 12/BP. 11 (2 November 1978).

79. United Nations Economic Commission for Western Asia (ECWA). Preliminary Report on the Development of Water Resources in ECWA Region. E/ECWA/41. Revised (March 1977).

80. United Nations Economic Commission for Western Asia (ECWA). Report of the ECWA Regional Preparatory Meeting for UN Water Conference. Baghdad, Iraq, 11-16 of December 1976. E/ECWA/42/Rev. (1976).

81. United Nations Economic Commission for Western Asia (ECWA). Second Region Water Meeting, 30 December 1978 to January 3, 1979 (1979).

82. United Nations Economic Commission for Western Asia (ECWA). Statistical Abstract of the Arab World, 1968-1975, E/ECWA/45/Add. 4, 77-869 (1977).

83. United Nations Economic Commission for Western Asia (ECWA). The Statistical Abstract of the Region of the Economic Commission for Western Asia. For the Period 1968-1976. Second Issue, Part II (1978).

84. United Nations Economic Commission for Western Asia (ECWA). Study on Manpower Training Needs and Problems in the Field of the Water Resources Development in the ECWA Region, 78-2297 (4 December 1978).

85. United Nations Economic Commission for Western Asia (ECWA). Water Resources Assessment. Document E/CONF-70/CBP1. (2 July 1976).

86. United Nations Economic Commission for Western Asia (ECWA). Joint ECWA/FAO Agriculture Division. Food Security in the ECWA Region: Analysis of Production and Consumption Problems. E/ECWA/AGRI/79/1, 79-2471 (March 1979).

87. United Nations Environment Programme (UNEP). Facts. Revised (September 1976).

88. United Nations Environment Programme (UNEP). Final Act of the Kuwait Regional Conference of Plenipotentiaries on the Protection and Development of the Marine Environment and the Coastal Areas. Kuwait, 15-23 April 1978.

89. United Nations Environment Programme(UNEP)/ Economic Commission for Western Asia (ECWA). Report of the Joint UNEP/ECWA. Mission on Human Settlements Technology in the ECWA Region. (November 1977).

90. United Nations Industrial Development Organization (UNIDO)/Economic Commission for Western Asia(ECWA). Identification of Manufacturing of Electrical Equipment in Jordan, by Najim K. Kassab, 79-24-21, (February 1979).

91. United Nations Water Conference (UNWC). Proceedings. Vol. 1, Part III, Pergamon Press (1978).

92. United States Bureau of Reclamation. Water and Land Resource Accomplishments 1970. 2 Volumes. U.S. Government Printing Office, Washington, D.C. (1971).

93. United States Department of Commerce/Bureau of the Census. Statistical Abstract of the United States. 97th Edition, Washington, D.C. (1976).

94. United States-Department of Commerce/Bureau of Economic Analysis. The National Income and Product Accounts of the United States, 1929-74. Statistical Tables. A Supplement of the Survey of Current Business. U.S. Government Printing Office, Washington, D.C. (1974).

95. United Stated Department of Health, Education and Welfare, Public Health Service. Individual Water Supply System: Recommendations of the Joint Committee on Rural Sanitation. (Revised edition), Pub. No. 22, Washington, D.C. (1950).

96. United Stated-Department of Interior, Geological Survey. A Qualitative Hydrological Appraisal of the Yemen Arab Republic From Lansat Images, by Maurice. J. Grolier, Gordon C. Tibbitts, Jr., and Mohammad Mukred Ibrahim, Open-File Report, Reston, Virginia (1976).

97. United States, Department of Interior-Office of Saline Water. Desalination Research and the Water Problem. Publication 941, Government Printing Office, Washington, D.C. (1962).

98. United States National Water Commission. Water Policies for the Future. Final Report to the President and Congress of the United States, Government Printing Office. Washington, D.C. (June 1973).

99. United States President's Water Resources Policy Commission. A Water Policy for the American People. Vol. 1 General Report. U.S. Government Printing Office, Washington, D.C. (1950).

100. Weber, Max. The Protestant Ethic and the Spirit of Capitalism. Translated by Talcott Parsons. Scribner, New York (1952).

101. Wheelwright, S.C. and Makridakis, S., Forecasting Methods for Management. John Wiley and Sons (1973).

102. White, G.F., and D.J. Bradly and A.U. White. Drawers of Water: Domestic Water Use in East Africa. University of Chicago Press, Chicago (1972).

103. Widstrand, Carl (ed.). Water and Society. Part I, The Social Ecological Effects of Water Development in Developing Countries. Pergamon Press, Oxford (1978).

104. Wittfogel, K.A., Oriental Despotism. Yale University Press, New Haven (1957).

105. The World Bank. An Appraisal of Aleppo Water Supply Project. Report No. 1542-SYR, Washington, D.C. (June 1977).

106. The World Bank. Syrian Arab Republic Water Supply and Sewage Report. Report No. 1566-SYR, Washington, D.C. (September 1977).

107. The World Bank. World Development Report. Washington, D.C. (1978).

108. World Health Organization (WHO). Reuse of Effluents: Methods of Wastewater Treatment and Health Safeguards. Technical Report Series, No. 517, Geneva, Switzerland (1973).

109. World Health Organization (WHO). Regional Approach to Integrated Wastes Management Planning. Problems in Community Wastes Management, by J. Sumner. Public Health Papers, No. 38, Geneva, Switzerland (1969).

110. World Health Organization (WHO). Urban Water Supply Conditions and Needs in Seventy-Five Developing Countries, by B.H. Dieterich and J.M. Henderson. Public Health Papers, No. 23, Generva, Switzerland (1963).

111. World Health Organization (WHO). WHO Features. "Water Source of Life," by Lalit Thapalyal, Geneva, Switzerland (July 1976).

112. World Health Organization (WHO). Regional Office for Eastern Mediterranean. The Attitude of WHO and Its Activities in Water Resources Development in ECWA Countries. Prepared for the Regional Preparatory Meeting for UN Water Conference (November 1976).

113. World Meteorological Organization (WMO). Casebook on Hydrological Network Design Practice. No. 324, Geneva, Switzerland (April 1978).

APPENDIX A

TABLES AND ILLUSTRATIONS

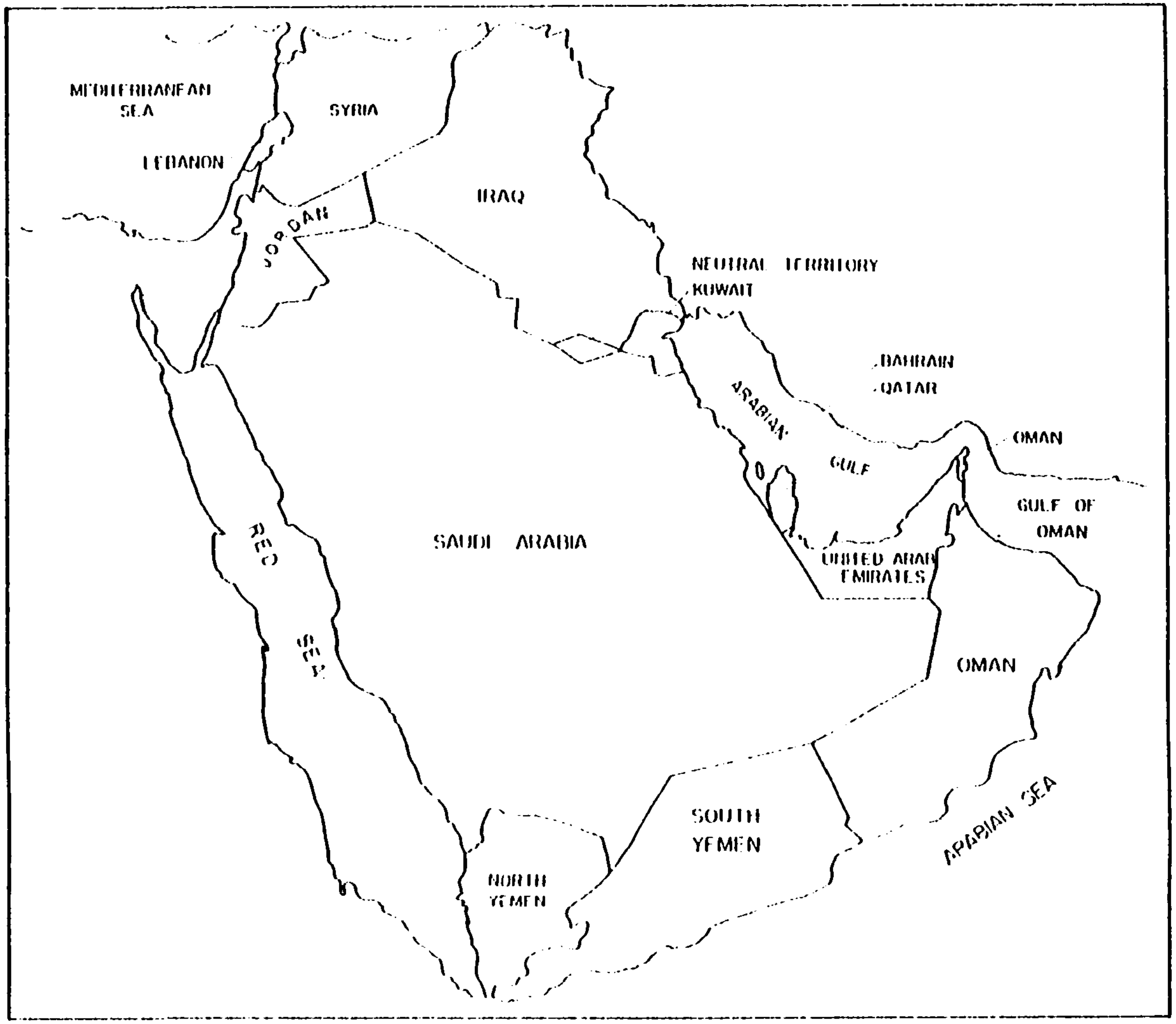
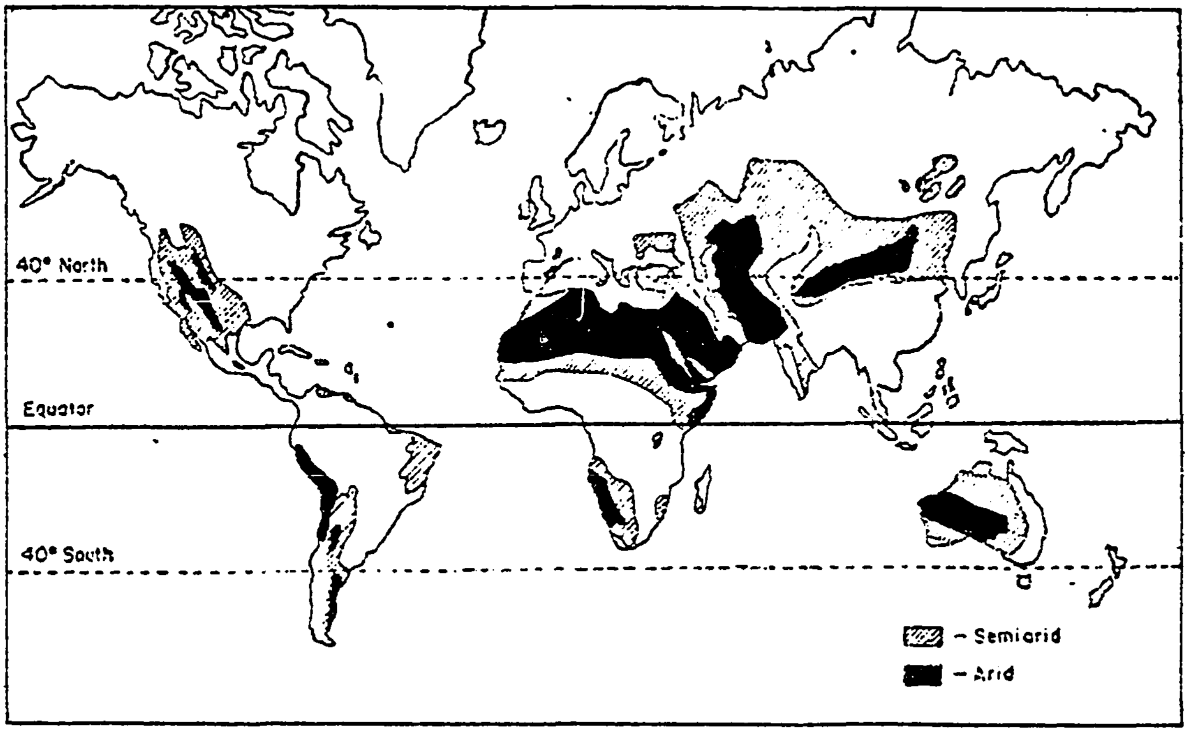


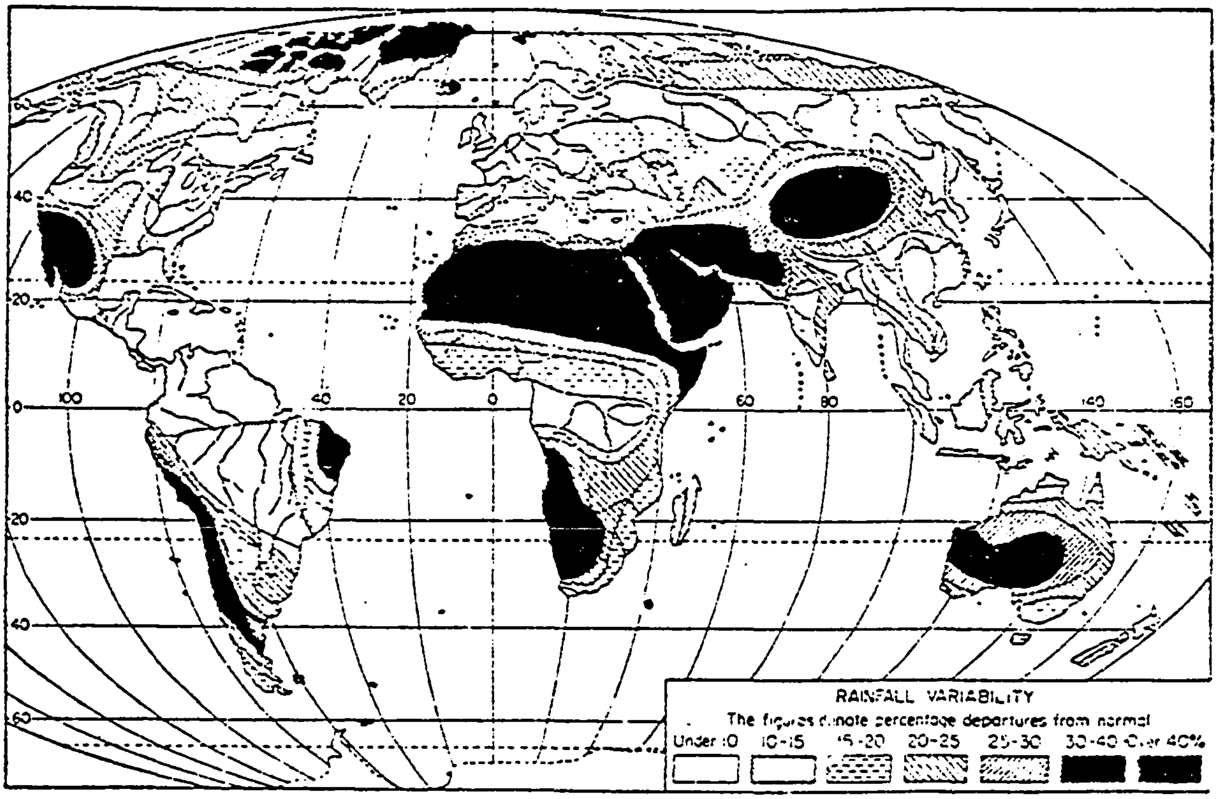
Figure A.1. A Map of the Arab-Asian Countries.

FIGURE A.2. The Distribution of Aridity on Earth.



Source: Office of Saline Water, Dept. of Interior, U.S.A. Desalination Research and the Water Problem. Publication 941. Washington, D.C., 1962.

FIGURE A.3. Variability of Annual Rainfall in the World.



Source: WMO. Casebook on Hydrological Network Design Practice. No. 324, Geneva. April 1978.

TABLE A.1

Dams in Jordan

Dam	Location	Remarks
1. Sama Sudud	Mafraq	Utilized for irrig. and livestock.
2. Ghadeer Abyad	Mafraq	Utilized for irrig. and livestock.
3. Bowayda	Mafraq	Utilized for irrig. and livestock.
4. Al-Lahafi	Dhuleil	Utilized for recharging underground water and partially for irrigation.
5. Ziqlab	Wadi Ziqlab	Utilized for irrig.
6. Shuib	Wadi Shueib	Utilized for irrig.
7. Kufrain	Wadi Kufrain	Utilized for irrig.
8. Qatraneh	Qatraneh	Utilized for recharging underground water, livestock, and irrigation.
9. Sultani	Sultani-Karak	Utilized for recharging underground water, livestock, and irrigation.

Source: ECWA-UN, Report of the ECWA Regional Preparatory Meeting for the UN Water Conference. E/ECWA/42/REV. Baghdad, Iraq, 11-16 December 1976.

TABLE A.2

List of Dams and Their Characteristics

in Saudi Arabia

Name	Catchment km^2	Type	Storage Capacity m^3	Purpose
Wadi Jizan	1100	concrete gravity	71,000,000	flood control and irrigation
Abha	59	concrete gravity	2,400,000	water supply
Batham	20	concrete and earth	800,000	recharge aquifers and flood control
Majma'a	100	earth	1,500,000	flood control and recharge aquifers
Hreimlah	350	earth	1,500,000	diversion dam
Melham	20	concrete gravity	200,000	storage and recharge
Ananyyah		earth		diversion and infiltration
Al Ainyyah		masonary	1,000,000	storage and recharge
Safar	54	earth	300,000	recharge aquifers
Ghbeirah	21	earth	90,000	recharge aquifers
Hriqua	19	earth	80,000	recharge aquifers

Source: ECWA-UN. Report of the ECWA Regional Preparatory Meeting for the UN Water Conference. E/ECWA/42/Rev./ Baghdad, Iraq, 11-16 December 1976.

TABLE A.3.

Economically Active Population by Economic Classification (Thousand)

No.	Classification	Saudi Arabia 1970	1975	The Change	South Yemen 1976
1	Agriculture & Hunting	331.9	311.2	- 20.7	178.6
2	Shepherds & Bedouins	133.9	114.9	- 19.0	--
3	Mining & Quarrying	25.7	45.6	+ 19.9	2.1
4	Oil Refining	1.4	2.1	+ .7	--
5	Non-Oil Industry	34.7	44.4	+ 9.7	14.8
6	General Services	12.2	18.3	+ 6.1	2.93
7	Building Construction	141.5	314.2	+172.7	15.7
8	Trade (commerce, hotels, banks, etc	130.2	211.0	+ 80.8	40.44
9	Transport, Communication, & storage	62.1	103.2	+ 41.1	--
10	Service sector	137.5	188.4	+ 50.9	81.7
11	Total Employment in private sector	1353.3	991.1	-362.2	--
12	Government Offices	60.8	85.2	+ 24.4	--
13	Education	38.5	62.5	+ 24.0	--
14	Health	13.4	21.1	+ 7.7	--
15	Total Government Employment	112.7	168.8	+ 56.1	--
16	Total Employment	1103.8	1522.1	+418.3	
17	Others				19.0

Source: Compiled from ECWA-UN. <u>Statistical Abstract of the Arab World</u>, 1968-75, Amman, 1977.

TABLE A.4.

Percent Illiteracy for 1970 and 1975, by Age and Sex, of the Arab Asian Countries

Country	Illiteracy Rate Years 15-24				Illiteracy Rate Ages 25 and Over	
	% males		% Females			
	1970	1975	1970	1975	1970	1975
Bahrain	22.8	11.4	45.4	38.8	77.1	74.
Iraq	39.1*	21.6**	77.4*	58.3**	94.9*	--
Jordan	20.0	3.9	57.0	13.4	80.9***	40.9
Kuwait	28.5	22.3	39.9	34.0	72.3	66.5
Lebanon	9.6	7.5	24.1	22.0	74.3	--
Syria	22.0	16.5	64.5	60	87.9	--
U.A.E.	65.5****	34.5	83.8	43.6	--	72.2
YAR	89	70.6	99.0	96.6	--	99.1

* 1965
** 1973
*** 1961
**** 1968

Source: Compiled from ECWA-UN. Demographic and related socio-economic data sheets for countries of the economic commission for Western Asia. No. 2, Beirut, 1978.

TABLE A.5

Number and Ratio of Students of 1975 Over 1970, in Secondary and Higher Education, in the Arab Asian Countries

Country	Secondary Education			Higher Education		
	1970 (No. of Students)	1975 (No. of Students)	1975/1970	1970 (No. of Students)	1975 (No. of Students)	1975/1970
Bahrain	5262	7950	1.5	289	281	1.0
Iraq	314169	516755	1.6	43358	75598	1.7
Jordan	97612*	130326	1.3	4550*	9302	2.04
Kuwait	66836	106891	1.6	1988	5832	2.9
Lebanon	33101*	35427**	1.1	--	--	
Oman	146***	1295	8.9	--	--	
Qatar	911	2215****	2.4			
Saudi Arabia	512	2132	4.16	573	1741	3.0
YAR(N. Yemen)	1245	4350****	3.4	--	--	
YPDR(S. Yemen)	3000	7900****	2.6	--	--	
TOTAL	804048	849639	1.5	87519	98869	1.13

Source: ECWA-UN. Statistical Abstract of the Arab World, Amman, 1977.

* 1971
** 1977
*** 1972
**** 1974

TABLE A.6

Population in 1970 and 1975 and Ratio of 1975 Over 1970, in the Arab Asian Countries

Country	Population (Thousands)		1975/1970
	1970	1975	
Bahrain	220	260	1.18
Iraq	9,440	11,124	1.18
Jordan	2,300	2,700	1.17
Kuwait	740	990	1.34
Lebanon	2,314	2,557	1.1
Oman	660	770	1.7
Qatar	80	90	1.2
Saudi Arabia	7,740	8,930	1.15
Syria	6,300	7,350	1.17
UAE	190	220	1.16
YAR	5,770	6,470	1.12
YPDR	1,440	1,690	1.17
TOTAL	35,120	40,881	1.16

Source: ECWA-UN. Statistical Abstract of the Arab World 1977.

TABLE A.7.

Per Capita Income in 1970 and 1975, and Ratio of 1975 over 1970 in the Arab Asian Countries

Country	Per Capita Income (U.S. Dollars)		1975/1970
	1970	1975	
Bahrain	550	2,350	4.27
Iraq	370*	1,100	3.0
Jordan	250	430	1.72
Kuwait	3,760	11,640	3.89
Lebanon	590	1,080	1.83
Oman	210	1,660	8.00
PDRY	120	220	1.8
Qatar	1,730	7,240	4.2
Saudi Arabia	440	2,830	6.4
Syria	290	560	1.93
YAR	80	180	2.25

*1973

Source: Compiled and computed from ECWA-UN. Demographic and related socio-economic data sheets for countries of the economic commission for Western Asia. No. 2, Beirut, 1978.

TABLE A.3.

Distribution of Birth Rate and Death Rate in the Arab Asian Countries for 1970 and 1975

	Crude Birth Rate (% 0)		Crude Death Rate (% 0)	
Country	1970	1975	1970	1975
Bahrain	42.8	45.0	8.0	7.0
Iraq	48.9*	41.6	17.8	10.1
Jordan	47.5	50	15.7	15
Kuwait	49.2	51.1	5.8	6.1
Lebanon	34.4	33.0	9.1	8.0
Oman	50.0	50.0	19.0	19.0
Qatar	50.0	50.0	--	20.0
Saudi Arabia	49.7	49.5	21.4	20.2
Syria	47.8	47.8	15.1	15.1
UAE	--	50.0**	--	18.0**
YPDR	49.8	45.4	21.6	23.1
YAR	47.3	48.9	28.7	25.0

*1965

**1973

Source: Compiled from UCWA-UN. Demographic and related socio-economic data sheets for countries of the Economic Commission for Western Asia. January 1978.

TABLE A.9.

Percent Age Distribution in the Arab Asian Countries for 1970 and 1975

Country	Under 15 Year (Percent)		65 Years and Over (Percent)	
	1970	1975	1970	1975
Bahrain	44.3	46.4	2.7	2.4
Iraq	47.3*	48.9	4.1	3.3
Jordan	45.8	50.6	3.1	2.8
Kuwait	43.2	44.3	1.7	1.6
Lebanon	43.9	41.6	4.9	4.9
Oman	44.9	46.2	2.5	2.0
Qatar	44.9	44.4	2.5	2.6
Saudi Arabia	44.1	--	2.7	--
Syria	49.3	49.3	4.4	4.4
UAE	33.6***	45.0**	2.2	2.2
YPDR	44.1	47.8**	2.7	4.0
YAR	44.0	46.8	4.3	3.6

**1973

***1968

Source: Compiled from ECWA-UN. Demographic and related socio-economic data sheets for countries of the Economic Commission for Western Asia. January 1978.

TABLE A.10

Distribution of Health-Related Indicators

Country	Life Expectancy at Birth		Mortality Rates Per Thousand: Infants Aged 0-1		Mortality Rates Per Thousand: Children Aged 1-4		Population Per: Physician		Population Per: Nursing Person	
	1960	1975	1960	1975	1960	1975	1960	1974	1960	1974
Iraq	45	53	--	104	2	--	5,600	2,370	6,680	3,310
Jordan	46	53	54	22	5	--	5,900	2,440	--	1,020
Kuwait	58	67	--	44	4	1	760	1,140	190	290
Lebanon	57	63	--	--	12	8	1,000	1,330	--	3,670
Saudi Arabia	37	45	--	--	--	--	13,000	6,660	--	5,510
Syria	46	54	31	22	--	4	4,600	2,910	--	2,620
Yemen Arab Republic (YAR)	37	45	--	160	--	--	--	26,440	--	11,400
Yemen People's Democratic Republic (YPRD)	45	--	40	--	--	--	--	--	--	--

Source: The World Bank, August 1978, World Development Report, 1978, Washington, D.C., pp. 108-109.

TABLE A.11

Relationship Between Health Practice and Life Expectancy in Arab Countries of Western Asia

Rank	Country		
	Health Practice # of Persons Per Physician 1974		Life Expectancy at Birth 1975
1	Kuwait	(1,140)	(67)
2	Lebanon	(1,330)	(63)
3	Iraq	(2,370)	(53)
4	Jordan	(2,440)	(53)
5	Syria	(2,910)	(54)
6	Saudi Arabia	(6,350)	(45)
7	Yemen	(26,440)	(45)

Source: Ranked from data on Table 8.

TABLE A.12.

The Imports of the Arab Asian Countries in 1968 and 1975 (millions local currency)

Country	1968	1975	Ratio 1975/1968
Bahrain	52.05	232.90	4.5
Iraq	144.0	1244.7	8.6
Jordan	57.5	234.0	4.1
Kuwait	218.3	693.1	3.1
Lebanon	1574.5	3617.9*	2.3
Oman	12.0**	361.4	30.1
Qatar	252.2***	1609.8	6.4
Saudi Arabia	2526.8	7270.3*	2.8
Syria	1193.0	6173.0	5.1
United Arab Emirates	958.4**	7115.1	7.4
Yemen Arab Republic	157.85****	1341.4	8.5
Yemen People Democratic Republic	4.5	59.4	13.2

*1973

**1970

***1961

****1969

Source: Compiled from ECWA-UN. The Statistical Abstract of the Arab World. 1968-1975, First Issue, Amman, Jordan, 1977.

TABLE A.13.

Agricultural Imports and Ratio of Increase in the Arab-Asian Countries for Selected Years

Country	Agriculture Imports (Thousand of U.S. Dollars)			Ratio of Increase 1977/(1961/65)
	1961/1965	1970	1977	
Bahrain	9,840	18,510	136,020	13.8
Iraq	94,390	98,320	734,960	7.8
Jordan	43,640	64,400	267,090	6.1
Kuwait	68,060	123,000	446,270	6.6
Lebanon	129,840	149,690	431,460	3.3
Oman	6,020	12,030	89,970	14.9
Qatar	7,700	14,780	87,140	11.3
Saudi Arabia	93,990	222,520	1,106,570	11.7
Syria	51,500	99,390	401,540	7.8
UAE	--	470	282,250	60.5*
YPDR	55,040	53,480	113,170	2.1
YAR	5,170	17,090	188,900	36.5
TOTAL	565,170	873,660	4,285,320	7.1**

*1977/1970

**UAE excluded

Source: Compiled and computed from UN-ECWA/FAO <u>Agriculture and Environment</u>. May 1979.

TABLE A.14.

Sources of Irrigation in the Arab Asian Countries, 1975 (Thousand Hectars)

Country	Surface Water Resources: Rivers and Springs	Surface Water Resources: Floods (Washwater)	Underground Water Resources
Iraq a/	1,547,000 c/	--	20,000
Jordan a/	23,000	1,500	4,500
Lebanon a/	47,500	--	12,500
Syrian Arab Republic a/	456,100	40,000	20,000
Democratic Yemen b/	--	84,000	26,000
Saudi Arabia b/	--	98,800	91,200
Yemen b/	73,000	120,000	37,000
Oman b/	--	--	36,000
Other Arabian Peninsula Countries	--	--	21,000

Source: ECWA, on the basis of national and international sources.

a/ Irrigated crop area.

b/ Gross equipped irrigated area.

c/ Includes a small area irrigated by flood water.

TABLE A.15.

Average Yields of Selected Crops in the Irrigated and Rainfed Sector of Various Countries in the Region, 1975 (Tons Per Hectare)

Crop	Iraq		Jordan		Syrian Arab Republic	
	Irrigated	Rainfed a/	Irrigated	Rainfed b/	Irrigated	Rainfed b/
Wheat	1.06	0.43	1.80	0.64	2.10	0.71
Barley	0.99	0.54	--	0.41	1.60	0.59
Maize	2.90	--	1.10	--	1.90	--
Sorghum	--	--	3.53 c/	0.65 c/	1.70 c/	0.72
Rice	1.91	--	--	--	5.20	--
Lentils	--	0.94	--	0.78	1.20	0.67
Chickpeas	--	0.65	--	0.69	--	0.47
Potatoes	15.60	--	13.30	--	16.40	12.50
Tomatoes	--	8.66 d/	18.20	6.33	19.60	4.20
Groundnuts	--	--	--	--	1.65	--
Sesame	0.64	0.52	--	--	0.81	0.20
Seed Cotton	1.02	1.90	--	--	2.20	0.40
Sugar beet	24.40	--	--	--	22.42	9.44

Source: Compiled by ECWA on the Basis of National Sources and FAO, Production Yearbook 1976, Rome, 1977.

a/ Average 1974-76.
b/ Average 1971-75.
c/ Feed grains, total.
d/ Vegetables, total.

TABLE A.16.

Comparative Statistics on Agricultural Production.

1962-1966, in 100 Bilogram/Hectare

Crop	Country	1962	1963	1964	1965	1966
Wheat	Iraq	6.8	2.9	5.0	5.9	4.8
	Yugoslavia	16.5	19.3	17.6	20.6	25.1
	USSR	10.5	7.7	11.0	8.5	14.4
	USA	16.8	16.9	17.3	17.9	17.7
	Australia	12.5	13.4	13.8	10.0	15.3
Barley	Iraq	9.5	6.5	5.7	7.4	7.1
	Yugoslavia	13.5	15.0	14.5	16.8	19.1
	USSR	12.0	9.7	13.2	10.3	14.4
	USA	18.8	18.8	20.2	23.1	20.7
	Australia	11.0	12.1	13.4	10.4	14.9
Rice	Iraq	4.7	4.9	5.0	5.0	5.1
	USA	8.8	9.8	9.9	10.0	9.3
Cotton	Iraq	4.7	4.9	5.0	5.0	5.1
	USA	8.8	9.8	9.9	10.0	9.3
Tobacco	Iraq	6.5	3.1	8.8	7.5	7.6
	USA	21.2	22.3	23.2	21.3	21.7
	Turkey	6.0	5.6	7.1	6.0	5.9
	Spain	16.9	15.0	13.7	13.7	17.1

Source: A.A. Kaisi, Rural-Urban Migration in Iraq, Kuwait Institute of Economic and Social Planning in the Middle East, 1970-71.

TABLE A.17.

Decline in Percentage of Labor Force in Agriculture in Various Countries of the Region from 1960 to 1970

	Percentage of Labor Force in Agriculture	
Country	1960	1970
Iraq	53	47
Jordan	44	34
Lebanon	38	20
Syria	54	51
Democratic Yemen	71	65
Kuwait	2	2
Saudi Arabia	72	66
Yemen	83	79

Source: The World Bank, August 1978, World Development Report, 1978, Washington, D.C., pp. 102-103.

TABLE A.18.

Annual Average Growth in the Asian Arab Countries

Country	Average Annual Growth Rate (Percent) 1960-1970	1970-1975
Democratic Yemen	3.4	2.7
Iraq	3.2	3.3
Jordan	3.3	3.2
Kuwait	9.7	6.2
Lebanon	2.5	3.0
Saudi Arabia	1.7	2.4
Syria	3.7	3.3
Yemen	2.3	1.9

Source: The World Bank, August 1978, World Development Report, 1978, Washington, D.C., pp. 100-101.

TABLE A.19.

Population Projection, 1976-2000, and Hypothetical

Stationary Population

Country	Mid-1976 Population (Millions)	Projected Projected Population (Year 2000) (Millions)	Hypothetical Size of Stationary Population (Millions)	Year When Stationary Population Is Reached
Democratic Yemen	2	3	9	2130
Iraq	12	25	65	2090
Jordan	3	5	11	2110
Kuwait	1	2	7	2090
Lebanon	3	5	9	2070
Saudi Arabia	9	19	48	2120
Syria	8	15	31	2085
Yemen	6	9	26	2145

Source: The World Bank, August 1978, World Development Report, 1978, Washington, D.C., pp. 106-107.

TABLE A.20.

Average Annual Growth in Per Capita Gross National Products in the Countries of the Region, 1970-1975

Country	Growth Rate* Per Capita - GNP (Percent)	GNP Per Capita** 1975 U.S. Dollars
Iraq	34.4	1,052
Jordan	8.6	443
Kuwait	21.3	10,326
Lebanon	8.8	1,239
Oman	43.2	2,284
Saudi Arabia	51.7	4,311
Syria	20.1	737
Yemen (North)	27.1	178
Yemen (South)	4.2	245

*1970-1974 for Lebanon and 1971-1974 for Iraq.

**1974 for Iraq and Lebanon.

Source: ECWA, based on data compiled from National and international sources.

TABLE A.21.

Comparison of Urban to Rural Population in the Arab-Asian Countries for the Years 1968 and 1976(In Percent)

	Urban Population	
Country	1968	1976
Iraq	54.6	64.9
Jordan	49.1	56.0
Kuwait	85.2	88.3
Lebanon	60.0	64.9
Oman	4.9	5.3
Qatar	79.0	88.6
Saudi Arabia	16.0	20.7
Syria	43.0	47.3
TOTAL	43.4	49.1

Source: Data from The Statistical Abstract of the Region of the Economic Commission for Western Asia. For the period 1968-1976. Second Issue, Part II, 1978.

TABLE A.22.

Rural Income vs. GNP in Syria and Iraq, 1975

Country	Per Capita Agricultural Income* (Dollars)	Per Capita GNP** (Dollars)	Agricultural Income GNP (Percent)
Iraq	204.00	1390.00*	14.6
Syria	289.00	780.00*	37.0

*Data from ECWA-UN, The Current Situation and Prospects of Rural Developments in Selected Countries of the ECWA Region, 1978.

**World Bank Atlas.

TABLE A.23.

Changes of Sex Ratios (Males Per 100 Females)

by Urban - Rural, 1957-1980

Age	1957	1965	1970	1975	1980
Urban	104.5	103.6	103.1	102.8	102.9
0-14	104.4	103.2	102.1	101.0	100.3
15-59	106.1	105.5	106.0	106.7	107.8
60^+	91.2	90.8	87.4	85.3	83.8
Rural	96.5	99.4	99.3	99.2	98.6
0-14	101.6	104.0	105.2	106.8	108.6
15-59	92.0	94.8	93.7	92.5	90.2
60^+	95.3	99.5	98.1	96.9	96.9

Source: KOZO Ueda, UN demographer, UNOTC, report on revised estimates of population by Urban and Rural in Iraq for 1957-1980, Baghdad, 1970, p. 13.

TABLE A.24.

Comparison of Urban to Total Population Growth Rates

Country	Average Annual Growth Rates (Percent)			
	Total Population		Urban Population	
	1960-70	1970-75	1960-70	1970-75
Democratic Yemen	3.4	2.7	5.5	5.4
Iraq	3.2	3.3	6.3	5.0
Jordan	3.3	3.2	5.1	4.9
Kuwait	9.7	6.2	13.0	8.2
Lebanon	2.5	3.0	7.4	5.4
Saudi Arabia	1.7	2.4	6.6	6.3
Syria	3.7	3.3	4.8	4.2
Yemen	2.3	1.9	9.0	8.0

Source: The World Bank, August 1978, _World Development Report, 1978_, Washington, D.C., pp. 100-101.

APPENDIX B

DIFFUSION OF THE TECHNOLOGY OF WASTEWATER REUSE WORLD-WIDE

APPENDIX B

DIFFUSION OF THE TECHNOLOGY OF WASTEWATER REUSE WORLD-WIDE

Windhoek, South Africa (Nambia), Chanute, Kansas, and the U.S. space program stand out. These cases represent the application of wastewater treatment technology to a standard fit for drinking. After appropriate treatment to meet drinking quality standard, wastewater was returned to the domestic water supply or potable usage.

In Windhoek, water demand was rapidly overtaking the available supply. The rapidly growing city confronted the challenge by developing an effluent reclamation for integration with the city's existing water supply. Wastewater reuse has been an economic advantage. The water-wastewater system of this city is the only integrating system existing in the world today.[1]

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[1]Telfer, James G. "The Medical Profession's Attitude Toward Water Reuse," Water Reuse. Lawrence K. Cecil (editor). Symposium Series 78, Vol. 63, 1967. American Institute of Chemical Engineering, New York. 1967, pp. 101-105.

In Chanute, the Neosho River, the source for the community's water supply, had ceased to flow in the summer of 1956. Sewage water was, therefore, treated and used domestically. No virus was identified, and no ill-health effect has ever been found. In Chanute there was a reversal of the decision to use wastewater for potable usage, after it had been used for several months. The reversal was due to the reaction of the community, manifested in the prosperity of the local water bottling industry and water hauling from distance places. Nevertheless the system has proven a success in the sense that no adverse health affect was registered, that it is currently used for non-potable usages, and is still on a stand-by basis for potable usage in case of future emergencies.[2]

In the U.S. space program, the amount of water that the space aircraft can carry is limited and inadequate for the astronauts' outerspace journies. A system of water and wastewater resolved the problem. In this case no health problem due to drinking treated wastewater has been reported. In the space program, the reuse of wastewater is currently accepted in case of future space flights.[3]

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[2] Ibid.

[3] Ibid.

Moreover, this pattern of wastewater reuse is spreading. Currently Denver, Colorado, is contemplating the idea. Instead of wastewater treatment and discharge, the city is in the process of adopting a wastewater treatment program that will incorporate the community's water supply and its wastewater as a system.(4)

In Santee, California, wastewater is being reused for recreation. The municipality of Santee made the place a tourist attraction and beautified the semi-arid land by creating lakes from reclaimed wastewater. In this town, the role of wastewater reuse in recreation for the community can best be described by this quote:

> "A unique festival is held each June in Santee, California. It features a long, colorful Saturday morning parade that starts from a shopping center and ends up at the town's recreational lakes. For the remainder of the weekend, as many as ten thousand people celebrate the construction of eight beautiful man-made lakes laid out in a line for the better part of a mile. At this 'Festival of the Lakes' people fish, picnic, boat, and swim, with little concern that nearly every drop of the water is supplied by Santee's municipal sewage system."(5)

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[4] Ogilvie, J.L., "Reuse Research in Denver." AWWA Seminar Proceedings. Reuse. Presented at AWWA Conference June 8, 1975, American Water Works Association, Denver, 1975.

[5] Stevens, L.A., Clean Water; Nature's Way to Stop Pollution, E.P. Dutton, publisher, New York, 1974, p. 143.

In all the above-mentioned wastewater treatment applications, the program was a success, and local adaptation to the technology had occurred. The technology had secured a stable role in the broader institutional milieu of the corresponding communities. The wastewater treatment services in the three cases--Windhoek, Chanute, and Santee--provided a significantly needed service, without which the economic survival of the community would have been in jeopardy.

There are other cases of wastewater reuse, mostly for industry and in industrialized societies.

Japan began reuse in 1955. And thereafter it diffused fast. The rapid program of Japanese industry has resulted in increasing demand for water. Consequently, some of the cities have built large industrial wastewater plants supplying treated sewage plant effluent as the water source to industries in the area. The highly industrialized Japan benefited economically from wastewater reuse.(6)

In the U.S., the practice of wastewater reuse has been mostly in the westward states, where an expanding economy and westward moving population is increasingly pressing upon already limited supply. Treated

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[6] Ide, Tetsuo, Nabuo Matsumoto, and Hidenobu Arimitsul. "The Utilization of Municipal Wastewater in Japan." Water Reuse. Lawrence K. Cecil, editor. No. 78, Vol. 63, American Institute of Chemical Engrs., New York, 1967.

municipal wastewater is currently being used for irrigation and industrial purposes. The Federal government is even indirectly encouraging the reuse, by strict legislation and by grants for municipal wastewater treatment. The Federal Water Pollution Control Act Amendments of 1972 can be interpreted as requiring that effluent discharged to the receiving water be similar to freshwater resource.[7] In Tucson, about 40,000 acre-feet per year of secondary effluent is produced at the wastewater treatment plant. For more than 20 years, a substantial portion of the effluent was used for irrigation of forage crops and cotton. Presently, except for a minor quantity used on the city treatment plant farm, it is being discharged to the otherwise dry channel of the Santa Cruz River, where it flows, at times, as much as 27 miles downstream.[8]

In all these cases of wastewater reuse, water became scarce relative to the demand and wastewater reuse paid off.

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[7] Johnson, J., Planning for Water Reuse: The Urban Corps of Engineers Urban Studies Program in Complete Water Reuse. Lawrence K. Cecil, ed., Institute of Chemical Engineering, EPA-Technology Transfer, New York, 1973, pp. 591-596.

[8] DeCook, K. James, "Reuse of Wastewater in Desert Region." Conference on Alternative Stategies for Desert Development and Management. Scaramento, California, May 31 - June 10, 1977 (1977).

APPENDIX C

HISTORIC SCENARIOS

APPENDIX C

HISTORIC SCENARIOS

A. A Historic Scenario of the United States: The Impact of Water Development for Agriculture on the Society of the Western States

In the United States the problem of water scarcity began with the settlement of the West. The West is arid and semi-arid, and irrigation is necessary to develop the land. With the Federal Reclamation Act of 1902 the Department of Interior was authorized to develop water resources for irrigation and other purposes. Since then a series of reclamation projects have been the important means of increasing the productive potential of Western agriculture. Table C.1 shows the increase in the development of the land due to these reclamation projects.

The impact of the reclamation projects on the West were tremendous. In 1950, the president's Water Resource Policy Commission said:

> "Had it not been for the big and little reclamation projects, the West as we know it today would not exist, for impounded water alone makes possible not only agriculture, but the very life of the people in the vast semi-arid region....Federal

TABLE C.1

Total Acreage Irrigated by Bureau of Reclamation Water for Selected Years

Year*	Irrigated Acreage*	Percent Cumulative Land Reclaimed
1906	22,300	.25
1910	473,423	5.4
1920	2,205,420	24.9
1930	2,790,856	31.6
1940	3,391,070	38.4
1945	4,162,588	47.1
1950	5,077,186	57.5
1955	6,261,761	70.9
1960	6,899,711	78.1
1965	8,012,021	90.7
1969	8,575,761	97.0
1971	8,833,998	100.0

*Source: U.S. Bureau of Reclamation (1972). Federal Reclamation Projects, Water and Land Resource Accomplishments 1971. U.S. General Printing Office, Washington, D.C. Table 5, Page 64.

reclamation projects have had much to do with the development of the West."(1)

No attempt will be made here to enumerate all the possible impacts. Such a task is impossible. Effects generate other effects and a listing, therefore, cannot possibly be exhaustive.

1. Economic Impacts: Water development changed the economy of the West. Besides employing, directly or indirectly, a large number of people in agriculture and other related industries, the reclamation projects stimulated growth and relative prosperity. For example, the Minidoka irrigation project in Idaho produced $150 million of gross crop value in 1970;(2) and the Tucumcuri project, New Mexico, produced $3 million in crop value in 1970.(3)

2. Demographic Impacts: (Population Growth, Mobility, and Dispersion): Water development programs for irrigation have had impact on geographic distribution of population--mobility to new agricultural small towns, settlements and cities--which led to

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[1]U.S. President's Water Resources Policy Commission (1950). A Water Policy for the American People. Volume 1, General Report. U.S. Government Printing Office, Washington, D.C., pp. 152-153.

[2]U.S. Bureau of Reclamation. Water and Land Resources Accomplishments 1970. 2 Volumes. U.S. Government Printing Office, Washington, D.C.,(1971).

[3]U.S. Bureau of Reclamation. Water and Land Resource Accomplishments 1970. Statistical Appendix, U.S. Government Printing Office, Washington, D.C., P. 155(1971).

population dispersion.[(4)] Currently, however, in the United States this impact from irrigation projects is insignificant. While it is true that an irrigation project may still increase farm income and enhance the prosperity of residents, even very large irrigation project will not attract a large population, because agriculture in U.S. is not labor intensive.[(5)] Labor-saving technology had its impact on labor resource flows: the tremendous labor-saving and output-increasing farm technology has made larger-scale farms more feasible and more economical in terms of land and capital, but, not, in terms of labor.[(6)]

While the past irrigation projects in U.S. relocated people, they had also impact on family size. In general, the rural family has been and still is larger than the urban family. However, the difference in fertility is decreasing.[(7)] One can interpret this trend

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[4]Lewis, W. Cris et al. Utah State University Foundation. Regional Economic Development: The Role of Water. Prepared for the National Water Commission, National Information Service, Springfield, Va. Accession No. PB. 206372.

[5]National Water Commission. Water Policies for the Future. Final Report to the President and Congress of the United States. Government Printing Office, Washington, D.C., June 1973, P. 50.

[6]Johnson, Rich. The Central Arizona Project 1918-1968. The University of Arizona Press, Tucson, Arizona,(1977).

[7]Freedman, Fonald. "American Studies of Family Planning and Fertility: A Review of Major Trends and Issues," Charles B. Nam (editor), Population and Society. Houghton Mifflin Company, Boston, 1968, P. 256.

as being a result of the fact that agriculture is no longer labor-intensive. The question cannot be answered categorically. What is known is that rural dwellers have had higher natality, and that this fact cannot be explained away as being caused by the expectation of higher infant mortality rate in rural areas. In the early part of this century, U.S. urban infant mortality was higher than the rurals due to pollution and conjested living conditions.(8) A more plausible explanation is that children were economic assets. For agriculture, in the early period, the human number was an input resource factor. Just as economic considerations are given today as major reasons for the usage of contraceptive measures to control the family size (although clashing still with religious morality),(9) the same logic can apply to the fact that rural families in the past desired more children. Thus, it is more likely that agricultural settlements entailed larger families, because children were an insurance against a shortage of labor in what was then labor-intensive farming.

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[8] Llewellyn-Jones, Derek. Human Production and Society. Pitman Publishing Corporation, New York, 1974.

[9] Davis, Kingsley. Ibid.

3. Social Organizational Impact: What is unique about the early irrigation projects in the U.S. is that they socially organized and settled people. New communities were created (social entities). This is tantamount to saying that a social structure emerged with role differentiation and patterned social relationships.(10) The organization process entailed status hierarchy and power differentiation or social stratification. In the words of Amos Hawley: "Every social group or system is an organization of power."(11) The settlers brought with them their own individualistic values--values of hard work, competition, and achievement, etc.--, and the west boomed.

4. Disputes and controversies: Water projects created legal, economic, social and environmental problems. A water project means a loss of water for those with plenty, a gain for those without sufficient water. The result is conflicting claims. For example, the Colorado River Compact of 1922, created a long fight between Arizona and California which was settled as late

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[10] Olsen, Marvin E. The Process of Social Organization. Holt, Rinehart and Winston, New York, 1968.

[11] Hawley, Amos H. "Community Power and Urban Renewal Success," The American Journal of Sociology, Vol. 68, (January 1968), pp. 422-431.

as in 1944; and in both states, the people heard only that they faced thirst and ruin if the other state had its way.(12)

5. Organizational Elaboration and Centralization: In the U.S. water laws have evolved under a system of dual sovereignty--Federal and State--and sometimes these are incompatible. But the Federal Government is centralizing the control by becoming more involved as potential financer, builder and operator of the water projects. The result is a diversity of Federal organizational arrangements:

1. Water Resources Council: To coordinate the water activities of the various federal agencies among themselves and with the state.

2. Intra-state arrangement: To organize and manage water projects involving a single state.

3. Multi-state arrangement: for river basins.

6. Environmental Impacts: All water projects alter the natural environment. The environmental result of a water project may be bad as well as good. Glen Canyon undammed was beautiful, but so is Lake Powell. The type of water projects that have the greatest impact

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[12] Johnson, Rich. The Central Arizona Project 1918-1968. The University of Arizona Press, Tucson, Arizona, 1977.

on the environment are the interbasin transfer. An inter-basin transfer of water from one watershed to another has been a common means of augmenting water supply in areas where supply is limited. For example, in Colorado, water for agriculture has been imported from the Colorado River Basin into the arid South Platte; and in California, the rivers flowing out of the Sierra Nevadas has been rerouted to the more arid parts of the central valley. The natural environmental configuration may generate, for instance, a subsequent impact on tourism, and for certain communities in the West tourism is the only mean of survival and the basis for the continued functioning and existence of the community.

Furthermore, the water projects for irrigation can be good as well as bad in terms of sanitation. The irrigation projects allowed the rural community to have connected continuous domestic water. But the use of chemicals in irrigated farming polluted the environment around--soil, air, and water.[(13)] This pollution poses a health hazard to the community living around. "The poisoning of Michigan" in 1974 is a well-documented example of such a result. In that year the country

[13] Loehr, Raymond C. Pollution Control for Agriculture. Academic Press, Inc., New York, 1977.

witnessed the worst man-made pollution disaster in its history.[14] The cattle-feed additive, Nutrimaster, became accidentally mixed up with what is known since then as polybrominated biphenyls (PBB), a poisonous and carcinogenic chemical. The cattle died by the thousands across Michigan, and even the farmers themselves got sick. "The poison (PBB) is now permanently embedded in barn-fed lots, machinery, barn walls...., it may be 20 years or more before PBB's long range effects are known."[15]

B. A Historic Scenario for Mexico: The Impact of Water Development for Agriculture on the Society of Northern Mexico*

Northern Mexico is also arid or semi-arid, with the expansion of agricultural production depending on the supply of water for irrigation. In recognition of this, Mexico has made enormous investments in irrigation projects to augment and stabilize the quantity of water available to farmers.

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[14] National Broadcasting Corporation (NBC). Today. January 4, 1980.

[15] Rakstis, Ted J. "The Poisoning of Michigan," Reader's Digest, Vol. 115, No. 689, September 1979, p. 108.

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*The ideas in this section owe much to information illicited from interviews with three Mexican Ph.D. Environmental and civil engineering students at Oklahoma University, who had working experience in Mexico: José Antoni Ortega (working for Undersecretary for the Improvement of the Environment; Homero Silva (Environmental Projects-water); Roberto Contreras (Environmental project-water).

Mexico's land reform started with the Mexican Revolution in 1910. The basis of Mexico's program is the ejido. The ejido is an area of land owned by the government (as a result of expropriation or purchase) and given to landless peasants. Each ejidatario (farmer in the ejido) "owns" a parcel of this land (usually a parcel is 2 to 10 hectares), owns it in the sense that he may use it as he will but may not sell it or rent it. In the twenties and the thirties, there was regression in the agrarian reform because social and economic conditions inhibited accumulation possibilities and meant that agricultural production levels stagnated. During the period from 1934-1940, the agrarian process was consolidated programmatically. Plans for constructing a dam and developing canals and distribution laterals in the ejido became part of the land redistribution program. A government bank (National Ejido Credit Bank) made capital available to ejidos. The result was 25 years (1940-1965) of "spectacular growth" in farm production.(16)

The programmed ejido became a significant social factor in northern Mexico. Below is a brief summary of its impacts:

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16 Banco Nacional De Comercio Exterior. "Latin America in Perspective--Economic and social Conditions in Mexico," Comercio Exterior de Mexico, S.A., Vol. 25, No. 5, Mexico, D.F., May 1979, pp 172-177.

1. Economic Impacts: Before, the peasants could crop only once a year; now, they can crop 2-3 times annually, and more land was reclaimed. Moreover, the water for the ejido stabilized the per capita income of the farmer. Water became an insurance against the risk of weather uncertainty. For example, Comarca Lagunera is an irrigation district; it receives virtually all its water from the Cardenas Reservoir located in the mountains some 200 K.M. away; the government Bank sells the majority of the cotton crops produced and then gives the income to the farmers.[17] Water storage thus is converted to income. But water for the ejido is more than an insurance of farmer's income; water in the reservoir represents income generation. It insures the continuous functioning of a community--its distribution of employment and income. In Rio Bravo*, for example, farming is booming, but so is business related to agriculture, such as the cotton factory constructed in the district.

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[17] Cummings, Ronald. Water Resource Management in Northern Mexico. Resources for the Future, Inc., Washington, D.C., 1972.

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*Rio Bravo is the home town of one of the Mexican students--Homero Silva.

2. Demographic Impacts: (Population growth, mobility, and dispersion): The water project increased the population, and the new rural prosperity attracted labor. The population of Rio Bravo numbered 2000-3000 in 1950; after the irrigation project and the building of the canals and the dams, its population swelled. Currently, Rio Bravo numbers around 35 thousand. Furthermore, there is no end in sight to its population growth. The three Mexican students interviewed were consistent in their belief that rural unemployment will not restrict the size of the rural family because children are a strong value in and of themselves, an end. Children are a prestige to have regardless of religion; and the poor usually have more children. Unless there is an education program to limit the size of the family, birth control will in all likelihood not be practiced.

3. Disputes and controversies: The irrigation project in Mexico had the potential for a number of troublesome problems. In San Juan, "During the immediate post-revolutionary period, conflict became rampant. The power of the local landed elite over water was openly challenged. Water users refused to pay water costs or participate in canal cleaning. Water stealing became a common practice and several violent fights and murders occurred in a period of a few years.... Once the

traditional unified authority of the 'powerful' class was partially broken, by land expropriation, conflict increased greatly. Many farmers stopped producing because there were dangers of becoming involved in fights. The result was disorder and disadvantage to everyone."(18)

The new normative system of equitable water appropriation remained an ideal in many places. The ideal normative system was challenged. The traditionally powerful resisted the change and actually persisted in power. Water is owned by the government, and in theory the appropriation is egalitarian. But the actuality is different. Bribery is quite common, so is water stealing. The result is an uneven distribution of actual access to water, and constant petty minor conflicts. The control became more disruptive with the increase in population, and the introduction of rice--the water-hungry crop.(19)

4. Social Organizational Arrangement: While the irrigation projects entailed competition, conflict, and controversy, they also generated coordination and

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[18] Hunt, Eva and Robert C. Hunt. "Irrigation, Conflict, and Politics. A Mexican Case." Irrigation's Impact on Society. Theodore E. Downing and McGuire (editors), p. 150. University of Arizona Press, Tucson, 1974. (Anthropological Papers of the University of Arizona, No. 25).

[19] Ibid.

organizational arrangement in the farming communities. The irrigation system was not only physical and technological, it was also a social organization.

The irrigation system created an elaborate bureaucracy and a set of government roles--Instituto Nacional Indigenista. The basic function of the bureaucracy was, and still is, to control water, administer the construction and maintenance of a dam or a canal system, allocate capital expenditures over water, and to schedule the distribution of water to keep the system going efficiently. Needless to say, not all the functions were successfully done; many projects failed simply because of lack of expertise and deficiency in management, bribery and stealing, and the persistence of the old power structure.[20]

5. Centralization of Authority Structure: The crucial roles in the bureaucracy gave the persons occupying them expansive powers in other domains of social life, such as entrepreneurial activities, access to courts, and the use of the military to settle disputes and challenges to their authority. These powers inevitably tended to centralize the authority structure in Mexico. Though Mexico is a federation and policies

[20]Responses to interviews.

in ejidos result from a collective decision by a group including a representative from the Ministry, the Bank, and the farming community, the national government, as represented by the Ministry and the Bank, nevertheless remains the ultimate authority.

APPENDIX D

DELPHI: QUESTIONNAIRES, PANEL, AND MATRICES

TABLE D.1

List of the Panel Members for Delphi Method

No.	Name	Title
1.	Ayoub, Dr. G.M.	Associate Professor of Civil Engineering (Environmental Engineering), American University of Beirut(AUB), Beirut, Lebanon.
2.	Dajani, Dr. J.S.	Associate Professor of Civil Engineering (Planning), Stanford University, Stanford, California.
3.	Fayyad, Dr. M.S.	Chief, Transport, Communication and Tourism Division, United Nation. Economic Commission for Western Asia, Beirut, Lebanon.
4.	Ghandour, Dr. J.	Economic Affairs Officer, United Nations, Joint ECWA/FAO-Agriculture Division, Beirut, Lebanon.
5.	Herzalla, Mr. B.	Civil Engineer, United Nations-ECWA, Water and Natural Resources Division, Beirut, Lebanon.
6.	Jabbar, Dr. Kamel	Economic Affairs Officer, United Nations, ECWA, Beirut, Lebanon.
7.	Khan, Dr. M.L.	Resource Planning Economist, United Nations, FAO, Beirut, Lebanon.
8.	Lehn, Dr. Walter	Professor of Linguistics, Expert on the Middle East, and currently a Director for a research project at United Nations, Beirut, Lebanon.

TABLE D.1 (continued)

No.	Name	Title
9.	Yacoub, Dr. Munir	Professor of Sociology, Beirut University College (BUC), Beirut, Lebanon.
10.	Yacoub, Dr. Salah	Rural Sociologist, Social Affairs Officer, United Nations, ECWA, Beirut, Lebanon.
11.	Yunis, Dr. S.M.	Environmental Science Engineer, Economic Affairs Officer, United Nations, ECWA, Beirut, Lebanon.

APPENDIX D

QUESTIONNAIRE--FIRST ITERATION

Name:

Profession:

Specialty:

Below is a list of items to tap the experts opinion on what the potential impact on the Arab-Asian society could be with the technology of domestic wastewater reuse for agriculture. Corresponding to each item are three values (1, 2, 3). You are kindly requested to check only one value for each item. Check either (1) if you agree that the society will more likely have the impact stated by the item with than without the technology; or (2) if you are undecided; or (3) if you disagree.

It is more likely that the technology will:

1.	Increase food production	(1)	(2)	(3)
2.	Provide cleaner environment	(1)	(2)	(3)
3.	Integrate and coordinate the rural population	(1)	(2)	(3)
4.	Emerge new values--values of rationality, individual competition, specialization, etc.	(1)	(2)	(3)

5.	Increase rural per capita income	(1)	(2)	(3)
6.	Improve rural housing	(1)	(2)	(3)
7.	Build new agricultural settlements	(1)	(2)	(3)
8.	Abate rural drop in manpower	(1)	(2)	(3)
9.	Increase rural social services--clinics, schools, etc.	(1)	(2)	(3)
10.	Reduce the disparity in living standard between rurals and urbans	(1)	(2)	(3)
11.	Flourish business between urban and rural centers	(1)	(2)	(3)
12.	Generate two way mobility instead of only to the cities	(1)	(2)	(3)
13.	Reduce urban problem	(1)	(2)	(3)
14.	Increase birth rate, decrease death rate	(1)	(2)	(3)
15.	Enhance farmers' education in modern farming	(1)	(2)	(3)
16.	Increase rural population size	(1)	(2)	(3)
17.	Enlarge rural family size	(1)	(2)	(3)
18.	Alleviate the burden of rural woman	(1)	(2)	(3)
19.	Enhance rural family integration	(1)	(2)	(3)
20.	Alter religious taboos which frown on sewage	(1)	(2)	(3)
21.	Farmers will use treated sewage for irrigation	(1)	(2)	(3)
22.	Provide eventually lakes for recreation--people will enjoy	(1)	(2)	(3)
23.	Agriculture will become machine-intensive	(1)	(2)	(3)
24.	Assuming agriculture become machine intensive, rurals will accept birth control	(1)	(2)	(3)
25.	Will halt desertification	(1)	(2)	(3)

QUESTIONNAIRE--SECOND ITERATION

Dear Sir:

I would like to express my appreciation for your prompt response to my first questionnaire concerning the likely social impacts of reused water for irrigation in the Arab-Asian countries.

As you know, my "Delphi Panel", on which you agreed to participate, involves successive questionnaires to panelists toward the objective of refining a panel consensus.

This is the second round questionnaire of the Delphi. I have added new reference information for you to consider and possibly modify your opinion. The information is from historical studies of the U.S.A. and Mexico, and from your collective responses to the first round questionnaire. The information is summarized in the accompanying table. You'll note that the table is divided into two parts: (1) social constraints to technology application, and (2) subsequent social impacts to an applied technology.

First, the table lists 26 items of a "Social Impact Index", (Column 1).

Second, the table indicates for each impact in the Index, the agreement among the panel of experts to the first round of Delphi: the agreed number that the impact will occur (Column 2), the undecided number (Column 3), and the disagreed number (Column 4).

Third, the table checks each impact in the Index on whether in the U.S.A. (Column 5), and Mexico (Column 6), the impact actually happened when water was increased for irrigation (+), did not happen (o), the opposite happened (-), or a combination happened (+ and/or o and/or -).

Please compare this information with your own opinion (enclosed is your response to the first round of Delphi). Then give your response to each impact in the Index.

For each impact in the Index check the likelihood of it happening, in your opinion, by the year 2000 in the Arab-Asian countries as an impact of water reuse for irrigation. Check only one column for each impact. Check either:

- Column 7 for high likelihood
- or, column 8 for medium
- or, column 9 for low
- or, column 10 for no chance
- or, column 11 for opposite impact will occur

Please, make your judgement with the understanding that: first, the technology of water reuse in the Arab-Asian region will be programmed, i.e., the governments (1) will provide farmers with credit institutions, retraining in modern farming technologies, advisory assistance, etc. (2) will monitor the progress of the irrigation project, and (3) will enact and enforce equitable water allocation laws and regulations. Second, your forecasting should be for the year prior to the year 2000.

Thank you,

Abla Yunis

Second Iteration Questionnaire - Part I

Please forecast, by the year 2000, the likelihood of resolving societal constraints to water reuse for irrigation in the Arab-Asian countries. If additional significant constraints exist in your mind, please add them in the space provided.

Const. No.	Societal Constraint Resolutions	FIRST ROUND RESPONSE Resolutions will Occur (Frequency Distribution)			HISTORIC EXPERIENCE + occurred o=no occurrence -=opposite occurred		REQUESTED SECOND ROUND RESPONSE Likelihood of Resolving the Constraints (by the year 2000)				
		Agree	Undecided	Disagree	USA	Mexico	High	Medium	Low	No Chance	Opposite Will Occur
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	A. Individual And Family Level Constraints										
1.	Farmers will become skilled in Modern Farming.	7	3	1	+	o,+					
2.	Farmers will accept treated sewage for agriculture.	10	1	o	+	+					
3.	Rurals will more accept individual achievement rather than inherited status.	6	3	2	o (prior)	o					
4.	People will accept eating crops irrigated with treated sewage.	New	Question		NA	NA					
	Others (Please Identify)										
	B. Rural Community Level Constraints										
5.	Rural class hierarchy differentiation will decrease.	New	Question		- (class emerged)	o					
6.	Rural communities will become more organized and integrated.	4	1	6	+	+,-					
7.	Rural life will become more controlled and organized by the central government.	New	Question		+	+					
	Others (Please Identify)										
	C. (Central) Government Level Constraints										
8.	Government will provide the mechanism to effectively train the needed manpower.	New	Question		+	+					
9.	Government will build the distribution network necessary for sewage collection and delivery.	New	Question		NA	NA					
10.	Government will enforce water allocation laws.	New	Question		+	+,-					
11.	Government will build agricultural "new towns."	7	2	2	+	+					
12.	Government will provide new rural social services - schools, clinics - equal to urban services.	7	2	2	+	+					
	Others (Please Identify)										

Second Iteration Questionnaire - Part II

Assuming implementation of water reuse for irrigation in the Arab-Asian countries, please forecast, by the year 2000, the likelihood of the resultant social impacts.

Impact No.	Resultant Social Impacts	FIRST ROUND RESPONSE Impacts will occur (Frequency Distribution)			HISTORIC EXPERIENCE + occurred o no occurrence - opposite occurred		REQUESTED SECOND ROUND RESPONSE Likelihood of Impact Occurring (by the year 2000)				
		Agree	Undecided	Disagree	USA	Mexico	High	Medium	Low	No Chance	Opposite Will Occur
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	A. Individual and Family Level										
1.	Women will have easier life (no more water hauling.	9	0	2	NA	NA					
2.	Rural per capita income will increase.	10	-	-	+	+					
3.	Rural housing will improve.	5	4	2	+	+					
4.	Rural family will re-integrate.	New	Question		NA	NA					
5.	Rural family size will increase.	2	4	5	+	+					
6.	Public will accept treated sewage lakes for recreation.	8	0	2	+	0					
	Others (Please Identify)										
	B. Rural Community Level										
7.	Rural manpower loss will abate.	9	2	0	+,0	+					
8.	Rural population will increase.	8	2	1	+,0	+					
9.	Rural employment opportunities in agro-business will increase.	New	Question		+	+					
10.	The community environment will become cleaner.	10	-	1	+,-	+					
	C. Nation Level										
11.	Countries will develop self-sufficiency in food production.	11	-	-	+	+,0					
12.	The disparity in standard of living between rural and urban settlement will reduce.	6	4	1	+	+,0					
13.	Rural-urban interaction will increase (business activities, mobility).	8	2	1	+	+					
	Others (Please Identify)										
	D. Subsequent Impact										
14.	Urban problems will ease.	11	-	-	NA	NA					
	Others (Please Identify)										

TABLE D.2.

Matrix of Scores by Delphi-Panel to the Second Iteration Questionnaire - Part I

H = High, M = Medium, L = Low, NC = No Chance, O = Opposite Will Occur

Const. No.	Societal Constraint Resolutions	The Delphi-Panel (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	A. Individual and Family Level Constraints											
1.	Farmers will become skilled in modern farming.	M	H	NC	M	L	M	L	NC	NC	L	M
2.	Farmers will accept treated sewage for agriculture	M	H	L	M	M	H	M	L	L	M	M
3.	Rurals will more accept individual achievement rather than inherited status.	L	L	L	L	NC	L	L	L	NC	L	L
4.	People will accept eating crops irrigated with treated sewage.	M	M	M	H	M	L	H	M	H	M	M
	B. Rural Community Level Constraints											
5.	Rural class hierarchy differentiation will decrease	L	H	NC	NC	L	H	M	O	H	NC	H
6.	Rural communities will become more organized and integrated.	L	L	H	L	M	L	L	H	M	L	L
7.	Rural life will become more controlled and organized by the central government.	M	NC	M	NC	M	NC	NC	M	L	NC	M
	C. (Central) Government Level Constraints											
8.	Government will provide the mechanism to effectively train the needed manpower.	L	H	M	H	M	M	H	M	M	M	H
9.	Government will build the distribution network necessary for sewage collection and delivery	L	H	L	H	H	H	H	L	M	H	L
10.	Government will enforce water allocation laws.	M	H	L	H	L	H	H	M	M	H	H
11.	Government will build agricultural "new towns."	M	L	H	L	H	L	L	H	M	L	L
12.	Government will provide new rural social services - schools, clinics - equal to urban services.	M	M	H	M	H	M	M	H	M	M	M

TABLE D.3.

Matrix of Scores by Delphi-Panel to the Second Iteration Questionnaire - Part II

H = High, M = Medium, L = Low, NC = No Chance, O = Opposite Will Occur

Impact No.	Resultant Social Impacts	The Delphi-Panel (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	A. Individual and Family Level											
1.	Women will have easier life(no more water hauling.	H	M	H	NC	L	NC	L	H	NC	M	M
2.	Rural per capita income will increase.	H	H	O	H	H	H	H	H	NC	H	H
3.	Rural housing will improve.	M	M	NC	M	M	M	M	H	NC	M	M
4.	Rural family will re-integrate.	L	L	L	NC	O	L	NC	O	L	L	L
5.	Rural family size will increase.	L	NC	L	NC	L	NC	NC	NC	L	NC	NC
6.	Public will accept treated sewage lakes for recreation	L	M	NC	L	H	M	L	L	L	M	M
	B. Rural Community Level											
7.	Rural manpower loss will abate.	H	H	L	H	NC	H	H	NC	M	H	H
8.	Rural population will increase.	M	H	H	H	L	H	H	O	M	H	H
9.	Rural employment opportunities in agro-business will increase.	H	L	M	L	M	L	L	NC	H	L	L
10.	The community environment will become cleaner.	M	M	H	H	L	H	H	L	M	L	H
	C. Nation Level											
11.	Countries will develop self-sufficiency in food production	H	L	H	M	H	M	M	H	M	H	M
12.	The disparity in standard of living between rural and urban settlement will reduce.	M	NC	H	M	M	L	L	H	NC	M	L
13.	Rural-urban interaction will increase (business activities, mobility).	H	NC	H	NC	M	H	NC	H	NC	M	L
	D. Subsequent Impact											
14.	Urban problems will ease.	M	L	H	NC	H	NC	NC	H	H	NC	NC