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WATER RESOURCES AND CONFLICT IN THE MIDDLE EAST

The Middle East is a region of international concern and political unrest. With severe water shortages, water, not oil, threatens the renewal of military conflicts and social and economic disruption in the region.

This book forms a complete reference to both the hydrological as well as the social, economic, political and legal issues in the region. With resources over-extended due to natural and human causes, *Water Resources and Conflict in the Middle East* analyses the river basins of the Euphrates, Tigris, Nile and Jordan. The book provides a detailed study of the hydrology, hydrography and geography of these river basins and an analysis of the needs of the economies and societies of the countries bordering these basins.

Conclusions on likely areas of conflict are set within the legal framework of the Helsinki and International Law Commission Rules.

The book will be a reference for all interested in the hydrology of the Middle East as well as the social implications of the region's water resources.

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WATER RESOURCES AND CONFLICT IN THE MIDDLE EAST

Nurit Kliot

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For my parents

Yocheved and Chaim Kliot

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UNITS AND CONVERSION FACTORS

Units of area

1 feddan=4.200 m^2=0.42 ha=1.037 acres
1 feddan=4.2 dunum
1 dunum=0.10 ha=0.222 acres
1 ha=10 dunums
1 ha=2.47 acres
1 km=100 ha=1,000,000 m^2
1 dunum=0.25 ha=0.62 acres (in Iraq)
1 ha=4 dunum (in Iraq and Turkey)

Units of flow (volume)

km^3=$m^3 \times 10^9$=billion
1 cubic metre=1,000 litres
1,000 million m^3=1 billion m^3=10^9 cubic metres=1 cubic km

INTRODUCTION: PRINCIPLES AND REALITY IN WATER ALLOCATION OF INTERNATIONAL RIVERS

The events of the 1980s have made people throughout the world understand that water is a scarce resource on earth. The Sahelian drought which has continued for almost a decade, for example, is responsible for famine and starvation in Ethiopia, the Sudan and the Horn of Africa and, as a result, this part of Africa has been dependent on food aid for almost a decade. Even the USA which seems to produce an endless source of surplus food, is suffering from drought in the arid western regions, especially in California, and from over-utilization of its water resources. Europe, another important source of cereal exports, suffered from severe drought conditions in 1990, not only causing Greece and France to introduce water rationing but also causing severe water shortages in England, Italy, Spain, Switzerland and Hungary.

There are severe water shortages in the Middle East, the subject area of this book. The resources of the Nile, the Tigris-Euphrates and the Jordan are over-extended owing both to natural causes and to those deriving from human behaviour.

One hypothesis which might explain the frequent droughts of the last decade is offered by climatologists who believe that climatic changes tied to the greenhouse effect are responsible. The fact is that droughts have affected the Nile and Jordan river basins resulting in water shortages for the co-riparians of these basins: Egypt and the Sudan in the Nile and Jordan, Syria and Israel in the Jordan river basin.

In addition to a severe shortage in the quantity of water, there is a growing concern over water quality and the United Nations Environmental Programme has called for a sustainable water development policy in which water development will be carried out within the context of environmental preservation and improvement (Biswas and Kindler 1989:225). In the study area, for example, contamination of water supplies in the Gaza Strip is reaching critical proportions and deteriorating water quality will be a dominant point of controversy among the co-riparians of the Euphrates: Turkey, Syria and Iraq (Starr and Stoll 1987: 8–9). During the next decade Israel is likely to lose one of its major underground water sources owing to contamination, and water quality in the Lower Nile limits water usage. This combination of factors means that the people of the Middle East are on the verge of a crisis the dimensions of which will make all previous crises seem minor (Kolars 1990). One of the major reasons for this situation is that over 50 per cent of all populations in the Middle East and North Africa (excluding the Maghreb) depend directly on water for their livelihood.

The demand for water in the developing world, of which the Middle East is a part, has grown significantly over the past thirty years, as the result of an accelerating population growth. The world's population is projected to reach 6.5 billion by the end of this century and this will increasingly be a major cause for the exhaustion of water resources. In the Middle East the average annual population growth is currently 3 per cent and, as a result, scarce water resources of the region are being severely drained since water for irrigation is competing with water needed for domestic and industrial use in the rapidly growing metropolitan areas. The result is that there is a growing gap between food production and population size in all of the countries of the Middle East. In the Tigris-Euphrates system, for example, both Turkey and Syria are engaged in enormous agricultural development in order to provide for their expanding populations.

Another factor affecting water availability throughout the world in general, and in the Middle East in particular, is poor water management and the increasing politicization of agricultural policies which encourage water waste and inefficient irrigation systems.

This is the background to the current emerging conflict over water resources in the international rivers of the Middle East but to understand the issues in depth one must relate to the specific properties of rivers which affect their utilization.

PLANNING AND UTILIZATION OF RIVERS

Two basic concepts which have evolved during the first half of this century concern the purposes and the planning of water projects. Any water project must first be defined as a single-purpose development project or a multipurpose project. Most of the major water projects are multipurpose, a fact which imposes on planners the major task of co-ordinating the various and possibly over-ambitious numbers of targets for water resource development (Chapman 1963). International rivers have always been used for navigation, irrigation and as hydropower sources for flour-milling, mining and metallurgy (Teclaff 1967; Pounds 1972: 313–16). Rivers have also served as sources of drinking water and for recreational purposes. The basic idea behind multipurpose planning is that as many water uses as possible should be included in any water project (United Nations 1970:3). Planning, the second concept concerning water resource development, can be unified planning, co-ordinated planning or the most desired form of planning method—integrated planning. Integrated planning is crucial in international river basins because jurisdictional divisions are imposed on the physical and hydrological unity of river basins. Integrated planning operates in two ways: (a) between countries within an international river basin and (b) between projects within a country (Chapman 1963).

The need for integrated river basin development arises from the relationship between the availability of water and its possible uses in the various sectors of a drainage area. It is now recognized that individual water projects, whether single purpose or multipurpose, cannot, as a rule, be undertaken with optimum benefit for the people affected before establishing the broad outlines of a plan for the entire drainage area. Integrated river basin development involves the co-ordinated development of the various projects in relation to all the reasonable possibilities of the basin. These may include irrigation and drainage, electric power production, navigation, flood control, watershed treatment, industrial and domestic use of water, recreation and wild life conservation (United Nations 1970:1).

Basin-wide planning is needed because of the physical unity of a river basin where intervention in one area is going to influence other parts of the basin. The hydrology of a river does not change when an international frontier runs across or along it—only the politics change. Demands on the water resource are different among basin countries owing to many factors including population growth, economic development, cultural practices, foreign policy objectives and the availability and accessibility of other domestic water resources (Le Marquand 1977:147). When considering the broad possibilities for water use it is important to distinguish between consumptive and non-consumptive uses. Consumptive uses are those in which the water is wholly or largely used up. Irrigation and domestic uses are consumptive uses but, even here, some of the water can be re-cycled and re-used. Navigation represents a non-consumptive use and another example is provided by the utilization of water for the generation of hydro power, since the physical quantity of the water used in the production of hydroelectricity remains undiminished. Some of the non-consumptive uses, however, may cause deterioration in water quality and, as mentioned before, water contamination has become a source of major concern all over the world.

The most desirable method for international water basin management is multipurpose integrated river basin development. Most integrated basin development has occurred on rivers which flow wholly within a single state: thus, in the Soviet Union, the Volga-Kama, Don-Dnepier and Syr-Darya systems have been the subjects of basin-wide development; in the USA the concept has been extended to include an entire region under the Tennessee River Valley Authority. To a lesser extent multiple-purpose development has occurred on a unilateral basis on those portions of international streams located within the boundaries of a particular state. For example, projects on the Rhone and Tigris-Euphrates have been executed by and for the sole benefits of France and Iraq respectively (Olmstead 1967:6). This generalization, however, is no longer accurate for the Tigris-Euphrates system since it is at present used by all its co-riparians: Syria, Turkey and Iraq. Integrated river basin development seldom takes place in international water basins because the co-riparians compete with each other and adopt methods of consumptive water utilization which curtail or eliminate other riparian rights to the river's waters. Hence, conflict over water resources is almost inevitable. Possible conflict (as exemplified by European rivers) may arise as a result of various uses: navigation versus irrigation or sanitary uses versus navigation. In the Middle East the irrigation needs of one country often clash with the irrigation needs of another (Hirsch 1956:212). Ordinarily, conflicts over such consumptive uses are less likely to be resolved than conflict over non-consumptive uses (Naff and Matson 1984:163).

WATER UTILIZATION IN INTERNATIONAL RIVERS

International rivers are defined as drainage basins shared by two or more states (called successive rivers) or constitute the boundary between them (called contiguous rivers) (Briggs 1952:274; Olmstead 1967:3; Barberis 1986:212). The International Law Commission (ILC), a UN affiliated body involved in the formulation of the Law of the Non-Navigational Uses of International Water Courses, has provided a different definition of international rivers. The concept adopted by the ILC is 'international water course'. A water-course system is formed by hydrographic components such as rivers, lakes, canals, glaciers and groundwater constituting, by virtue of their physical relationship, a unified whole, where any use affecting waters in one part of the system may affect waters in another part (United Nations 1989:353).

To the extent that the use of waters of an international water-course system in the territory of one system state affects the use of waters of that course system in the territory of another water-course state, the waters are considered a shared natural resource (Hayton 1981:162).

There are over 200 international rivers according to the UN E.C.O.S.O.C. Commission on Natural Resources and the *Register of International Rivers* (United Nations 1978). Only 110 of these rivers have river basins sufficiently large in size for use and development. There are forty-three international rivers in the Americas, twenty in Europe, twenty-seven in Africa and fifty in Asia (United Nations 1970: Maps 1, 2).

The UN Water Conference at Mar del Plata, Argentina (1977), clearly declared that: 'In relation to the use, management and development of shared (international) water resources, national policies should take into consideration the right of each state sharing the resources to equitably utilize such resources as the means to promote bonds of solidarity and cooperation' (United Nations 1977:53).

The major problem in the management of international rivers is the sovereignty of the states which share the river basin. Co-operation in the development of an integrated river basin is a challenge to the state's proclaimed sovereignty over its resources. States must feel that they will be compensated economically and politically by the other riparians for their readiness to co-operate and share water resources (Le Marquand 1981:147–8).

Four major legal principles concerning the sovereignty of the states over water resources have evolved over the years.

1 *The Harmon Doctrine or the principle of absolute territorial sovereignty:* According to this concept, a state has the right to use the fluvial waters which lie within its territory without any limitation whatsoever, regardless of the effects of this utilization on other states. This theory is known as the Harmon Doctrine after J. Harmon, Attorney General of the USA, who expounded it in 1895 during a dispute with Mexico over the utilization of the waters of the Rio Grande. The USA maintained the Harmon Doctrine in its relations with Canada regarding the exploitation of the rivers Milk and St Mary and the basin of Lake Birch (Barberis 1986:213). India embraced it in its dispute with Pakistan over the Indus (Lipper 1967:21). The doctrine has often been adopted by the upper riparian states which claim that a state, being fully sovereign over its own territory, may act within that territory as it sees fit no matter what the consequences to co-riparians may be (Teclaff 1967:158). Generally, upstream position confers marked power advantages. Diversion, overuse, contamination and flow delay are tactics available for use in accordance with one's (superior) position (Frey and Naff 1985: 78). There is a general agreement nowadays that the Harmon Doctrine was not an expression of international river law. Rather, it was an assertion that, since no rules of international law governed usage of waters, states were free to do as they wished (Lipper 1967:23). This doctrine, which contradicts the international law, was rejected by the USA a few times after it was used.

2 Lower riparians often favour the principles of *absolute territorial integrity* by which no state may utilize the waters of an international river in a way which might cause any detrimental effects on co-riparian territory (Doherty 1965:38). This means that states must conduct themselves within the limits of their territories in such a way as not to alter the natural regime of the river when it runs through the territory of another state. This principle was advocated by the Kingdom of Bavaria in a dispute with Austria and by Egypt at the Nile Commission in 1925 but Egypt later retreated from this position (Barberis 1986:213). The doctrine is often tied to prior appropriation of water, in which existing water rights of lower riparians must first be respected and satisfied before any other claims can be met (Hirsch 1956:210; Chapman 1963:23). At present existing use is one of the factors which need to be taken into account when determining what the just and equitable sharing of the benefits of an international river basin is. Existing uses of the water by one country may also exceed the reasonable share to which that country may equitably be entitled. Prior appropriation may simply reflect the fact that one area was favoured by its previous European masters over another area (Hirsch 1956).

Intermediate theories

The Harmon Doctrine and the theory of absolute territorial integrity constitute two extreme positions. Between them there are other concepts which are more pragmatic, which state that use of the water of international rivers is subject to various restrictions which may favour the other riparian states (doctrines 3 and 4). All these intermediate theories were evolved out of the conviction that no state should harm the water utilization of another state.

3 Condominium or *common jurisdiction* of all riparians over the whole international river or river system aims at limiting a state's freedom of action over the utilization of international rivers. The application of this principle would mean that a state would need to obtain prior consent from co-riparians for all projects concerned with the utilization of the waters. According to this system, based on the community theory, the emphasis is placed on the mutual development of a river's waters by all riparian states.

International law has recognized that a river is the property of the community of all riparian states (Barberis 1986:213–14). This has been followed by a recognition of the existence of certain limitations to territorial sovereignty in favour of the international community in general (Barberis 1986:214). Many treaties which regulate the use of boundary waters are based on the acceptance of this principle. Examples are the 1909 US-Canadian Treaty regulating the boundary waters (Columbia River); the agreement concerning the River Meuse between Belgium and the Netherlands; and the USA-Mexico Rio Grande Treaty of 1944. The principle as such (though without any formal agreement) has been acknowledged by Chile and Bolivia in their dispute over the Lauca River and by Israel and the Arab states in their conflict over the Jordan River (Lipper 1967:25–8). The Permanent Court of International Justice has confirmed the principle of limited sovereignty in its adjudications over the case of the River Oder and in the case of Lake Lanoux arbitration between France and Spain (Lipper 1967:29).

4 Finally, there is the principle of *equitable utilization,* which permits use of a river's waters to the extent that this does no harm to other riparian countries. This principle has become the most widely advocated by the international legal community, as evidenced by treaties, judicial decisions, academic research and international bodies (Chapman 1963; Le Marquand 1977:154; Barberis 1986: 215). The best expression of the principle of equitable utilization can be found in the *Helsinki Rules* drawn up by the non-governmental International Law Association (ILA) in 1966 and they have become the accepted legal foundation for utilization of international rivers (Hayton 1981; Le Marquand 1981:149) (see Appendix A). Caponera (1992) made a more detailed division of the above general principles of international law concerning international rivers. He defined the following seven doctrines:

1 the doctrine of riparian rights
2 the prior appropriation doctrine
3 the theory of absolute territorial sovereignty
4 the theory of absolute territorial integrity
5 the theory of equitable apportionment
6 the theory of limited territorial sovereignty
7 the theory of equitable utilization

Another international organization working on a set of rules for sharing international water resources is the ILC, a UN affiliated body. Since 1971 this organization has been developing the Law of the Non-Navigational Uses of International Watercourses, and by 1992 some thirty-two articles had been formulated and approved (see Appendix B).

Article 6 of the ILC set of rules firmly states that equitable and reasonable utilization of participation in international river basins is the only principle accepted in the body of international law (United Nations 1989:354). The Helsinki Rules concerning international river basins were compiled in 1966, based on the principle of equitable distribution. In subsequent years this body compiled rules about flooding and marine pollution of land origin (New York, 1972); about cost allotment for the conservation of navigable rivers (New Delhi, 1974); about the administration of international water resources and protection of waterworks in the case of war (Madrid, 1976); about the pollution of basins (Montreal, 1982); and about underground water (Seoul, 1986). The Committee on International Water Resources (which organized the work of the various conferences listed above) terminated its activity in 1988 (Cano 1989:167–71).

The Helsinki Rules on the Uses of the Waters of International Rivers contain six chapters. The first chapter is a general chapter which defines the term 'international drainage basin'. Chapter 2, which has five articles, deals with the equitable utilization of the waters of international drainage basins; Chapter 3, which contains three articles, formulates rules concerning pollution. Chapter 4 presents nine articles concerning navigation in international river basins. The remaining two chapters concern timber floating (Chapter 5) and procedures for the prevention and settlement of disputes (Chapter 6) (United Nations 1970:80) (see also Appendix A).

The ILC Law of the Non-Navigational Uses of International Watercourses contains thirty-two articles. Articles 1–4 are general articles which provide the basic definitions. Article 5 deals with equitable and reasonable utilization of watercourse systems. Article 6 presents the factors relevant to equitable and reasonable utilization. Article 7 specifies the obligation not to cause harm. Articles 8 and 9 deal with the general obligation of co-riparians to co-operate and exchange data and information. Articles 10–23 provide a whole framework for co-operation among co-riparians when they plan to develop international water courses (United Nations 1989:334–58) (see also Appendix B). The process of codification of the International Law of Water Resources is currently continuing at a slow pace (Cano 1989:170).

In this book, articles of both the Helsinki Rules and the ILC which specify the relevant factors for equitable water utilization will be discussed with reference to the international river basins of the Middle East. Chapter 2 of the Helsinki Rules begins with Article IV which states that each basin state is entitled to a reasonable and equitable share of the benefits deriving from the use of the waters of an international drainage basin. Article V contains the following eleven relevant factors involved in the equitable utilization of international river basins:

(a) the geography of the basin including, in particular, the size of the drainage area in the territory of each basin state;
(b) the hydrology of the basin including, in particular, the contribution of water by each state;
(c) the climate affecting the basin;
(d) the past utilization of the waters of the basin including, in particular, existing utilization;
(e) the economic and social needs of each basin state;
(f) the population dependent on the waters of the basin in each state;
(g) the comparative costs of alternative means of satisfying the economic and social needs of each basin state;
(h) the availability of other resources;
(i) the avoidance of unnecessary waste in the utilization of waters of the basin;
(j) the practicability of compensation to one or more of the co-basin states as a means of negotiating settlements over conflicts among users;
(k) the degree to which the needs of a basin state may be satisfied without causing substantial injury to another basin state (United Nations, 1970:78– 80).

Rules concerning international aquifers were formulated at the Seoul meeting of the ILA. The rules called for the prevention of pollution of international groundwater, the exchange of relevant information concerning the aquifer and integrated management, ‘including conjunctive use with surface waters, of their international groundwater’ (see Appendix A). But there is no suggestion of how these waters should be divided among the co-riparians.

The relevant articles of the ILC Rules which are compatible with the above Helsinki Rules are Articles 5 and 6. Article 5 calls for equitable and reasonable utilization and participation in the international river basin. Article 6 specifies the factors relevant to the equitable and reasonable utilization of international rivers:

(a) geographic, hydrographic, hydrological, climatic and other natural factors;
(b) the social and economic needs of the water course states concerned;

(c) the effects of the use or uses of an international water course (system) caused by one water-course state to other water-course states;
(d) the existing the potential uses of the international water course (system);
(e) conservation, protection, development and economy of use of the water resources of the international water course (system) and the costs of measures taken to effect the above;
(f) the availability of alternatives, of corresponding value, for a particular planned or existing use (United Nations 1989:355–6).

It is extremely important to note that neither the Helsinki Rules nor the ILC Rules are legally binding, but the principle of equitable utilization of international river basins has become that most widely advocated by the international legal community (Le Marquand 1977, 1981; Kirimani 1990:204). On the basis of state practice almost all scholars and researchers who have studied this question maintain that equitable utilization is a norm of international law (Barberis 1986:215). However, as yet, there have been few adjudications over international water disputes and thus few opportunities to apply the doctrine in a practical setting (Glickman 1985:698). Many treaties and 'state practices' reflect the adoption of the Helsinki Rules or ILC Rules. Thus the responsibility to supply prior information about plans to use the water of international rivers was demonstrated in the arbitration process concerning Lake Lanoux between Spain and France and in the Treaty of the Rio de la Plata (Barberis 1986:216). The agreement reached between the USA and Mexico for the protection and improvement of the environment in the border area which regulates the issue of transboundary pollution is an example of the adoption of Helsinki Rule V or ILC Rules which advocate avoidance of any detrimental change in the quality of water in international rivers. A similar principle has been applied by the International Commission for the Protection of the Rhine against Pollution (Glickman 1985:715).

The principle of respecting existing water utilization when new projects are developed was adopted in the case of the Helmand River which was the focus of a dispute between Afghanistan and Iran and in the case of the River Roji, which is shared by Italy and France (Lipper 1967:31). The 1963 agreement over the River Niger provided support for the norm of legitimate utilization of an international river and its tributaries by each riparian state. The use made by the eleven co-riparians in respect of the portion of the River Niger base lying in their respective territories was recognized and this principle was also adopted by South American countries. This principle is consistent with the Helsinki Rules (Article V(a)) and ILC Rules (Article 6(d)).

In the Columbia River Treaty, Canada agreed to permit the USA to use large areas of Canadian territory for storing water for flood control. In return, the USA agreed to pay for this use with both hydroelectric power and money. This solution is also consistent with Articles V(i) and V(j) of the Helsinki Rules which refer to the principles of avoiding the unnecessary waste of water and the practicability of compensation for co-basin states. The co-operative investigation programme in the Lower Mekong River and the common committee for the co-riparians to the Senegal River which oblige members to submit projects to it are other examples (Teclaff 1967:175–8). In Europe, co-operation over the Rhine and Danube mainly concerns matters of navigation and hydroelectric power; consumptive use and pollution are seen as secondary.

Thus, whereas the Helsinki Rules do not have formal legal status they serve as guidelines for state practice in various parts of the world. Moreover, there are legal interpretations of these regulations. For example, there is agreement that while the cornerstone of equitable utilization is equality of right, this is not synonymous with the equal division of waters. Equitable utilization is concerned with the economic and social needs of the co-riparians, and the water should be distributed in such a manner as to satisfy needs to the greatest extent possible and provide maximal benefits for each co-riparian. Equitable utilization minimizes the damage one state might cause another but it cannot always prevent it entirely (Lipper 1967:44–7). Such utilization also indicates that, although the right to equitable utilization is recognized only in so far as it relates to the beneficial use of the water, underdeveloped states which are incapable of meeting the efficiency standards for the utilization of irrigation waters will not be deprived of their water, provided that no user is wilfully wasteful or inefficient.

A special problem is presented by the principle of prior appropriation or the 'natural' or 'historic' right of a state to utilize water (Caponera 1992). Under international law, it is clear that existing uses have preferential status over projected uses in matters of equitable utilization. The practice of states, however, has not reflected approval of the primacy of the doctrine of prior appropriation to the exclusion of other factors. The right of prior or existing use was recognized in the Nile Commission discussions (1929) and in the dispute over the irrigation water of the Helmand; but the existing treaties refer to protecting 'existing' uses rather than 'prior' uses. Where the conflict is over respective existing uses, the comparative period of use is disregarded and the 'existing use' factor is neutralized, thus eliminating its important role in equitable utilization.

Another problem presented by the existing norms for equitable utilization is raised by the notion of 'preferential use', namely preference given to a particular use within an international river over other different and perhaps conflicting uses. This derives its significance from a time when navigation was considered supreme to any other use. At present, however, no use or category of uses is entitled to any preference over any other use or category of uses. This is clearly expressed in the Helsinki Rules, but there seems to be a tendency among governments and courts to give drinking and other domestic uses preference over other uses (Lipper 1967:63–7). One can thus see the complexities of weighing the various needs of co-riparians to an international basin. In 1986, the ILA, at its Sixty-Second Conference, which was held in Seoul, adopted three complementary rules to the Helsinki Rules. Article 1 called states to prevent acts or omissions within one's territory that would cause substantial injury to any cobasin states. Article 2 called for co-ordination in connection with water utilization and Article 3 called for providing notice on any water projects to all the co-riparians. The Seoul Conference also defined, for the first time, international groundwater aquifers and called for the prevention of pollution of such aquifers, formulated the necessity to consult and exchange relevant information concerning utilization of such water, and called for a common management of such groundwater.

Three other legal and customary principles which have developed in relation to international rivers also assist in sharing water more equitably. The first is the principle of *mutual benefits.* An upstream country may be reluctant to go ahead with its projects unless it can be assured of receiving some compensation for the unexploited water resource it might send downstream. The benefits, which might be economic or political, must be clearly described in quantitative and qualitative terms to all riparian states, in order for them to agree to co-operate (United Nations 1970:33). Reciprocity of benefits distributed is needed in order to gain the co-operation of all riparian states. The second principle is the principle of *linkage.* Agreement with a neighbour state about an international river project that the neighbour might want may be used to gain concessions for other bilateral issues such as favourable trade arrangements or support for some multilateral policy (Le Marquand 1977:155). According to Holsti and Levy (1974), linkages between policy areas are typical of countries with high levels of conflict. Finally, the third and last factor which shapes water utilization is the attitude a state adopts in legal matters and, more particularly, to international law concerning international rivers. The *image* a country wishes to project can also be important and so the desire to pursue a good neighbour policy, to be a model of cooperative international behaviour, will influence a country's willingness to co-operate with its riparian neighbours (Le Marquand 1977:153).

The legal norms and customary international law which has been presented in such detail here conceal the important but sorry fact that conflicts over the precious waters of international rivers are common phenomena, as can be seen in the cases of the Indus and Jordan Rivers.

Examples of current and potential surface water conflicts involve the Nile, Senegal, Niger, Zambezi and Orange Rivers in Africa and the Jordan River in the Middle East. Others are the construction of the Atatürk Dam in Turkey and its far-reaching consequences for the Euphrates flow in Iraq, and the Kumgang Dam in North Korea and the potential reversal of the southward flow of the Han River (Vlachos 1990:186).

Vlachos (1990) distinguishes between three types of conflicts.

(a) Cognitive conflicts represent our disagreements about the 'facts'. These lead to debates over the extent and availability of resources because of differences about factual data—something increased knowledge and research were supposed to help prevent.
(b) Stakeholder conflicts reflect the patterns of power distribution, the historical coalitions of social power or, more broadly, the 'parties at interest'. Such conflicts exemplify the question of 'who is at stake' and refer not only to the obvious national entities but also to regional, community, local and other sub-national interest groups.
(c) Ideological conflicts are really the ultimate expression of values and prior ities. They reflect not only different models of social development (e.g. conservation versus exploitation) but more subtle orientations toward the present and the future (Vlachos 1990:187–8).

This classification can be usefully applied to identifying the current conflicts over water resources in the Middle East, but an overview of the situation is first needed to place things in perspective.

THE MIDDLE EAST AND NORTH AFRICAN SETTING OF INTERNATIONAL RIVERS

Because water is scarce in the Middle East and North Africa water resources play a very important role. The Middle East and North Africa is defined in this book as the area which includes Turkey, Iran, Iraq, the Arabian Peninsula, the Levant (Syria, Lebanon, Jordan and Israel), Egypt and the Sudan. Because of its relation to the Nile river basin, we have also included Ethiopia and the Equatorial States. The climate in most parts of the region is arid or semi-arid and any perennial rivers are vital to the agricultural economies of most of the states. Most of the Middle Eastern states were controlled at one time by the colonial powers, especially Great Britain, Italy and France.

The Center for Strategic and International Studies predicts that water, not oil, will become the dominant subject of conflict for the Middle East by the year 2000. Rapidly growing populations, ambitious development programmes and the prolonged droughts of 1989 have accelerated this transformation. A recognition of this global trend has elevated hydropolitics into a new diplomatic endeavour (Tekeli 1990: 212).

The Nile, the Jordan and the Tigris-Euphrates river systems were governed by one authority for centuries —often ancient empires which applied unified management to the river basins. Integrated river planning was carried out as long as the colonial powers were able to control a whole river system, as was the case with British management of the Nile. The 1922 definition of the Palestine-Syria boundary, however, placed the entire Jordan River under Palestinian (British) jurisdiction; it separated the Syrians from the river but left the Banias and Hasbani, two of the Jordan sources, within French Mandatory territory. The Syrian-TransJordan boundary on the Yarmuk was drawn with reference to a railway line and the boundary moved from the thalweg of the river to the well and up the southern shore of the river whenever the railway track crossed the river (Hirsch 1956:218). Since 1967 the Jordan and the Yarmuk Rivers have served as the borders between Israel and Jordan, and this has not assisted in establishing better management of the river. A similar process took place in the Nile basin when political boundaries were imposed on the valley. The colonial powers signed agreements and treaties concerning the division of the waters of the region's international rivers without receiving the consent of the states involved, and these agreements had to be

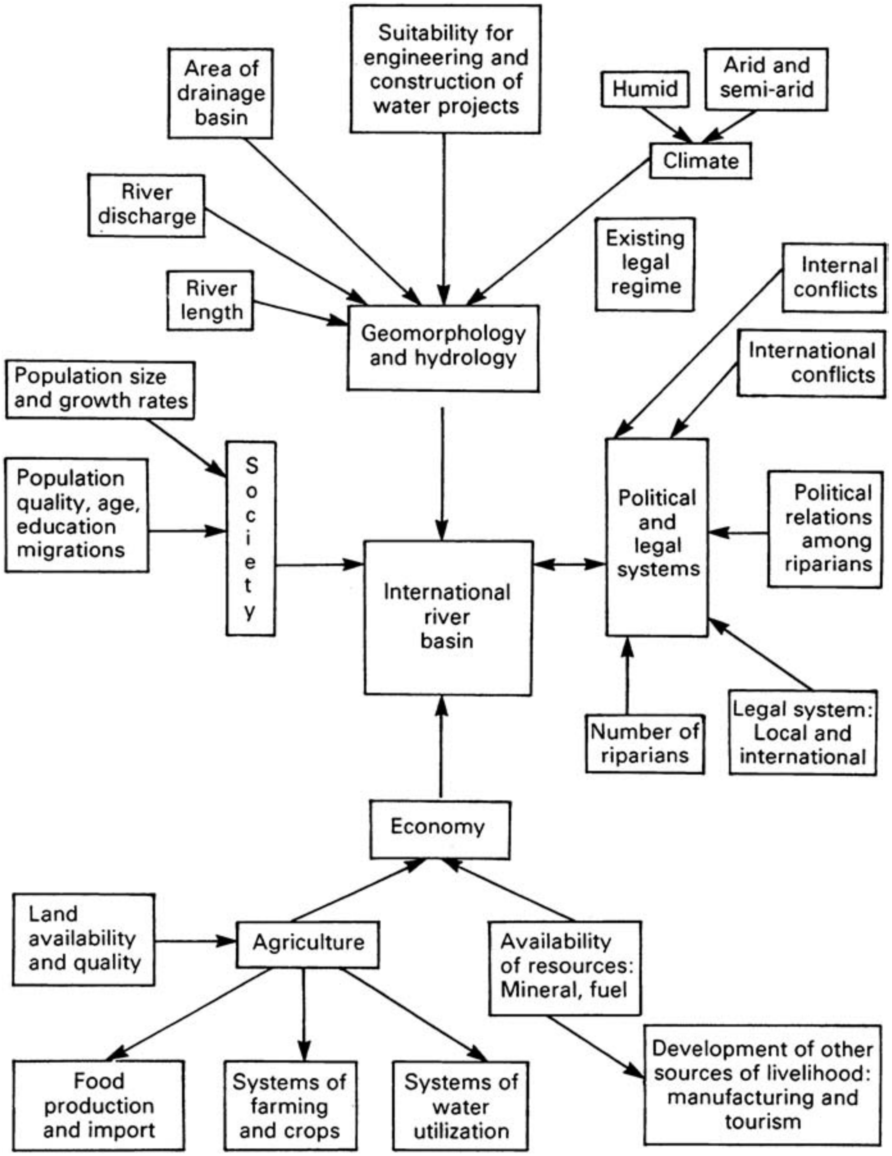


Figure 1.1 A framework for the analysis of international rivers based on the Helsinki Rules

changed when the colonies became independent states. The principles that went into the framing of Middle Eastern water treaties and the patterns of international law and state practice which emerge from them prove that international river law has adjusted itself to the Middle East (Saliba 1968:59).

In most of the river basins of Asia and Africa, fluvial civilizations flourished in antiquity and management of the river basin as one unit developed early (Teclaff 1967:193). In all these states, water, in all its forms, is part of the *public domain* and its utilization and division are often handled by central governments (United

Nations 1972:36–7, 51–6). The patterns which created the existing legal regime of water management evolved over thousands of years of water utilization in an arid environment and are difficult to change.

The international rivers which constitute the subject of this book are not special in any way. The Nile basin has a large drainage basin and nine co-riparians, but the Zaire (Congo) basin is larger and has ten riparians, while the Niger is smaller in area but has eleven co-riparians. The Euphrates and Tigris systems are not the largest rivers in Asia, and they are shared by Iraq, Turkey and Syria (the Euphrates) and by Turkey, Syria, Iraq and Iran respectively. The Jordan River is one of the smaller international basins in the world, yet its scant water supply is very precious for its co-riparians Syria, Jordan, Israel and Lebanon; and it is an additional facet of the Arab-Israeli conflict.

The international river basins in this book are examined within the framework presented in Figure 1.1 which shows international river systems as complex systems influenced by complex legal, political, economic and social processes. While the book will discuss most of the factors which have an impact on the water utilization of the international rivers of the Middle East, it will specifically focus on the Helsinki and ILC Rules and their suitability and applicability to the co-riparian countries in the region. As the principles of the Helsinki and ILC Rules are accepted as an appropriate standard for water sharing, the analysis will focus on the positive applications of these principles as well as the potential for conflict when the principle of equitable allocation is abandoned. Chapter 1 will deal with the Nile basin; Chapter 2 will focus on the Tigris and Euphrates systems, and Chapter 3 will discuss the Jordan River and its tributaries.

1
THE GEOPOLITICS OF THE MONOPOLIZED DIVISION OF THE NILE WATERS

GENERAL—THE INTERNATIONAL CHARACTER OF THE NILE BASIN

The Nile Basin encompasses nine countries (containing 250 million people) in northeast Africa: Ethiopia, Uganda, Tanzania, Kenya, Zaire, the Sudan, Egypt, Rwanda and Burundi (Shahin 1985:15; Hulme 1990: 60). Some scholars also add the Central African Republic as a partner to this great river basin (Jovanovic 1985:82). Studies of the Nile basin made over almost a century have produced differing and even conflicting data about the dimensions of the river and its tributaries, as shown in Table 1.1. The differences probably arise from the difficulty of including secondary and tertiary tributaries in the Equatorial Lakes region within the drainage basin of the Nile.

In this book we have adopted the measurement of the Nile provided by the *Register of International Rivers* in which the catchment area of the Nile is listed as 3,030,700 km^2 and its length as 6,825 km, which probably includes all secondary and tertiary tributaries (United Nations 1978:16; Collins 1990b: 154).

What are the particular geographical and political aspects of the Nile basin which might give rise to conflict over its waters? First, the Nile basin, which covers one-tenth of the African continent and is either the longest or the second longest river in the world, shows the lowest specific discharge (Hulme 1990:60; Okidi 1990:193)[1] of comparable large rivers (Shahin 1985:15). Second, there is a great contrast between the riparian state which contributes almost all the water to the Nile but uses almost none (Ethiopia) and that which contributes nothing to the Nile but uses most of its water (Egypt). Third, sharing the waters of the Nile has become urgent for rapid population growth, and the needs of the farming economies of the riparian states has turned the Nile waters into a greatly demanded but scarce commodity. These issues and the way they are related provide the bulk of the material in this chapter.

Table 1.1 The length and catchment area of the River Nile (various sources)

Source	*Catchment area*	*Length*
Collins (1990b)	3.1 million km^2	6,825 km
Hulme (1990)	4.0 million km^2	6,640 km
Krishna (1988)	3.030 million km^2	5,411 km
Naff and Matson (1984)	2.978 million km^2	6,695 km
Shahin (1985)	2.9 million km^2	6,500 km

1 Specific discharge where is the long-term mean discharge and *A* is the surface area of the river catchment.

Source	*Catchment area*	*Length*
Waterbury (1979)	3.1 million km^2	6,058 km
Gischler (1979)	2.8 million km^2	–

THE CLIMATE, HYDROLOGY AND GEOMORPHOLOGY OF THE NILE BASIN AND THEIR IMPACT ON THE RIVER'S MANAGEMENT

The Nile's hydrological and topographical course

The Nile basin extends from 4°S to 31°N latitude and from about 21°30 E to 40°30 E longitude (Shahin 1985:15). The latitudinal extension over 35° explains why five climatic regions shape the hydrology of the Nile drainage basin.

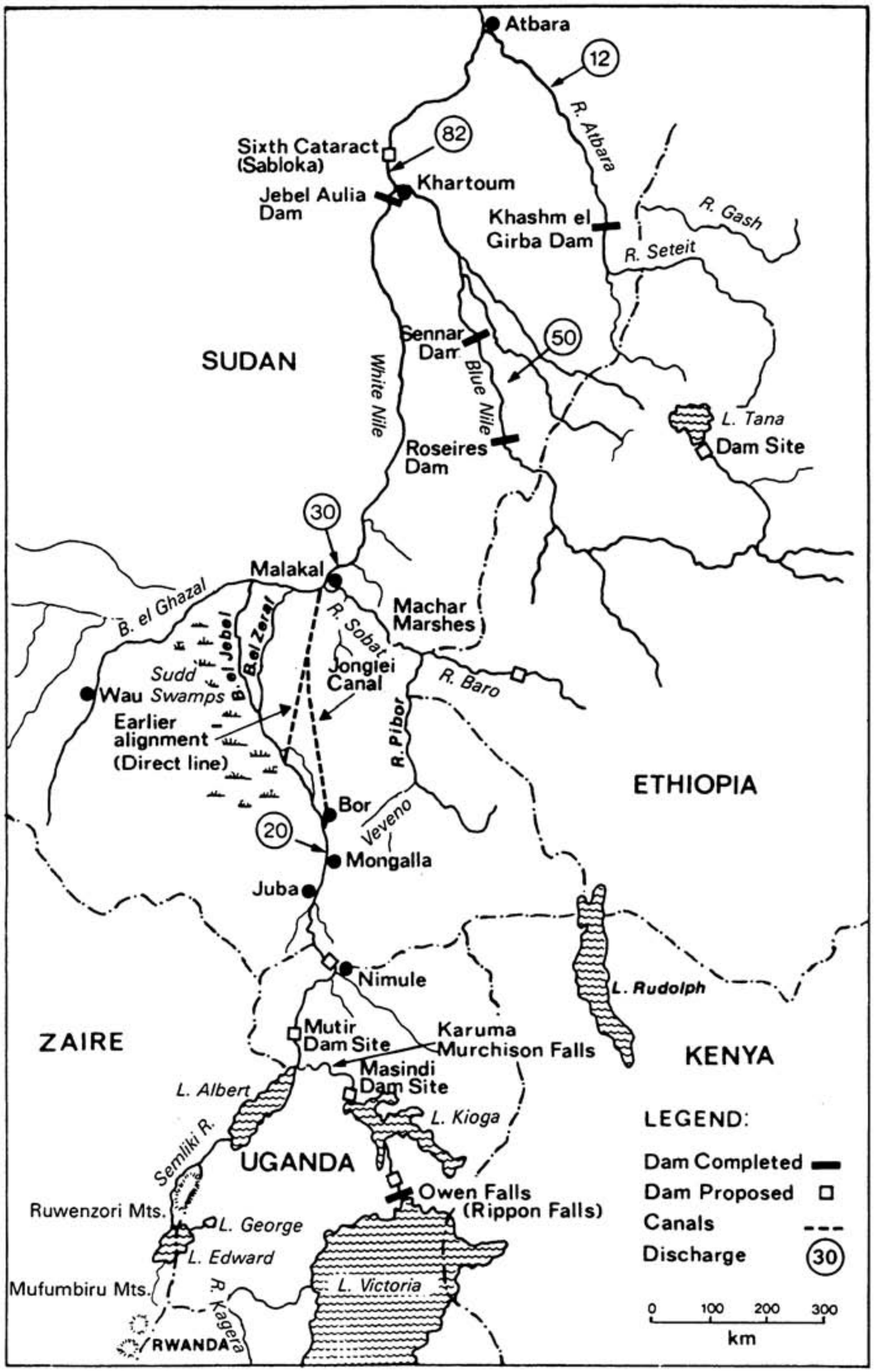
The Nile's most remote source is the upper catchment of the Luvironza River, a tributary of the Kagera River. Burundi and Rwanda are brought into the basin by virtue of the Kagera River which is the most important feeder of Lake Victoria, the source area of the White Nile (Map 1.1 and Table 1.2). The Kagera flows into Lake Victoria, the second largest freshwater lake in the world in terms of surface water (after Lake Superior). The Lakes Plateau, where Lakes Victoria, George, Edward (also called Lake Idi Amin) and Albert (also called Mobutu Sesse Seko) are situated, is located between two branches of the Great Rift Valley which runs from Zimbabwe to the Jordan Valley (Shahin 1985:19).

Three sources contribute the net supply of water to Lake Victoria: the Kagera (one-third of Lake Victoria's entire inflow), direct precipitation over the lake itself and the runoff from the land portion of the catchment area.

The only outlet of Lake Victoria, the Upper Victoria Nile, is at the Rippon Falls or, since 1952, at the Owen Falls Dam. The Victoria Nile descends in a series of rapids through quiet navigable reaches into Lake Kioga, a shallow, swampy body of water (Map 1.1 and Table 1.2). The high evapotranspiration from the lake and the nearby swamps make Lake Kioga a site of water loss. The lower Victoria Nile (the Kioga Nile) leaves Kioga at Masindi Port. After Masindi Port the river descends steeply over a series of spectacular falls (the Karuma and Murchison Falls) to discharge itself into Lake Albert. As is the case with Lake Kioga, the runoff from the drainage basin of Lake Albert and the direct precipitation over it are all lost through evaporation (Shahin 1985). At its southern end it also receives the flow of the Semliki which carries the runoff from the

Table 1.2 Geographical, hydrological and topographical features of the Nile

The Nile's sources	*Climate and precipitation*	*Topography*	*Size (length of rivers, drainage basin areas)*	*Riparian countries*
White Nile				
Kagera	Tropical savannah climate (1,800 mm mean rainfall)	Mountainous area 600–1,200 m	Length 500 km; drainage basin 60,000 km^2	Burundi (50%) Rwanda (50%)
Lake Victoria	Tropical savannah climate (1,810 mm)	1,134 m	Lake Victoria 68,900 km^2	Kenya (5–10%) Uganda (40–44%) Tanzania (50%)



Map 1.1 Southern Nile basin: physical features

The Nile's sources	*Climate and precipitation*	*Topography*	*Size (length of rivers, drainage basin areas)*	*Riparian countries*
Victoria Nile	Tropical savannah climate (1,400 mm)	600–1,500 m	130 km long	Uganda (100%)
Lake Kioga	Tropical savannah climate 1,300– 1,400 mm)	600–1,500 m	Area 7,500 km^2	Uganda (100%)
Lower Victoria Nile (Kioga Nile)	Tropical savannah climate(1,300– 1,400 mm)	600–1,500 m	Length 75 km	Uganda (100%)
Lake Albert (Mobutu Sesse Seko)	Tropical savannah climate (1,400 mm)	1,500–2,000 m	Area 5,300 km^2	Zaire (50%) and Uganda (50%)
Lake George	Tropical savannah climate (1,400 mm)	1,500–2,500 m	Area 300 km^2	Uganda (100%)
Lake Edward	Tropical savannah climate (1,400 mm)	1,500–2,500 m	Area 2,200 km^2	Zaire (100%)
Semliki River	Tropical savannah climate (1,400 mm)	1,500–2,500 m	Catchment area 8,000 km^2	Zaire (100%)
Bahr-el Jebel	Steppe (800–900 mm)	500–1,000 m	Length 440 km; catchment area 79, 000 km^2	Sudan (95%)

The Nile's sources	*Climate and precipitation*	*Topography*	*Size (length of rivers, drainage basin areas)*	*Riparian countries*
Sobat	Tropical savannah climate (600–700 mm)	500 m	Length 350 km; catchment area 225,000 km^2	Ethiopia (50%) Sudan (50%)
Blue Nile				
Lake Tana	Highland (1,400– 1,600 mm)	2,000 m	Catchment area 17,500 km^2	Ethiopia
Blue Nile	Highland (600–1,400 mm)	2,000–3,000 m	Length 1,300 km; catchment area 324,530 km^2	Ethiopia (50%) Sudan (50%)
Main Nile	Desert (0–25 mm)	300–500 m	Length 2,853 km	Sudan (35%) Egypt (65%)
Atbara	Steppe (400–500 mm)	300–500 m	Length 880 km; catchment area 112,400 km^2	Ethiopia (20%) Sudan (80%)

Sources: Shahin 1985; Naff and Matson 1984; Waterbury 1979; Gischler 1979; Collins 1990a, b; Sutcliffe and Lazenby 1990

Mufumbiro and Ruwenzory Mountains. The Semliki River supplies Lake Albert with the runoff from a total catchment area of about 30,500 km^2. It is at Lake Albert that Zaire, as a basin state of the Nile, makes its contact through the Semliki River catchment area. The Albert Nile leaves the lake at the northern end and from this point to Malakal in the Sudan it is known as Bahr-el-Jebel, part of the White Nile. From Lake Albert to Nimule (on the Uganda-Sudan border) the river flows quietly through its flood plain and then descends steeply through the rapids of Fola and Bedden to Juba. Between Nimule and Mongalla the Bahr-el-Jebel receives a number of torrents, notably the Aswa, Kaia and Kit which add 4 billion m^3 per year to the Nile. The swamps and seasonal grasslands of the Bahrel-Jebel flood plain between Mongalla and Malakal is known as the Sudd and covers an area ranging between 16,931 km^2 and 30,600 km^2 (Sutcliffe and Parks 1987:143–59; Sutcliffe and Lazenby 1990:117–19). Between 22 per cent and up to 61.2 per cent of the discharge into the Sudd is lost through evaporation (Collins 1990b: 156).

At Lake No, the Bahr-el-Jebel is joined from the west by the Bahr-el-Ghazal which receives its water from Zaire and the Central African Republic and by the Bahr-el-Arab and Lol Rivers of Western Sudan (Waterbury 1979:16; Naff and Matson 1984).

From the east, the Bahr-el-Jebel is joined by the Bahr-el-Zeraf which originates in the swamps east of the mouth of the Awai River. The Bahr-el-Jebel is also joined from the east by the Sobat River, which has two major tributaries, the Baro and Pibor (Maps 1.1, 1.2). The large Machar Swamp is a site of water loss from the Baro (Sutcliffe and Lazenby 1990:119). The final stretch of the River Bahr-el-Abiad from Lake No to its junction with the Blue Nile is the White Nile which runs down a very shallow slope from Malakal to Khartoum.

The Blue Nile

The Blue Nile basin, including Lake Tana, has an area of 324,530 km^2 and covers half of Ethiopia. The Blue Nile drains the Ethiopian plateau which lies at an average elevation of 2,000–3,000 m and which has a summer rainfall of 1,400–1,600 mm.

The source of the Blue Nile (the Abbai in Ethiopia) is a small spring appearing at a height of 2,900 m about 100 km south of Lake Tana (Hurst, Black and Simaika 1950). From this spring, the Abbai flows down to Lake Tana which is 1,829 m above sea level (Shahin 1985:42). From Lake Tana the river flows for 35 km before it drops 50 m over the Tissisat Falls and continues 50 km further downstream where the river cuts a deep canyon through the highland. The Blue Nile emerges from the plateau near the western border of Ethiopia where it enters the Sudan at an altitude of 490 m. The important tributaries of the Blue Nile, the Dinder and Rahad, join the Blue Nile in the reach between Sennar and Wad-Medani. These two rivers are virtually dry most of the year and have a high discharge only in the summer (Shahin 1985:45). In the Sudan the Blue Nile flows through a clay plain up to Khartoum where it joins the White Nile to form the Main Nile River. The Main Nile is joined by the last tributary of the Nile, the Atbara, about 320 km downstream from Khartoum, which drains a mountainous area in northern Ethiopia.

The Main Nile flows for 1,885 km from Khartoum to Aswan. In its flow the river crosses crystalline rocks and six rocky rapids or cataracts are created. From Aswan to the Mediterranean the Main Nile is almost fully regulated by both the old and new Aswan dams. In its natural condition the length of the river from Aswan to the Delta Barrages is 968 km in the low-flow season and 923 km in the flood season. The Nile north of Cairo bifurcates into the Rosetta and Damietta branches. The Edfina Barrage on the Rosetta branch prevents salt water from penetrating inland. The mean width of the Rosetta is 500 m and that of the Damietta branch is 270 m (Shahin 1985:54). The gradient of the river is highly variable in the Equatorial Lakes district—averaging 1:216; its gradient is reduced to 1:13,900 as it flows across the alluvial plain above the Sudd. Especially steep courses are found in the Blue Nile, Atbara, the Upper Sobat and the White

Nile in the Equatorial Lakes district. Below Aswan the Nile again flows on alluvium and the gradient is 1: 13,200.

The significance of the hydrological and topographical course of the Nile is twofold: first, it cuts through the nine riparian political units which share the river and, second, it shows a complex and varied physiography which makes the process of harnessing the river for human needs especially difficult.

Climate and discharge of the sources of the Nile

These are five climatic regions in the Nile basin. Egypt and parts of the Sudan have a dry climate of the desert type (BW) with precipitation of less than 200 mm a year. The Sudan and small parts of Ethiopia have another type of dry climate— a steppe type (BS) with rainfall ranging between 200 and 400 mm a year. The areas in these two climatic regions do not contribute any water to the Nile. More important to the water balance of the Nile are the tropical rainy climates—the tropical rainforest climate (Af), the tropical savannah climate (AW) and the highland (tropical) climate (H) cover large parts of Ethiopia and the Equatorial states which serve as the source region of the Nile. These areas annually receive a quantity of rainfall ranging between 1,400 and 1,800 mm (Gischler 1979; Waterbury 1979; Shahin 1985). The precipitation is greatly influenced by the Ethiopian Highlands.

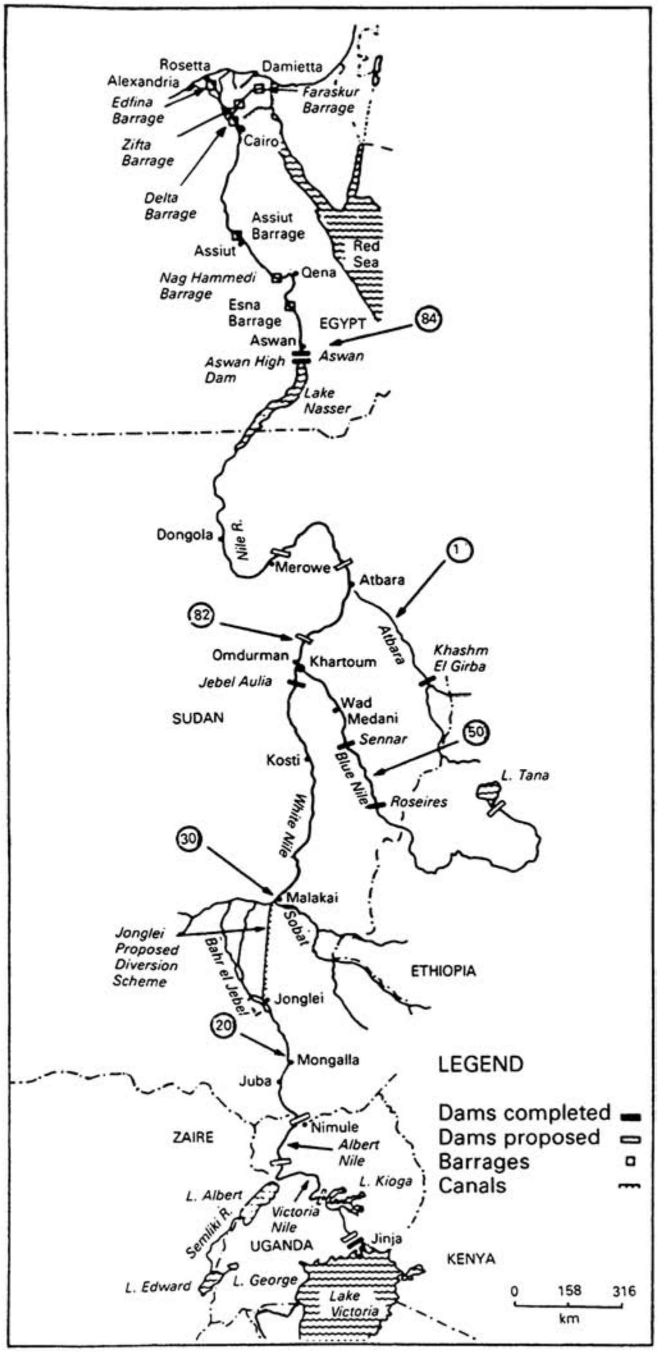
Figure 1.1 which is based on the measurement of monthly fluctuations from 1912 to 1973 demonstrates stability in the month-to-month flow of the White Nile. The White Nile discharge varies between 1,650 billion m^3 for the lowest month to 3,402 billion m^3 for the highest month. This regime contrasts with the Blue Nile discharge pattern which shows a very large variation between the lowest month (0.369 billion m^3) and the highest month (15,499 billion m^3). This variation in discharge which is influenced by the monsoon rains is also revealed in the discharge regime of the Atbara. The Main Nile discharge, as measured at both Dongola and Aswan, reflects the impact of the Blue Nile high summer flows in the summer months of August to October. Since the fluctuations in the Nile's tributaries are great, Figure 1.1 by no means reflects an average discharge. Figure 1.2, on the other hand, more clearly shows the mean flows of the Nile and its tributaries.

Figure 1.2 compares the discharges for the years 1912–89 with three mean values:

(a) 1870–1959 mean discharge flow, 102 billion m^3
(b) 1899–1971 Mean discharge flow, 88 billion m^3
(c) 1972–86 mean discharge flow, 77 billion m^3

Figure 1.2 points to a constant reduction in the mean discharge of the Nile during the three periods. There is an even more dramatic fall in the mean for the years between 1984 and 1987 when it drops to less than 52 billion m^3 (Evans 1990:20; Howell and Allan 1990: Foreword).

Science, especially climatology, cannot yet offer a clear explanation for the current climatic changes within the Nile basin. One group of scientists considers the data collected so far on climate changes as insufficient to support theories suggesting that the global warming of the atmosphere has an impact on rainfall. Another group of scientists suggests that the greenhouse effect has actually had an impact on the reduced Blue Nile flows and on the constant slight increase in White Nile flows (Evans 1990:21; Hulme 1990:72). According to this theory, the overall global atmospheric changes which are tied to decreased rainfalls are called the El-Niño years. El Niño is the Southern Oscillation influence on the Tropical Easterly jet stream which affects the extent and vigour of monsoon circulation. The Blue Nile catchment, being under a monsoonal regime, has been more sensitive to these global shifts. El Niño years produce mean



Map 1.2 The Nile sources and tributaries: control and discharge

precipitation deficits of between 5 and 15 per cent over the Nile basin (Hulme 1990:63–7). Hulme suggests that between 10 and 40 per cent of interannual precipitation variability may be accounted for by the El Niño

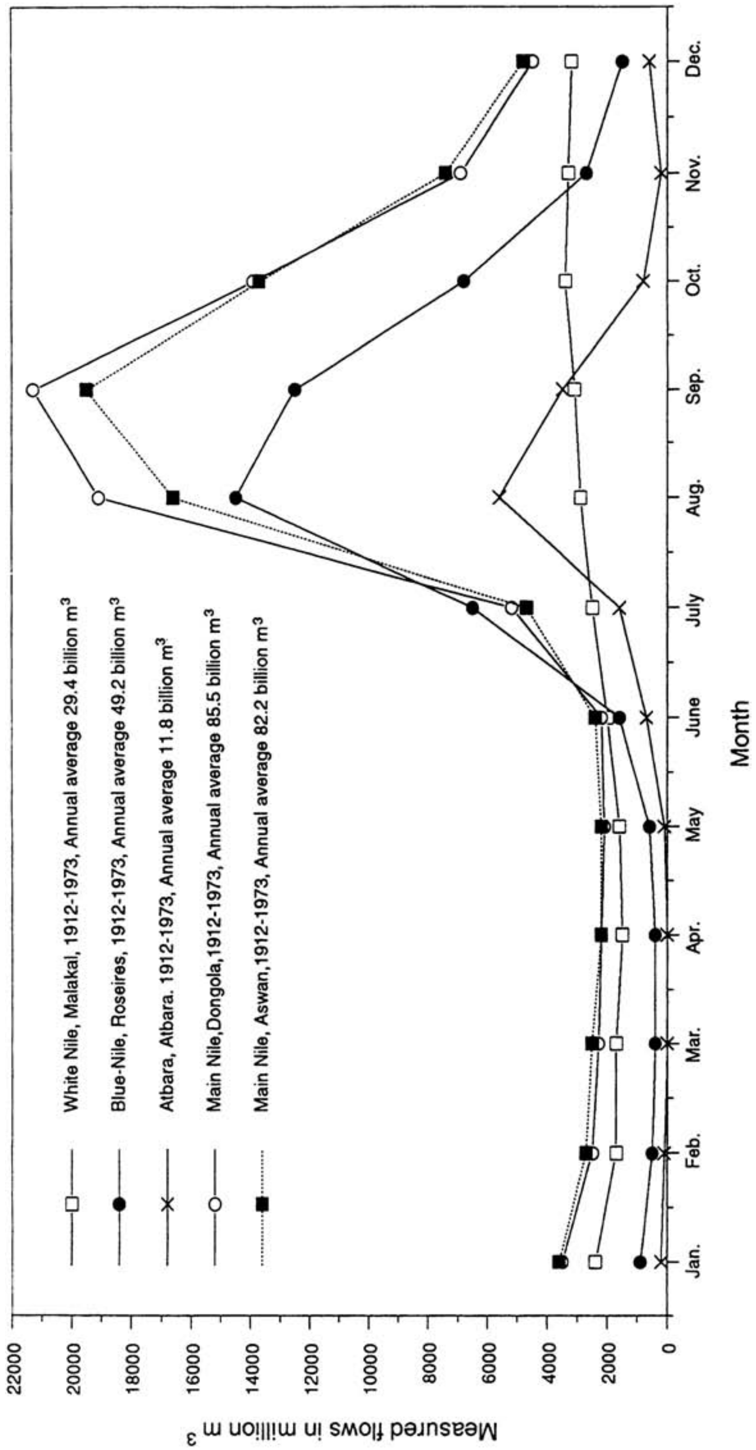


Figure 1.1 Monthly and annual discharges of the Nile's sources, 1912–73 (in million m^3)

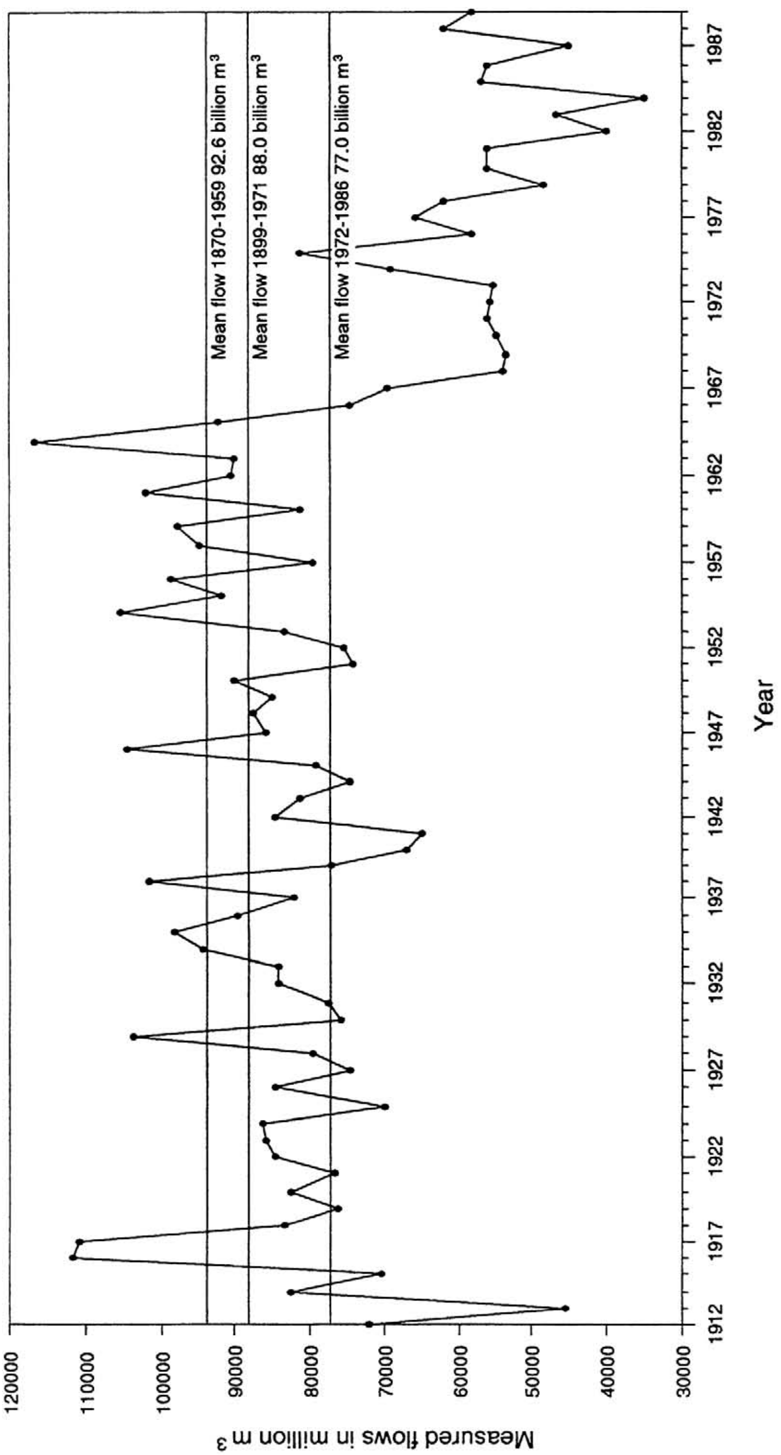


Figure 1.2 The Nile mean average flows, 1912–87 (in million m^3)

Southern Oscillation events. There is a growing consensus among leading climatologists that the drought is likely to continue albeit with fluctuations (Evans 1992).

The above climatic events create changes in precipitation. There was a decline in precipitation in the Sudan by about 100 mm (or 9 per cent) between 1950–67 and 1968–88 (Sutcliffe and Lazenby 1990:113). The White and Blue Nile catchments have witnessed different trends in annual precipitation yields. The White Nile has experienced little long-term increase in annual yield whereas the Blue Nile catchment has experience an overall decline of 5 per cent in seasonal summer precipitation. These changes are reflected in the relative contribution of the Ethiopian and Equatorial catchments as presented in Table 1.3. The contribution of the Equatorial catchment has increased from 14 to 20–30 per cent whereas the contribution of the Ethiopian catchment has decreased from 86 per cent to 70–80 per cent (Hulme 1990; Tvedt 1992:82).

Evans (1990:19–21) gives the Equatorial catchment contributions as higher than this, estimating 40 per cent as the Equatorial catchment share to the combined flow of the Nile in recent years. The great fluctuations in the mean flow of the Nile's tributaries certainly make the accuracy of the data presented in Table 1.3 suspect.

It seems that the earlier figures which suggest that the Ethiopian catchment contributes 86 per cent of the Nile's flow whereas the Equatorial catchment contributes only 14 per cent do not reflect the current discharge.

If changes in the relative contribution of the Ethiopian and Equatorial catchment areas do in fact take place, then we can also anticipate changes in the 'water year' of the Nile. Generally, the water year begins in July and during the four months between July and October the Blue Nile contributes 50 billion m^3 of water, and about 20 billion m^3 more is contributed by the Sobat and Atbara (Table 1.3 and Figure 1.1). More than 80 per cent of the Nile's total discharge occurs from August to October while nearly 20 per cent (mostly contributed by the White Nile) is spread over the remaining eight months.

The recent changes in the Nile flow rate make the presentation of accepted mean flows for the Nile and its tributaries more difficult as these means are obviously changing. In this book the following mean discharges are seen as a reasonable basis for discussion (Sutcliffe and Lazenby 1990).

Table 1.3 The contribution of the main Nile sources (measured at Aswan for the years 1910–85)

Catchment	*Discharge of tributaries for 12-month water year (1910–70)*		*Percentage for 1910–70*	*Percentage for 1965–85*	*Flood period (5 months), July-November (1910–70)*	*Percentage*
Ethiopian catchment	Blue Nile	53.5 billion m^3	59	70–80	50 billion m^3	59.5
	Sobat	12.4 billion m^3	14		8–10 billion m^3	9.3–11.5
	Atbara	11.8 billion m^3	13		10 billion m^3	11.5
Equatorial catchment	White (Mongalla Bahr-el-Jebel)	31.3 billion m^3	14	20–30	15.0 billion m^3	17.5

Sources: Shahin 1985; Waterbury 1979:23; Evans 1990:26; Okidi 1990:195; Hulme 1990:67–80

White Nile (Malakal)	29.6 billion m^3
Blue Nile (Khartoum)	49.7 billion m^3

Atbara (Atbara)	11.7 billion m^3
Main Nile (Aswan)	84.0 billion m^3

The data for Aswan represent the average discharge after evaporation and seepage water losses have been calculated. Without these water losses the discharge at Aswan is 90.0 billion m^3 (Evans 1990:36; Sutcliffe and Lazenby 1990:112).

Finally, the issue of water loss due to evapotranspiration is of extreme importance for the water balance of the Nile. According to some calculations, Lake Victoria loses some 3.5 billion m^3 a year to evaporation and both Lake Kioga and Albert are sites of water loss. The latter is losing 2.5 billion m^3 per year (Shahin 1985; Sutcliffe and Lazenby 1990:116). The greatest source for water loss, however, is the Sudd where between 12.0 to 30.0 billion m^3 of water are lost annually (Shahin 1985; Collins 1990b: 157; Sutcliffe and Lazenby 1990: 117). One should add some 10 billion m^3 of water loss in the Machar swamps in the Sobat area to this loss (Shahin 1985). As can be seen enormous water loss takes place in the Nile's riparian countries which are also susceptible to drought (in the Sudan and Ethiopia) and to major changes in their precipitation patterns. Projects to reduce this water loss are discussed on pages 32–51.

The meeting point between hydrology and politics

The Helsinki Rules for the use of international river waters delineate several relevant factors for a reasonable and equitable share of waters. The relevant factors examined in this section are the geography of the basin (including the extent of the drainage area in the territory of each basin state) and the hydrology of the basin (including the contribution of water by each basin state). Other relevant Helsinki Rules will be examined in the following sections of this chapter (Appendix A).

The first criterion for the allocation of water resources to a riparian country is its share in the river basin area. Table 1.4 shows the status of the Sudan as the country with control of the largest area of the Nile basin and a large portion of the river itself: 1,500 km in the Main Nile, 800 km in the White Nile, and 780 km in the Blue Nile. Ethiopia's share of the Nile basin places it second since it possesses more than 700 km of the Blue Nile's channel and its tributaries. Ethiopia also has 400 km in the Atbara River which contributes waters to the Main Nile. Egypt has 10 per cent of the Nile basin area and some 1,300 km of the Main Nile channel. Uganda controls 7.7 per cent of the area of the drainage basin of the Nile, but it also has 40 per cent of the area of Lake Victoria and is sovereign over some 600 km of the channel of the Upper White Nile. From the

Table 1.4 The riparian states of the Nile basin

Area of Nile (km^2)	*Constituent countries*	*Share per country, area km^2*	*per cent*	*Share per country, length of river*	
3,030,700	Sudan	1,900,000	62.7	White Nile	800 km
Blue Nile	780 km				
Main Nile	1,500 km				
Ethiopia	368,000	12.1	Blue Nile	700 km	
		Atbara	400 km		
Egypt	300,000	9.9	Main Nile	1,300 km	
Uganda	232,000	7.7	Lake Victoria	40%	
		Upper White Nile	600 km		

Area of Nile (km²)	*Constituent countries*	*Share per country, area km²*	*per cent*	*Share per country, length of river*
Tanzania	116,000	3.8	Lake Victoria	50%
		Kagera	200 km	
Kenya	55,000	1.8	Lake Victoria	10%
Zaire	23,000	0.8	Lake Edward, Lake	Albert
Semliki River	250 km			
Rwanda	21,500	0.7	Kagera basin	200 km
Burundi	14,500	0.5	Kagera basin	200 km

Sources: United Nations 1978; Jovanovic 1985; author's survey 1990

perspective of their share in the area of the basin and their ownership of the river itself or the Equatorial Lakes, all other riparian states are minor partners. More significant from the perspective of international law and the Helsinki Rules is the amount of water which each riparian state contributes to the Nile. Table 1.5 presents these data.

Tables 1.4 and 1.5 highlight the relative importance of the Ethiopian catchment of the Nile including the Blue Nile, Sobat and Atbara which provide some 86 per cent of the Nile's water, as measured at Aswan (Howell, Lock and Cobb 1988:29). Moreover, Table 1.5 points to the position of Ethiopia as the most important contributor to the Nile, contributing at least 72 billion m^3 on average via the Blue Nile, Atbara and Sobat (Abate 1990:144). On the basis of its share of the area of the Nile's drainage basin and its huge water contribution to it alone, Ethiopia should be entitled to a large portion of the Nile's waters but in reality it uses less than 1.0 billion m^3 (Tvedt 1992:79). Even at present, with the highland tropical monsoon climate of Ethiopia failing to produce sufficient precipitation, with drought prevailing in Ethiopia, Sudan and the Horn of Africa since 1978, Ethiopia is still the most important contributor of water to the Nile, providing 56 per cent of its water, as measured at Khartoum (Evans 1990:21; Sutcliffe and Lazenby 1990:113). There is no doubt that, according to Articles V(a) and V(b) of the Helsinki Rules which emphasize the importance of the

Table 1.5 Riparian share in the Nile's drainage basin

River	*Area of drainage basin (km²)*	*Share per country in drainage basin (%)*		*Mean discharge (billion m³)*	*Mean discharge (%)*
Blue Nile	324,530	Ethiopia	92	49.7	55.5
(Khartoum)		Sudan	8		
Atbara	100,400	Ethiopia	45	11.7	13.5
(mouth)		Sudan	55		
Sobat	225,000	Ethiopia	40	13.7	15.5
(mouth)		Sudan	60		
White Nile	1,332,070	Sudan	64	29.6	33.5
(Malakal)	Zaire	2.5			
Kenya	4				
Rwanda	3.5				
Uganda	13				

River	*Area of drainage basin (km^2)*	*Share per country in drainage basin (%)*		*Mean discharge (billion m^3)*	*Mean discharge (%)*
Burundi	3.5				
Tanzania	9.5				
Main Nile	3,030,700	Sudan	62.7	84–88	100
(Aswan)	Ethiopia	12.1			
(1899–1971)	Egypt	9.9			
Uganda	7.7				
Tanzania	3.8				
Kenya	1.8				
Zaire	0.8				
Rwanda	0.7				
Burundi	0.5				

Sources: Shahin 1985; Evans 1990; Sutcliffe and Lazenby 1990; author's survey
Notes: Percentages do not sum to 100 per cent because the points of measurement of the proportional discharges are not the same. Evaporation is not included.

geography of the basin including the extent of the drainage area and the water contribution of the state, Ethiopia is entitled to a more equitable allocation of the Nile's water. However, the Helsinki Rules do not grant primacy to the geography and hydrology of the drainage basin over any of the other rules such as those which emphasize the economic and social needs of a state.

The Sudan

Tables 1.4 and 1.5 also point to the very peculiar position of the Sudan in the Nile basin. The Sudan has the largest share of the drainage area of the Nile and its share in the basins of the White Nile, Atbara and Sobat make it a significant partner in the utilization of the Nile's waters. The Sudan's particular contribution to the water balance of the Nile, however, is either nil (Okidi 1990:195) or even negative. The Sudan's share in the Blue Nile basin places sections of the drainage basins of water-contributing tributaries such as the Dinder and the Rahad within its territory together with some minor tributaries. While its territory within the Sobat is large, only a few water-contributing tributaries such as the Pibor (most of its basin) and the Ful Lus are located in its territory and its role in the Atbara basin is even less important. The negative role which the Sudan plays in the Nile basin water balance is related to the huge water loss in the Sudd. It is important to note, however, that neither the Helsinki Rules nor the ILC rules refer to water losses as a factor which should be considered in the process of equitable water allocation. Perhaps this factor should be considered when the geography and hydrology of certain drainage basins is weighed. The fact that the Sudan is plagued by drought, famine and civil war, all of which prevent the reclamation of some of the Sudd's lost waters, is also meaningful. The Sudan no doubt holds the key to any successful endeavour to save scarce waters from the Sudd in order to increase the flow of Nile water into Egypt.

Egypt

Egypt contains 9.9 per cent of the Nile's drainage basin and, although it contributes no water to the river, it uses most of its waters: some 55 billion m^3 per year. Egypt has used the Nile since time immemorial and is entitled to the Nile's water because of this ancient right, its arid climate and its overall dependence on Nile waters. This right should be weighed against the growing need for Nile water by the other riparian states, and it seems reasonable to assume that Egypt might have to renegotiate its Nile water use with the other riparians.

The Equatorial countries

All the Equatorial states which share the sources of the White Nile are countries with a relative surplus of water—except, perhaps, for Kenya. They enjoy high precipitation—an outcome of their tropical Equatorial climate—and the Equatorial lakes and rivers provide enough water for both agriculture and hydroelectricity. The key role of the Equatorial catchment which, in the past, contributed on average 14 per cent of the Nile's waters (Howell, Lock and Cobb 1988:29) is in its crucial position as an area responsible both for contributing water to the White Nile and for losing large quantities of water due to evaporation in the Equatorial Lakes. The most important source of the White Nile is Lake Victoria and the Kagera River. The Kagera basin, which contributes 7.9 billion m^3 out of the inflow of 18.3 billion m^3 to Lake Victoria, is divided almost equally between Rwanda and Burundi. Kenya contributes approximately 30 per cent of the water to Lake Victoria, followed by Tanzania (18 per cent), Uganda (12 per cent) and Rwanda and Burundi (43 per cent) (Shahin 1985). Zaire is a partner to the Nile basin by virtue of its water contribution in the Semliki (4.69 billion m^3) and its territorial share in Lake Albert and Lake Edward. It should be noted that Uganda owns either all or a large portion of the Equatorial Lakes (the whole of Lakes Kioga and George, parts of Lakes Edward and Albert, and 44 per cent of Lake Victoria are within Ugandan territory). As a result it is crucial to any plan which aims to reclaim more White Nile waters for other co-riparians and for Uganda whose semi-arid areas in the north could also benefit from irrigation. Kenya has 5 per cent of the water surface but 25 per cent of the catchment area of Lake Victoria. According to Shahin, its part in this catchment makes it an important contributor to the White Nile (Shahin 1985:318, Table 8.1). Tanzania has 51 per cent of the water surface of Lake Victoria and also 44 per cent of the land portion of the Lake Victoria catchment—hence its important role in contributing waters to the White Nile. This detailed account is vital to understanding the future role of the Equatorial riparians in any conservation plan for the White Nile. Between 1962 and 1985 the White Nile increased its flow on average by 16 per cent or 8 billion m^3 and contributed to some 44 per cent of the Main Nile water in Khartoum (Collins 1990b). This suggests that the Equatorial riparian states are increasing their relative strategic importance in any water conservation project that might take place in the Equatorial region. On the basis of their share and contribution to the White Nile, the six Equatorial states are entitled to more than the 0.5 billion m^3 of Nile waters which they use at present. However, the great contribution of the Equatorial states is offset by significant water losses to which the Helsinki Rules and ILC Rules, in their present form, do not relate.

In this section, the Helsinki Rules which relate to the geography, climate and hydrology of the Nile's basin have been applied to the nine riparian states in order to suggest that a more equitable water allocation might be in order. Some difficulties have emerged from this application. First, as there is no preferential precedence to any of the rules, it is difficult to evaluate how equity and justice can best be served. For example, a 'just' water allocation for Ethiopia would be founded on its large territory within the basin, its large water contribution and its enormous economic needs. A 'just' water allocation for Egypt would be based on its ancient rights, its total dependence on the Nile and its enormous needs. The hydrology and geography factors of the Helsinki Rules in this case would be given less weight.

A second difficulty in the application of the Helsinki Rules is the meagre and often contradictory data, for example the hydrological data, which make judgement of 'equitable allocation' almost impossible. In the Nile basin the recent climatic changes have been creating difficulties of this kind.

A third difficulty is connected with water losses or the negative contribution of a basin state to the water balance of its basin as the case of the Sudan clearly shows. This matter calls for the attention of the jurists and specialists in international law when they prepare the final draft of the law. Application of the relevant ILC Rules to the Nile results in similar difficulties.

It is most important to remember that the Helsinki Rules applied in this section take into consideration only the *water of the Nile*. Other sources of surface water and underground water sources are not accounted for. These water sources and past and present patterns of utilization are discussed in the next section.

PATTERNS OF UTILIZATION OF THE NILE WATERS

Nile utilization until 1920

The control of the Nile in ancient Egypt began in about 3400 BC with Menes, who united Upper and Lower Egypt and reclaimed the river's left bank through the construction of canals and dykes. To prevent disastrous floods, a channel was cut from the main stream to the deep natural Fayum Depression which was converted into a cultivated area containing a small lake to receive the excess waters (Wilcocks 1908:62). The control of the Nile was multipurpose and it was used for both irrigation and flood control as well as for navigation. The extent of Egyptian suzerainty bears a significant relationship to the use of the river as an artery of communication. The natural barriers to movement—the six great cataracts—signified the limits of Egyptian suzerainty and the sources of the river remained unknown (Tecliff 1967:30).

Water utilization in modern times began in 1834 when Mohammed Ali attempted to expand the area utilized for summer crops by creating a system of canals in the delta. In 1834 Ali tried to regulate the river by constructing a barrage across the Nile on its bifurcation at the head of the delta. The barrage was intended to raise the level of water, but it was not until 1861 when British engineers completed the construction that the Delta Barrage functioned properly (Mountjoy and Embleton 1966:287). Several barrages were constructed across the main Damietta and Rosetta branches to maintain the low winter levels.

The process of seasonal water retention and the extension of summer cultivation accelerated after the British occupation of Egypt and culminated in the construction of the first Aswan Dam in 1902. The height of the dam was raised twice, in 1912 and 1934, until its storage capacity grew from 1 billion m^3 to 5.7–6 million m^3 (Waterbury 1979:34; Howell, Lock and Cobb 1988:33; Chesworth 1990:47) New barrages were built at Assiut (1902), Zifta (1903), Esna (1909), Nag Hammadi (1909) and Edfina (1950) (Table 1.6). (See Map 1.3.)

All the barrages served Egypt which, until the middle of the nineteenth century, used basin irrigation for its farming, leading to extreme population dependence on the natural hydrological regime. The first Delta Barrage not only enabled the extension of the irrigable area, but also provided irrigation water for perennial use. These Delta Barrages were built during the period of the charismatic leader, Mohammed Ali, but the British occupation of Egypt in 1882 was also very influential in this since they showed great interest in the flow of the Nile and considered Egypt to be a Middle Eastern 'Jewel in the Crown'. 'It is no

Table 1.6 Barrages on the Nile 1902–50

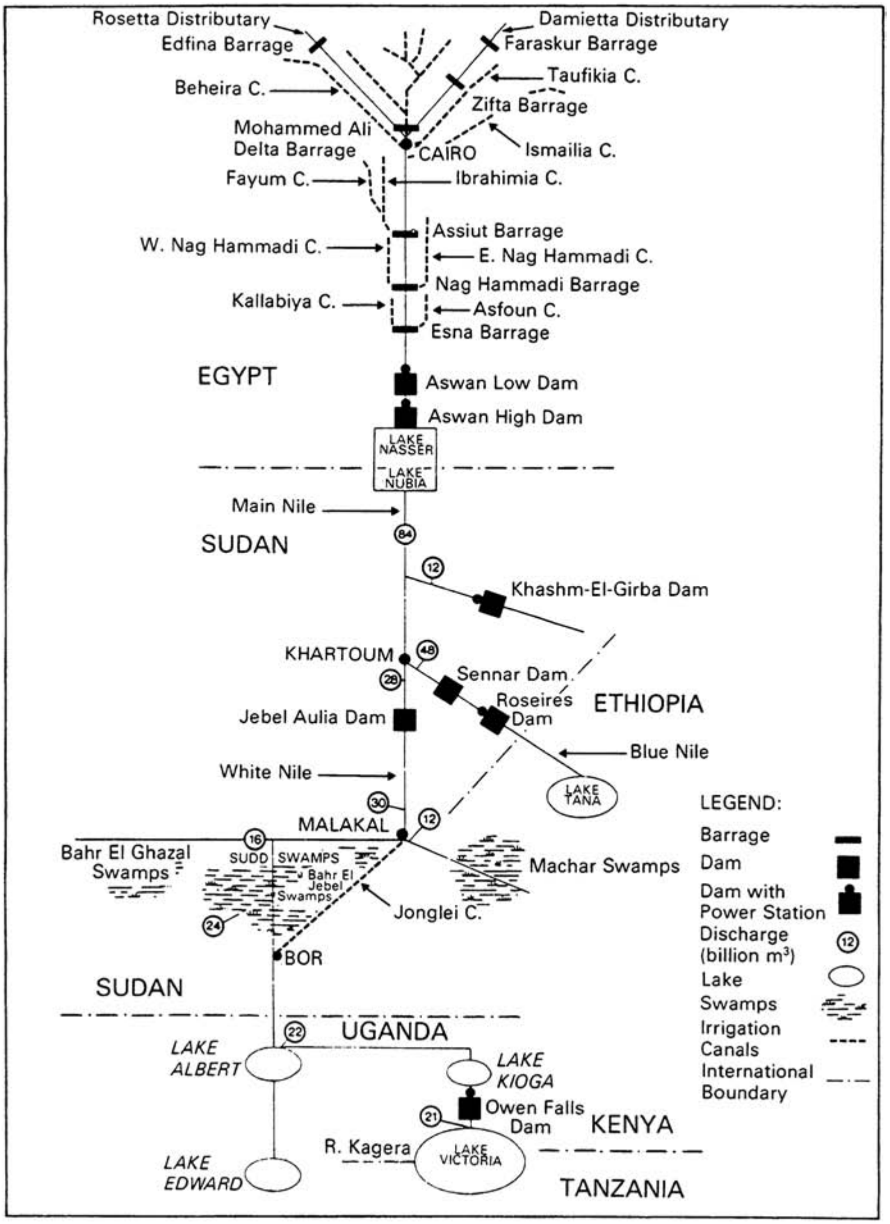
Name	*Type*	*Year completed or heightened*	*River or tributary*	*Functions*
Edfina, Faraskur and Rosetta Sudd	Bank barrage	1948–50	Delta -Damietta (Egypt)	Protection against the intrusion of sea
Zifta	Barrage	1902, 1953	Delta -Damietta (Egypt)	Raising water to 3.80 m and diversion of water for perennial irrigation
Muhammed Ali Delta Barrages	Barrages	1861,1890, 1939	Damietta and Rosetta (Egypt)	Raising water for irrigation to 3.5 m; control of sea water penetration
Assiut	Barrage	1902, 1933, 1938	Main Nile (Egypt)	Raising water to 3.5 m for summer irrigation; associated with perennial irrigation; remodelled in 1938; water transfers to Fayum
Nag Hammadi	Barrage	1909, 1930	Main Nile (Egypt)	Raising water to 4.65 m for irrigation
Esna	Barrage	1909	Main Nile (Egypt)	Raising water to 2.5 m for irrigation

Sources: Adopted from Waterbury 1979; Haynes and Whittington 1981; Gischler 1979; Shahin 1985; Howell, Lock and Cobb 1988:33; Chesworth 1990:49

longer possible to think of our occupation of Egypt as merely a stepping-stone on the road to India' (Peel 1904:134). This quotation accurately reflects the attitudes of the British administration and its interest in growing cotton. Two factors led to the development of a whole network of dams in Egypt and the Sudan and very ambitious planning for full control of the Nile basin (Collins 1990b: 155). These were the population growth of Egypt and the need for more water for irrigation. The addition there was Lord Cromer's conviction that Britain's paramountcy in Egypt was not going to be temporary.

Nile control—the Century Storage Plan

Full Nile control or, as it became known, the Century Storage Project evolved from several sources. Basically, the plan envisaged storage of water on the Blue and White Nile from affluent years for use during drought years. The first impotant contribution was made by Garstin and Wilcocks during the first decade of the twentieth century. Garstin (1904) suggested storing water in Lake Tana and dams along the Blue Nile and Atbara. Garstin was also the first to suggest digging channels through the Sudd in order to improve water flow. Garstin noted that by constructing dams on the Blue Nile in places such as Senar, cotton cultivation could develop in the Gezira. The second part of Garstin's plan was to store waters in Lakes Victoria, Kioga and Albert by constructing dams to regulate water flow (Collins 1990b: 156–7). After Garstin retired, Sir Murdoch MacDonald became adviser to the Egyptian Ministry of Public Works and to Lord Kitchener (the British High Commissioner) who advanced Garstin's plans by approving the construction of the Sennar and Jebel-el-Aulia dams—but the outbreak of the First World War interrupted the plans. Following his resignation in 1921, MacDonald left behind him the two volumes of *Nile Control* which



Map 1.3 The barrages, dams and discharge of the Nile's tributaries

included all the plans for the full control of the White Nile and the Blue Nile. MacDonald was eventually succeeded by J.Hurst who became the Director General of the Ministry of Public Works in 1919.

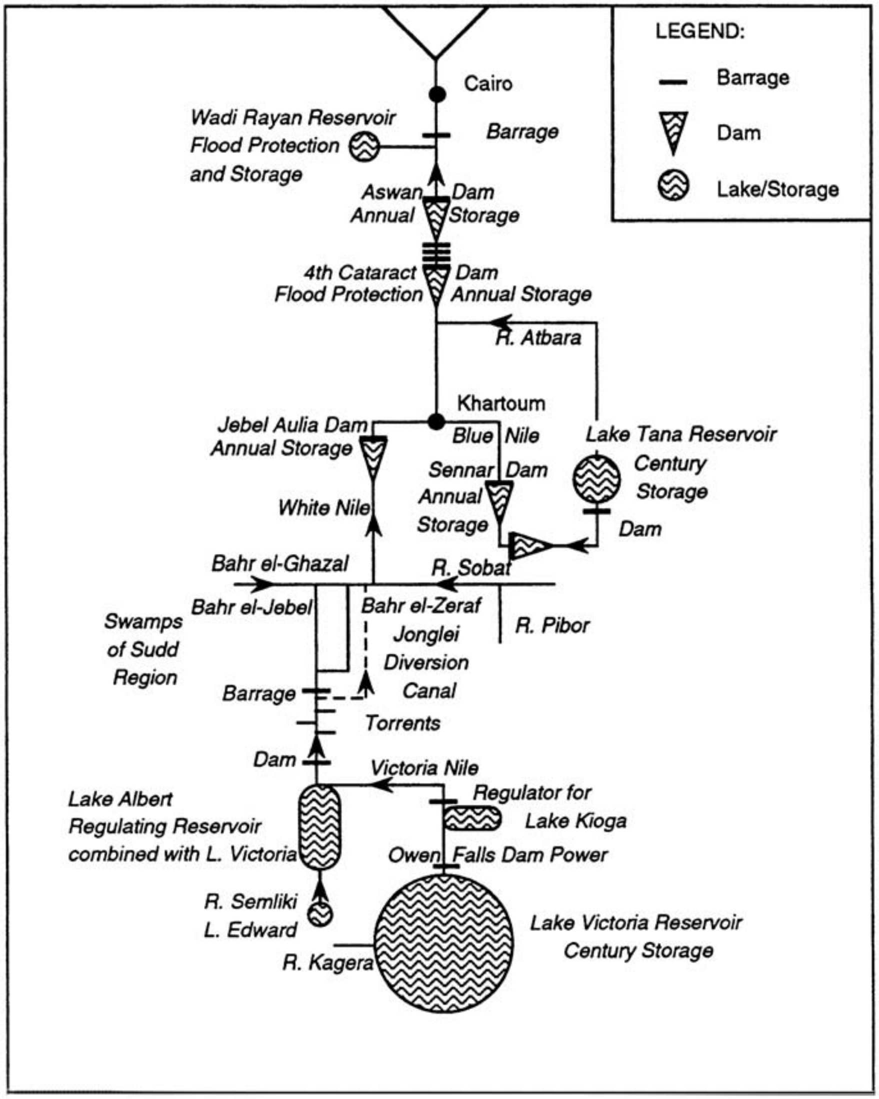
During the interwar years Hurst and his partners published the six volumes of *The Nile Basin* in which they laid the foundation of a total plan for the efficient hydrological development of the Nile Valley. A seventh volume of this monumental work included the detailed, long-term plan for Nile development along the lines of Garstin's report and introduced the concept of 'Century Storage'.

For the White Nile Basin, Hurst and his partners envisaged the Equatorial Nile Project which included storage at Lake Victoria, a dam to regulate Lake Kioga, a smaller reservoir in Lake Albert, a balancing reservoir in the Nimule-Bedden reach and a diversion canal through the Sudd (Howell, Lock and Cobb 1988:36). The Equatorial Nile Project provided seasonal control through using storage for timely water releases between mid-December and mid-June. Hurst analysed the Nile's flood levels between the years 1870 and 1957 and concluded that a hundred years was the period over which the desired amount of water was to be made available; this became known as 'century storage'. Hurst calculated that a storage capacity of 90 billion m^3 should be capable of providing 84 billion m^3, with a reliability of 96 per cent (Evans 1990: 18). He believed that this storage capacity would be enough to regulate the Nile's flood fluctuations (Hurst *et al.* 1966).

For the Blue Nile Hurst proposed a reservoir for over-year storage in Lake Tana and a dam on the Blue Nile at Roseires. Also included in the plan were a storage and flood protection reservoir at the fourth cataract of the Main Nile and a reservoir at Wadi Rayan. The Hurst Plan for Nile Control was accepted by the Egyptian Government in 1947 (Collins 1990b: 162).

It is not surprising that attention in the early days concentrated upon Egypt's need for 'timely water' with only 'some regard' for the emergent Sudan, which became a separately managed entity in 1925 (Howell, Lock and Cobb 1988). What is surprising is the way in which Egyptian monopolization of the Nile water was encouraged by the British administration of Egypt. Sudanese interests, the few times they were protected, were defended only by the British administration of the Sudan. Collins (1990b) vividly portrays how Sudanese British administrators responded with their own plans for Nile control to each plan which was suggested by the British hydrologists of Egypt. This game of diplomatic ping-pong is reflected in W.D.Roberts's report which was a response to the Egyptian-British plan to build a canal at Jonglei. Roberts showed that the canal would have a deleterious effect on the Nilotic inhabitants of the Sudd region. When the British administration of Egypt adopted the Jonglei Canal Project in 1938 the Sudanese administration, led by Winder, criticized it and showed that the Jonglei Canal would inflict many hardships upon the people of the Upper Nile (Collins 1990b: 159). Eventually, the Sudanese administration, incensed by the Egyptian proposal for a new straight line Jonglei Canal between Sobat and Jonglei, established the Jonglei Committee in Khartoum. The Jonglei Investigation Team (established by the Jonglei Committee under the leadership of Dr P.Howell) worked on their report between 1949 and 1953. The report showed, in detail, the possible impact of the Canal on the 700,000 Nilotic people living in the canal zone (Howell, Lock and Cobb 1988). But these efforts came too late, since Great Britain was losing its standing in the Sudan. As Collins so correctly observed, many British officials in the Sudan during the 1920s had good reason to feel embarrassed and guilty about their past indifference to the Southern Sudan (Collins 1990b: 159). Egyptian (British) hegemony over the Sudan culminated in the 1929 Anglo-Egyptian Nile Waters Agreement under which Egypt received 48 billion m^3 of the Nile's water, leaving only 4 billion m^3 for the Sudan. It is possible to present the hydropolitical situation succinctly as follows. The British hydrologists and administrators of Egypt played against the British hydrologists and administrators of the Sudan and the former won.

In relation to the Helsinki and ILC Rules it is clear that the implementation of the Century Storage Plan in its original form could have benefited all the riparian states—although the implementation of several components of the plan (such as the Jonglei Canal) would have caused unfair hardship to the local Sudanese Nilotic population.



Map 1.4 The Century Storage Plan according to Hurst (1952)

This damage to the economy of 700,000 Sudanese would be in contradiction to Article V(k) of the Helsinki Rules which states that the needs of a basin state may only be satisfied if no substantial injury is caused to a co-basin state. The Century Storage Plan also had the advantage of being an integrated plan, dealing with the whole Nile basin as one unit and relating to the various water uses possible within the basin. The plan, however, was never fully implemented and the water projects which Egypt constructed until the 1950s reflected Egyptian hegemony and established prior use in the Nile basin.

The development of water utilization projects by the Nile's riparians

Following the failure to implement any general plan for Nile control, all the riparian states, but especially Egypt, gradually developed their own separate water projects. Table 1.7 presents all the multipurpose water projects in the Nile basin. The table points to the fact that almost all the dams and their reservoirs had to control floods, store water and produce electricity. Another facet of the water projects is that almost all of them were primarily intended to serve Egyptian needs. Sudan's needs were secondary, if they were considered at all, and no consideration was given to the needs of the Equatorial countries. It is also important to note that the Sennar and Jebel Aulia Dams originally appeared as part of the Nile control plans, as did other projects (Sayed Badour 1960:201). The Sudan had expanded its use of the Sennar Dam before it signed the 1959 Agreement with Egypt, a process which Egypt considered as going beyond the limits of the 1929 agreement. Before the construction of the Aswan High Dam, the dams stored a total of 12–13 billion m^3. Most of them lost much of their storage capacity because of silting and the quantity of water lost through evaporation was large.

Table 1.7 shows that Uganda has expanded its contribution to the water balance of the Nile by raising Lake Victoria by 1 m. Perhaps this rise in the Lake Victoria water level in combination with the unprecedented rains of 1961–4 was partially responsible for the flooded areas near Lake Victoria (Collins 1990b: 168). Owen Falls Dam is an example of a water project carried out in the spirit of the Helsinki Rules, especially Article V(i) which calls for the avoidance of unnecessary waste in the utilization of waters of the basin. There is a clear advantage to storing water for Egypt in one of the Equatorial lakes, in an area with lower rates of evaporation than the Aswan Dam site area where evaporation rates are considerably higher. Egyptian interests are represented in the Owen Falls Dam by an Egyptian engineer who is located there on a permanent basis in order to ensure a constant flow of water for what Egypt defines as its 'water security' (Collins 1990b: 163; Okidi 1990).

Of the four dams located in the Sudan (Sennar, Jebel Aulia, Khashm el-Girba and Roseires), Jebel Aulia (1937) was the one intended to store water for Egypt. Again, the original idea was specified in the above-mentioned Article V(i). However, owing to silting and the water lost through evaporation, Jebel Aulia Dam became totally useless and its storage capacity is almost nil. This has led Waterbury to suggest that the destruction of the Jebel Aulia Dam would save 1.5 billion m^3 of water of the annual discharge of the Nile (Waterbury, 1979:93). Even the original purpose of the dam at Khashm el-Girba (1964) was also indirectly influenced by Egypt. As a result of the construction of the Aswan High Dam, Wadi Halfa in the Sudan was flooded and 70,000 inhabitants had to be relocated; Khashm el-Girba's sole purpose was to provide water for the resettled inhabitants of Wadi Halfa. This again brings into question Article V(k) of the Helsinki Rules which calls for the satisfaction of the needs of one co-basin state without causing substantial injury to another co-basin state (United Nations 1970:78). The Aswan High Dam, a controversial project in more than one way, is discussed in the next section.

Table 1.7 Water projects on the Nile

Name of dam	*Year completed or remodelled*	*Location*	*Storage capacity (billion m^3)*	*Evaporation (billion m^3)*	*Functions*
Old Aswan Dam	1902,1912, 1934 (raised to 34 m)	Main Nile (Egypt)	Original capacity (1902) 1.0; 1912, 2.5; 1934, 5.1–5.7[a] (6.3[b])	2.0–3.01[c]	Storing water for irrigation hydroelectricity: seven 47 MW turbines, two 11 MW turbines

Name of dam	*Year completed or remodelled*	*Location*	*Storage capacity (billion m³)*	*Evaporation (billion m³)*	*Functions*
Sennar Dam	1925	Blue Nile (Sudan)	Originally (0.8) 1.0; today 0.6[d]; area 160 km^2	0.28–0.3	Storage of water for irrigation and raising water levels
Jebel Aulia Dam	1937	White Nile (Sudan)	Originally 3.6–3.5; today 2.2; area 600 km^2	2.5 (2.8)[e]	Storage of water for Egypt
Khashm el-Girba	1964	Atbara (Sudan)	Originally 1.3; today 0.96[f]	0.1–0.75[a]	Regulation and provision of water for irrigation originally to provide water for the Wadi Haifa displaced persons
Roseires Dam	1966	Blue Nile (Sudan)	2.3; area 290 km^2	0.4–0.5	Storing water for the Rahad Scheme and Managil, 60 MW for Sudan
Owen Falls Dam	1954	Victoria Nile (Uganda)	Raises Lake Victoria by 1 m and adds 68 billion m^3		Hydro power (1,150 MW) for Uganda; long-term storage
Aswan High Dam	1971	Main Nile (Egypt)	107 billion m^3 live storage; 162 billion m^3 total storage (168 billion m^3[a]); area 6,000 km^2	13–14	Long-term storage, hydroelectric power

Sources: Waterbury 1979; Haynes and Whittington 1981; Shahin 1985; Gischler 1979; Chesworth 1990; Whittington and Guariso 1983

Notes:

[a] According to Whittington and Guariso (1983:43).

[b] The storage capacity of the Old Aswan was 6.3 billion m^3 according to Haynes and Whittington (1981).

[c] Estimated evaporation could be between 2.0 and 3.0 billion m^3. According to Shahin (1985) the capacity is only 5.10 billion m^3

[d] According to Shahin, storage capacity was 0.8 billion m^3. Chesworth (1990) suggests it is at present only 0.6 billion m^3

[e] Annual evaporation loss of 2.5 billion m^3 is suggested by Chesworth (1990). According to Haynes and Whittington it is 2.8 billion m^3

[f] According to Shahin, estimated rate of sedimentation in the reservoir is 40 million m^3 per year.

The Aswan High Dam

Background: geopolitics and water security

Two settings for the decision-making process concerning the Aswan High Dam can be identified: the first is internal and Egyptian, the second is global and regional. Let us first examine the internal Egyptian development. Egypt, fresh from the revolution of the Free Officers including Nasser, faced water shortages in the early 1950s. Nasser also needed a spectacular and visible symbol both for the new Egypt and for the creation of Egyptian primacy in the Middle East. He probably adopted the concept of 'water security' from his enemies, the British. 'No one can hold Egypt securely unless he also holds the whole valley of the Nile. The sources of the river in hostile or even in indifferent hands must always be a grave cause of danger' (Peel 1904:112). The Aswan High Dam was to free Egypt from being the historic hostage of upstream riparian states (Pompe, quoted in Sayed Badour 1960:213; Collins 1990b: 163). Water security has a dual purpose: providing freedom from foreign control over Egyptian waters but also providing security from water shortages. The Aswan High Dam's first and most important purpose was to provide long-term storage of water within the boundaries of Egypt. Over-year storage would protect Egypt from the fluctuations of the Nile floods.

On the global scale the most dramatic influence affecting the construction of the Aswan High Dam was the Egyptian shift from its political alliance with the West to the Soviet Union. In 1956 the USA, Great Britain and the World Bank withdrew their offers to Egypt to construct the High Dam because of Egyptian policy towards neutrality and its alignment with the USSR. Subsequently, Egypt nationalized the Suez Canal in order to finance the construction of the High Dam with profits from the Canal. The consequent Anglo-French-Israeli war against Egypt (1956) made the Egyptians even more insistent on realizing the project. The Soviet Union stepped in and offered its technical and financial assistance in the construction of the dam. The Aswan Dam represented a very prestigious project for the USSR which was anxious to show its superior technology in this showcase project. Success meant gaining more geopolitical clout in the Middle East at large.

On the regional level, the most important variable was the complex state of Egyptian—Sudanese relations. These will be examined on pages 87–9, but two facts can be noted here. First, the 1929 Water Agreement between the Sudan (then under British-Egyptian administration) and Egypt was imposed, and the Sudan subsequently did not consider itself bound by it (Sayed Badour 1960: 222). The 1929 Agreement is presented as an example for the advocation of the absolute territorial integrity doctrine in relation to the Nile (Barberis 1986:213). Egypt later renounced this doctrine. Second, Egypt planned the Aswan High Dam without consulting the Sudan or the other riparian countries. It has been claimed by some that Egypt acted as if the Nile were its national property (Pompe, quoted in Sayed Badour 1960:212); and not until 1954 did Egypt decide to involve the Sudan in the project (Naff and Matson 1984:145). Moreover, the negotiations between the two countries failed, straining the relations between them. Egypt, in fact, made it clear that it would go ahead with the High Dam project even without Sudan's consent and indeed the planning and some of the construction of the dam actually began before the two countries were able to reach an agreement over the division of the stored water in the High Dam. This sequence of events confirms the usefulness of the stipulations made at the United Nations by the ILC in the formulation of Articles 8–18 of the law of the non-navigational uses of international water courses. These articles obligate the co-riparian states to participate in negotiations and consultations and spell out their duty to notify other co-riparians of any plans to utilize the water of international rivers (United Nations 1989) (Appendix B). Only after the Sudanese army, led by Lieutenant General Ibrahim Abboud, took over the government of the Sudan were the two neighbours able to reach an agreement since the new regime was friendly towards the Free Officers regime in Egypt. Thus, a complex framework operating on several levels shaped the decisions made concerning the Aswan High Dam, and this subsequently had an impact on its performance and outcome.

The Aswan High Dam: features and objectives

The construction of the dam began in 1960, and the dam was inaugurated in 1971. It is a rock-fill dam, 110. 70 m high above the river bed, 980 m wide at the base, and with a length of 3,820 m. Lake Nasser-Nubia is 450 km long and 10 km wide (on average) and is designed for the storage of 162 billion m^3. There are three important levels in the lake. The level of 146 m with a capacity of 30 billion m^3 is the dead capacity of the reservoir only in relation to electricity generation. Electricity production stops at this level but, in times of emergency, Egypt can draw off an additional 24 billion m^3 of water and reduce the level of the lake to 123 m and to a dead storage capacity of only 6.8 billion m^3 of water. The live capacity of the lake is estimated at 90 billion m^3 when the lake reaches 175 m above sea level (Figure 1.3).

The maximum water level of Lake Aswan is 182 m above sea level and, although the lake can absorb 37 billion m^3 above the 175 m level at times of high floods, it can never go beyond the 182 m level (Whittington and Guariso 1983:108). The total storage of the lake is 160 billion m^3, but as we have already noted, only 90 billion m^3 is 'live storage' with 70 billion m^3 unavailable for current use (Shuman 1988:22). This information is extremely important when one critically examines the 'water security' function related to the High Dam.

Lake Nasser and its Sudanese portion, Lake Nubia, cover an area of 6,000 km^2. The size of the lake is reduced to 4,016 km^2 when the lake stores only 89.2 billion m^3, and the water level drops to 168 m above sea level (Gischler 1979:24; Shahin 1985:442). The Aswan High Dam and Lake Nasser-Lake Nubia, among the largest in the world, are estimated to have cost $820 million to construct, but combined with the cost of land reclamation the total costs were closer to $1.5–2.0 billion (Waterbury 1979:112).

The purposes specified for the Sadd-El-Aali or Aswan High Dam are as follows:

1 to protect Egypt against fluctuations and variations in the flow of the Nile and guarantee water supply for municipal, industrial and agricultural uses (Gischler 1979:22; Naff and Matson 1984:148);
2 to expand the cultivated area by 1.3 million ha and extend it beyond the limits of the Nile Valley;
3 to expand farming by multiple cropping along the Nile Valley (since irrigation water would be available throughout the year);
4 to convert 294,000 ha (700,000 feddans) from basin to perennial irrigation;
5 to generate 10 billion kWh of electricity per year;
6 to improve navigation conditions below the dam;
7 to guarantee the cultivation of 294,000 ha of rice every year;
8 to develop fishing in Lake Nasser and to turn the High Dam into a tourist attraction. More generally, the Aswan High Dam was to assist and accelerate food production in order to accommodate the accelerated population growth of Egypt.

The Nile Waters Agreement of 1959 proposed the following water allocations to Egypt and the Sudan of the waters they share, based on the following data:

Average Nile flow in Aswan, 84 billion m^3
 Evaporation losses from Lake Nasser, 10 billion m^3

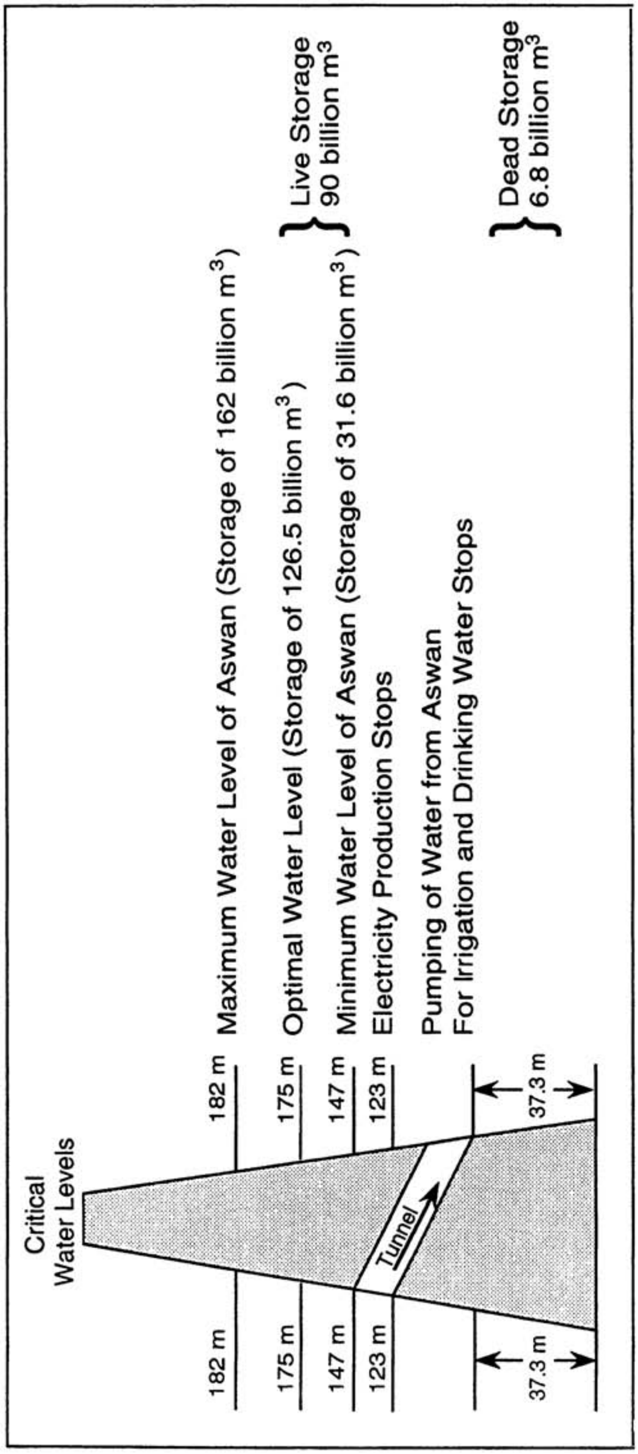


Figure 1.3 Specific water levels of the Aswan High Dam

Available water, 74 billion m^3
Sudan: 18.5 billion m^3
Egypt: 55.5 billion m^3

Table 1.8 presents the data on the available water at Aswan.

The Lake Nasser reservoir has been in operation since mid-1964; since then Egypt has always released its quota of water each year and more in years of high floods. But the rule is that on 1 August each year the reservoir level should not exceed 175 m in order to accommodate the incoming flood. By the end of 1975–6 the reservoir had reached a live storage of 81.5 billion m^3 (Shuman 1988:23).

By 1976 Lake Nasser was almost full with a storage of 134 billion m^3. Since 1975 Lake Nasser's levels have fallen and the influence of the Sahalian drought on lake levels is clearly visible (Shuman 1988:22; Evans 1990:20–3). Two factors have saved Egypt over the years from being damaged by the drought in the Ethiopian catchment area. First, the reduction in the flow of the Blue Nile has been accompanied by a higher flow in the White Nile. Second, as the Sudan is not using its full allocation of 18.5 billion m^3 of Nile water, but perhaps only 70 per cent of it, Egypt has used and is still able to use this additional water—between 1.5 and 6 billion m^3 (Haynes and Whittington 1981:21; Howell, Lock and Cobb

Table 1.8 Available water flow and water releases at Aswan

Year	*Flow to Lake Nasser (billion m^3)*	*Water level (m)*	*Release (billion m^3)*	*Evaporation and seepage losses*
1970	77.2	164.87	54.7	9.3
1971	77.1	167.62	55.9	10.7
1972	58.0	165.26	55.5	12.4
1973	79.5	166.24	56.4	8.0
1974	69.0	165.60	56.1	10.8
1975	81.5	172.42	54.4	14.2
1976	58.0	171.70	54.7	15.0
1977	65.6	172.52	57.7	14.6
1978	62.1	173.04	61.9	13.9
1979	48.4	171.13	56.0[a]	13.0[a]
1980	55.97	171.02	56.7	12.8
1981	55.91	170.34	58.0	12.9
1982	40.71	165.84	59.1	12.5
1983	47.95	163.32	57.6	8.4
1984	35	157.00	57.3	9.7
(storage end of July 72.9)				
1985	57.70	162.50	55.8	6.4
1986	56	159.00	(60.5)[a]	5.7
(storage end of July 53.7)				
1987	45	154.00	(60.5)[a]	(5.2)[a]
1988	80	165.00	(60.5)[a]	(12.5)[a]

Year	*Flow to Lake Nasser (billion m³)*	*Water level (m)*	*Release (billion m³)*	*Evaporation and seepage losses*
(storage end of July 41. 4)				

Sources: Allan 1988–9:48; Chesworth 1990:45; Shahin 1985:444; Shuman 1988:23
Note: [a]Estimates.

1988:67; Allan 1988–9:47; Chesworth 1990; Tvedt 1992). Egypt itself has admitted that it released 60 billion m^3 of water from the Aswan Dam in 1989 (*alAchbar* 19 January 1990), a figure which constitutes 5 billion m^3 more than the allocation made by the 1959 Agreement. It seems that the estimate made of an average consumption of 55.5 billion m^3 is less than what Egypt is borrowing from Lake Nasser, probably from the unused Sudanese allocation. In July 1988, after years of overpumping water from Lake Nasser, the water level reached a low of 150.58 m and the volume of water was only 36 billion m^3. The Egyptian Government responded by reducing water for irrigation by 10 per cent and electricity production from 1,750 MW to only 850 MW (*al-Achbar* 18 April 1988). Lake Nasser itself has been reduced in size to 1,800 km^2 and has been split into two separate lakes. The high flood of 1988 (which flooded Khartoum in August 1988) scarcely improved the situation. In 1989 the live storage at Lake Nasser was 60.0 billion m^3 followed by 69.0 billion m^3 in 1990, 62.0 billion m^3 in 1991 and 68.0 billion m^3 in 1992, and these quantities enabled Egypt to utilize more than its quota (Evans 1992). Lake Nasser has never dropped again to the critical level of water supply of 31.6 billion m^3, but neither has it reached its 1970s high levels of 176 m.

A severe water shortage in the next few years can thus be anticipated. According to Evans (1992) with a long-term drought only between 49 and 52 billion m^3 of water may be available for Egypt. What, then, is the political significance of the above process? First and most important, there is no doubt that Lake Nasser has provided, and still provides, Egypt with some level of 'water security' and has succeeded in cushioning Egypt from the water fluctuations of the Nile (the first objective for the High Dam construction). But the most important message is that Nile water remains a scarce, and perhaps finite, resource for both Egypt and the Sudan. If both countries, but especially Egypt, insist on carrying out all their plans for agricultural, municipal and industrial expansion, both will face severe deficits. Water scarcity means that both Egypt and the Sudan will be more dependent on mutual co-operation between each other and the other riparian states of the Nile basin, since any additional increase in Nile flow will be of crucial value in Aswan.

The impact of the Aswan High Dam

The impact that the Aswan High Dam has made can be divided into two broad categories: the ecological-environmental impact and the socio-economic impact. We shall first discuss the ecological-environmental impact of the High Dam.

Ecological and environmental impact

Loss of sediment In the past the Nile waters carried between 50 and 110 million tons of silt clay and sand annually either to Egypt's fields (12 per cent) or to the Mediterranean (88 per cent). Today the silt is dropped at the entrance to Lake Nasser/Nubia, where a new delta has formed (Gischler 1979:22). The sediment is deposited at a rate of 110 million tons annually. As a result, the live storage of the dam will be exhausted after 500 years (Waterbury 1979:130). Instead of Nile silt which was once used to enrich the soil, farmers in the Nile Delta must now use expensive fertilizers—estimated to cost more than £E20 million per year (Shibli 1971:154). The silt was once an important ingredient for the local production of bricks, but today farmers are using productive soil for materials for the brick industry. The loss of silt is also reflected in the reduced fish population of the Mediterranean (Gischler 1979:23; Biswas 1980:9).

Evaporation and seepage One of the greatest controversies concerning the Aswan High Dam is the issue of seepage and evaporation. As stated before, the planners of the dam estimated that, when the reservoir was full (175 m), the

Table 1.9 Lake Nasser: storage, evaporation and electricity production

Water level	*Lake area (km²)*	*Volume of water (billion m³)*	*Evaporation (billion m³)*	*Electricity production (M W)*
185	7,174	182.7	15.3–16	1,750
175	5,108	126.5	14.0	1,750
164	3,454	74.3	9.4	1,200–1,500
150.0	1,962	37.2	5–7	850
147.0	1,737	31.6	3–5	0
123.0	540	6.8	1	0

Sources: Waterbury 1979; Gischler 1979; Shahin 1985

annual loss of water due to evaporation would be 10 billion m^3 and to seepage an additional 2.0 billion m^3 (Table 1.9).

Levels of evaporation for Lake Nasser, however, range between 12.0 and 15.0 billion m^3 of water per year when the storage level is between 172 and 175 m (Gischler 1979:33; Waterbury 1979:125; Shahin 1985). More than half of Egypt's planned increment from the Aswan is thus lost because of evaporation (12–15 billion m^3) and seepage (0.6–2.0 billion m^3) (Waterbury 1979; Shahin 1985) which is between 12 and 21.4 per cent of the annual discharge of the Nile.

Erosion and degradation The silt-free waters released from the dam are eroding the riverbed of the Nile and the delta coast (Gischler 1979:22–3; Whittington and Guariso 1983:88). The downstream sides of the major barrages are now so deeply eroded that the Ministry of Irrigation has been building barriers behind the Aswan, Esna and Nag-Hammadi Barrages over the last decade to reinforce them (Shibli 1971:154). In addition sea water is entering the great lakes in the Delta as a result of the Delta's erosion by the sea.

For 1963–72 the average riverbed level dropped downstream from the Aswan dam by 17 cm, downstream from the Esna Barrage by 31 cm, downstream from the Nag Hammadi Barrage by 24 cm, and downstream from the Assiut Barrage by 9 cm (Whittington and Guariso 1983:89). As a result, by 1992 the riverbed had deepened by approximately 60–70 cm below Aswan and by 75 cm downstream from Nag Hammadi.

Water quality The continuing process of deterioration in the quality of water in Egypt and the issue of water quality will attract interest and require investment by Egypt in the future (Haynes and Whittington 1981: 19). Salinity and water-logging have always been severe problems for Egypt and, between the Roman era and the beginning of the Moslem era, as much as 1.5 million acres in the northern Delta were lost to cultivation due to soil salinity. Salinity and waterlogging have become increasingly more severe, however, in recent years because of over-watering and inadequate drainage (Waterbury 1979:37). About 33 per cent or 0.8 million ha are affected by salinity and poor drainage (El-Gabaly 1980:60) and yields have dropped by 30 per cent in the affected areas. These processes have been accelerated since the operation of the Aswan Dam. Moreover, the quality of water has deteriorated because of the large amounts of pesticides, copper and other chemicals which have been used to increase agricultural production. Substances such as oil, grease, petrol, heavy metals and leached salines have been added to the water but irrigation runoff also carries nitrates, phosphates and insecticides into the Nile and the Delta (Fahim 1981:14). As a result of the changes in water quality and total control of Nile water bilharzia began to spread, although studies report that the Egyptian Government's measures against the disease have been effective and that it is again declining (*Mideast Markets* 12 July 1982:2–3). Water hyacinths which clog vast surface areas of Lake Nasser and other reservoirs increase the evaporation from these reservoirs but the Egyptian Government is taking measures to reduce the hyacinths and weed growth in the Nile system.

The socio-economic impact of the Aswan High Dam

The construction and operation of the Aswan High Dam has had a pronounced social and economic impact on Egypt mainly in farming and irrigation, industry and electricity production, fishing and tourism (Fahim, 1978:7). The most important and constant result of the operation of the High Dam is that it has guaranteed a consistent supply of water for farming and municipal use. In the drought year of 1972–3 and in the 1980s, the Aswan High Dam provided the water which protected Egypt from a severe shortage (Allan 1988–9:45).

The High Dam has made possible an expansion of the cultivated area by 546,000 ha and a conversion of 294,000 ha from basin to perennial irrigation (Beaumont, Blake and Wegstaff 1988:98). Perennial irrigation enabled multiple cropping throughout Egypt but mainly between Aswan and Esna. On average, two crops are grown annually, and thus food production was doubled (Whittington and Haynes 1985:126–8). Also important is that the Aswan High Dam has put an end to the floods and water fluctuations of the Nile and saved significant expense incurred by the damage. A second economic outcome was the development of a fishery in Lake Nasser. Some 7,000 fishermen have moved to Lake Nasser, which has become an important source of fishing, replacing lost Mediterranean and Lower Nile fishing grounds—but distance from markets hampers development.

The High Dam also enabled an accelerating rate of industrialization. The town of Aswan, which has grown by a factor of 5 as a result of the construction of the dam, has also become an important industrial centre. There is no doubt that electricity production is one of the most important economic benefits of the Aswan High Dam.

The twelve turbines of the High Dam were designed to produce 10 billion kWh annually or 1,750 MW when Lake Nasser is at a level of 185 m above sea level and the reservoir contains 182.7 billion m^3. When the lake contains 74.3 billion m^3 (at 164 m above sea level) it generates 1,200–1,500 MW, but when the water level reaches a low of 150.50 m, as it did in April 1988, electricity from the Aswan is cut by half (from 28 per cent of the Egyptian total to less than 6 per cent). The loss of Aswan's electricity capacity was reflected in electricity shortages during the summer of 1988 (*al-Achbar* 18 April 1988).

When the water level reaches 147 m electricity generation stops at the Aswan. However, Waterbury contends that the High Dam, which currently supplies about 18.5 per cent of Egypt's total power needs, will supply no more than 10 per cent of Egypt's power by the year 2000 and will become, in that respect, obsolete (Waterbury 1992:24). It should be noted that the Aswan's electricity potential was not fully used in the first years after its construction as Egypt's industry and infrastructure were not yet ready for the large quantities of electricity available. However, by 1973, Egyptian industry was consuming some 5.1 billion kWh of the 7.6 billion kWh which represented the country's total supply of electricity (Waterbury 1979: 150–1).

Finally, the improvement of transportation can be included among the minor economic outcomes of the Aswan High Dam. Roads were added to the existing network and the navigation conditions along the Nile have been improved. Also, Aswan has become a tourist attraction and millions of tourists visit the site each year.

The major social outcome of the construction of the Aswan High Dam was the displacement of many Sudanese and Egyptian farmers who were removed from the flooded areas of Lake Nasser. Some 100,000 people, mostly Nubians, have had to be evacuated; Egypt paid the Sudan £E15 million in compensation for the displacement and relocation of 50,000–70,000 Nubians in Khashm elGirba but Egypt herself has also had to relocate 30,000–50,000 people in the Kom Ombo region (Waterbury 1979:73–4).

The Aswan High Dam—an appraisal

The lesson learned from the Aswan project is that dams may be built with missionary zeal but little careful planning and monitoring of side effects' (Fahim 1981:42). The Aswan High Dam, no doubt an engineering feat, has benefited Egypt by its control of flooding and storing of water for drought years—yet it has not provided Egypt with water security or, more particularly, with food security. Egypt adopted the view that the High Dam would not only serve as a symbol of its sovereignty over the Nile waters but would enable it to achieve its most ambitious goal: food self-sufficiency. Egypt lacks the capital for land reclamation and the productivity of the newly reclaimed lands is very low because of a shortage of water (Voll 1980:147–8). Aswan cannot be blamed for the 'Malthusian trap' into which Egypt has fallen over the past fifteen years which is the outcome of accelerated population growth. The Aswan High Dam did, however, provide the short-term illusion that it would fulfil Egypt's dream of food self-sufficiency, and as a result measures to cut population growth were either not taken or were unsuccessful. Hostage to the concept of the High Dam and its seemingly limitless waters, Egypt did not take any measures to stop water wastage arising out of evaporation, seepage, a poorly maintained irrigation network and wasteful irrigation methods. It has been estimated that the adoption of conservation methods and better water management would provide Egypt's farming population with some 6.5–10 billion m^3 more water (Evans 1992).

The Aswan High Dam has not answered Egypt's electricity needs for manufacturing, but electrification of the rural sector has been successfully completed. Since agriculture's contribution to the gross domestic product (GDP) was overtaken by the manufacturing industry in 1980, more emphasis should have been placed on electricity generation. Yet, as Allan so rightly states, 'Egypt is committed to land reclamation, food self-sufficiency and extension of irrigated agriculture more than any other sector of the economy' (Allan 1988–9:46). The environmental impact of the High Dam is severest in the waterlogging and soil salinity which each year reduce the availability of productive lands. Silting, bank deterioration and erosion have added to the negative impacts of Lake Nasser and to the economic cost of maintaining the irrigation system and land fertility.

Finally, owing to natural processes in the Nile basin (droughts) and human-made processes—specifically the enormous population expansion—Egypt today is perhaps more vulnerable than ever before to riparian action and non-action throughout the Nile basin as a whole since its dependence on additional water has become very great.

The Owen Falls Dam

The Owen Falls Dam was first conceived of by Great Britain in its attempt to secure an agreement with upper riparians on behalf of Egypt and the Sudan. In 1946 the Ministry of Public Works (Egypt) drew up a comprehensive plan in which the main components (as specified in the various versions of the Century Storage Plan) were a dam on the Equatorial Lakes, the construction of the Jonglei Canal in Sudan, Lake Tsana (Tana) Reservoir and a dam at Merowe near the fourth cataract on the Nile (Okidi 1990:203).

The first choice for a suitable storage site was Lake Albert, but a dam on this lake would have flooded a considerable area around it, mostly in Uganda and the Belgian Congo, and both countries opposed the plan. This led Egypt to present an alternative proposal for the dam which was subsequently built at the outlet of Lake Victoria. The Owen Falls Dam, about 30 m high and 762 m long, has an average outflow of about 620 m^3/s

which reduces to about 500 m^3/s. The difference is used to build up storage in the lake to the level required by Egypt (Shahin 1985:559). The dam which was built between 1950 and 1954 began to generate electricity in 1954; and the lake level has remained in the range 11.5–13.5 m since 1962 (Howell, Lock and Cobb 1988:90). It should be noted that Britain, the administrating power before Uganda got her independence, was not opposed to allowing the level of the lake to rise by a maximum of 1.3 m. Uganda was to benefit from the dam which would produce 15,000 kW (150 MW). Uganda wants to raise the height of the Owen Falls Dam by 1 foot in order to increase hydro-power generation to supply electricity to Kampala, the capital, and to expand export of electricity to Tanzania and Kenya (Waterbury 1992: 21). Today, Uganda sells surplus electricity to Kenya.

The purpose of the dam was to produce hydroelectric power for Uganda but the project fitted nicely into Egypt's plans for the development of the White Nile and the Equatorial Lakes (Whittington and Guariso 1983:36). At the request of the Egyptian Government, Uganda increased the height of the dam by 1 m to provide about 68 million m^3 of storage for irrigation purposes during the low years. Egypt contributed to the cost of construction and compensated Uganda with £980,000 for damages incurred to lakeside residents as a result of the increased level of Lake Victoria. Most important, the Owen Falls Dam Authority stipulated clearly that priority had to be given to control of discharge flows and storage (for Egypt). Egypt also assumed a further obligation to the other two riparians of the lake—Kenya and Tanzania—that, in the event of any physical or environmental change suffered from the rising levels of the lake, Egypt would pay similar compensation.

The floods of 1961–4 increased the level of the Equatorial Lakes by approximately 2.5 m, producing extensive damage around their shores. Egypt (and the Sudan) responded by increasing the outflow through the Owen Falls Dam and the resulting floods destroyed herds of livestock and caused casualties to the Nilotic population in the Sudd. Between 1961 and 1962 the discharge at Owen Falls increased from 20.6 to 38.6 billion m^3, rising to 44.8 billion m^3 in 1963 and 50.5 billion m^3 in 1964 (Collins 1990b: 168). Egypt used the additional water and the Equatorial states were able to provide their lake shore population with some relief from the floods, but the Sudan, as always the weakest link in the chain, did not provide adequate flood protection for its own population. The great flood of 1988 reminded the riparian states of the Nile that repeated negligence ultimately extracts a high cost.

Nile water utilization—concluding remarks

The features of the patterns of Nile water utilization, including those that actually evolved and those which failed to leave the drawing-board, are as follows.

1 Because Britain controlled the whole of the Nile basin, the first series of plans for Nile utilization were based on the principles of total control and integrated river basin development of the Nile basin, namely, water storage in the Equatorial Lakes to meet the needs of the downstream states Egypt and the Sudan. Yet, rising nationalism among the riparian states, especially Egypt (but also among the Equatorial countries), combined with the diminishing power of Great Britain created patterns of water utilization which favoured a single state (Egypt) at the expense of the interests of the whole basin.

2 Egypt's stand in relation to the development and utilization of the Nile started with the adoption of the doctrine of absolute territorial integrity which gave priority to its historic and ancient rights to the Nile waters. With the support and encouragement of Great Britain, the various Century Storage Plans, the Jonglei Canal and other projects all gave priority to Egyptian needs. The 1929 Agreement to share the Nile's water still reflects Egyptian adherence to the doctrine of absolute territorial integrity. Only in the 1959 Agreement did Egypt distance itself from this doctrine and accept the principle of more equitable

allocation of the Nile's water especially in relation to the Sudan. However, the construction of barrages and dams in the Nile basin reflected more the doctrine of absolute territorial integrity than equity. Barrage and dam construction in the Nile basin significantly departs from the principle of integrated and efficient basin development since the dams in the Sudan accumulate silt very rapidly and all lose large amounts of water due to evaporation and seepage. The Aswan High Dam which was the culmination of Egyptian self-interest also showed how Egypt ignored the principles stipulated in the Helsinki Rules or in the ILC Rules which called for equitable and reasonable water utilization. Article V(i) of the Helsinki Rules called for the avoidance of unnecessary waste in water utilization. Article 7(e) of the ILC Rules specified the obligation of co-riparians to conserve, protect, develop and use the water resources of international water courses economically. Egypt chose to construct the Aswan in her territory because it was motivated by water security policy, but the location of the Aswan High Dam in Egypt is a wasteful and inefficient siting when the principle of reasonable and equitable water sharing is applied to the case of the Nile.

In the case of the Owen Falls Dam, Egypt, although its self-interest was very strong, showed more readiness to comply with the principles of international law by compensating (or expressing her readiness to compensate) her co-riparians for damage it might cause (because of its water demands).

The patterns of water supply and demand among the Nile's co-riparians certainly reflect the results of Egypt's adoption of the above doctrines as is described in the next section.

THE NILE WATERS: SUPPLY AND DEMAND

General

All the current projects based on the Nile have not exhausted all the Nile's water. As noted earlier, large quantities of Nile water are lost in large areas of swamps and marshland. In addition to the Century Storage Plan which envisaged the total and efficient control of the Nile, several minor plans have been proposed in order to reduce water losses and expand water supply downstream for Egyptian and Sudanese use. In this section we review the major sources of water losses which are located mainly in Sudanese territory, specifically the Sudd swamps, the Machar swamps and the Bahr-el-Ghazal swamps. We also discuss the Jonglei Canal project which, if implemented, would 'solve' the problem of the Sudd water loss, although it would probably create new problems. In the second part of this section we review patterns of supply and demand for Nile waters among the riparians and their political ramifications in detail.

Expanding the Nile's water supply—some possibilities

The Sudd and the Jonglei Canal

The Sudd

The Sudd is a vast area of swamp and marshland in the Bahr-el-Jebel system of the White Nile. The Sudd swamps are located between Mongalla and Malakal and much of the White Nile's water is lost in the Bahr-el-Jebel flood plain owing to evaporation and seepage (Sutcliffe and Lazenby 1990:117).

Garstin, the first to note and assess the large loss of water in the Sudd, estimated that between 50 per cent and 80 per cent of the water discharge into the Sudd disappears. Howell, Lock and Cobb (1988) find this estimate too high, claiming that, in reality, it is probably not over 60 per cent. Table 1.10 shows that the percentage losses are directly related to the mean discharge of water: the larger the discharge the greater the water loss. The table does not show the wide range of inflow into the Sudd, but from a low discharge of 22 per cent to a high of 61.2 per cent of the inflow into the Sudd as measured at Mongalla is lost through evaporation and seepage (Collins 1990b: 156). The high evaporation rates are increased by the large quantities of vegetation, mainly water hyacinth (which is estimated to account for a yearly loss of up to 10 per cent of river water yield) and papyrus which absorb and dissipate large amounts of water (Tvedt 1992: 79). This high percentage of lost water led Garstin, as early as 1904, to adopt an earlier proposal suggested by Beresford to dig a canal east of the Sudd

Table 1.10 Water loss in the Sudd

Period	*Mean discharge at Mongalla*	*Discharge at tail of swamps*	*Loss (billion m^3)*	*Percentage loss*
1905–60	26.8	14.2	12.6	47.0
1905–80	33.0	16.1	16.9	51.2
1961–80	50.3	21.4	28.9	57.5

Source: Based on Howell, Lock and Cobb 1988:25

Table 1.11 Permanent and seasonal swamps (various years)

Swamp	*Year*		*Increase*
1952	*1980*		
Permanent swamps	2,700 km^2	16,200 km^2	13,500 km^2 (400%)
Seasonal swamps	10,400 km^2	13,600 km^2	3,200 km^2 (32%)
Total	13,100 km^2	29,800 km^2	16,700 km^2 (127%)

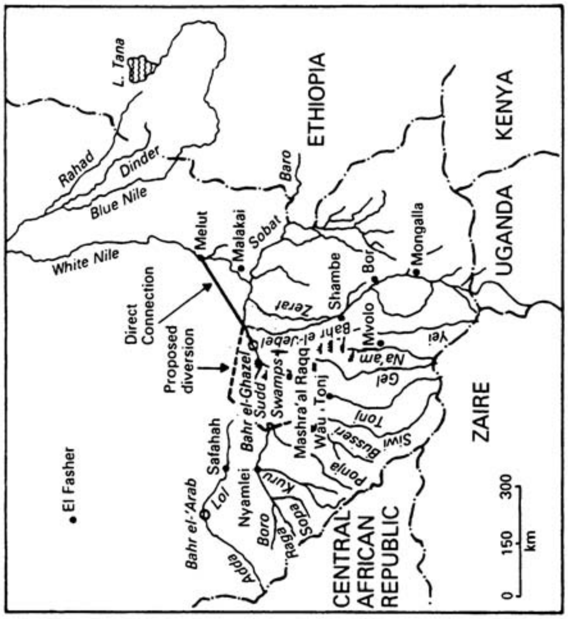
Source: Based on Howell, Lock and Cobb 1988:44

which would cross the swamps and carry the White Nile's waters directly to the main channel of the White Nile (Howell, Lock and Cobb 1988; Collins 1990b: 156).

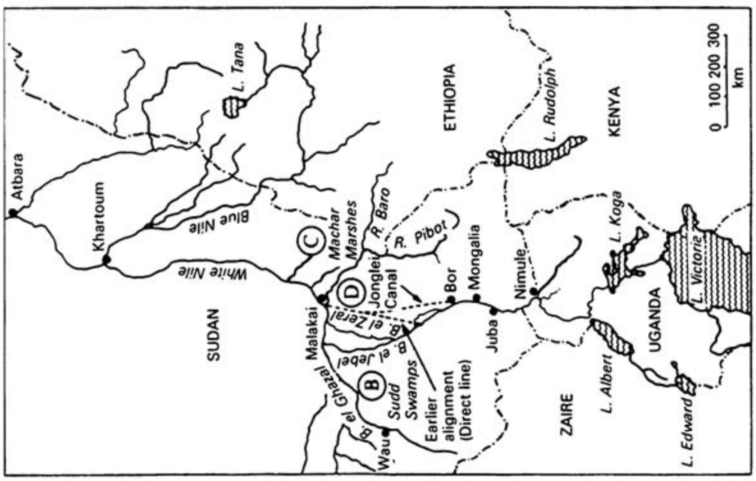
The marshlands as presented in Map 1.5 are divided into two parts: permanent swamps and seasonal swamps (Table 1.11). The area of both varies with the volume of the floods. The Equatorial rains in 1961–4 which caused great flooding in the White Nile were responsible for the enormous expansion of the swamp area from an average of 8,000 km^2 before 1961 to over 30,000 km^2 in 1964 and have since remained between 20,000 km^2 and 30,000 km^2 (Sutcliffe and Lazenby 1990:118). The Jonglei Canal Phase I was planned to salvage some 3.8 billion m^3 (as measured at Aswan) of the water wasted in the Sudd; the main reason for saving such a small amount of water is related to technical difficulties and ecological considerations.

The Jonglei Canal

The Sudd marshland with its huge water losses has fascinated almost all hydrologists concerned with Nile control. As we have seen, the first proposal to reduce water loss came from Garstin who suggested either improving the natural channels of the Bahr-el-Jebel by dredging and straightening them or constructing a diversion canal. The canal Garstin wanted to cut from the Sobat mouth to Bor would carry 55 million m^3/day past the Sudd (Howell, Lock and Cobb 1988; Collins 1990a, b). In the mid-1920s the Egyptian



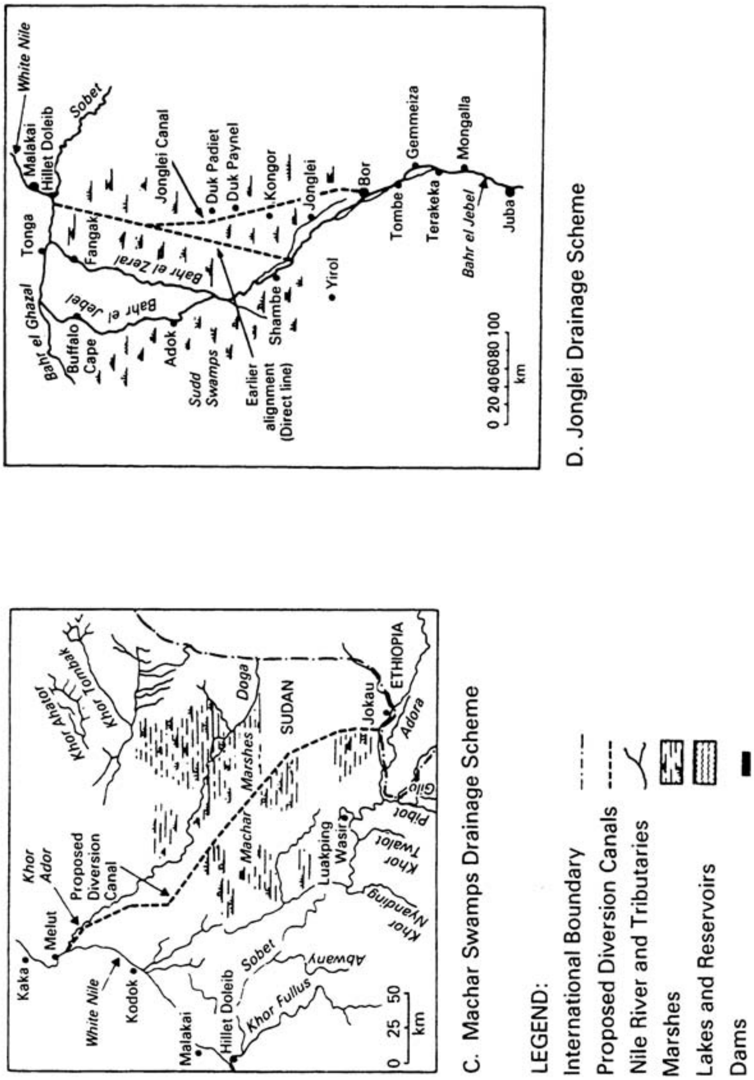
B. Bahr el Ghazal Drainage Scheme



A. General Location Map

Government approved a plan for a canal from Jonglei to the Bahr-el-Zeraf, some 100 km above its mouth. The Sudan Government expressed its opposition to the plan through the above-mentioned Roberts Report which stated that Egyptian irrigation needs could not be met by the Jonglei Canal, but only by proper water storage at the site of the Equatorial lakes.

The Jonglei Investigation Team Report of 1954 recommended abandoning the idea of digging a canal which would run close to the natural channels of the river with an exit near the mouth of the Zeraf in favour of the 'direct line' which would run much farther to the east (see Map 1.5). The Jonglei Investigation Team modified the Jonglei scheme in order to reduce its negative impact on some 600,000 Nilotic people who



Map 1.5 The Sudd and Machar marshes and the various plans for drainage schemes

earned their livelihood from grazing and fishing in the seasonally flooded plains area (Howell, Lock and Cobb 1988). The decision to construct the canal was made in 1974 and its objective was to increase the mean annual discharge of water to the White Nile at Malakal. In the 1959 Nile Water Agreement Egypt and the Sudan had already agreed to share the additional waters of the Jonglei scheme (and other projects) equally.

The benefits that the Jonglei Canal would bring were listed as follows:

(a) It would reduce the damaging effect of flooding from Bahr-el-Jebel in years of high discharge. Collins estimated that the floods of 1961–4 caused disastrous flooding in the Sudd and that tens of thousands of people perished (Collins 1990b: 168).
(b) It would carry 20 million m^3 of water per day or 4.67 billion m^3 per annum (measured at Malakal), or 3. 8 billion m^3 as measured at Aswan. In 1981 it was decided to increase the water flow in the canal to 25 million m^3 per day.
(c) It would improve river transport by shortening the navigational distance between Kosti and Juba by some 300 km.
(d) It would improve road transport by providing an all-weather road along one of the canal embankments.
(e) It would provide year-round water supplies along the line of the canal for the benefit of the local population.

The total length of the canal would be 360 km with a ground slope of between 7.0 and 12.5 cm/km; the depth of water would decrease from 8.0 m to 5.0 m; and the bed width of the canal would be 38 m.

Both Egypt and the Sudan planned agricultural expansion with the additional water. It was believed that some 252,000 ha would be irrigated in the Sudan with Jonglei waters and in addition navigation between Juba and Khartoum would be improved (Howell, Lock and Cobb 1988).

Construction work on the Jonglei Canal began in 1978 and by 1984 when the Southern Sudanese rebels (SPLA) brought the works to a halt (after two attacks in 1983 and 1984), 240 km of the canal (of a total of 360 km) had been excavated. Even if peace is restored the cost of completing the canal, including repair of the eroded sectors and the neglected excavating equipment, will exceed the original budget ($124, 855, 967 in 1980 prices). Since 1970 the Jonglei plan has heightened the resentment of the Nilotic population of the Sudd because they were not consulted during its planning and their interests were neglected. Their major complaint has been that the canal was designed for the benefit of the users in the north—both in the Sudan and in Egypt. The Jonglei is not central to the conflict in the Sudan, but for the people of the south it has become a symbol of the exploitation of their territory and resources by the north. The Southern Sudanese resentment of northern exploitation also expresses itself over oil reserves discovered in the Jonglei area.

The Jonglei Canal described above is the first phase of the Jonglei Canal Plan. The second phase calls for doubling the present planned capacity from 25 million m^3 to 50 million m^3 per day or 3.2 billion m^3 a year. This will be achieved by excavating a second canal either close to the present canal or at some distance from it. The second phase of the Jonglei Canal Plan will require control and annual storage upstream, mainly in Lake Albert and perhaps even in Lake Victoria. The probability of this scheme being realized, however, is remote as long as the Jonglei Canal Phase I is frozen. The Jonglei was, and is, vital for Egypt, but not for the Sudan which does not use all of the water allotted to it by the 1959 Nile Water Agreement. Moreover, Sudan, in its difficult economic situation, is barely capable of carrying the financial burden involved in the completion of Jonglei Phase I, and cannot finance a new project.

The Machar-Baro-Sobat swamps

An area of some 6,000 km^2 north of the Sobat has become a marshland created by water spillage from the Baro which amounts to 2.8–3.5 billion m^3 (Sutcliffe and Lazenby 1990). Other tributaries such as the Yabus and Daga contribute 1.40–1.74 billion m^3 to the swamps and the return flow of the White Nile is 0.12 billion m^3. Hurst, Black and Simaika (1966) have estimated the annual volume of water disappearing by evaporation from the Machar swamps at 9.9 billion m^3. There are two kinds of plan to save some of these losses. The first envisages a canal from Jokau on the Baro to Melut, a distance of some 300 km, which would contribute an annual benefit estimated at 4.0–4.4 billion m^3 at Aswan (Haynes and Whittington 1981; Howell, Lock and Cobb 1988:460). An alternative plan calls for a dam on the Baro near Gambel (a project with a reservoir of 25 billion m^3) as well as the embankment of Khor Machar (Haynes and Whittington 1981; Howell, Lock and Cobb 1988). The water yield expected from this project is 4.0 billion m^3 (Whittington and McClelland 1992:151).

Bahr-el-Ghazal

All along the Bahr-el-Ghazal and to the south and east of it are large areas of swamp which are fed by the streams Gel, Lau, Noam, Tonj, Jur and Lol. The annual flow entering the swamps has been estimated at 13. 0–14.0 billion m^3, but only 0.6 billion m^3 reaches the mouth of the Bahr-el-Arab (Ahmed 1990; Shahin 1985:365). The Bahr-el-Ghazal scheme will consist of a canal 425 km long running from the vicinity of Wau north and then east to the Bahr-el-Ghazal-Bahr-el-Jebel junction at Lake No, and its gross annual benefit is expected to be 5.1 or 7.0 billion m^3 of water (Howell, Lock and Cobb 1988:461; Whittington and McClelland 1992:51).

In conclusion, projects in the Sudd, Machar and Bahr-el-Ghazal marshlands, if realized, could provide some additional 13.0 billion m^3 of water at Aswan (Evans 1992; Whittington and McClelland 1992:151). But the Bahr-el-Ghazal marshland is located in Southern Sudan, where the conflict between south and north halted the Jonglei Canal project. The Machar swamps project needs the co-operation and consent of Ethiopia, and there is little chance that that country, burdened with heavy debts, will be ready to consider the project at the moment. Other suggestions for water saving measures include remodelling Esna Barrage (a saving of 1.0 billion m^3), remodelling Nag Hammadi (1.0 billion m^3) and rehabilitation of Jebel Aulia reservoir (2.0 billion m^3) (Evans 1992). Altogether an additional 4.0 billion m^3 of water could be available for Egyptian use (see Map 1.5).

Water demand and supply in Egypt

It is clear that Egypt is totally dependent on Nile water and has been so for thousands of years, but certain facts about the supply of water should be kept in mind. The annual potential of evapotranspiration in Egypt ranges between 2,500 mm/year in southern Egypt and 1,750 mm/year in the Mediterranean region (Shahin 1989:209). Evaporation rates are lowest in the Nile Delta, a fact which makes this region good for farming. It is also important to note that Lower Egypt is favoured by its precipitation, the Delta receiving between 100 and 200 mm of annual rainfall compared with only 25 mm of rainfall in Upper Egypt.

For all its dependence on this precious resource, water management in Egypt leaves a lot to be desired. Guided by the supreme principles of water security and food security, water policy in Egypt was formed mainly by the constant need to expand areas of reclaimed land and to intensify cropping in order to increase food production (Waterbury 1982:65).

Table 1.12 presents the patterns of water demand and supply in Egypt. This table is based on Egyptian Government sources (Egyptian Water Master Plan (EWMP)) and external sources. There is a problem with the data provided by the EWMP since it has provided estimates for water demand which have been found to be too low while water supply figures have been over-estimated. As a result the EWMP data do not allow the gap between water supply and demand in Egypt to be unequivocally shown. The problem is most conspicuous in the estimates made of water demand for agriculture, the most important consumer of water in Egypt. The lowest estimate for Egypt’s water consumption in the agricultural sector put it at 33.0 billion

m^3 on average for the period 1980–6 (Whittington and McClelland 1992:146). Both Waterbury and EWMP estimate higher water consumption in agriculture.

EWMP estimates of the demand for irrigation water in the Old Lands are on average 3.0 billion m^3 lower than Waterbury's estimate and the EWMP also under-estimates water needs for the New Lands, which consume large amounts. According to Waterbury each hectare of newly reclaimed land needs 16.667 m^3 of water per year, whereas the EWMP estimates demand to be only 12.850 m^3 of water per year (Waterbury 1982:70). For the year 2000 the gap between the EWMP estimate of the demand for irrigation water and those of independent sources ranges from 5.0 to 10.0 billion m^3 (Shahin 1989:217; Stonner 1990). This discrepancy, if it eventuates, would mean a shortage in irrigation water of 5.0–10 billion m^3 and an ensuing shortage of food.

In the domestic and industrial sectors demand ranges between 2.0–2.5 and 4.0 billion m^3 for the first years of the 1980s and as high as 4.8 billion m^3 for 2000 (Evans 1992; Whittington and McClelland 1992).

The same trends appear on the supply side of the Egyptian water balance sheet. Water supply has been over-estimated and is based on the incorrect assumption that the Upper Nile projects, including the Jonglei, will provide Egypt with an additional 9.0 billion m^3 per year (Samaha, 1980:35). However, the Egyptian Minister for Water still believes that Egypt can expand its water supplies by 2000 to some 77 billion m^3 compared with the 57 billion m^3 used in 1989 or the 60 billion m^3 used in 1990 (Shahin 1989; *Aa'achar Sa'ah* 21 February 1990).

In 1990 Egypt still assumed that an additional 12.7 billion m^3 could be provided by recycled sewage, re-use of underground sources, the Jonglei project and saving water which currently flows into the Mediterranean Sea (*Aa'achar Sa'ah* 21 February 1990). At present, any water supply plan that relies on the enlargement of water supplies from these sources is misleading. In an average year during the past decade Egyptian water supply has been increased by the addition of 1.5 billion m^3 of water, termed the 'Sudanese loan', and this is based on the fact that the Sudan has been incapable of using all of its water quota according to the 1959 Water Agreement. The Sudanese water loan has expanded Egyptian supply to 57.4 billion m^3 for the period 1980–5 (55.5 billion m^3 released at Aswan and 1.9 billion m^3 Sudanese loan). But for the period 1986–92 releases from Aswan have been reduced to below 55.5 billion m^3 in order to conserve water (Evans 1992). In addition, a quantity of 3.0 billion m^3 was assumed to have found its way downstream from the High Dam. This is due to a real discharge above the mean of the 84.9 billion m^3 assumed in the Nile Water Agreement of 1959 (Waterbury 1982:73). Between 1980 and 1986 Egypt released a total of 11.5 billion m^3 above its annual quota of 55.5 billion m^3 of water from the Aswan High Dam (Chesworth 1990:48). This additional water has protected Egypt from its overly optimistic annual supply estimates and has helped it meet the water demand which has exceeded the planned supply.

On the supply side one should count also the groundwater resources which are estimated at 3.0–3.4 billion m^3 (Shahin 1989). The total extraction of water from wells in 1979 was about 2.9 billion m^3 of which 65 per cent was used for non-agricultural purposes (Arid Lands Information Center 1980:19). According to a recent estimate, the Eastern Desert deep water aquifers have a large water potential (Alam 1989:125). In addition, some 1.0 billion m^3 of water were extracted from the deep wells in the Eastern Desert. Drainage re-use is also possible, but this water is part of the 55.5 billion m^3 of the Nile's water which can be recouped and re-used. Estimates for the supply of drainage water for reuse range between 5.0 billion m^3 and 12–13 billion m^3 (Waterbury 1979; Samaha 1980:30–1; Shuman 1988:23).

Table 1.12 Water supply and demand in Egypt (various years, billion m^3)

Demand and supply		*Mid-1970s actual*[a] *MOI*		*1980*		*1990*				*1987 CHES*		*EWMP*	*2000 STON Drought*		*SH Full*
		EWMP	*WBUR*	*EWMP*	*WBUR*										
Demand															
Irrigation		40.0[b]													
		(26.0)		29.4	37.2	37.9	44.2			33.6	40.9		45.2		50.7
Old Lands					32.4	29.4	33.0				29.4		30.5[c]		31.5[c]
New Lands					4.8	8.5	11.2				11.5		14.7[c]		19.2[c]
Domestic		(3.5)		1.8	3.0	2.2	4.0				3.5				
Industrial	5.0[d]		0.3	1.0	0.8	2.0		2.4	1.4	4.8	4.8				
Navigation			3.8	2.5	1.6	1.6		17.5	1.6						
Drainage		9.3		16.0	15.0	14.2	14.2			13.4		11.7		11.7	
Evaporation		8.0			6.7	2.2	7.4			2.0	2.3		2.0		2.0
Conveyance and unaccounted			2.7												
Total		62.3	54.0	65.4	58.9	73.4			55.5	63.1		63.7		69.2	72.4
Supply															
Aswan release		55.5		57.5	60.0[e]	61.7	58.9[e]			55.5	No		50.0		55.5
Drainage re-use				–	2.5	5.4	6.0				data		5.5		6.0
Drainage return flow				–	4.0	–	4.0						3.5		3.0

Demand and supply	*Mid-1970s actual[a] MOI*	*1980*		*1990*		*1987 CHES*	*EWMP*	*2000 STON Drought*	*SH Full*
		EWMP	*WBUR*	*EWMP*	*WBUR*				
Underground waters[f]				3.4				3.4	3.4
Total	55.5	57.5	66.5	70.5	68.9		62.4	67.9	
Balance		+3.5	+1.1	+11.6	−4.5	0	−1.3	−1.3	

Sources:
[b]US Department of Agriculture 1976. According to this report, all the authorized water available from the Aswan High Dam was used in 1974!
[c] Author's estimates
[d]Chesworth 1990
[e]Samaha 1980; Waterbury 1979
[f]Shahin1989
Notes: MOI, Ministry of Irrigation; EWMP, Egyptian Water Master Plan; WBUR, Waterbury (1979, 1982); CHES, Chesworth (1990); STON, Stonner (1990);
SH, Shahin (1989).
[a] Included is the Sudanese loan of 1.5 billion m^3 and additional water to flow downstream from Aswan.

Other means of enlarging the water supply include the conservation of 1.5– 3.5 billion m^3 of the Nile's winter flow into the sea (Arid Lands Information Center 1980:25) and the recycling of municipal and industrial flows. This method would provide 4.5 billion m^3 of water to Egyptian farming (Stonner 1990:90–1).

The improvement and selection of water-efficient crops and even cutting the area cultivated with rice and sugar cane (which consume large amounts of water) could also assist in reducing water usage (up to 1.5 billion m^3) and would allow for the diversion of extra water to more important uses (Stonner 1990:87; Evans 1992). The use of salt-tolerant crops such as certain oil-seed crops might also help save some of the fresh water (Alam 1989:127; Shahin 1989:217). The most serious source of water loss, however, is the Egyptian irrigation system which is extremely wasteful. Unnecessary over-irrigation and re-irrigation is common, as is the use of water during daylight hours only (Arid Lands Information Center 1980:22).

Overall irrigation efficiency ranges from 44 to 58 per cent. This is a low figure for a river system such as the Nile (US Department of Agriculture 1976:33). According to another source, however, the re-use of drainage water is widely practised in the irrigation systems of Egypt and it raises the overall efficiency of the irrigation system to about 65 per cent of the present usage (Stonner 1990: 89).

But even this figure leaves room for improvement. Wasteful irrigation methods are used as farmers are reluctant to irrigate at night, which causes water to escape from the canal tails in the dark, and much of the irrigation system is under-utilized owing to channel deterioration and poor control (there are more than 30, 000 km of canals!) (Stonner 1990:88). It has been estimated that between 20 per cent and 50 per cent of the water entering the irrigation network is lost—some 8.0 billion m^3 per year (Samaha 1980; *South* June 1988; Haynes and Whittington 1981). Waterbury (1982:71) estimates conveyance losses at 6.7 billion m^3 per year.

In order to improve irrigation efficiency, Egypt has converted open-drainage systems into a system of underground pipes; more than 1,050,000 ha were converted to this method in Lower Egypt during the 1970s (Beaumont, Blake and Wagstaff 1988:526). Finally, water could be saved if priority were given to agricultural cultivation in the Delta since irrigation is the most efficient in this region because of its lower evaporation rates. Yet, every year 30,000 ha of fertile land are lost to farming in the Delta as a result of urban encroachment (Stonner 1900:87). Perhaps Egypt should consider charging for the water which it traditionally delivered to the fields at no cost to the cultivator (Waterbury 1979: 214). No-cost commodities tend to be wasted and charging for water, even a very low price, might reduce waste.

To sum up, Egypt could enlarge its water supply by perhaps 12.7–20.0 billion m^3 by using methods of conservation. At present water supply in Egypt as estimated by EWMP stands at 67.1 billion m^3 whereas Waterbury estimates it at 68.9 billion m^3. According to Waterbury the water deficit is above the 4.0 billion m^3 while the Egyptian Government estimates show a positive water balance of 8.2 billion m^3 (a very unrealistic estimate, based on an underestimation of the demand side of the equation). In the next decade, as Table 1.12 shows, Egypt will probably face a deficit of at least 0.8–1.3 billion m^3 per year.

These patterns in Egypt's policy towards water provision and water supply again point to attention being diverted towards possible water projects in the Upper Nile instead of the adoption of water-saving measures. One explanation for the Egyptian Government's avoidance of water economy measures is that at least some of the measures may place the government and the rural communities on a collision course since farmers would have to learn how to use water properly. The Egyptian Government might even consider setting a price tag on water delivered to the irrigated fields but this is a step that would reduce water wastage but outrage the farmers. There is also, of course, the cost of many of the water-saving projects, such as a system of drainage pipes or recycling plants, which would prevent the realization of other projects. In its policy of supporting food security, the government subsidizes crops such as rice and sugar-cane which consume large amounts of water. Moreover, the prices that farmers receive for their crops are kept low and so the crops are hardly profitable. The Egyptian government's policy of guaranteeing low food prices benefits the urban population at the expense of the rural population—so the attainment of food security appears difficult. Egyptian plans to reclaim some 600,000 ha (1.3 million feddan) until 1997 and irrigate it with 9.0 billion m^3 of Nile water seem to be unrealistic if one takes the current water deficit of this country into account (*South* June 1988). Yet in 1990, 70,000 ha still remained as the goal for reclamation with 10 billion m^3 of water (*Aa'achar Sa'ah* 21 February 1990). A more realistic estimate of reclaimed land is 340, 000 ha which will be irrigated by 6.5–8.5 billion m^3 of drainage water—not by any Aswan releases (Whittington and McClelland 1992).

The cultivated area is supposed to expand from 3.6 million ha (1990) to 4.3 million ha in 2000 and such an expansion will require 71 billion m^3 of Nile water which will not be available (*Ruz al-Yussuf 29* June 1990). Unless the next decade is very rich in precipitation in the Nile basin, Egypt will have to cut water consumption in accordance with water supply. Evans, for example, provides an estimate in which, under conditions of continuing drought, Egypt will reduce its Aswan release to 50.0 billion m^3 and hence the water allocation for irrigation will be reduced to 31.0 billion m^3, leaving no room for reclamation (Evans 1992).

Water supply and demand in the Sudan

Water supply in the Sudan depends mostly on the climate of the Sudan. Rainfall increases towards the south which mostly has a savannah-type climate; the north is semi-arid and arid. Annual potential evapotranspiration rates ranged between

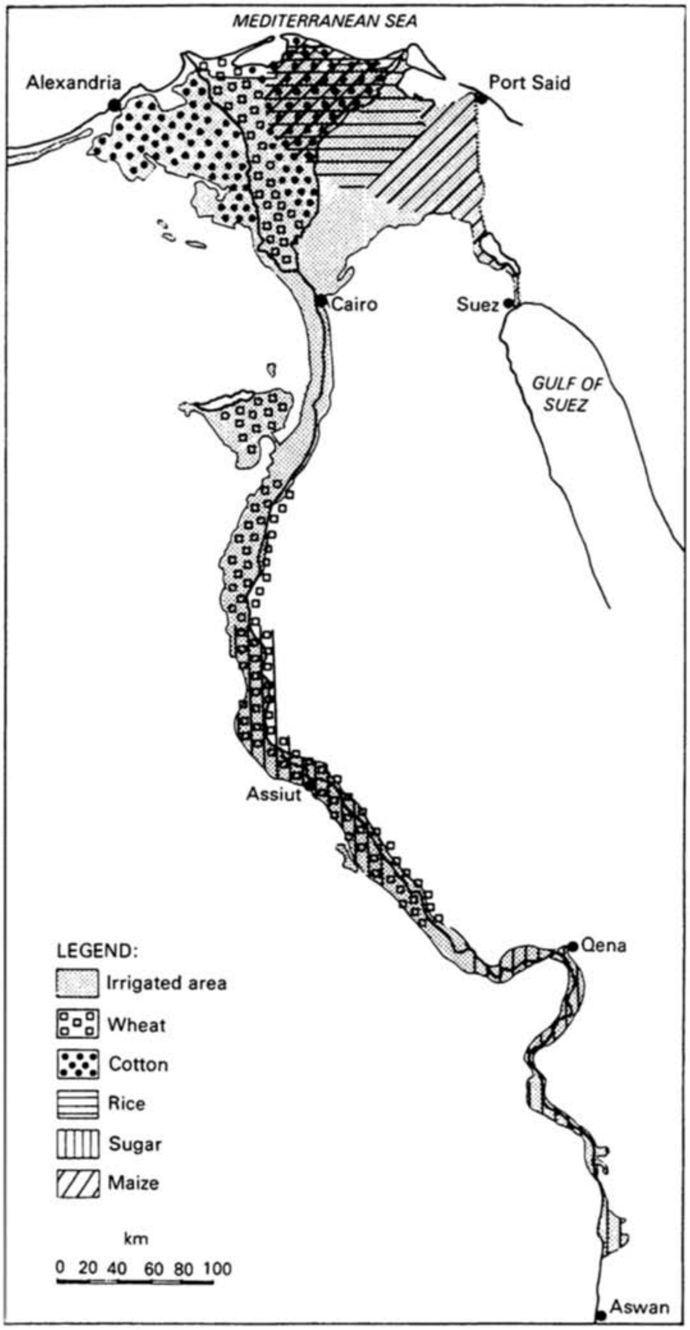
Table 1.13 Water supply and demand in the Sudan (billion m^3)

Supply and demand	*1985–6*	*1990 (estimates)*	*Mid-1990s[a] (estimates)*
Demand			
Irrigation	14.3–16.9 (12.60)[b]	12–14.0	14.0–16.0
Domestic and industrial	2.0	2.0	0.70
Evaporation	2.5	2.5	3.60
Seepage			3.74
Total	18.8–21.4	16.5–18.5	22.04–24.04
Supply			
Underground water	0.3	0.3	0.3
Nile Water	20.5[c]	20.5	20.50
Agreement			
Total	20.8	20.80	20.80
Balance	+2.0 to −0.6	+4.3 to +2.3	−2.76 to 3.24

Sources: Waterbury 1979, 1982; Chesworth 1990:50; Knott and Hewett 1990; Whittington and Haynes 1985:128
Notes:
[a]Whittington and Haynes (1985) believe that Upper Nile projects will be completed by 1995, providing an extra 3.85 billion m^3 to the Sudan. They also over-estimate Sudan's needs for water in agriculture.
[b]Waterbury estimates a range from 14.3 to 16.9. Chesworth estimates it as only 12.60.
[c]15.5 billion m^3 in Aswan is taken as equivalent to 20.55 billion m^3 measured in Sennar.

2,250 mm/year in the north and 1,500 mm/year in the south (Shahin 1989: 209). Rainfall is only 100–200 mm in the north of Sudan, but rises to 1,200 mm/year in the south. Farming is based on livestock and subsistence rainfed farming (Knott and Hewett 1990:95). The Sudan, unlike Egypt, has a substantial rain-fed agriculture and is less dependent upon the Nile River, but its best soils which are ideally suited for irrigated cultivation all lie within the catchments of the Blue and White Niles. Agriculture, which is the most important consumer of water in the Sudan, accounts for over a third of the Sudanese GDI and over 90 per cent of Sudan's exports (Whittington and Haynes 1985:130). In addition, about 72 per cent of the labour force is employed in agriculture (McLachlan 1985:35); so we may assume that water and the development of water resources is given the highest priority in the Sudan. A word of caution is in order regarding the quality of the data which are hard to obtain and, as with Egypt, not always accurate or reliable, especially concerning the areas under actual cultivation (Waterbury 1983:74). Table 1.13 presents the water supply and demand in the Sudan.

The data in Table 1.13 show a water deficit of between −2.76 and −3.24 billion m^3 but, as has been pointed out before, Egypt has been using 1.5–3.0 billion m^3 of the Sudan's unused water in addition to extra flood water stored in the Aswan High Dam. Thus Chesworth (1990) and Evans (1992) are right when they estimate Sudan's actual use of water for irrigation at a low of 12.0–13.0 billion m^3 per year, a total which leaves some 1.5 billion m^3 for Egypt. Chesworth has estimated that the total water use in the Sudan in the 1980s ranged between 11.5 and 13.1 billion m^3.



Map 1.6 The agricultural areas of Egypt

Other sources quoted by Waterbury suggest that in 1980 Sudan used 13.0– 18.0 billion m^3 per year depending on the area irrigated, which ranges from 1.13 million ha to about 1.34 million ha (Waterbury

1982:74). The total area currently irrigated in the Sudan is estimated as ranging between 2.7 and 4.5 million feddans (1.2–1.9 million ha) (Knott and Hewett 1990:97). We tend to accept the lower estimates as more realistic for the current water situation in the Sudan. This means that water deficits in the Sudan will most probably not appear until the end of the century. Finally, it should be noted that about 48.9 per cent of Sudan's electricity production is produced by the Nile's dams and the importance of this source will probably grow in the future (EIU (Economist Intelligence Unit) 1992e).

Water supply and demand in Ethiopia

Ethiopia, which contributes some 80 per cent of the water to the Nile, currently uses less than 1 billion m^3 of water (Tvedt 1992). Most of Ethiopia's territory has a highland tropical climate type controlled by monsoon air masses. The mean annual rainfall in most of the country is between 1,200 and 1,800 mm (Shahin 1985:135). This large amount of rainfall, however, is not evenly distributed, leaving northern and northeast Ethiopia with less precipitation. In addition Ethiopia has been ravaged by severe drought since the 1970s which has had serious effects. The Ethiopian highlands were badly struck in the 1970s which contributed to the starvation of over 1 million people in the 1980s and scarred the land so badly that it will require decades to recover (Smith and Al-Rawahy 1990:218). The overall decline of 5 per cent in seasonal summer precipitation in the Blue Nile catchment has not greatly changed the basic fact that this is Ethiopia's most important water resource.

The potential for water development in Ethiopia is enormous according to the US Bureau of Reclamation which carried out a field investigation and study of the Blue Nile catchment area between 1958 and 1964. The report found seventy-one suitable sites for dams including thirty-one storage reservoirs with a total net storage capacity of 85 billion m^3 and a hydro-power generating capacity of 8,700 MW (87 billion kWh each year) (Jovanovic 1985:84). Waterbury (1982) has noted the basic weakness of these sites for both water storage and power generation: first, they have steep slopes and so rapid siltation of the reservoirs can be expected (the Khashm el-Girba reservoir siltation is a good example) (Waterbury 1982:77); second, the Blue Nile tributaries are highly seasonal in their discharge, a characteristic which makes power generation more difficult. As for land irrigation, the US Bureau of Reclamation identified 430,000 ha of land suitable for irrigation within the Blue Nile catchment. Other plans for agricultural development include a proposal for diverting the Setit river (a tributary of the Atbara) to develop 70,000 feddans, requiring about 300 million m^3 of water per year (Tvedt 1992). The Blue Nile Plan, if fully implemented, would lead to the elimination of the annual variation in the flood of the Blue Nile, and the total quantity of Blue Nile water would be reduced by 8.5 per cent, drawing off between 5.4 and 6.0 billion m^3 of Blue Nile water which would become available for irrigation (Collins 1990b: 166–7; Waterbury 1982:78). In reality, Ethiopia has done very little to implement this plan.

In the 1970s Ethiopia constructed a run-of-the-river power station known as *Tis-Issat,* 25 km downstream from the Blue Nile outlet of Lake Tana. By the mid-1970s a second project, the Fincha hydroelectric power plant, had been constructed, producing 100 MW of electricity and also being used for irrigation (Jovanovic, 1985). Installed hydroelectric capacity in Ethiopia (1987) was 230 MW compared with a technical potential of 4,000 MW (World Resources Institute 1990:320). These projects utilize tiny quantities of Blue Nile waters, and currently Ethiopia is only using 1.0 billion m^3 of the waters of the Blue Nile. According to Egyptian sources the Fincha project stores only 0.3–0.5 billion m^3 of water (*Aa'achar Sa'ah* 19 February 1990; *Ruz al-Yussuf* 29 June 1990). Since about 80 per cent of Ethiopia's electricity is hydroelectric it is expected that the importance of the Blue Nile as a source of hydropower will expand in the future (EIU 1991–2).

Since 1957, Ethiopia has on several occasions claimed that it reserves the sovereign right to use Blue Nile water for the benefit of its own population (Naff and Matson, 1984:147). At the UN Water Conference at Mar de Plata, Argentina (1977), Ethiopian statements on its rights to exploit its natural resources alarmed Egypt (Waterbury 1979:348). Ethiopian statements pointed to the fact that Egypt had gone ahead and built the Aswan High Dam without even consulting Ethiopia (Okidi 1990:216). Ethiopian plans for the late 1970s foresaw a development project of 91,000 ha in the Blue Nile basin and 28,000 ha in the Baro, with water extraction capacity of 4.0 billion m^3 (Waterbury 1982: 78). In 1981, at the UN Conference on the Least Developed Countries, Ethiopia presented a ten-year investment plan which listed fifty irrigation projects totalling 704,000 ha in area of which 381,000 ha were sited in the Blue Nile basin and 15,000 ha in the Baro-Akobo basin (Waterbury 1982:79). In 1990, the Egyptian newspapers again returned to the Ethiopian plans to use the Blue Nile. Some officials expressed their view that population growth in Ethiopia and cultivation of new lands in the region near the Ethiopian border with the Sudan would reduce Blue Nile discharge by 5.4 billion m^3 (*Ruz al-Yussuf* 29 June 1990). The Egyptian reaction towards Ethiopia's plans to develop the Blue Nile has reflected Egypt's 'historical paranoia' and its fears for its water security (Collins 1990b: 167). In 1978, for example, Sadat warned that any country depriving Egypt of its water would find itself at war with Egypt (Waterbury 1979:78).

In a response to Jovanovic, the Egyptian hydrologist Shahin estimated that Ethiopia could claim large amounts of the Nile's waters, and proposed that Egypt and the Sudan divert 2.0 billion m^3 of water from Aswan to Ethiopia to assist that country during the drought period. Shahin also suggested that water saved in the Upper Nile projects should be divided between the Sudan, Ethiopia and Egypt (Shahin 1986).

Collins contends that, ironically, the Blue Nile Plan, if properly managed, would not substantially affect the water available to Egypt and the Sudan. Even if Ethiopia could implement the Blue Nile Plan and draw off 6 billion m^3, Egypt and the Sudan would still benefit from the construction of the reservoirs on the Blue Nile which would lose only 2.5 billion m^3. Ethiopia would release 46.9 billion m^3 or substantially more than the current mean annual discharge at Roseires (Collins 1990b: 167). But the political and environmental difficulties in Ethiopia (and the Sudan) might be something of a blessing in disguise for Egypt since the ambitious plans to impound Blue Nile waters envisioned for Ethiopia and the Sudan have never materialized (Smith and Al-Rawahy 1990:218).

In the area covered by the White Nile and its tributaries, the US Bureau of Reclamation located 600,000 ha of very fertile soil, and also specified a potential of 5–6 billion kWh of hydroelectricity on the Baro, Ghilo and Akobo (Jovanovic 1985:85). There is population movement from the over-farmed highlands towards the alluvial plain near Homera, along the Sudanese border. This region is similar to the heavy cotton clay zone of the Sudan which is watered by the Blue Nile and Rahad, the Dinder and the Seteit-Atbara. Waterbury believes that this is the region targeted for current development, together with the southwest Baro region (Waterbury 1982:79).

To summarize, the future demand for Nile waters by Ethiopia largely depends on the drought situation in the north and on resettlement projects. Ethiopia, after the defeat of the regime of Mengistu Meriam, worn by civil war and threats of secession in Tigre and Eritrea and weakened by drought and famine, is in no position to take advantage of the Blue Nile water. The Ethiopian economy is incapable of raising the necessary funds for the implementation of the ambitious plans for Blue Nile development and there is no chance in the near future that Blue Nile discharges downstream will be significantly reduced. As always, Egypt is very sensitive and on 7 January 1990 Egypt warned Ethiopia and Israel not to take any steps that would affect the Blue Nile discharges (*Ha'aretz* 7 January 1990).

In the long term, Egyptian interest lies with development of the White Nile (not least because it does not involve Ethiopia), whereas the Sudan's interest focuses on the Blue Nile because water stored on the Blue Nile can be delivered to Sudan's best lands by gravity flow. The Sudan's priority immediately raises the possibility of a deal with Ethiopia potentially at Egypt's expense (Waterbury 1992).

Nile water supply and demand in the Equatorial countries

The six Equatorial states which are riparian to the White Nile basin are located in the equatorial climate region (Zaire, Rwanda, Burundi and parts of Uganda), and in the highland tropical climate region (Kenya, Tanzania, parts of Uganda). Generally speaking, all these countries are well endowed with precipitation, but there are vast areas which need irrigation—such as the Vembere Steppe in southern Tanzania, the Kerio Valley in Kenya and areas lying in the Western Rift valley (Okidi 1990:216). One of the major dry zones in the Equatorial region lies in the Western Rift valley and the area surrounding Lakes Edward and George in Uganda, while another dry belt located between Lakes Edward and George stretches south into Tanzania. Local dams and boreholes have been constructed to provide water to these water-deficient areas (Kabera 1985:119). In 1961, at a meeting between representatives of the three Lake Victoria states attended by Egyptian and Sudanese representatives, the East Africans put their future needs for Nile waters at 5 billion m^3 compared with their current needs of 1.7 billion m^3 (Waterbury (1982:80). This estimate was rejected by Egypt and the Sudan because of lack of supporting data. In the meantime, agriculture developed around the shores of Lake Victoria. Kenya, Uganda and Tanzania could bring some half a million hectares under irrigation by the year 2000 but this use together with storage losses of irrigation water might reduce flows into Lake Victoria by 6–7 billion m^3 per year (Waterbury 1982:80). This would represent 0.2 per cent of the lake's volume, and even such a small amount would gradually reduce the lake's level by a few centimetres each year. Moreover, if the three Equatorial states were to focus on irrigation, they would share an interest in keeping the lake at its present level to feed agricultural areas adjacent to Lake Victoria. This need, of course, conflicts with the interests of the downstream consumers who would like to use Lake Victoria for storage and use the water for their arid lands. It should be noted that all the Century Storage schemes have envisaged long-term storage of an additional 4–5 billion m^3 downstream. Jonglei II, if ever implemented, would also require increased storage in the Equatorial lakes (Waterbury 1982:81).

Another project which might consume the Nile's waters is the Kagera River Basin Project. Rwanda, Tanzania and Burundi signed an agreement in 1984 for the construction of a hydroelectric station at Rusumo Falls on the Kagera (Okidi 1990:212). The project is a multipurpose project which includes the total economic development of the Kagera basin, including the irrigation of 90,000 ha and the intensification of water use in an additional 200,000 ha. The three partners have 1 million ha of irrigable land (Tvedt 1992:84). Altogether, all the irrigation projects may consume about 2.0 billion m^3 of water (Tvedt 1992:83). Finally, in addition to the Owen Falls Dam, the Equatorial states have enormous potential for hydroelectric power with over 200 possible storage combinations having been found (Waterbury 1982: 79). All the Equatorial states rely heavily on hydro power as a source for electricity production: Rwanda, 97. 7 per cent; Tanzania, 69.8 per cent; Uganda, 98.3 per cent; Zaire, 97.4 per cent; and Kenya, 72.3 per cent (*Economist* 1990).

In conclusion, in the short and medium term the Equatorial states will probably expand their water use from the current 1.7 billion m^3 to some 2.0–2.5 billion m^3 of water and this level of use will probably be acceptable to Egypt and the Sudan. It seems that there will be greater interest in flood control measures and hydro power than in large irrigation schemes in the Equatorial zone, and this will represent a smaller threat to water security for Egypt and the Sudan.

Future expansion in supply and demand in the Sudan

The IBRD (1979) *Agricultural Sector Report* contends that the Sudan's existing irrigated 1.7 million ha can be expanded to 2.1 million ha with a total water requirement of 20.5–21.8 billion m^3 per year. Waterbury (1982) has accepted this estimate as sound. However, he is more sceptical about the ambitious Sudanese plans to expand irrigation to over 1.26 million ha of new irrigation projects. Even if only 665,000 ha were to be irrigated (belonging to the category of top priority projects) it would require 8.4 billion m^3 of water, and it is hard to see where this additional water would come from. Moreover, Sudan has a plan to expand its current 33,600 ha of sugar-cane production (with water use of 2.5 billion m^3) but it is unlikely that it will have the water needed for this.

What will the Sudan's future demand for Nile water be? Sudan's water consumption is expected to remain at the present level, or a little higher, in the near future since the economic recession and a shortfall in investment from foreign or local sources will postpone all plans for land reclamation and development of new water projects (Waterbury 1982; Allan 1990). The dissidence in the south might also change Sudanese priorities in the planning and development of water projects to advance those projects which can provide benefits to the south Sudanese region. A slightly higher demand can be expected in the urban centres which are expanding rapidly and use Nile water for municipal and industrial use. In conclusion, at least in the near future, Sudan will have sufficient water since it does not even use its full water allocation of 20.5 billion m^3. Any improvement in the Sudanese economy can expect to be reflected by the full utilization of its present water and land resources.

The future expansion of water supply might be considered promising if political stability were to prevail in the future. First, and most importantly, there are vast water losses of up to 30 per cent due to badly maintained irrigation systems, of which the deteriorating irrigation grid in the Gezira-Managil scheme is an obvious example (Waterbury 1982:74). Khashm el-Girba reservoir has lost half of its storage capacity owing to siltation, and to a lesser extent the reservoirs of Roseires, Sennar and Jebel Aulia have also lost much of their capacity. It is clear that improvements in water storage in the reservoirs would save water. Raising the level of the Roseires Dam to increase the volume of stored water is planned and water storage will increase the reservoir capacity by 4.2 billion m^3 (from 2.4 billion m^3 to 6.6 billion m^3). There are plans to construct storage on the Upper Atbara tributary of Seteit at Rumela and the reservoir will store 1.3 billion m^3 (Knott and Hewett 1990:100–1). All of these will also add water.

In the long run, the conservation projects in the Sudd, Sobat and Machar swamps and the Bahr-el-Ghazal basin may produce an estimated 20.0 billion m^3 of water to be stored by Egypt and the Sudan. The cost of the projects, the Sudanese civil war and the economic situation in the Sudan make the possibility of these projects being built very remote. Moreover, it is in the best interests of the Sudan to prefer development of the Blue Nile projects over the White Nile projects. Storage sites on the Dinder and Rahad and on the Upper Atbara will provide better sites for hydro-power stations and will protect the older reservoirs (Roseires, Sennar, Khashm el-Girba) better from further siltation. Most important, water stored in these locations will be delivered by gravity flow and pumping expenses will be kept at a minimum. Finally, the Blue Nile region is far from the area controlled by the southern rebels and the Sudanese Government will have total control of it. The Achilles heel of this approach is the need to come to some kind of agreement with Ethiopia. Egypt, of course, is not likely to sit idle should she suspect that the Sudanese development of the Blue Nile might reduce the water available downstream.

It seems that the best strategy for the Sudan is not to resume Phase I of the Jonglei Canal, even if Egypt is anxious to renew work on the canal. The Sudan's meagre resources would be better used on projects in the Blue Nile. Yet, the Sudan has subjected her will to Egypt before, and may do so again.

Supply and demand in the Nile basin

Table 1.14 lists the water consumers and water contributors in the Nile basin. The discrepancy is very conspicuous: Egypt is vulnerable to the dangers inherent to remote water supply sources which it cannot control directly. Also conspicuous is the non-use of water by Ethiopia and the Equatorial states, a situation which may change in the future.

The table is based on an assumption that seems realistic at present: Upper Nile projects are not going to be completed. Water supply at Aswan will thus remain more or less the way it is at present. Of course any expansion of water usage in Ethiopia and the Equatorial states would reduce the water quantity downstream. Egypt, and to a lesser extent the Sudan, can anticipate a water deficit in any case and will have to prepare themselves for serious water shortages in the year 2000 (Table 1.15). The geopolitical meaning of these water shortages is that solutions to this shortage problem, peaceful or otherwise, will have to be found very soon.

Table 1.14 Water producers and water consumers in the Nile basin (in percentages)

Country	*Producers*	*Consumers*
Egypt	–	80
Sudan	1	18.5
Ethiopia	85	1.0
Equatorial states	14	0.5

Finally, we have to apply the Helsinki and ILC Rules to the patterns of water supply and demand in the Nile basin. First, on the supply side, two contradictory claims can be raised concerning the water losses in the Sudd, Machar and other marsh areas. On the one hand one can claim that such water wastage violates the rule which calls for avoidance of unnecessary waste in the utilization of waters in the basin. This principle is also useful for assessing current water utilization patterns in Egypt which are also wasteful. On the other hand, Chapter 2, Article V(k) of the Helsinki Rules stipulates that the needs of a basin state may only be satisfied without causing substantial injury to a co-basin state (such a damage to the Nilotic population of the Sudd). A far-fetched interpretation of this rule could blame the Sudan for the water wastage in the Sudd marshes or in the dams in its area. Neglecting the needs of the Nilotic population of the Sudd which finds its living in the Sudd could be another example. Equitable and reasonable utilization and participation in an international water basin also certainly calls for the greater participation of Ethiopia and the Equatorial states within the framework of both the Helsinki and the ILC Rules.

Articles 6(e) and 6(f) of the ILC Rules are also useful in evaluating the patterns of supply and demand because Article 6(e) calls for conservation, protection, development and the economic use of the water resource. The detailed account of patterns of supply and demand in Egypt and the Sudan show low levels of conservation and protection and almost no consideration for economy of use. Article 6(f) of the ILC Rules points to available alternatives (in this case alternatives to the Nile waters) as an important element in equitable water

Table 1.15 Supply and demand for Nile water in the year 2000

	Egypt	*Sudan*	*Ethiopia*	*Equatorial states*	*Whole basin*
Supply (billion m^3)	62.4	18.5	69.0	29.6	172.6
Demand (billion m^3)	63.7–69.2	22.04–24.04	2.0	5.0	108.2

	Egypt	*Sudan*	*Ethiopia*	*Equatorial states*	*Whole basin*
Balance	−1.3 to 6.8	−2.76 to 3.24	67.0	24.6	64.4

sharing. Article V(h) of the Helsinki Rules states simply that the availability of other resources should be considered. The Equatorial states, Ethiopia and, to a lesser extent, the Sudan have other water resources—both underground and surface resources—whereas Egyptian dependence on the Nile is complete; hence its right for the Nile is virtually unchallenged. To a lesser extent, Sudan's dependence on the Nile is also high.

Another feature which emerges from the survey of the supply and demand pattern is the scarce and contradictory data. The ILC Rules stress the need for co-basin states to gather and exchange information and plans for new projects. In this respect the situation in the Nile is not satisfactory although, at present, there is better co-operation among the co-riparians than in the past.

THE SOCIAL AND ECONOMIC IMPLICATIONS OF WATER SCARCITY

Introduction

Both the Helsinki and ILC Rules emphasize that the economic and social needs of each basin state, and the population dependent on the waters of the basin in each basin state, are relevant and important factors in the process of establishing equitable and reasonable water allocations. However, these principles are given equal weight with other principles which emphasize the need also to account for other alternative resources a basin state might have. The difficulties which arise out of the application of the Helsinki Rules to the economic and social life of the Nile's co-riparians are enormous. This is because the status of development of basin states is directly related to the water resources of the Nile, and only to the Nile. They ignore the fact that the link between the Nile waters and economic development is neither direct nor simple. Thus, the discussion in this section aims at demonstrating the basic economic and social weaknesses in the economies and societies of the Nile's basin states.

Social and economic facets of development

Dependence on water should be examined in the broader context of social and economic development. Under consideration are the levels of development which may indicate alternative solutions to water scarcity among the nine riparian countries. Table 1.16 shows some of the social indicators of the nine riparians of the Nile basin.

First, it should be stressed that all nine countries belong to the category of least developing countries, and they reflect a very low state of development in their social features. The relative ranking is intended to indicate their relative social standing. Egypt is ranked first or second on three of the four indicators. Nevertheless, it should be emphasized that on all these indicators Egypt's rate of social development is significantly lower than Europe's, where the average life

Table 1.16 Selected social indicators of the Nile countries

Country	*Life expectancy (at birth, 1995)*		*Infant mortality (%) (1990–5)*		*Adult illiteracy 1990*	
	Years	*Rank*	*No.*	*Rank*	*%*	*Rank*
Egypt	61.6	1	57	1	52	4

Country	*Life expectancy (at birth, 1995)*		*Infant mortality (%) (1990–5)*		*Adult illiteracy 1990*	
	Years	*Rank*	*No.*	*Rank*	*%*	*Rank*
Kenya	61.0	2	64	2	31	2
Tanzania	55.0	3	97	5	n.d.	n.d.
Zaire	54.0	4	75	3	28	1
Sudan	51.8	6	99	6	73	5
Rwanda	50.5	7	112	8	50	3
Burundi	49.5	8	110	7	50	3
Uganda	53.0	5	94	4	52	4
Ethiopia	47.0	9	122	9	n.d.	n.d.

Sources: World Bank 1987; World Resources Institute 1992–3; Human Development Report 1991
Note: n.d., no data.

expectancy at birth is 75–6, infant mortality is 10–15 per 1,000, adult literacy is 100 per cent, annual population growth is 0.2–0.3 per cent and per capita gross national product (GNP) is $11,000–14,000. On most of the indicators Sudan and Ethiopia are classified lowest and their relatively low population growth rates are related to the high mortality rates due to war and famine.

The data provided in Table 1.16 point to socially weak societies which are still struggling to provide fundamental health and education services. The Nile basin countries are economically and technologically weak and dependence on water will not be compensated for by strengths in other sectors of the society and economy. This picture is reinforced by Table 1.17 which shows selected economic indicators.

The per capita GNP in each of the countries is extremely low, averaging 5 per cent of that of most European countries. Moreover, the average annual growth of GNP is very low in Zaire, Tanzania and the Sudan.

The grave situation in Egypt, which has the largest and most advanced economy of all the riparians, has worsened in recent years. In the euphoric days after the Camp David Accords, Egypt borrowed money at high interest rates to develop its economy, but this has resulted in a long-term public debt which currently stands at $50 billion and represents 130 per cent of the Egyptian GNP causing foreign banks to refuse to allow any more borrowing. The International Monetary Fund (IMF) has made further loans and the rescheduling of Egyptian debts conditional on the introduction of significant reductions in government subsidies for basic foods such as flour and bread. Income from oil, the Suez Canal and remittances from Egyptians working abroad (the major Egyptian sources of foreign currency) dropped by the late 1980s and this exacerbated the economic situation.

Table 1.17 Selected economic indicators for Nile basin countries

Country	*GNP per capita ($ 1989)*		*Average GNP annual growth, 1979–89*		*Agriculture as percentage of GDP, 1990*		*Total debt as percentage of GNP, 1989*	
	$	*Rank*	*%*	*Rank*	*%*	*Rank*	*%*	*Rank*
Egypt	630	1	5.6	1	17	8	130	2
Sudan	540	2	1.7	6	33[a]	6	53	5
Kenya	380	3	4.2	2	28	7	50	6
Rwanda	310	4	2.2	3	38	5	28	9

Country	*GNP per capita ($ 1989)*		*Average GNP annual growth, 1979–89*		*Agriculture as percentage of GDP, 1990*		*Total debt as percentage of GNP, 1989*	
	$	*Rank*	*%*	*Rank*	*%*	*Rank*	*%*	*Rank*
Uganda	250	6	2.7	8	67	1	37	8
Zaire	260	5	1.6	7	30	7	83	3
Burundi	220	7	4.2	3	56	3	77	4
Tanzania	120	8	1.8	5	59	2	170	1
Ethiopia	120	8	2.4	4	41	4	48	7

Sources: World Bank 1987; Human Development Report 1991; World Resources Institute 1992–3
Note: [a]Data for 1988.

In 1988 oil revenues had been reduced from $3.0 billion to $1 billion and remittances dropped from $4 billion to $3.0 billion (*Ha'aretz* 5 August 1988). Egypt still received assistance of some $500 to $1,000 million from Saudi Arabia and Kuwait and American assistance to Egypt remains very significant, amounting to $2.3 billion since the mid-1980s ($800 million in economic assistance and $200 million in the form of agricultural commodities). This dependence on foreign, especially American, aid has had a restraining affect on Egyptian political behaviour in the international arena. In April 1991, as a result of its participation in the Gulf War against Iraq, Egypt's economic situation improved with most of Egypt's European and World Bank debt ($40.16 billion) being erased as an American reward to Egypt (*Ha'aretz* 11 April 1991).

The economy of the Sudan has been totally shattered by civil war and drought and its debt of $13 billion (equal to 70 per cent of the 1988 GNP) has made international banking reluctant to extend further loans. Efforts to exploit Sudan's rich natural resources have been halted by the civil war with the Unity Oil fields, for example, being held by the SPLA and not in use (*Africa News* 2 November 1987). In Ethiopia and Zaire, the large populations constitute a disadvantage, with the lagging economies and societies being unable to provide food, shelter and employment for all.

The contribution of agriculture to the GDP can be viewed in a similar way. Countries which rely heavily on the contribution of their farming sector are more vulnerable to fluctuations caused by nature or human action in this sector. Uganda, Burundi and Tanzania belong to this group but Egypt has a more varied economic structure and agriculture contributes only 21 per cent to its GDP. In the developed economies of Western Europe, the average contribution of agriculture to GDP is 3–5 per cent, the remainder being generated by manufacturing and services.

In conclusion, the economies of all nine riparian states are similar with indebted economies and alternative branches of the economy underdeveloped. In addition, a low rate of development and political turmoil have had a negative impact on the economies. Civil wars in Uganda (in the past), in the Sudan (at present) and in Ethiopia (just ended), as well as past and present upheavals in Zaire, Rwanda, Burundi and Kenya, have all damaged the economies of those countries.

The battle between accelerating population growth and food scarcity in the Nile basin

According to T.Malthus, population growth depends on the ability of agriculture to provide food for more people. Should agriculture fail to produce adequate food, the population will tend to decline (Tuma 1974:

381). However, this simplistic Malthusian formula does not account for states importing food and other commodities or for income earned in other sectors of the economy. The situation in the Nile basin shows that the efforts of the co-riparians to become self-sufficient in food production has failed, as Tables 1.18 and 1.19 clearly indicate.

Table 1.18 presents the relation between farming productivity and population growth. If we look at the index of food production, we find that Ethiopia, Tanzania, Uganda, Rwanda and the Sudan cannot supply enough food for their

Table 1.18 Population growth and agricultural productivity

Countries	*Total population*		*Average annual growth of population (%)*		*Average annual growth rate in Agriculture (%) 1980–7*	*Food production per capita index (1979–81 =100) 1988–90*
1990	*2000*	*1985–90*	*1995–2000*			
Ethiopia	49.2	66.4	2.6	2.9	−2.1	85
Zaire	35.6	49.2	3.1	3.2	3.2	97
Tanzania	27.3	39.6	3.6	3.6	3.8	88
Burundi	5.5	7.4	2.9	2.9	1.7	95
Uganda	18.8	27.0	3.6	3.4	−0.5	92
Rwanda	7.2	10.2	3.4	3.4	1.1	76
Kenya	24.0	35.1	3.5	3.8	3.4	107
Sudan	25.2	33.6	2.8	2.8	0.8	75
Egypt	52.4	64.2	2.4	1.9	2.7	123

Sources: World Bank 1987; World Resources Institute 1992–3; *Human Development Report* 1991

Table 1.19 Food importation in the Nile basin

Countries	*Cereal imports (thousands of metric tons)*		*Food aid in cereals (thousands of metric tons)*		*Food aid (million $) 1988–9*	*Food imports as percentage share of merchandise imported 1990*
1974	*1990*	*1974–5*	*1989*			
Ethiopia	118	687	54	573	538	17
Zaire	343	336	1	55	107	20
Tanzania	431	73	148	76	22	7
Burundi	7	17	6	–	2	18
Uganda	36	7	0	17	35	8
Rwanda	3	21	19	–	7	9
Kenya	15	188	2	112	62	10
Sudan	125	586	46	198	335	18

Countries	*Cereal imports (thousands of metric tons)*		*Food aid in cereals (thousands of metric tons)*		*Food aid (million $) 1988–9*	*Food imports as percentage share of merchandise imported 1990*
1974	*1990*	*1974–5*	*1989*			
Egypt	3.877	8.580	610	1.427	1.210	31

Sources: World Bank 1992; World Resources Institute 1989; Human Development Report 1991

expanding population but that Egypt, Kenya and Zaire can. In 1990 the Nile basin had to feed 247 million people and by the year 2000 will have to feed some 330 million people, a task which will be impossible because of the current drought situation. The average annual growth in agriculture is very significant in Tanzania, Kenya, Zaire and Egypt and (except for Kenya) matches or outpaces the rate of population growth.

A survey of the daily calorie supply (as a percentage of requirements, 1984–6) also shows that there is no hunger in Egypt, Zaire, Uganda and Burundi, and that only Ethiopia, the Sudan and Rwanda rank low on this scale. This points to a process in which the population needs for food are satisfied by importation, as Table 1.19 clearly shows. Cereal imports have expanded in Ethiopia, Kenya, Sudan and Egypt and food aid in cereals has been increased for Ethiopia, Zaire, Kenya, Sudan and Egypt with the percentage of food imports relatively high for Sudan and Egypt.

There is a suspicion that the data for Ethiopia may be unreliable because, since the mid-1980s, that country has been receiving enormous foreign food aid and also imports food to alleviate the prevailing famine. There were reports that in 1987 Ethiopia had to import 15 per cent of its food (500,000 metric tons) and, in 1988, the Government received 1 million tons of food aid (*Africa News* 30 November 1987:7). In 1982, per capita food production was only 81 per cent of what it had been in 1969–71 (Vestal 1985:10). The USA provided $1 billion of emergency aid to Ethiopia during the 1984–5 famine and $450 million was provided to Ethiopia in 1985 and 1986 (*Africa News* 30 November 1987:6).

The famine which has plagued the Sudan and Ethiopia has affected some 10 million people in the two countries and is an important factor to consider when water allocation of the Nile water is discussed (*Sudanow July* 1985:15; *Africa News* 30 November 1987). Both the Sudan and Ethiopia rank high according to their needs, but there is no guarantee that projects within the Nile basin will solve their famine problems. Egypt imports between 75 and 80 per cent of its cereal requirements and, more significantly, draws some 80 per cent of its revenue from exports to food imports (Hairash 1988; Dethier and Funk 1987:26; *Christian Science Monitor* 8 March 1990). In recent years food has constituted one-third of all Egyptian imports and other important sources of Egyptian income are barely enough to cover the constantly expanding needs of the ever-growing population. According to recent data, only 38 per cent of the Egyptian labour force is employed in agriculture—the lowest percentage employed in agriculture among the Nile co-riparians.

In relation to the application of the relevant Helsinki Rules to the Nile basin this puts Egypt in a vulnerable position as she is more dependent on the Nile resources than any other co-riparians and, accordingly, should receive priority.

The Sudan has also been ravaged by ten years of drought and at least 2.0–3.0 million people have been affected by it (*Sudanow* January 1985:9). Drought and desertification have been the main reasons behind wide-scale population movements in the western regions (*Sudanow* July 1985:15). It is ironic that a decade ago Sudan was being touted as the future 'bread basket' of the Arab world (Stork and Pfeifer 1987:4).

Seventy-one per cent of Sudan's labour force is employed in agriculture (1980) but agriculture contributes less than a third of the GDP and 50 per cent of Sudan's export earnings are required to buy food imports (Stork and Pfeifer, 1987:6). Finally, the six Equatorial states have farming economies which employ between 71 and 92 per cent of their labour. Imported cereals and other foods constitute nearly 10 per cent of their total imports. Nevertheless, their agricultural needs could be satisfied with water from sources other than the Nile.

The potential for 'food security' in the Nile basin

'Food Security' is a somewhat elusive, ideological concept which refers to government policies aimed at self-sufficiency in food production. This policy is important for many developing countries where food security is accompanied by a policy of subsidies for food and the agriculture which produces it. Often, policies motivated by 'food security' lead to inefficient and unreasonable policies in the water sector and this is the reason for the inclusion of such a topic in this book. The agricultural potential of the Nile's co-riparians will be examined with this in mind.

Potential for agricultural expansion in Egypt

Agriculture in Egypt is almost completely confined to the Nile Valley and Delta, a handful of oases and a few areas of arable land in the Sinai peninsula. About 2.6 million ha, all irrigated, are cultivated annually, and approximately 3 per cent of the total area in the country—55.039 km^2—is habitable (Whittington and Haynes 1985:125).

There are three strategies for the expansion of agricultural production: expansion of the cultivated area mainly by land reclamation; intensification of the agricultural sector; and restructuring the agricultural sector within the economy. None of the three methods seems very promising. The Egyptian new land reclamation programme has turned out to be extremely expensive while the land reclaimed contributes less than 1 per cent of the total agricultural production (Voll 1980:147–8; Richards 1980:9). It does not look as though Egypt will have the water necessary to irrigate the newly reclaimed lands, however (Allan 1988–9:47).

The intensification of farming also carries problems with it as it is accompanied by increased salinity and drainage problems. Finally, restructuring the agricultural economy through a different pricing policy is politically very difficult and it is not very likely that the Egyptian government will raise the price of bread or cut wheat subsidies because such actions will anger the public. Only minor changes such as cutting back on crops which consume large amounts of water can be anticipated.

Potential for agricultural expansion in the Sudan

The land area of the Sudan is 237,632,000 ha but only 3.0 per cent of this is arable—some 36 million ha. Only 10.9 million ha are cultivated and only 1.8 billion ha (0.6 per cent of the total area) are irrigated. But the Sudan also has rain-fed farming of some 2.3 million ha. According to Adams and Holt (1985: 64) 14 per cent of the arable land and permanent crop land is irrigated. Sudan's relative reliance on farming is greater than Egypt's, with 90 per cent of its exports based on agriculture and 64 per cent of Sudanese labour engaged in agriculture (Whittington and Haynes 1985:130). As much as 35 million ha in Sudan may be potentially arable and 1.7 million ha are irrigable, in addition to the 9.5 million ha of rain-fed farming. The drought of the 1980s and the civil war have impaired Sudan's ability to feed itself. Sudan specializes in the production of cotton, peanuts, wheat and sugar-cane; it has enormous areas of grazing land (estimated at between 120 and 150 million ha, but the drought killed almost a third of all the livestock in the major livestock raising region of Darfur (*Sudanow* January 1985:9). Sudan still has very substantial areas of land suitable for future cropping and it could use Nile water which it is not currently using and even additional Nile water lost in the Sudd marshlands. Thus, its potential to increase its agricultural production is excellent, even better than Egypt's, but it urgently needs political stability—something which looks very remote at present.

Potential for agricultural expansion in Ethiopia

Ethiopia, which is one of the poorest countries in the world, has enormous farming potential but drought and two civil wars have turned the country into a large food importer at the end of the 1980s with food representing one-third of all imports. Yet, there are 430,000 ha of land suitable for irrigation within the Blue Nile basin, some 600,000 ha in the Baro, Gilo and Akabo basins (tributaries of the Sobat) and the possibility of expanding rain-fed farming in areas such as the clay-belt near the Sudanese Jezira. The collectivization efforts of the Ethiopian Governments and the policy of maintaining artificially low prices for the main grains (teff, sorghum, barley, millet, wheat and maize) have resulted in reduced production of these basic foods (Vestel 1985:10). Over the next decade it is doubtful whether Ethiopia will be stable enough to cope with its agricultural problems.

Finally, Tanzania, Kenya and Uganda also have enormous reserves of arable land with dry areas in the rift valley which could benefit from irrigation. Their major problem is that civil war and revolt, enormous population growth, corrupt or inept regimes and their situation as developing countries have left little room for planned development in the agricultural sector.

Conclusions

A thorough examination of the economies and societies of the nine co-riparians of the Nile clearly shows that all rank very highly in their needs. Egypt is relatively better off than the rest and one can speculate about whether this incremental benefit should be related to the Nile waters or not, since Egypt has utilized the river since time immemorial. Most of the Nile co-basin states have very large and dependent populations with all exceeding 24 million except for the smaller states Rwanda and Burundi. Extremely large populations can be found in Egypt and Ethiopia.

A different, and perhaps better, indicator for measuring dependence on the Nile is agriculture. It has been pointed out that all the countries of the Nile have farming economies, that agriculture represents between one-fifth and two-thirds of their GDP, and that between one-third and two-thirds of their labour is employed in the agricultural sector. They all need to import food but Egypt, the Sudan and Ethiopia are especially dependent on food importation and the Sudan and Ethiopia rank low on the food production per capita index. Egypt ranks low in future potential for agricultural growth whereas all the other co-riparians rank higher.

The equitable and just allocation of Nile water will probably give Egypt, Sudan and Ethiopia priority over the rest of the co-riparians and practical compensation for Nile basin states should be allowed for. Egypt could compensate her upper co-riparians and provide assistance for the development of their farming and other branches of the economy. Egypt and the Sudan could also utilize underground water resources and improve water usage efficiency. However, it does not look as though Egypt or the Sudan can hope for a water allocation from the Nile greater than they already have.

THE LEGAL AND GEOPOLITICAL SETTING OF THE NILE BASIN

The geopolitical situation consists of legal and political aspects which concern principles of mutual benefits, linkage and image. Current and potential conflicts will be classified and identified and, finally, proposals for possible conflict solutions will be presented.

The legal regime in the Nile basin

The legal regime of the Nile is presented in Table 1.20 which shows that most of the legal agreements signed on the consumptive usage of the Nile's waters have been colonial agreements. These agreements were inspired by Great Britain which managed to secure the waters of the Nile for Egypt and the Sudan and, as a result, Egypt is almost the only beneficiary of the colonial agreements. Italy, France and Belgium, the other colonial powers in the Nile basin, were not sufficiently vigilant in their efforts to protect the interests of their colonies with regard to the Nile's water. Most of the agreements listed in Table 1.20 do not deal with the utilization of the Nile's waters but focus on prevention of any water projects which might infringe on Egyptian patterns of utilization. Being typical colonial agreements, they were more concerned with defining the spheres of influence of the colonial powers and their frontiers than with the economic welfare of the colonies. The agreement which Great Britain signed on behalf of its colonies clearly favoured Egyptian interests over the interests of the upper riparian states, and the weakness of Ethiopia is also conspicuous with none of the agreements protecting its natural right to Nile waters.

There are only three agreements which govern the consumptive utilization of the Nile: the 1929, the 1959 and the Kagera Basin Agreement. The 1929 AngloEgyptian Nile Agreement, to which the Sudan was not party, allotted Egypt 48 billion m^3 of water for agricultural needs; this was determined by what was needed for Egypt to irrigate 2.1 million ha. Egypt made it clear that the agreement was to be temporary and conditional upon future political developments, especially in the Sudan, and also recognized Sudanese rights to Nile utilization; only 4 billion m^3 of water, however, was allotted to the Sudan (Okidi 1990:201). Sudan was allowed to increase its utilization of Nile water as long as it did not infringe upon Egypt's natural and historical rights to the waters of the Nile. No irrigation or power works which would infringe upon Egyptian interests were to be constructed on the Nile or its tributaries.

The 1929 Agreement reserved all the Nile's natural flow during the low season from 19 January to 15 July (at Sennar) for Egypt's use. The Sudan was given the right to appropriate waters from the Sennar Dam from surplus waters

Table 1.20 Legal regime of the Nile, 1891–1990

Type of agreement	*Sides to the agreement*	*Contents of agreement and utilization patterns*	*Beneficiaries*	*Legal status at present*
Colonial agreements				
1 1891 protocol	Italy and UK	Italy agreed not to construct any work on the River Atbara which might modify its flow	Egypt	No longer effective with end of Italian and British colonial rule
2 AddisAbaba 1902	UK and Ethiopia	Ethiopia committed itself not to construct or allow to be	Egypt	Ethiopia questioned the validity of the Agreement as it was

Type of agreement		Sides to the agreement	Contents of agreement and utilization patterns	Beneficiaries	Legal status at present
			constructed any work across the Blue Nile, Lake Tana or the Sobat		not ratified and its own rights were not mentioned
3	London 1906	UK and Congo	Redefined spheres of influence; Congo undertook upon itself not to construct any work on or near the Semliki or Isango	Sudan and Egypt	Ceased to be effective with end of colonial rule
4	London 1906 (1891)	Great Britain, Italy, France	The three states committed themselves to the preservation of the integrity of Ethiopia and reconfirmed the 1891, 1906 Agreements	Ethiopia, Egypt and Sudan	No longer effective with end of colonial rule
5	Rome 1925	Great Britain and Italy	Great Britain obtained from the Abyssinian Government the concession to build a dam on Lake Tana; the hydraulic rights of Egypt and the Sudan were recognized	Egypt and the Sudan	The agreement was found not binding in 1925 by the League of Nations
6	1929 Nile Agreement	Egypt/ Great Britain	The agreement allocated 48 billion m^3 of water to Egypt and 4.0 billion m^3 of irrigation water for the Sudan	Egypt and the Sudan	Not binding. Replaced by the 1959 Agreement

Type of agreement		Sides to the agreement	Contents of agreement and utilization patterns	Beneficiaries	Legal status at present
	1929	Great Britain (on behalf of the Sudan, Kenya, Tanganyika, Uganda)	No work of any kind could be undertaken on the Nile or on the Equatorial Lakes without Egypt's consent	Egypt	Egypt sees it as binding. The Equatorial states see it as not binding

Type of agreement		*Sides to the agreement*	*Contents of agreement and utilization patterns*	*Beneficiaries*	*Legal status at present*
7	1934 London Agreement	Great Britain (on behalf of Tanganyika) and Belgium (on behalf of Rwanda and Burundi)	The agreement prevented any construction work which would damage the flow of the Kagera to Lake Victoria	Egypt and the Sudan	No longer effective with end of colonial rule
8	Owen Falls Agreement 1949	(a) Great Britain/ Egypt (b) Great Britain/ Egypt	Egyptian supervision of water discharges at the dam. Egypt took the responsibility for any damages resulting from the rising of Lake Victoria	Egypt, water; Uganda, hydro power	The agreement is still binding; it is binding today also to Uganda
9	Owen Falls Dam 1950 Exchange of Notes	Great Britain/ Egypt	To secure the co-operation of Uganda for Egyptian data collection in Lake Victoria	Egypt and the Sudan	This agreement remains in force; it is also binding in Uganda
Post Colonial Agreements					
10	1959 Nile Water Agreement	Egypt and the Sudan	Construction of the Aswan Dam for flood control, irrigation water and electricity; Egypt would receive 55.5 billion m^3 and the Sudan 18.5 billion m^3	Egypt and the Sudan	Still binding
11	Kagera Basin Agreement 1977	Burundi, Rwanda, Tanzania and Uganda (joined in 1981)	Multipurpose development of the Kagera basin: hydropower, agriculture, trade, tourism, fisheries	Rwanda, Burundi, Tanzania	Binding; difficulties in implementation

12	1967 Nile Hydro-meteoro-logical Survey (with UNDP Agreement	Egypt, Kenya, Sudan, Tanzania, Uganda	To survey Lakes Kioga, Victoria and Albert; to measure water balance in Lake Victoria catchment	Egypt, Kenya, Sudan, Tanzania, Uganda	Binding and effective

Sources: Allan 1990; Okidi 1990; Collins 1990a; Ahmed 1990; Sayed Badour 1960; Krishna 1988; Rogers 1992
Note: Some minor agreements are not included. These are as follows: the 1932 Jebel Aulia Compensation Agreement between Egypt and the UK; the 1950 Egypt-UK Agreement to co-operate in a meterological and hydrological survey of Lake Victoria; and two agreements between Kenya, Uganda and Tanzania concerning a hydrometeorological study of the Equatorial Lakes.

of the summer (Krishna 1988:27). The Nile regime established by the Agreement of 1929 was supplemented three times: first by the Jebel Aulia Compensation Agreement of 1932, later by another agreement concerning the working arrangements for this dam and finally by the Egyptian Declaration of 1949. These supplements were followed by a reported agreement in 1952 with respect to the fourth cataract dam (Krishna 1988:28). The sequence of these agreements point to a gradual Egyptian abandonment of the doctrine of absolute territorial integrity and its adoption of a somewhat more restrictive attitude towards the Nile.

In 1956 when Sudan became independent it declared that it did not see itself bound by the 1929 Agreement as it was not a party to it (Sayed Badour 1960: 222). The 1959 Agreement for the full utilization of the Nile's water was concluded when both countries were independent but, even in this process, Egypt began its planning and financing of the High Dam at Aswan without consulting the Sudan (Sayed Badour 1960:221). According to this agreement, Egypt would receive 55.5 billion m^3—a gain of only 7.5 billion m^3 over the Nile Agreement— while the Sudan's share would increase from 4 billion m^3 to 18.5 billion m^3, a substantial increase of 14.5 billion m^3 from its allotment of 1929 (Collins 1990a: 165).

The 1959 Agreement proclaimed that it covered the full utilization of Nile water, making it clear that the Agreement of 1929 only regulated the partial use of the natural river. The Agreement recognized the established rights of the parties. The quantities of water actually used by Egypt up to the date of the Agreement constituted the established rights of Egypt (48 billion m^3 annually) and Sudan (6 billion m^3). Thus, in the 1959 Agreement the Sudan recognized the prior allocation principle and the 'historic rights' of Egypt as fixed at 48 billion m^3. The Sudan agreed to advance a water loan of 1.5 billion m^3 to Egypt but the amount would not exceed 1.5 billion m^3 and its use would not extend beyond November 1977 (Krishna 1988:29). Egypt and the Sudan also agreed to adopt a common view toward any claim for allocation of the Nile's waters originating from any of the upper riparians. Any additional water which might be conserved or discovered would be divided on a 50–50 basis between Egypt and the Sudan.

Of equal importance was the establishment of the Permanent Joint Technical Commission (PJTC) which would henceforth be responsible for the planning and implementation of all hydrological works on the Upper Nile. The 1959 Agreement reflects, at least partially, not only Egyptian recognition of the principle of equity in the appropriation of the Nile's water resources but also acknowledgement, by both the Sudan and Egypt, that mutual benefits would be gained from the construction of the Aswan High Dam. The 1959 Agreement also finally established the linkage between the varied policies of Egypt and Sudan which formed the foundation for adopting a common policy against the other co-riparians of the Nile.

Ethiopia and the East African states were not invited to any of the negotiations of the 1959 Agreement. In the 1959 Agreement future Ethiopian requirements from the Blue Nile were not specifically taken into account nor were the modest claims of the East African countries who, under the earlier 1929 Agreement, had been prevented from taking any water at all except for what was provided in the prior Egyptian agreement. Possible future claims by other countries were tacitly acknowledged within the new agreement between the two republics, however, when they declared that they would consider and 'reach one united view regarding claims by other riparian states' (Howell, Cobb and Lock 1988:47).

When the UK became aware of Egyptian-Sudanese plans for utilization of the Nile waters, it moved quickly. In August 1959, Britain sent notes to the United Arab Republic, the Sudan, Belgium (responsible for the Congo) and Ethiopia, reserving the rights of three co-riparians (Kenya, Uganda and Tanganyika) with respect to any accord concluded between Egypt and the Sudan. The latter responded immediately and Egypt and the Sudan signed an agreement on 8 November 1959 (Waterbury 1979:72). Despite the disproportionate quota ratios which favour Egypt and the complete denial of the upper riparian needs, the 1959 Agreement is an international river agreement and very few of those exist (Naff and Matson 1984). The only other agreement in the Nile basin is the Kagera Basin Agreement.

The Kagera Basin Agreement

The Kagera Basin Agreement between Rwanda, Burundi, Tanzania and Uganda is a multipurpose agreement for the use of the Kagera basin. The objectives of the agreement are hydro-power development, the provision of water for municipal, industrial and agricultural use, the development of fisheries trade and transport, and environmental protection. The Kagera Basin Agreement has met with difficulties in mobilizing resources and implementing its wide array of projects but that may well be only a matter of time.

There is a broad legal and political debate concerning the status of all the agreements listed in Table 1.20. First, there is the Egyptian position. Egypt claims that all the agreements signed by the European colonial powers for their African colonies are recognized by international law as having continuing validity. According to this view, the Vienna Convention of 1978 about state succession and treaties confirms that treaties remain valid and obligate successor states (Ahmed 1990:229). Those who considered the above treaties which Great Britain signed for Egypt as valid also held the view that the treaties had created ‘an international regime’ for the whole Nile basin, governing seven states or dependent territories and securing the paramountcy of Egypt’s agricultural interests (Sayed Badour 1960:212).

A totally different view has been adopted by the upper riparians. The upper riparians regard the present legal regime as the vestiges of the ‘colonial era’ and unacceptable since the agreements totally disregard the interests of the upper basin states (Godana 1985:197).

Thus, the upper riparians have on various occasions made it clear that they reserve their rights to Nile water. Ethiopia declared this in 1956, 1977 and 1980 (Collins 1990b: 166). Kenya, Uganda and Tanzania adopted a similar policy which was spelled out in the Nyerere Doctrine (Collins 1990b: 165). Ethiopia and the Equatorial states do not recognize the validity of the 1929 and the 1959 Agreements since their rights for Nile water were not acknowledged. Egypt responded by stating that all the agreements are valid and that Egypt would go to war if Ethiopia tried to block the waters of the Blue Nile (Sayed Badour 1960: 212; Shahin 1985; Okidi 1990:203–4).

In conclusion, the legal status of present agreements concerning the Nile basin are not recognized by all co-riparians. Both the Helsinki Rules and the ILC Rules encourage international agreements for the reasonable and just water sharing of international rivers. Nevertheless, because the existing agreements do not involve all the co-riparians and do not rely on the Helsinki Rules for equitable water allocation among all riparians, the agreement will probably not gain the approval of specialists in customary international law of river basins. Potential conflicts between upper and lower riparians are classified as stakeholder conflicts and reflect the patterns of power distribution, historical conditions and regional competition for power. Solutions to stakeholder conflicts may be found in the geopolitical setting of the Nile basin.

Geopolitical circles in the Nile basin

Three levels of political processes affect the events in the Nile basin and the relations among states. The first is the political stability and territorial integrity of the riparian states; the second is the interaction and transaction flows among riparian states; and the third is regional power politics (within African and Arab contexts) and superpower politics. All these levels will be analysed as part of the complex relations between Egypt, Sudan and Ethiopia. It is estimated that the relations between these three are more crucial to the future solution of the water-sharing problems than the relations between upper riparians, though a survey of the relations in this part of the basin will also be made.

Egypt-Sudan: The politics of dominance

The basic political approach which has guided the level and intensity of the relationship between Egypt and the Sudan is the 'unity of the Nile basin'. This is supported by the fact that the ancient, powerful civilization of Egypt was always able to impose its dominance on the Nile Valley, and by the fact that Sudanese nationalism developed late (1880 with the Mahdia movement's struggle against Anglo-Egyptian rule). Although the unity of the Nile Valley was one of the more potent slogans of the Egyptian nationalist movement, the unity of the Nile in the past was always achieved through the imposition of Egyptian and/or British colonial rule (Waterbury 1979:43).

The Sudan serves as a cultural, religious and geographical link between Arab-Moslem North Africa, the Middle East and Black-Nilotic Africa, south of the Equator. Its final boundaries, which are a good example of imperial-colonial boundary drawing, were set in 1928 after the British imposed their rule on the Nuer and the southern provinces (Waterbury 1979:47). The Sudan was an artificial administrative entity with more than 115 tribal and linguistic groups, too pluralistic to develop a unifying state idea. This basic weakness in its foundation is responsible for the permanent instability and frequent revolts and changes of the regime which have characterized the state since it was born. Sudanese nationalism, weak in nature, was affected by Egyptian nationalism and the unity of the Nile Valley policy was adopted by one of the two major Sudanese parties in the 1940s and 1950s. By the mid-1950s all Sudanese parties advocated a separate Sudanese entity and, in 1956, the Sudan won its independence, ending Egypt's hegemony. Rising Sudanese nationalism clashed with rising Egyptian nationalism and the crisis between the two countries deteriorated into a military confrontation in 1958 when Egypt dispatched an unsuccessful expedition to reclaim disputed border territory. This was followed by Sudanese abrogation of the 1929 Water Agreement and only after the short-lived Sudanese parliamentary democracy was replaced by a military dictatorship led by General Aboud were the Egyptians (led by Nasser and the Free Officers) and the Sudanese ready to sign the 1959 Nile Water Agreement. In 1964 the military dictatorship of Aboud was ousted and, for five years, the Sudan was led by an unstable parliament later replaced by General Numeiry (1969). Numeiry was able to stabilize Sudan in the 1970s and the relations between the Sudan and Egypt became very close, but Numeiry's regime was replaced by that of another general, Al-Dahab, and parliamentary democracy returned to the Sudan in the mid-1980s with the fundamental Moslems headed by Sediq Mahdi. This regime was, in turn, replaced by another military regime led by General el-Bashir in 1989 (Ronen 1985:10–12). During the years 1958–85 Egypt and the Sudan developed a close co-operation based on equality and mutual benefit and the forming of a coalition against other African states including Upper Nile countries. Sudanese politics, like those of Egypt, were anti-Libyan and Libya was involved in two coups against Numeiry. Libya supported the Mahdi regime and maintains warm relations with the present ruler of the Sudan, General Omar el-Bashir. (*Economist* 11 August 1990:51).

What really lies at the base of Sudanese instability and endangers the present utilization patterns of the Nile water is the Sudanese civil war. The economically retarded south's claims against the north are based on two fundamental issues: the colonialist treatment of southern Sudan, especially the exploitation of its resources (oil, Nile water); the imposition of Moslem law, the Sharia, on the Christian population of the south. The Sudan's adoption of the Jonglei Plan revived additional latent fears in the south of Egyptian settlement and a fear that the Jonglei would open the way to Egyptian and northern Sudanese economic and political influence. The SPLA is demanding an equitable share of the future economic benefits derived from the natural resources of the south. Yet the present regime does not show any signs of willingness to accommodate the southern rebels and there are signs that the south, plagued by famine and war, may be considering secession from the Sudan. Meantime, the SPLA has been supported by Ethiopia and the Sudanese Government has been, in turn, supporting the rebel movements in Eritrea and Tigray (Tigre) since each country has an interest in destabilizing the other (*Africa News* 16 November 1987:8). This involvement only complicates the tangled situation in the Upper Nile even more.

Egypt has always sought regional security to cushion it against unforeseen developments in the Upper Nile (Waterbury 1979). The instability of the Sudan (and other riparians) has reinforced Egypt's 'Fashoda complex', a term coined by Waterbury (1979). The Fashoda complex is a fear Egypt has had for generations of unstable regimes in the upper Nile basin which might affect the Nile flow to Egypt. The name derives from an incident in 1898 that brought the French and British to the brink of hostilities because of a French expedition to secure the headwaters of the White Nile (Naff and Matson 1984:143). For example, fears were aroused in Egypt by the presence of Cuban troops in Ethiopia, and by the two uprisings in the Shaba Province of Zaire in 1977 and 1978. At present Egypt is greatly concerned about the civil war in the Sudan (which halted the Jonglei Canal excavation in 1983) and the prospect that a separate independent state in the south might endanger Egyptian utilization of the Nile—hence the Egyptian efforts to assist in solving the Sudanese civil war. Moves towards unification between Libya and the Sudan are also perceived as being a direct threat to Egyptian control of Nile water. Egypt is also concerned with the Moslem fundamentalist nature of the present regime in the Sudan for an extremist Moslem regime in the Sudan might have an effect on the Moslem fundamentalists of Egypt. The Sudan's interest in Egypt are also economic and, according to some sources, some 2 million Sudanese are working in Egypt though Sudanese trade with Egypt is no more than 5 per cent of its total trade (Waterbury 1979:54: *Middle East International* 6 March 1987).

Of course the common interests in the Nile and the two countries' need for a common position *vis-à-vis* the other riparians creates pressure for Egypt and the Sudan to remain close. Ten years ago Waterbury observed that 'Egypt's stability is relatively meaningless while Sudan's instability is of incalculable importance for it is the midstream and not the downstream state which may affect the flow of the Nile' (Waterbury 1979:208). This observation is still valid at present. Any future solution for southern Sudan will have to include a more equitable allocation of water, or a payment of water rent to the Nilotic population of the Jonglei area whose local economy of fishery and grazing is going to be hurt by the Jonglei Canal (Howell, Cobb and Lock 1988:469). In the short run Egypt can only gain from Sudanese instability and war because it utilizes all the additional waters which the Sudan cannot use in its current state of economic devastation. In the medium and long run only stability in the Sudan can bring about the implementation of the Upper Nile projects; so, the interests of Egypt and the Sudan coincide here.

Egypt, Sudan and Ethiopia—complex relations forged by war and instability

The tensions between Sudan and Ethiopia and between Egypt and Ethiopia have arisen for different reasons. The Egyptian-Ethiopian tension concerns utilization of the Nile—more particularly the Blue Nile which Ethiopia claims it has a natural right to exploit. The conflict between the Sudan and Ethiopia moves across a wide spectrum and each is involved in attempts at the political and military destabilization of the other.

Ethiopia is one of the poorest countries in the world and, until 1974, was a feudal monarchy. The military regime which ousted Haile Selassi in 1974 established a socialist regime based on the nationalization of capital and land and the collectivization of villages. Ethiopia is ethnically and culturally very heterogeneous and this ethnic pluralism is the reason for the present civil wars. Ethiopia has been involved in almost two decades of internal civil and ethnic wars, and external war with Somalia. At present (1992) there is no civil war since the military regime of Mengistu has been brought to an end and replaced by the rebel front of Tigray which is trying hard to stabilize the country. In the east, Moslem Eritrea has become autonomous and, eventually, will probably become independent.

During the last decade Ethiopia, in addition to war, has suffered from drought and famine with 6–8 million Ethiopians facing possible starvation. Hundreds of thousands of refugees have moved to neighbouring countries and many more have become internal refugees.

More positively, there is hope that the end of warfare in Ethiopia also means that Sudan and Ethiopia are not going to be involved in the conflict and the southern rebels of the SPLA will receive no support from Ethiopia.

Egypt is extremely sensitive to any Ethiopian efforts to use the Blue Nile and, as stated before, has warned Ethiopia that any impediment to the flow of Blue Nile waters will be seen as *casus belli* for Egypt. Israel has also been blamed several times by Egypt for assisting Ethiopia in her efforts to develop the Blue Nile (*Aa'achar Sa'ah* 21 February 1990; Allan 1990:181; Collins 1990b: 166; *Ruz-al-Yussuf* 29 June 1990; *al-Salam-Al-Arabi* March 1990).

Yet, Egypt has tried to maintain good relations with Ethiopia and has been involved in mediation efforts to end the civil wars there. It seems reasonable to assume that Egypt will eventually arrive at 'new arrangements' with the new regime of Ethiopia, through agreements which will not impair Egyptian water rights but will be fairer and more equitable for Ethiopia. The reconstruction of a future Ethiopia (in whatever form it takes, as a divided or federated land), will necessitate the planned and integrated utilization of all water resources, including the Nile.

Finally, we have to discuss Libya's role in the destabilization of the Nile basin. Between 1977 and 1985 Libya supported the Ethiopian regime when it was interested in the replacement of Numeiry. Today it supports the new regime in the Sudan and has stopped its support of the Ethiopian Government.

The geopolitical relations between the upper riparians and the lower riparians

In the past Egypt and the Sudan have ignored the interests of the upper riparians and have not invited them to take part in the planning or construction of any water projects such as the Aswan. Three of the upper stream states—Kenya, Uganda and Tanzania—do not see any of the Nile treaties or agreements as binding upon them (Nyerere Doctrine). Egypt and Uganda do co-operate in Owen Falls Dam matters and an Egyptian engineer is supervising there to ensure that the water discharges meet Egyptian requirements (Collins 1990b: 163).

The UNDUGU grouping which consists of Egypt, Sudan, Uganda, Zaire, the Central African Republic, Rwanda and Burundi is a co-ordinating body, dominated by Egypt, which operates on a ministerial level and discusses the members' various common interests concerning the Nile, agriculture resources development etc. (Ahmed 1990). Egypt is upset that Ethiopia, Tanzania and Kenya not only did not join the discussions, but adopted an attitude critical of the activities of UNDUGU. In fact, the nine states of the Nile basin have very little interaction such as interdependence in trade, and most trade is with the developed industrial world. In addition, there are no strategic groupings based on shared concern or mutual interest with respect to factors particular to the Nile and its catchment area (Allan 1990:181).

The East African states might not necessarily impair the flow of water to the north, but they see no reason to impede the development of their own water resources to improve or secure the position of Sudan and Egypt (Allan 1990: 188).

The most important obstacle to the Nile integrative planning and develop ment for the Nile is the poverty and lack of development of the co-riparians which do not allow them to participate in the construction of large water projects either alone or in co-operation with others. The political instability, tribal and ethnic rivalry, autocratic regimes and limited foreign aid increase the incompatibility of these states and negatively affect their ability to cope with their economic and social misfortunes.

Conclusions

The legal regime and geopolitical setting in the Nile's basin seriously limit the possibilities of integrated river basin planning of water utilization of the Nile. The past legal agreements for Nile water allocation were subject to Egyptian hegemony and its initial espousal of the doctrine of absolute territorial integrity which was later replaced by the doctrine of limited sovereignty. Egypt also insists upon prior use of the Nile as a legal right which entitles it to the greatest portion of the Nile's water. Ethiopia, on the one hand, and the Equatorial states, on the other, claim their own sovereign right to the utilization of water resources within their own territories. There is no single legal statement or agreement which acknowledges that all the co-riparians of the Nile have rights to its water resources or that these rights are limited in any way and guided by the principle of just and equitable water sharing.

The three existing agreements which concern the Nile were developed for the benefit of Egypt, the Sudan and Uganda. The Owen Fall's Dam Agreement was developed for the mutual benefit of Uganda (electricity) and Egypt (irrigation water). Some parts of this agreement satisfy some sections of the Helsinki Rules such as the principles which call for compensation and the covering of the cost of projects by the main beneficiary (as in the case of Egypt). But the Agreement does not benefit other co-riparians and has been the cause of heavy damage to local populations.

The Aswan High Dam Agreement was written for the mutual benefit of Egypt and the Sudan but totally ignored the other co-riparians' rights to equitable allocation based on the principles of geography, climate and hydrology. The Kagera Basin Agreement involves more co-riparians but it is too early, yet, to evaluate whether it will operate on principles of equity when implemented.

Linkage is the key to the analysis of Egyptian policy towards co-riparians, especially the Sudan. It is the Nile flow which determines Egyptian policies of pacification, on the one hand (in the Sudan), or threats of war (in the case of Ethiopia), on the other. Alliances and power strategies in various areas are all linked together and motivated by Egypt's Fashoda complex.

The conflict in the Nile is a stakeholder conflict which is usually solved because of Egyptian domination of the Nile region. Egypt, being the most powerful nation in the Nile, is acknowledged by her co-riparians as the regional leader—a fact which assists in the amelioration of conflicts.

Egypt also has to maintain its image as a peaceful leader in the region. Thus,

Table 1.21 Principles for water allocation in the Nile basin

Country	*Country share in area of Nile basin (%)*	*Country water contribution to the Nile*	*Climate*	*Past and present utilization*	*Social and economic needs*	*Level of dependence on agriculture*	*Availability of other resources*	*Treaties and legal agreements concerning the basin*	*Notes and evaluation*
Egypt	62.5	None	Less than 200 mm (total desert)	79%[a]; historical right 59–60 billion m^3 (present)	Income 630 Pop. growth 1.9 Agric. growth 2.7 L. exp. 61.6 Inf. mor. 57	Food imports 31% Agric. in GDP 17%	Oil, Suez Canal, Industry	1959 Treaty with Sudan; Owen Falls with Uganda	Middle income economy Lower middle income
Sudan	12.1	1% ?	Desert 50%; savannah 400–1,500 mm 50%	20%[a]; 16 billion m^3 (present)	Income 540 Pop. growth 2.8 Agric. growth 0.8 L. exp. 51.8 Inf. mor. 99	Food imports 18% Agric. in GDP 37%	Oil	1959 Treaty with Egypt	Low-income economy
Ethiopia	9.9	84%[a] 72 billion m^3	Tropical 60%; highland 80%; semi-arid desert 12%	0.5%; less than 0.6 billion m^3 (present)	Income 120 Pop. growth 2.9 Agric. growth –2.1 L. exp. 47.0 Inf. mor. 122	Food imports 17% Agric. in GDP 41%	Gas, hydro power	–	Low-income economy
Zaire	0.8	River Semliki to Albert 10%	Tropical 1,500–2,000 mm		Income 260 Pop. growth 3.2	Food imports 20% Agric. in GDP 30%	Minerals, hydro power, oil	–	Low-income economy

					Agric. growth 3.2 L. exp. 54.0 Inf. mor. 75.0				
Kenya	1.8	30%[b] to Lake Victoria	Tropical 60%; savannah 30%; semi-arid 10%		Income 380 Pop. growth 3.8 Agric. growth 3.4 L. exp. 61.0 Inf. mor. 64.0	Food imports 10% Agric. in GDP 28%	Hydro power, tourism	–	Low-income economy
Tanzania	3.8	18%[b] to Lake Victoria	Savannah 50%; tropical 50%	Less than 1%; 1.7 billion m^3 (present)	Income 120 Pop. growth 3.6 Agric. growth 3.8 L. exp. 55.0 Inf. mor. 97.0	Food imports 7% Agric. in GDP 59%	Hydro power	Kagera Basin treaty with Uganda, Rwanda, Burundi	Low-income economy
Uganda	7.7	12%[a] to Lake Victoria	Tropical 1,000–1,500 mm		Income 250 Pop. growth 3.4 Agric. growth –0.5 L. exp. 53.0 Inf. mor. 94.0	Food imports 8% Agric. in GDP 67%	Hydro power	Kagera Basin treaty with Rwanda, Burundi, Tanzania; Owen Falls Dam with Egypt	Low-income economy

Country	*Country share in area of Nile basin (%)*	*Country water contribution to the Nile*	*Climate*	*Past and present utilization*	*Social and economic needs*	*Level of dependence on agriculture*	*Availability of other resources*	*Treaties and legal agreements concerning the basin*	*Notes and evaluation*
Rwanda	0.7	30%[b] to Lake Victoria through Kagera	Tropical 1,000–1,500 mm		Income 310 Pop. growth 3.4 Agric. growth 1.1 L. exp. 52.0 Inf. mor. 112.0	Food imports 9% Agric. in GDP 38%	None	Kagera Basin treaty with Uganda, Burundi, Tanzania	Low-income economy
Burundi	0.5	Tropical 1,000–1,500 mm	Income 220 Pop. growth 2.9 Agric. growth 1.7 L. exp. 49.5 Inf. mor. 110.0	Food imports 18% Agric. in GDP 56%	None	Kagera Basin treaty with Uganda, Rwanda, Tanzania	Low-income economy		

Sources: World Bank 1992; World Resources Institute 1992–3; Human Development Report 1991

Notes:

[a]Egypt and Sudan use about 60 per cent of the total flow of the lower Nile system. The other 40 per cent of water is only available for economic use to a minor extent (Allan 1990:183).

[b]The total contribution of the six countries is 14–16 per cent of main Nile discharge (Badr 1959:94–5; Waterbury 1979: 23). According to Okidi (1990:195), Ethiopia's water contribution to the Nile's discharge north of Khartoum is 75–80 per cent while the Equatorial lakes contribute between 20 and 25 per cent. According to Waterbury, Ethiopia contributes 86 per cent of the waters to the Nile, whereas Badr puts it at 84 per cent.

[c] Country share is by percentage of drainage basin.

[d]Water contribution is measured by percentage of discharge to the drainage basin to which a co-riparian is part.

[e] Utilization in billion m^3 and in percentage of total consumption of water.

[f] Income is GNP per capita ($); Pop. growth is population growth in percentage; Agric. growth is agricultural growth in percentage; L. exp. is life expectancy in

in contrast to recent prophecies that the Nile is going to become the arena of a 'water resource war' (Smith and Al-Rawahy 1990; Vlachos 1990) we consider the possibility to be remote. According to Waterbury, the only reason why there has not been a major war is because most of the states in the basin have been in such political disarray that they are incapable of financing and implementing the agricultural projects that would have established new claims to Nile water (Waterbury 1990).

Smith and Al-Rawahy (1990) examined several policy options for Egypt to take in her relations with other co-riparians. He found that, 'given the current scenario, planned aggression against any of the riparian users would not yield the overall preferred decision' (Smith and Al-Rawahy 1990:221). Investing in water technologies, on the other hand, would yield the most desirable solution given Egypt's current socio-economic status and high unemployment. But, if additional quantities of water are to be brought into the Nile system, they will have to be found at the sources of the White Nile, since the Blue Nile waters have already been heavily committed to irrigation by Egypt and the Sudan (Waterbury 1979: 30). On the other hand, if principles of equity are adopted by all the co-riparians of the Nile, and Ethiopia is allowed to go ahead with its Blue Nile Plan, Egypt and the Sudan might find that the plan, properly managed, will not affect the amount of water available to them (Collins 1990b: 167). Egypt and the Sudan would benefit from the construction of the reservoirs on the Blue Nile and would lose no more than 25 billion m^3 of water.

Other equitable arrangements may be projected for Ethiopia and the Sudan. We can envisage inter-basin water transference from the Blue Nile Atbara and Sobat basins to drought-stricken Eritrea and Tigray providing access to the Red Sea for landlocked Ethiopia. Transferring water to arid lands outside the above basins will involve water rents and thus compensation for the current users of the Nile, and the same arrangement of water rent can work in Upper Sudan. Water has become one of the more precious commodities in the Nile basin and its price tag should reflect its real economic value. This will encourage a more reasonable and efficient use of water and save this precious commodity which could, and should, be exchanged for other necessary commodities such as access to the sea, economic and social welfare, the development of an infrastructure or industrialization.

In the next decade there is very little chance that either the Sudan or Egypt will be able to affect the quantity of water flowing to Egypt because water projects take time and money to construct. Yet, both Egypt and the Sudan will have to prepare themselves for a future with less water.

CONCLUSIONS: PRINCIPLES OF WATER ALLOCATION IN THE NILE BASIN

The major rules for equitable sharing of the international rivers presented in the introduction are the geography of the basin, the hydrology and climate of the

Table 1.22 The relative ranking of the Nile co-riparians according to the Helsinki Rules

	Egypt	*Sudan*	*Ethiopia*	*Zaire*	*Kenya*	*Tanzania*	*Uganda*	*Rwanda*	*Burundi*
Country share in area of Nile basin (%)	1	2	3	7	6	5	4	8	9
Country water in contributi on to the Nile	8	7	1	6	3	4	5	2	2
Climate	1	2	3	7	4	5	6	8	9

	Egypt	*Sudan*	*Ethiopia*	*Zaire*	*Kenya*	*Tanzania*	*Uganda*	*Rwanda*	*Burundi*
Utilization									
past	1	2	4	5	5	5	3	5	5
present	1	2	3	4	4	4	4	4	4
Social needs									
Life expectancy	1	6	9	4	2	3	5	7	8
Infant mortality	1	5	8	3	2	5	4	7	6
Economic needs									
Income	1	2	9	7	3	8	5	4	6
Total debt	2	4	6	3	6	1	7	8	5
Total population 1990	1	5	2	3	6	4	7	8	9
Average annual growth of population 1987–2000	8	7	6	6	1	3	4	2	5
Average annual growth in agriculture 1980–7	4	7	9	3	2	1	8	6	5
Cereal imports	1	3	2	4	5	6	7	8	9
Food production per capita, index 1986–8	2	5	5	4	5	5	1	6	3
Percentage of labour force in agriculture 1985–8	9	8	7	6	5	4	3	2	1
Agriculture as percentag	8	6	4	7	7	2	1	5	3

	Egypt	*Sudan*	*Ethiopia*	*Zaire*	*Kenya*	*Tanzania*	*Uganda*	*Rwanda*	*Burundi*
e of GDP 1988									

*Sources: World Bank 1992; World Re*sources Institute 1992–3; Human Development Report 1991
Notes: Country share, 1, the largest; country water contribution, 1, the greatest; climate, 1 dry, 9 wet; past use, 1 oldest, 5 newest; present use, 1 largest, 4 smallest; life expectancy, 1 longest, 9 shortest; infant mortality, 1 lowest, 9 highest; income, 1 highest, 9 lowest; total debt as percentage of GNP, 1 largest debt, 8 smallest; total population, 1 largest, 9 smallest; average annual population growth, 1 highest; average annual growth in agriculture, 1 highest; cereal imports, 1 largest importer; food production index, 1 highest.

basin, past utilization, present utilization, economic and social needs, the population dependent on water, the comparative costs of alternative means of satisfying the economic and social needs of a basin state, the availability of other resources, avoidance of unnecessary waste of water, and the degree to which the needs of a basin state may be satisfied without causing substantial injury to a co-basin state. Tables 1.21 and 1.22 present the major details of the co-riparians of the Nile.

It should be emphasized that Table 1.22 reflects only the relative ranking of the co-riparians, on sixteen different variables which measure most of the features listed above according to the Helsinki and ILC Rules. In Table 1.21 the first, second, and third columns refer to the geography, hydrology and climate of the basin states. Egypt and the Sudan rank first and second in their relative share of the drainage basin area and in their arid climate which entitles them to a share of the water of the Nile. But both countries contribute no water to the Nile—a characteristic which could become a crucial point of contention if drought conditions in the Nile drainage basin prevail in the near future.

Ethiopia ranks first in her water contribution to the Nile and third according to her relative share of the Nile's drainage area and her climate. On all three variables she fares very well but, as stated before, Ethiopia is endowed with alternative water resources, though the droughts in the last decade improve her standing in the Nile. Kenya, Tanzania and Uganda occupy the middle positions in the above ranking: they are located on the fourth to sixth position on most of the variables. All three states have shares in the Equatorial drainage and they contribute to its waters through Lake Victoria. Rwanda and Burundi (through the Kagera) and Zaire (through the Semliki) make a relatively large and significant contribution to the White Nile, but all three have a humid climate and no need for irrigation water. All three could, however, use the Nile river sources for hydro power, and perhaps should be compensated by Egypt and the Sudan for the benefits they allow to flow downstream.

The next column (past and present utilization) shows that Egypt ranks high because of its historical rights (prior use) to the Nile's water from time immemorial. The Sudan only joined the users' circle in the 1920s whereas the other users of the Nile joined later. At present, Egypt utilizes the Nile's waters most, followed by the Sudan and then Ethiopia and the Equatorial states.

There is an obvious discrepancy in the modest ranking of Ethiopia and the Equatorial states in the geography, hydrology and climate variables and the present patterns of consumption of Nile water.

The social needs of the co-riparians are enormous but Egypt is best off followed by Kenya, Uganda and Tanzania. Ethiopia, Rwanda and Burundi are on the lowest economic level, being more needy than the other co-basin states. The economic needs of the co-riparians are also very great, all being developing societies with low-income populations and very high debts. Egypt which ranks relatively high on the variable of per capita income also has a very large external debt—only second to Tanzania in this. Sudan is second to Egypt in its per capita income whereas all the remainder are indeed very poor deeply indebted societies, with per capita incomes which range between $120 and $370. Some of the co-riparians have other resources such as minerals, fertile land or tourist attractions, but they lack the necessary funds to exploit them and are politically unstable—a fact which deters potential investors. On the variables which feature in the dependent population variables, Egypt, Ethiopia and Zaire have the largest populations in the basin but are not highest on average annual growth of population for 1987–2000. This future trend nevertheless offers very little comfort to a country like Egypt with some 1.4 million new babies to feed each year. In all the Equatorial states the average annual growth rate is very high and rapidly accelerating. Dependence on agriculture is also very high in the Equatorial states which have between 70–90 per cent of their population employed in farming, but Egypt has 'only' 38.2 per cent of its labour employed there.

The Sudan (64 per cent) and Ethiopia (79 per cent) are relatively very dependent in the farming sector and both have to worry about the continuing drought. The contribution of agriculture to GDP is relatively very high among the Equatorial states where it contributes some 30–70 per cent, while in Egypt it contributes a fifth of GDP. Thus, the relative importance of agriculture is smaller for Egypt than it is for its co-riparians, and Egypt has succeeded in developing other sectors of its economy.

Egypt which fares well on the food production index has accomplished this through enormous food importation. The Sudan and Ethiopia, second and third to Egypt in food importation, does not fare so well on the food production index. The Equatorial states are relatively low on cereal importation and Uganda and Burundi rank highly on the food index. Tanzania, Kenya and Zaire also show relatively high growth rates in their agricultural sectors, a fact which may improve their food supply situation in the future.

If all the Helsinki Rules or ILC Rules were applied equally, there is no doubt that Ethiopia and the Sudan and practically all the Equatorial states would rank higher than Egypt on almost all the above variables and the conclusion would be irrefutable. They are entitled to a large portion of Nile water. There are two factors which strengthen Egypt's position. First, it has prior usage—a factor which is nor quite acceptable from a legal point of view to all international law specialists. The second factor is, of course, Egypt's total dependence on the Nile which is reinforced by the rule which demands satisfaction of the co-riparians' needs without causing damage to Egypt. The needs of the Equatorial states and some regions of Ethiopia could be satisfied without using any Nile water at all.

The greatest disadvantage of the Helsinki Rules in their application to the Nile basin is that they are non-discriminatory (by their definition) by time and space. None of the Nile co-riparians constitutes a unified entity in relation to its needs. There are significant regional disparities, and some regions, often outside the Nile basin, have more urgent needs than the areas included within the Nile drainage basin. Moreover, the needs of co-riparians may change with time, a fact to which the inflexible Helsinki Rules cannot relate. The reasonable and just application of the Helsinki Rules necessitates, first, in-depth data collection which will specify the exact needs of the population within the basin and the exact availability of resources outside the basin. More exactly the Helsinki Rules should become location and time specific in order for them to be more useful. There is no escaping the attribution of relative weights to each rule. For example, dependent population and social and economic needs are more important in developing countries than in developed countries whereas rules which refer to the cost of alternative usage, the practicality of compensation and the prevention of water wastage are more easily applied to developed societies. The principles of equitable utilization may ultimately clash with power struggles and political instability within the Nile basin and eventually submit to these forces. This, of course, does not offer a very promising future for the application of the Helsinki and ILC Rules.

2
THE GEOPOLITICS OF INEQUALITY: THE TIGRIS-EUPHRATES DRAINAGE BASIN

GENERAL—THE INTERNATIONAL CHARACTER OF THE EUPHRATES AND TIGRIS DRAINAGE BASINS

The Euphrates (Firat or Furat as it is called in Turkey) is an international river shared by Turkey, Syria and Iraq. The Tigris (Dicle as it is called in Turkey and Digla in Iraq) is an international river basin shared by Turkey, Iraq and Iran, with Syria as a minor riparian. The Euphrates and the Tigris have almost completely separate basins which unify only in their last 190 km at the Shatt al-Arab; but as Iraq, Syria and Turkey share both rivers, it is customary to treat the two separate basins as one unit.

Table 2.1 presents the length of the Euphrates and Tigris and their tributaries and describes international participation in the main channel of the Euphrates 3,000 km long, which is shared by Iraq (36 per cent), Syria (23 per cent) and Turkey (41 per cent). Syria also has almost total control over the springs of the Khabour and Balikh, and controls some 70 per cent of their drainage basins. The Tigris is only 1,850 km long and most of it (77 per cent) is in Iraq followed by Turkey (22 per cent) and Syria which has 44 km in the main river channel (and a small tributary), constituting its border with Turkey (about 36 km) and with Iraq (about 8 km). Iran becomes a partner in the Tigris basin because of its part in the Lesser Zab and Diyalah, both important tributaries to the Tigris, and Iran also contains the Kharun which discharges its waters into the Shatt al-Arab. The Shatt al-Arab is unequally shared by Iran and Iraq and it constitutes the border between the two.

The Tigris-Euphrates system has the following particular hydro-political features. First, the two rivers are shared by Turkey, Syria and Iraq. Equitable allocation of their waters can take advantage of this fact by apportioning the waters of the Euphrates to one riparian while the waters of the Tigris and its tributaries can be allocated to other riparians. Second, the relations between Syria and Turkey and Syria and Iraq have gone through moments of crisis and tension in the past, a fact which poses difficulties for the readiness of the co-riparians to negotiate agreements in a spirit of trust. Third, Iraq, like Egypt, has possessed ancient rights to the Tigris-Euphrates waters for 6,000 years being

Table 2.1 The Euphrates-Tigris system: length of rivers within riparian states

River	*Total length*	*Turkey*		*Syria*		*Iraq*		*Iran*
(km)	*km*	*%*	*km*	*%*	*km*	*%*	*km*	*%*
Euphrates[a]	3,000	1,230	41	710	23	1,060	36	

River	*Total length*	*Turkey*		*Syria*		*Iraq*		*Iran*	
(km)	*km*	*%*	*km*	*%*	*km*	*%*	*km*	*%*	
(2,370)[b]									
(2,737)[c]									
Tributaries									
Khabour[d]	430[b]	40		390					
		30		70					
Balikh[e]	202	82		230					
Tigris	1,850	400	22	44	1	1,418	77		
(l,718)[b]									
Tributaries									
Greater Zab	392[c]	92				300			
Lesser Zab	380[b]					310			
400[c]									
Diyalah	440[b]					240		200	
386[c]									
Adhaim	210[b]					210			
(Uzaym)	230[c]								
Kharun	400[b]							400	100
(Karun)									
Shatt al-Arab	180[b],[f]								

Sources: Ionides 1937; Beaumont 1978; Brawer and Karmon 1968; author's own calculations

Notes:

[a]According to Saleh (1985) the total length of the Euphrates in Turkey from the point of confluence of the Kara-sue and Murat-Sue until it enters Syria is 455 km. The total length of 1,230 km includes the length measured with all the longest tributaries. For the Euphrates, Khader provided a length of 675 km (22.5 per cent of the total length of the river) and the same data appear in Naff and Matson (Khader 1984:169; Naff and Matson 1984). According to Tekeli the Euphrates' length in Syria is 600 km and in Iraq 750 km. The Tigris's length in Iraq is 1,195 km.

[b]Shahin (1989) provides different measures of length: the main channels only.

[c]Al-Khashab's (1958) data are based on Iraqi sources.

[d]According to Khader (1984:169) the length of the Khabour and its major tributaries in Syria is 460 km and the Balikh 150 km but Turkey also contains 270 km of the Khabour tributaries.

[e]According to Khader, the length of the Balikh including its tributaries in Syria is 105 km, in Turkey about 100 km (author's calculations).

[f] The Shatt al-Arab's length is not agreed upon by all students of the river. Its length is 100 km according to Naff and Matson (1984), 120 km according to Saleh (1985), 150 km according to Cressey (1960) and 180 km according to Brawer and Karmon (1968). The variation is explained in methods of measurement which either include each meander of the river or only a straight line. Note also that the river is shared by Iraq and Iran.

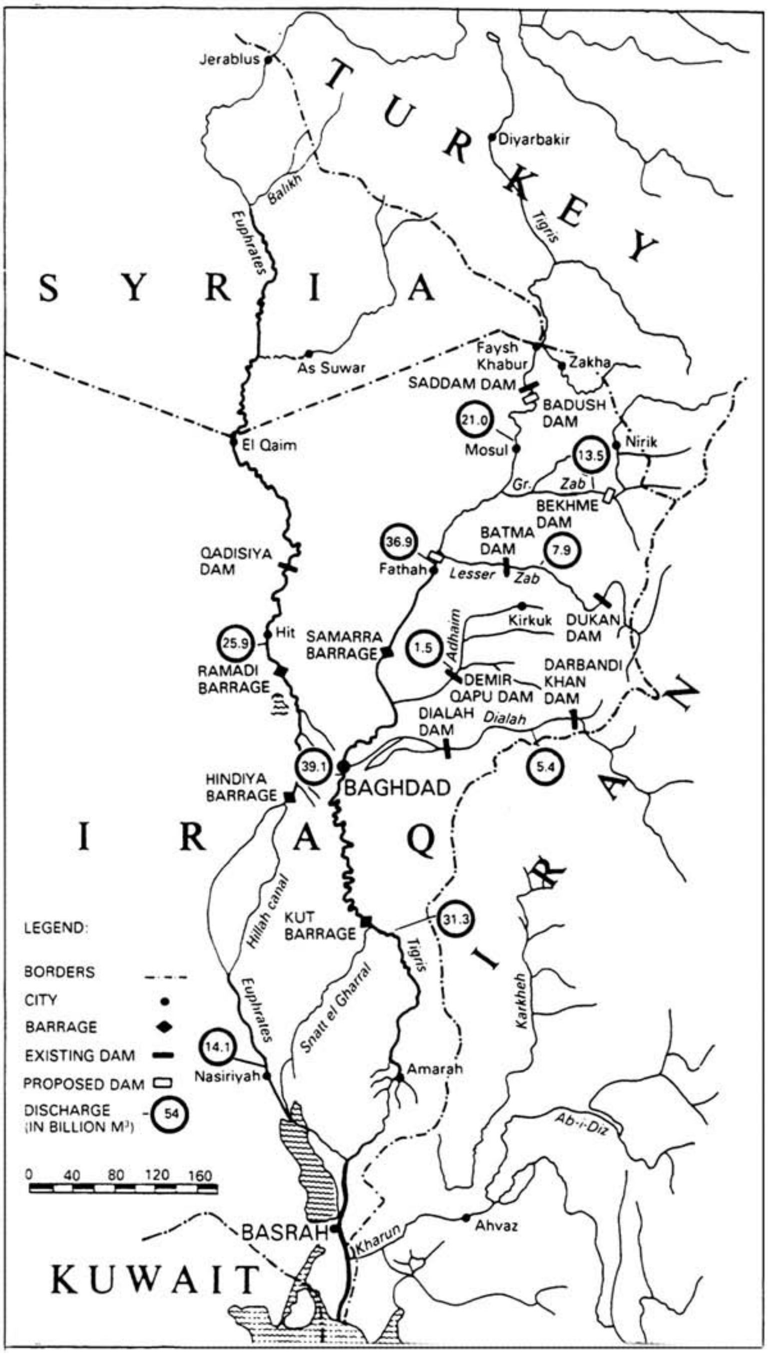
heir to the ancient civilization of Mesopotamia which evolved as a hydraulic civilization. Fourth, Iraq, similarly to Egypt, is an arid lower riparian, extremely dependent on the Euphrates and the Tigris waters. Finally, Turkey, currently the most prominent geopolitical force in the Tigris-Euphrates basin, is also the source of most of the waters of the Tigris-Euphrates.

THE CLIMATE, HYDROLOGY AND GEOMORPHOLOGY OF THE TIGRIS AND EUPHRATES AND THEIR IMPACT ON THE RIVER'S MANAGEMENT

The hydrological and topographic course of the Tigris and Euphrates

The Euphrates originates in the mountains of Eastern Turkey between Lake Van and the Black Sea, at latitude 40°N. The main sources are the Furat-Su (or Frat-Sue or Kara-Sue) which rises near Erzerum and, after flowing along a course of 450 km, meets the southern branch of the Euphrates—the Murat-Su—with the source of precipitation for the two branches being mainly snow. The united Euphrates begins at Kharput, 400 km west of Lake Van, with most parts drained by the Murat-Su and Furat-Su at heights ranging between 2,000 and 3,000 m. The united Euphrates first flows southeast, then southwest and breaks through the mountains in a gorge near Hilvan, approximately 200 km from the Turkish-Syrian border, eventually crossing the Syrian border at Jerablus. In Syria the Euphrates is joined by the Balikh after flowing for 230 km and by the Khabour 30 km south of Deir-el-Zor. The river flows from Deir-el-Zor to the Iraqi border and, by now wide and shallow, enters Iraq at Al-Kayem. In Iraq the river flows for 350 km until it reaches Ramadi, where it enters the giant delta of the Tigris-Euphrates, an almost totally flat area of more than 100, 000 km covered with very fertile alluvial soil. The two rivers flow within the river's embankments or levees and are higher than the neighbouring plains, which are densely settled. This fluvial morphology is the cause of flooding which constitutes a real hazard for Baghdad (located only 40 m above sea level) and Basrah. The delta is formed by the Tigris (which, every year, deposits 40 million m^3 of tin silt), the Kharun (30 million m^3 of tin) and the Euphrates (30 million m^3 of tin (silt)) (Naff and Matson 1984:87). The last section of the river turns into a vast area of marshland and saline lakes.

The Euphrates has a compact drainage basin and Turkey contributes most of its water. It has a very flat slope, which drops from 1:9,100 to 1:26,000 between Hit and Basrah. Altogether, the Euphrates traverses some 1,060 km through Iraq before reaching the sea, spreading over a belt extending from latitude 30°N to 40°N, a fact which shapes the climate prevailing in the drainage basin, as will be shown in the next section. The Tigris sources are also located in the high mountains of Eastern Turkey. The first source is a branch named Tigris which rises near Diyarbakir at an altitude ranging between 1,000 and 1,500 m. The second source of the Tigris is the Batman-Su which drains an area at an altitude of 2,000–4,000 m. The two branches join together near Ceffan and the united Tigris flows for about 100 km more before it reaches the border with Syria. The Tigris forms the boundary between Turkey and Syria and Iraq and Syria but the border is such that Syria might demand riparian status to the Tigris with rights to utilize the waters. From the Iraqi border up to Mosul the river is bordered by rolling hills on either side but is still confined to a deep valley in the Mosul area (Ionides 1937:115–18). From Mosul to Sharqat the Tigris flows through steppe country in a trough and this confinement limits the ability to exploit it in the higher regions of Iraq. About halfway between Mosul and Sharqat the Tigris is joined by the first of its tributaries, the Greater Zab River. The basin drained by the Greater Zab lies east of the Tigris basin and is bounded on the east by the Turkish-Iranian border. The Greater Zab rises at a point between Lakes Van and Urmia in Turkey and pursues a southwesterly course until it meets the Iraqi border. Its source area in Turkey is totally mountainous, containing no cultivable land and almost no settlement—a fact which leaves the water of the Greater Zab



Map 2.1 The geography and hydrology of the Tigris-Euphrates system

for Iraq to use. The united waters of the Tigris and the Greater Zab flow in a steppe from Sharqat to Baiji and are joined by the Lesser Zab halfway between Sharqat and Baiji. The Lesser Zab begins in Iran in a mountainous range which is part of the Zagros Mountains, and because the river flows through a deep gorge in Iran the area is sparsely settled. The third tributary of the Tigris is the Adhaim (or Uzaim), a very small contributor to the Tigris, and a few kilometres further downstream from Baghdad the Diyalah also joins the Tigris. The Diyalah also rises in the Zagros Mountains of Iran, again in a virtually unpopulated region with little cultivable land.

Downstream from Baghdad the river's slope is flat and the river becomes exceedingly tortuous (for example from Kut to Amarah, a direct distance of 203 km, the Tigris meanders for 343 km) with the Tigris joining the Euphrates to form the Shatt al-Arab north of Basrah. The combined river, the Shatt al-Arab, is a wide river—800–1,000 m across.

The Shatt al-Arab receives the last tributary of the river: the Kharun (the longest river in Iran) which drains mountain ranges as high as 5,000 m making snow a major source of precipitation. Most of the water in the lower part of both the Tigris and Euphrates is lost in the wide area of the salinated swamps and marshland. The combined area of the lakes and swamps at the head of the Persian Gulf varies from 8,288 km^2 at the end of the dry season to 28,490 km^2 during the spring flood—but during the 1946 flood the total inundated area reached 90,650 km^2. The Shatt al-Arab lies within Iraq (up to a point about 60 km above the Gulf or 915 km above the entry of the Kharun) below which it forms the international boundary between Iran and Iraq (Naff and Matson 1984: 85).

The climate and discharge of the Tigris-Euphrates and their tributaries

The Tigris-Euphrates basin experiences a sub-tropical Mediterranean climate regime with wet winters and dry summers. According to the Koeppen System of Climate Classification, the climate sub-type prevailing in the source area of the Tigris-Euphrates is mainly DSa. This is a cool and wet climate, continental in nature, with a dry season during the summer. The winter precipitation ranges between 1,000 and 2,000 mm in some areas while in others it ranges between 600 and 1,000 mm. The Euphrates and the Tigris also pass through a CSa Mediterranean sub-type climate characterized by rainy winters and dry warm summers. This climate prevails in southeastern Turkey, parts of Syria and the northern tip of Iraq. Winter precipitation ranges between 400 and 600 mm— which is enough for rain-fed agriculture. Most of Iraq and about half of the Syrian territory are under the BWh sub-climate type—an arid and warm climate with no more than 200 mm of rainfall.

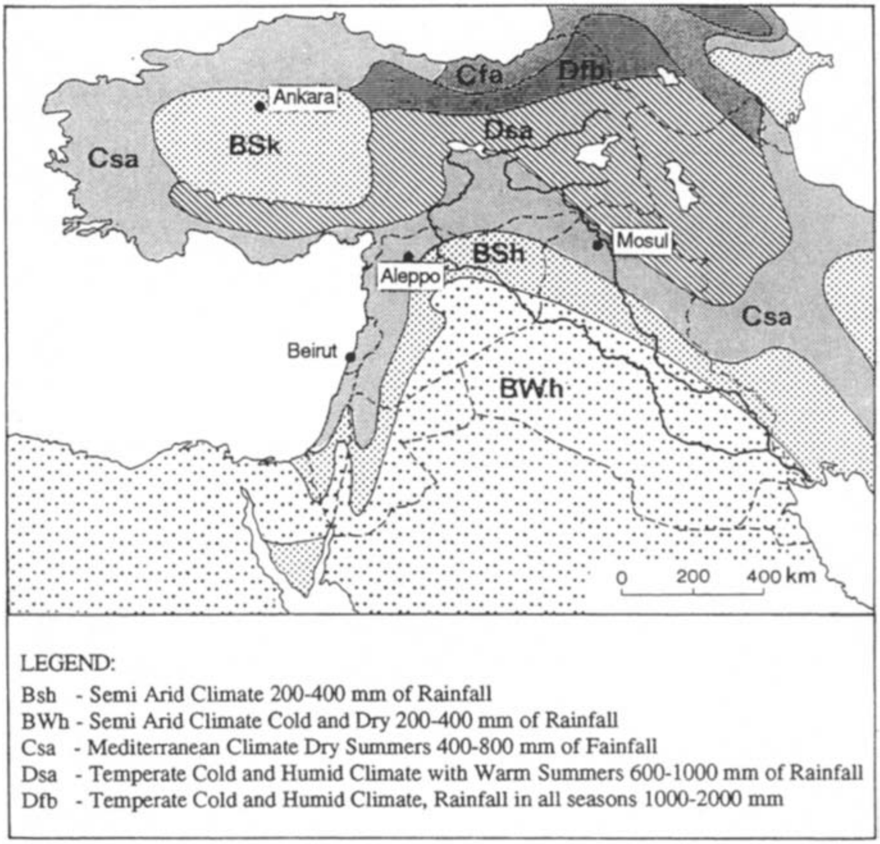
A narrow belt containing another dry climate, the BSh type with a warm dry climate and precipitation ranging between 200 and 400 mm, separates the CSa and BWh sub-climates (see Map 2.2). Most of the precipitation in the DSa region comes in the form of snow with the area around Erzerum having 115 snowy days each year. Its most important impact is on the frequency and intensity of Tigris-Euphrates floods (Izbirak n.d.: 84).

This climatic pattern points to the fact that within the Tigris-Euphrates basin there are wide areas particularly in Syria and Iraq which are arid and semi-arid

Table 2.2 Mean flows of the Euphrates 1937–64 (various periods (billion m^3))

	1924–51[a]	*1937–64*[b]	*1933–72*[c]	*1931–69*[d]	*1924–73*[e]
Euphrates, Hit	26.4		30.25	31.8	32.7
Euphrates, Keban		19.9			

Sources: Based on [a]Al-Khashab 1958; [b]Saleh 1985; [c]Ubell 1971; [d]Kolars and Mitchell 1991; [e]Kolars 1992c



Map 2.2 The climatic regions of Turkey, Syria and Iraq

and dependent on the waters of the Tigris-Euphrates. Moreover, if the total areas of the co-riparians are considered, then we find that annual rainfall is less than 250 mm in 59 per cent of the territory of Syria while 70 per cent of the territory of Iraq receives less than 400 mm per year (Gischler 1979:113; Khader 1984:166; Allan 1987:22). Iran, a minor co-riparian to the Tigris-Euphrates basin, has a mostly arid and semi-arid climate with precipitation ranging between 100 and 200 mm (Beaumont 1974:419). The Iranian areas in the Tigris basin have a semi-arid climate and irrigated farming is practised in the upper parts of the Lesser Zab and Diyalah (*Tubinger Atlas* 1984: Map AX3).

Another climatic feature which is extremely important in the TigrisEuphrates basin is the high temperature and resultant high evapotranspiration. The July mean temperature over half of Iraq is 30°C as it is over about 40 per cent of Iran's territory; only Turkey has somewhat lower summer temperatures. The mean annual potential evapotranspiration ranges between 570 and 1,140 mm for all four co-riparians and water loss due to evaporation is consequently high, especially in the man-made lakes of the region (Keban and Atatürk in Turkey, Assad in Syria and Lakes Habbaniya and Tharthar in Iraq). In Iraq, heavy evapotranspiration also reinforces water salination processes on the Mesopotamian plains.

We may conclude that the Tigris-Euphrates riparians are highly dependent on these rivers and are in desperate need of water for irrigation (Karmon 1968:50). Turkey, on the other hand which is well endowed

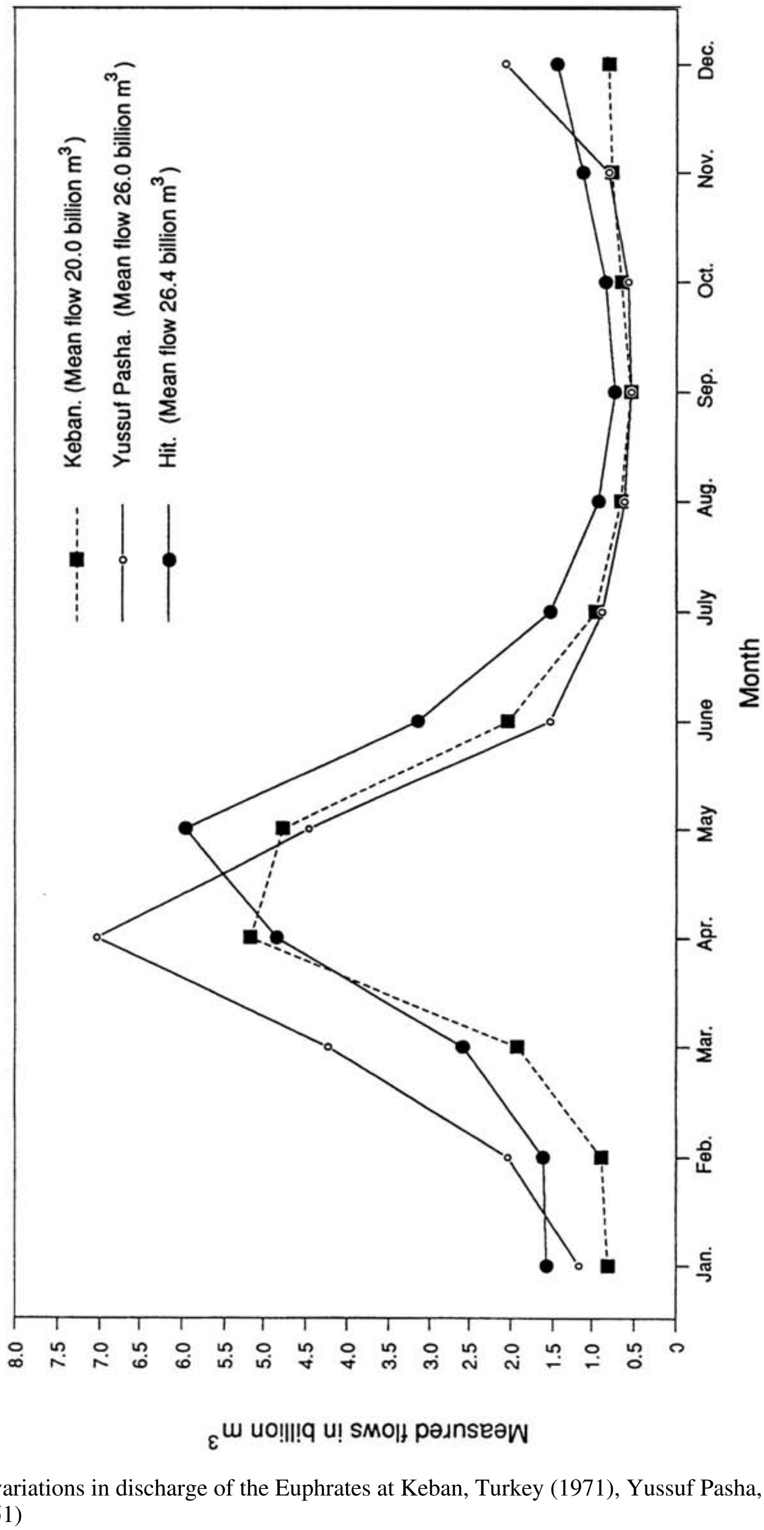


Figure 2.1 Monthly variations in discharge of the Euphrates at Keban, Turkey (1971), Yussuf Pasha, Syria (1950–66) and Hit, Iraq (1924–51)

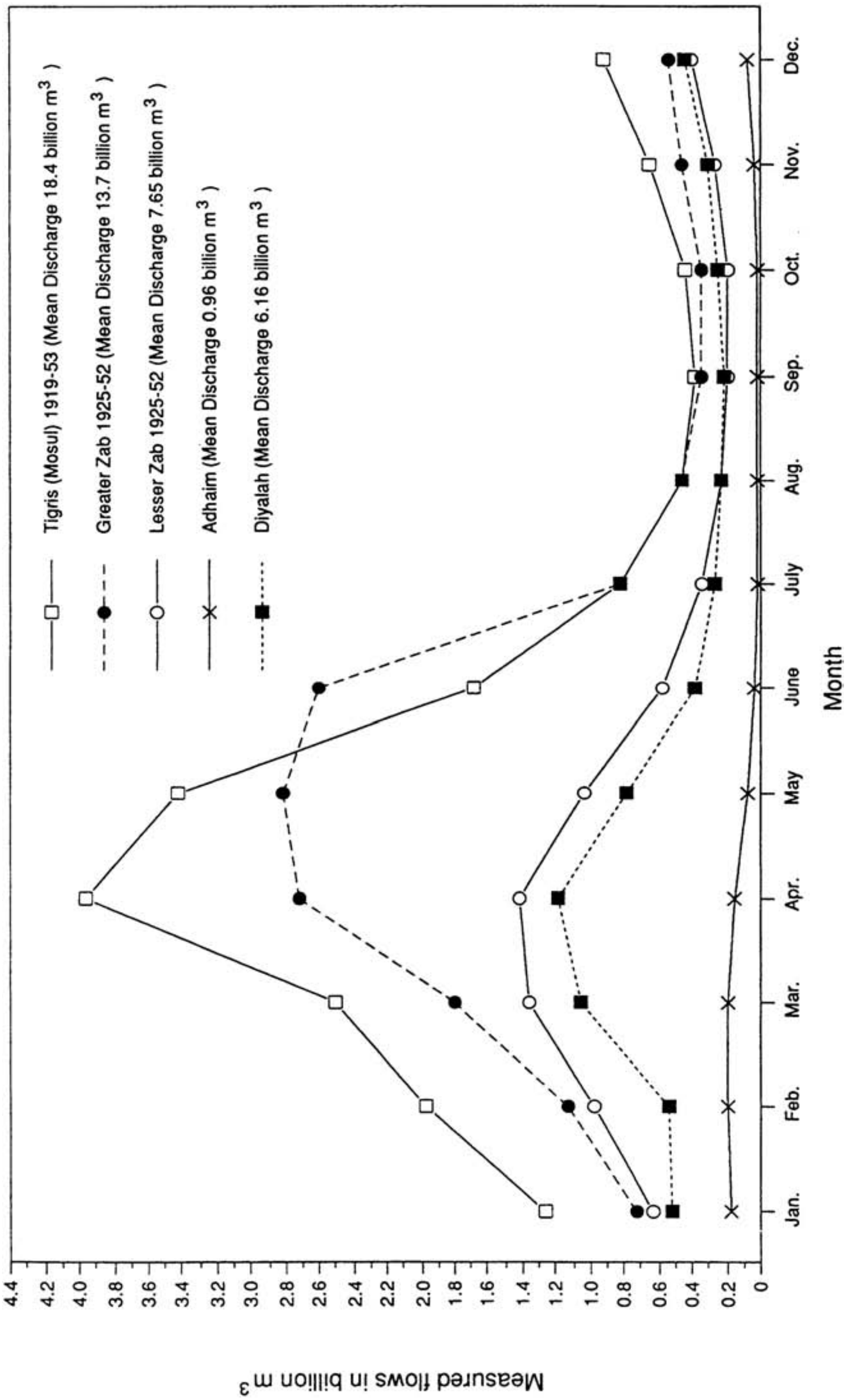


Figure 2.2 Monthly variation in discharge of the Tigris and its tributaries (in billion m^3)

with precipitation and has many rich perennial rivers, has only 5 per cent of its territory classified as semiarid and thus is less dependent.

The discharge of the Euphrates

The discharge pattern of the Euphrates and its tributaries is presented in Figures 2.1 and 2.2, but the data on the mean discharge of the Tigris and Euphrates is still a matter of dispute among students of the Tigris-Euphrates. According to Al-Khashab (1958) who based his figures on the average discharge flow of twenty-five years, the flow of the Euphrates in Hit is 26.4 billion m^3. Kolars (1992c) gives the Euphrates flow at Hit as 32.7 billion m^3 (Table 2.2).

There is a great variation in the data provided for the Euphrates flow at Hit, but in this book we use Ubell's mean flow of 31.8 billion m^3 as a valid value (Ubell 1971). Table 2.2 shows that, even for the short periods of mean measurement, there is a great variation in the mean discharge flow of the Euphrates. The annual discharge at Hit varies from 16.8 billion m^3 to 43.4 billion m^3 (Beaumont 1978:36; Naff and Matson 1984:86). Discharge at Hindiya varies between 17.2 billion m^3 (1950–9) and 23.0 billion m^3 (1940–9) (Beaumont 1978:38). Figure 2.1 portrays the water year of the Euphrates with discharge measured at Keban and Yussuf Pasha (Syria). The lowest discharge takes place at all stations during the month of September while the spring peaks are directly related to the melting snows in Turkey. It is possible to identify three distinct periods for the Euphrates in discharge (Saleh 1985:73):

(a) period of high discharge, March to June;
(b) period of low discharge, July to October;
(c) period of average discharge, November to February.

This means that during the summer season, when crops have the greatest need for irrigation water, the water supply is low in Iraq. During an average year, the water deficiency is estimated at 2.5 billion m^3 in July, 3.0 billion m^3 in August and 2.8 billion m^3 in September (Alii 1955:30).

In addition to its use of the waters of the Euphrates, Syria also utilizes the flow of the Khabour, which discharges 1.78 billion m^3 a year, and the Balikh, which discharges 0.2 billion m^3 a year (Allan 1987:37; Kolars 1992c). Table 2.3 and Figure 2.2 present the monthly discharge of the Tigris in selected places.

Table 2.3 Mean flows of the Tigris and its tributaries 1919–69 (various sources)

	Tigris (Mosul)	*Greater Zab*	*Lesser Zab*	*Adhaim*	*Diyalah*
1919–53[a]	21.053				
1931–69[b]	18.499				
1925–52[a]		13.719			
1931–69[b]		13.510			
1925–31[c]		9.7			
1925–52[a]			7.650		
1931–69[b]			7.950		
1925–32[c]			6.200		
1933–52[a]				0.969	
1925–32[a]				0.770	
1923–52[a]					6.167

	Tigris (Mosul)	*Greater Zab*	*Lesser Zab*	*Adhaim*	*Diyalah*
1925–32					4.100

Sources: Based on [a]Al-Khashab 1958; [b]Ubell 1971; [c]Ionides1937

The discharge of the Tigris

As is the case for the Euphrates, the variation in the data is very great. The Tigris mean flow discharge at Mosul varies between 18 and 21 billion m^3, the Greater Zab between 9 and 13.7 billion m^3, the Lesser Zab between 6.2 and 7.9 billion m^3, the Adhaim between 0.7 and 0.9 billion m^3 and the Diyalah between 4.1 and 6.1 billion m^3. In this volume we adopt the following means (billion m^3):

Tigris, Mosul	21.8–23.2
Greater Zab	13.2–13.5
Lesser Zab	7.2–7.6
Adhaim	0.8
Diyalah	5.7
Contribution of Tigris tributaries	26.7–29.4

The total for the Tigris and tributaries is 48.7–52.6 billion m^3, or between 43.0 and 49.2 billion m^3 according to Kolars (1992c) (Al-Khashab 1958; Ubell 1971; Gischler 1979; Shahin 1989; US Army Corps of Engineers 1991; Kolars 1992c).

The contribution of the Tigris tributaries is very significant and roughly contributes 50 per cent of the Tigris flow at Baghdad. This is an important variable if the water of these tributaries is allocated for Iraqi usage alone. Because the Tigris tributaries are relatively short and drain the high mountains in Armenia, Kurdistan and the Zagros, they carry large quantities of water for a short distance, in a very short time, and thus may be extremely dangerous (Brawer and Karmon 1968).

The Tigris has shown very great variation in its discharges over various periods with the lowest discharge measured at 163 m^3/s and the maximum discharge at 14,000 m^3/s (Naff and Matson 1984:86–7). The Tigris in its lower reaches is subject to more sudden and destructive flooding than the lower Euphrates is since it lies much closer to the sources of discharge (Naff and Matson 1984). This is also true for the Tigris tributaries such as the Greater Zab which has been known to discharge 1,320 m^3/s instead of 808 m^3/s (its annual normal mean) and which is defined as torrential down to the point of its junction with the Tigris (Ionides 1937:129).

Estimates for the total flow of the Tigris-Euphrates and their tributaries vary between 68 billion m^3 and 84.4 billion m^3 (Alii 1955:30; Ubell 1971:3; Beaumont, Blake and Wagstaff 1988:364; Shahin 1989; US Army Corps of Engineers 1991). This represents great variance in the data for the combined flow, and does not help in assessing how to allocate the water resources of the Tigris-Euphrates among the riparian states. in this volume we adopt the value of 80.0–84.4 billion m^3 for the combined flow of the Tigris-Euphrates. It should be noted that, in their mean annual discharge, both rivers reveal very wide fluctuations in discharge (Beaumont, Blake and Wagstaff 1988:357). Both floods and droughts are frequent events in the drainage basin—hence the urgent need for flood control on the one hand and water storage on the other.

The Tigris and Euphrates unite near Qurna and form a river 180–190 km long and 1 km wide near its confluence with the Persian Gulf. Here the Shatt al-Arab receives one last tributary: the Kharun, which brings between 20.0 and 24.8 billion m^3 to the Shatt al-Arab, draining a basin of 67,340 km^2 (Naff and Matson 1984). This explains why the flow of the Shatt al-Arab at Fao is 20.0 billion m^3 (Cressey 1960: 147).

An important issue which recently emerged—in connection with the Tigris-Euphrates flow, is whether a climatic change, particularly a change in precipitation, has taken place in the Tigris-Euphrates drainage basin. The modern flow records of the Tigris-Euphrates system reveal a large degree of interannual variation in spring flood levels (Clawson *et al.* 1971). Unlike in the case of the Nile, adequate records were not kept on the stream flow of the Tigris-Euphrates; hence, there are not enough data to allow any conclusions to be drawn about the long-term climatic changes in this basin (Kay and Johnson 1981:261). However, in the short term, there is evidence of very meagre years. For example, 1988–9 was the worst drought year of the last sixty years in Turkey—a country with a comparatively favourable hydrological position. The discharge into the Euphrates on the Turkish-Syrian border was reduced from 500 m^3/s to 150 m^3/s (16.87 billion m^3 instead of 30.0) (*NewSpot* 12 July 1990; Hindley 1990: v). 1974 and 1982 were also dry years and, in 1974, both Syria and Turkey began to fill their reservoirs in the Tabqa and Keban Dams. As a result, at the beginning of 1975 Iraq experienced a severe shortage in the Euphrates flow and blamed Syria for it. Between 1955 and 1962, the average discharge of the Euphrates at Hit was only 24.1 billion m^3 per annum—90 per cent of the regular flow (Beaumont 1978:41).

To sum up the discussion in this part, it is clear that aridity and drought have made both Syria and Iraq very thirsty for the Tigris-Euphrates waters, but both are always going to be affected by whatever takes place in Turkey—be it a drought or dam construction. The other feature which emerges from a study of the various data sources is that less is known about the Tigris-Euphrates than about the Nile; but it is clear that the utilization of both basins can be increased. Finally, the danger of flood is very real in the Tigris-Euphrates system with the tributaries of the Tigris being responsible for floods in downstream Iraq. Flood control is thus as important as irrigation water in the order of priorities of water management and control for the Tigris.

The meeting point between hydrology and politics

The relevant Helsinki and ILC Rules for this section are the climate of the basin states, hydrology and hydrography—namely the share of each state in the channels of the Tigris-Euphrates, their share in the area of the drainage basin and their relative contribution to its waters. Tables 2.4 and 2.5 provide the relevant data in detail.

Table 2.4 The geography and hydrology of the riparian states of the Tigris-Euphrates basin

Rivers	*Areas of constituent countries*	*Share per country*		*Length of rivers*		*Mean discharge*	
Area (km^2)	*% (km) %*	*(billion m^3)*	*%*				
Euphrates	Turkey[a]	125,000[a]	28	1,230[a]	41	26.5–28.5	88–98[b]
	Syria[a]	76,000[a]	17	710[a]	24	1.7–2.0	2?[b]
	Iraq[a]	177,000[a]	40	1,060[a]	35	0	0
	Saudi Arabia[a,c]	66,000[a]	15	0	0	0	0
Total		444,000	100	3,000	100	28.2–30.5 (29.0)[d]	

Rivers	*Areas of constituent countries*			*Share per country*		*Length of rivers*		*Mean discharge*	
Area (km^2)	*%*	*(km)*	*%*	*(billion m^3)*	*%*				
Euphrates tributaries									
Khabour	Turkey)	}	36,900 km^{2d}	9,000[e]	–	270[f]	–		
	Syria	27,900[e]	–	460[g]	–	(1.78)[d] (1.8)[b]			
Balikh	Turkey	}	14.4 km^{2d}	4,000[e]	–	100[g]	–	–	
	Syria	10,400[e]	–	105[g]	–	(0.2)[d]			
Euphrates and tributaries total									
	Turkey				28				88
	Syria				17			30.0–	2
	Iraq				40			33.0[b]	0
	Other				15				0
Tigris[h]	Turkey			45,000[i]	12	400[j]	21	21	100
	Syria			1,000	0.2	44	2	–	
	Iraq			292,000	54[b]	1,418[g]	77	–	
	Iran			37,000[i]	34[b]	–	–	–	
Total				375,000 (258,000)[d]	100	1,862	100	21	100
Tigris tributaries[b]									
Greater Zab	Turkey			6,000	35	220[e]	27.5	7–10.5	80–90
	Iraq			20,000[k]	65	580[e]	72.5	1–3	10–20
Total				26,000	100	800	100.0	10–13.5	100
Lesser Zab	Iran			2,600[k]	20	70	20	5.7–6.2	80–90
	Iraq			18,900[l]	80	280	80	1.0–1.5	10–20
Total				21,500[l]	100	350	100	7.2 (7.8)[d]	100
Adhaim	Iraq			13,000[d]	100	200[e]	100	0.8 (0.8)[d]	100
Diyalah[m]	Iran			2,300[l]	10	250[e]	48	4–5	90–100
	Iraq			30,600[l]	90	270[e]	52	0–1.5	0–10
Total				32,900[d]	100	520	100	5.4 (5.7)[d]	100
Tigris and tributaries total									
	Turkey				12[b]			43.0[n]	43–50
	Syria				0.2			49.2[n]	–
	Iraq				54				51
	Iran				34				9
Kharun	Iran			51,000[l] (58,000)	400		(24.2)	100	
Shatt el-Arab	Iran			–				–	
	Iraq				180			–	

Total Euphrates and Tigris	Area sharing	(%)	Share in total water discharge		(%)
	Iraq	46.0		Iraq	8–9
	Turkey	20.5		Turkey	70
	Iran	19.0		Iran	21
	Syria	9.0		Syria	2
	Saudi Arabia	5.5		Saudi Arabia	0
			Total water discharge 80.0–84.0 billion m^3		

Notes:
[a] Beaumont (1978:37).
[b] US Army Corps of Engineers (1991).
[c] Saudi Arabia joins the drainage basin of the Euphrates only by virtue of wadis and, in reality, does not contribute at all to the river flow.
[d] Shahin (1989).
[e] Calculated by the author from maps of various scales.
[f] The measurement of the Khabour and Balikh includes all their upper streams.
[g] Ionides (1937), Cressey (1960), Brawer and Karmon (1968), Beaumont (1978), author's calculations.
[h] According to US Army Corps of Engineers (1991), about 40 per cent of the Tigris and its tributaries runoff originates in Turkey, 51% in Iraq and 9% in Iran.
[i] Cressey (1960).
[j] The length of the United Tigris is 400 km and, with its tributaries, it has a total length of 1,100 km (the authors).
[k] Ionides (1937). According to Alii (1955) the Greater Zab drainage basin has an area of 26,000 km^2.
[l] Al-Khashab (1958).
[m] According to Alii (1955) the Diyalah has a total basin area of 30,000 km^2.
[n] Kolars (1992a,c).

Table 2.5 The discharge of the Tigris-Euphrates Rivers by countries (billion m^3 and percentage)

	Turkey	*Syria*	*Iraq*	*Saudi Arabia*	*Iran*	*Total (billion m^3)*
Total Tigris and Euphrates						
Billion m^3	56.5–59.5	2.0	2.8–6.8		10.7–11.2	80.0–84.0
Percentage	70–74%	2.4%	3–8%		13–16%	
Euphrates						
Billion m^3	26.5–28.5		–			28.7–30.5
Percentage	88–98%					
Euphrates tributaries						
Billion m^3	–	1.7–2.0				
Percentage	–	2.0%	–			1.7–2.0
Tigris						
Billion m^3	21.0–23.8		–			21.8–23.8
Tigris tributaries						
Billion m^3	7–10.5		2.8–6.8		9.7–11.2	26.7–29.7
Percentage	24–38%		11–24%		34–44%	

	Turkey	*Syria*	*Iraq*	*Saudi Arabia*	*Iran*	*Total (billion m^3)*
Total Tigris and tributaries						48.7–52.5

Sources: Beaumont 1978:37; Ionides 1937; Cressey 1960; Brawer and Karmon 1968; Beaumont 1978; US Army Corps of Engineers 1991; Shahin 1989; Al-Khashab 1958

Turkey

Turkey possesses 25 per cent of the drainage area of the Euphrates, some 41 per cent of its main channel, and contributes between 88 and 98 per cent of its water. The climate within the Euphrates basin has enough precipitation although, in southeast Anatolia near the Turkish border with Syria, the climate is more susceptible to variation in precipitation and some areas have semi-arid conditions. Turkey fares well also in the Tigris basin where it has 12 per cent of the basin area, 20 per cent of the river length and contributes all the water in the main river stream as measured at Mosul, and 50% of the total discharge of the Tigris (Kolars 1992a, c). In addition Turkey controls small sections in the basin of the Tigris tributary, the Greater Zab, and contributes most of its water as well. Mainly because of its water contribution, but also because of the other variables, Turkey is entitled to a large amount of the Euphrates waters. A question may arise in relation to the Helsinki Rules which give equal weight to the share in river length, area of river basin and water contribution. This is exemplified by Turkey which has a relatively smaller share in the drainage basin and in river length compared with Iraq but which makes an enormous contribution to its water volume. As water resources become scarcer and their cost higher, it becomes more reasonable and just to give the variable of water contribution a higher ranking within the framework of the Helsinki Rules.

Syria

Syria is a co-riparian only in the Euphrates where it has 17 per cent of the river basin, 24 per cent in the river channel and a doubtful water contribution of less than 2 per cent of the Euphrates flow through the Khabour and Balikh. As almost certainly these two tributaries are fed by Turkish aquifers, their water contribution should be related to Turkey (Kolars 1992a, c). But because Syria has 44 km in the main channel of the Tigris, it considers itself a co-riparian to the river too. Based on Helsinki Rules, this claim can be accepted.

Syria has an arid and semi-arid climate within the Euphrates basin and a great need for Euphrates water. There is no doubt, however, that Syria is a riparian of weaker standing in the Euphrates according to its share in the various hydrological variables, but it can utilize the Khabour and Balikh which are entirely within its territory.

Iraq

Iraq has 40 per cent of the territory of the Euphrates, more than a third of its channel but contributes nothing to its water budget. Iraq has a better position with regard to the Tigris because although it is still a downstream riparian—as is the case in the Euphrates—it has the largest portion of the area of the Tigris drainage basin (54 per cent), with 77 per cent of the length of its channel, but makes no water contribution to the river. Iraq also has shares in the Greater and Lesser Zab, Adhaim and Diyalah, and controls almost all their drainage basin areas, most of their respective channels and perhaps makes some contribution to the waters of the Greater and Lesser Zab, Diyalah and Adhaim (less than 5 billion m^3). As stated before, most of the territory of Iraq has insufficient precipitation and Iraq's utilization of the Tigris-Euphrates has existed from time immemorial.

Iran

Iran becomes a co-riparian to the Tigris-Euphrates system by virtue of her parts of the drainage basins of the Lesser Zab and Diyalah; as well as this Iran is a partner to the Shatt al-Arab. The Iranian use of the Diyalah and the Lesser Zab is only local and most of its water contribution, estimated as ranging between 8.5 and 11. 5 billion m^3, flows to Iraq.

Finally we have to look at Table 2.5 which shows the water contribution of the co-riparians to the Tigris-Euphrates. This table estimates Turkey's contribution at 70–74 per cent, Iraq's at 3–8 per cent, Iran's at 13–16 per cent and Syria's at 2 per cent. Another estimate is provided by Al-Khashab (1958) who has estimated Syria's water contribution as nil. The difficulties in evaluating often contradictory data is a major obstacle to providing accurate guidelines for equitable and reasonable water appropriation within the Tigris-Euphrates. The ILC Rules stress that data collection and exchange is a mandatory norm within international river basins, and this is no doubt a necessary condition for any effort to manage the Tigris-Euphrates basin in a more equitable manner.

If we return to our original question about the equitable sharing of the Tigris-Euphrates waters, we need to discuss the conflict over the 'rights' of Iraq which are founded on prior usage, an arid climate, a share in the drainage basin (40 per cent in the Euphrates, 54 per cent in the Tigris) and a small water contribution to the Tigris. Turkey is the source area of the Tigris-Euphrates waters, contributing more than 70 per cent of the united Tigris-Euphrates flow. Turkey also owns large portions of the drainage basins in the two rivers and, most importantly, it has the upper riparian position and so the opportunity to exercise its sovereign privilege to use the waters of the Tigris-Euphrates as it pleases.

Of the two other co-riparians Iran, the upper riparian in the Tigris tributaries, is in a better position to use the waters of the Diyalah or Lesser Zab but currently has no urgent need to do so. Syria, on the other hand, has urgent needs and an unsatisfactory position between two major rivals for the water: Turkey and Iraq.

Equitable sharing of the Tigris-Euphrates waters based on geography and hydrology will probably assign Turkey some 40 per cent of the combined waters, Iraq 50 per cent and Syria 10 per cent. Integrated planning within the basin will assign each riparian the best available (and cheapest) water resources. Integrated planning could also guarantee both the quantity and the quality of water downstream for both agricultural and domestic usage.

However, the discussion in the next section dealing with the evolving patterns of utilization will show that there is neither integrated planning nor co-ordination among the co-riparians, and that each is involved in individual and separate efforts to maximize utilization of its own water resources. This direction will certainly lead to tensions and conflict among the partners to the Tigris-Euphrates basin.

THE PATTERNS OF UTILIZATION OF THE TIGRIS-EUPHRATES WATERS

Tigris-Euphrates usage until the 1950s

The Euphrates and its tributaries served as the cradle for a very sophisticated civilization which evolved in Mesopotamia from the tenth millennium BC onwards. Historians have noted the progression of this civilization from north to south, with the oldest settlement dating back to the tenth millennium BC in Tel Merbit in Syria (Saleh 1985:70).

The earliest civilizations in Mesopotamia (Iraq) were those of the Sumerians, Akkadians, Babylonians and Assyrians. They organized an efficient hydraulic civilization which, at its peak, supported some 20 million inhabitants (Cressey 1960) and based itself on a well-maintained irrigation and flood control system. One of the most conspicuous structures of this civilization was the Nahrawan Canal built during the sixth century AD. The Canal, which was 300 km in length and more than 30 m wide, drew water from the River Tigris near Samarra and transported it southeast to the lower plains of the River Diyalah where it was used for irrigation purposes. It was the ancient 10 m high Nimrod Dam that moved waters to the Nahrawan Canal by closing off the old course of the Tigris and diverting the waters to it (Ionides 1937:147); but there were also ancient barrages on the Adhaim and Diyalah.

Agricultural decline gradually took place after the tenth century AD mainly as a result of the decreasing effectiveness of the central government. The necessary reconstruction and maintenance of the irrigation network tended to lapse and progressive siltation of the major canals occurred, reducing the efficiency of water transmission. By the middle of the twelfth century AD large areas of the alluvial lowlands could not be used for arable farming, and when the Mongol invasion took place in the twelfth and thirteenth centuries AD, the abandonment of the once fertile land was almost complete (Beaumont, Black and Wagstaff 1988: 362). Small parts of Turkey and Iran and areas in the Kharun in Iran were also part of this elaborate hydraulic civilization.

The period of Ancient Mesopotamia was the last time that some form of integrated planning took place in the Tigris-Euphrates basin for the basin as a whole. Yet this did not constitute a problem, as the demand for Tigris-Euphrates waters was only local and did not create any difficulties for the various users. Although the Habbaniya and Abu-Dibbis Lakes were used for flood control purposes in Iraq for thousands of years, modern engineering work in Iraq only began with the construction of the Hindiya Barrage on the Euphrates during the years 1911–14 when embankments and levees were constructed on both sides of the river channels to prevent flooding. This system allows water to be transferred to secondary feeders and carried to the fields all year round. Table 2.6 presents the patterns of utilization of waters in the Euphrates—Tigris system. The table presents simple water projects whose sole purpose is flood control and water diversion to the irrigation canals. It is not surprising that all the barrages, regulators and lakes listed in Table 2.6 are located in Iraq. Iraq was the first country in the basin to begin utilizing the Tigris—Euphrates waters in modern times because of its traditional use, especially of the ancient Habbaniya and Abu-Dibbis Lakes for thousands of years. The Iraqi system of water management reflects a combination of 'old and new' and the real and urgent need to prevent floods. It is also interesting to note that Iraq has accumulated a significant storage capacity in Habbaniya and Abu-Dibbis—a total of 46.0 billion m^3. Not all of it is available for irrigation (since some of it is too salinated for this purpose), but some of it is, and Iraq uses this water extensively when there is not enough water in the Euphrates.

Table 2.6 Barrages, regulators and lakes on the Tigris and Euphrates in Iraq

Name and type	*Size and discharge (m^3/s)*	*Year completed or heightened*	*Length (m)*	*Height (m)*	*River or tributary*	*Functions*
Habbaniya	430 km^2 32 billion m^3	Ancient			Euphrates southeast of Ramadi (Iraq)	To reduce flood intensity and provide irrigation water for the dry season

Name and type	*Size and discharge (m^3/s)*	*Year completed or heightened*	*Length (m)*	*Height (m)*	*River or tributary*	*Functions*
Abu Dibbis Lake	180 km^2 Storage of 14.5 billion m^3	Ancient			Euphrates south of Habbaniya Lake (Iraq)	Flood control (linked to Habbaniya Lake by a canal)
Hindiya Barrage	2,900 m^2	1911–14	249 m	7.7m	Euphrates (near Falluja) (Iraq)	To raise water level to supply water to the Hilla, Greater Mussaiyab, al-Hussainiya and Beni-Hasan Canals
Diyalah Barrage	4,000 m^2	1927–8	427 m	12 m	Diyalah (Iraq)	To divert water irrigation canals
Kut Barrage	6,000 m^2	1934–43	692 m	10.5 m	Tigris (Iraq)	To divert water to the Shatt el-Gharra Canal
Abu Dibbis Barrage	5,500 m^2	1950s	650 m	14 m	Euphrates near Abu Dibbis Lake (Iraq)	To absorb flood waters
Lake Tharthar	30.0 billion m^3 in a lake 2,700 km^2	1950	502 m	7 m	Tigris (Iraq)	To prevent Tigris water floods; canal conveys water to the Tharthar depression (from the Tigris) and also to the Euphrates
Ramadi Barrage	3,600 m^2	1957	209 m	10.0 m	Euphrates above Habbaniya Lake (Iraq)	To control water level in the river and divert water to Habbaniya Lake
Samarra Barrage	11,000 m^2	1958	252 m	12 m	Tigris (Iraq)	To divert water to Lake Tharthar; irrigation
Falluja Barrage	3,600 m^3	1985			Euphrates (Iraq)	To raise water level for irrigation; divert water to Abu-Gharaib, Yousufiya, Latifiya and Iskandriyah projects
Main Outfall Drain	550 km long	1992				To drain irrigation water into sea; 1.5 million ha drained

Sources: Ionides 1937; Cressey 1960; Beaumont 1978; Saleh 1985; Ockerman and Samano 1985; Beaumont, Blake and Wagstaff 1988

Note: This table includes only barrages or very small dams and diversion dams. Table 2.7 includes all the large dams which store large amounts of water.

In 1984 the Iraqi Government was able to release water stored in the Lake Habbaniya reservoir to local farmers to offset the low level of the Euphrates (Hindley 1989:5). The same is true for the depression of Tharthar which has become Lake Tharthar with a storage capacity of 30.0 billion m^3. More than $300 million has been invested in the Lake Tharthar Project in order to turn this natural depression into an artificial lake linked to both rivers (Tigris and Euphrates) by canals (Hindley 1989:5). The Tharthar link's main function is to alleviate water shortages within the Euphrates basin, to control flooding and to drain salts from the irrigated areas between the two rivers. But perhaps the greatest significance of the Tharthar link is that it connects (artificially) the Tigris-Euphrates and makes them one river system. In this way all the water resources have become one unified source and co-riparian rights to these water resources are not calculated according to their riparian share in the separate river basins of the Euphrates or the Tigris. This facilitates a more flexible process of water allocation according to the Helsinki Rules—a subject which is discussed in detail on pages 122–3. However, one limitation in the utilization of Lake Tharthar is its salinity. The high salinity considerably increases the salt content of the water conveyed to the Euphrates and back to the Tigris.

The Tharthar Lake and Samarra Barrage have succeeded in preventing floods in Baghdad since 1958, but most of the aforementioned water control projects have played a major role in providing irrigation water to a complex network of canals in central and lower Iraq, in areas already cultivated for thousands of years. Table 2.6 shows that most of the above single-purpose water control projects were completed by the 1950s and thus established Iraq's prior rights to the Tigris-Euphrates waters. The present system of barrages, regulators and lakes reflects the continuity of the hydraulic Mesopotamian civilization and, more specifically, the continuity of Iraq's utilization of the Tigris-Euphrates waters for irrigation. A more modern project included in Table 2.6 is the Main Outfall Drain, which is a 500 km long drain whose task is to drain some 2 million ha of irrigation waters and which empties into the Shatt al-Basrah.

The development of water utilization projects among co-riparians of the Tigris-Euphrates

Major water projects on the Tigris-Euphrates were carried out during the late 1960s, 1970s and 1980s and some are still under construction. The most important feature in this process of water resource development is the separate planning, development and lack of co-ordination among co-riparians as opposed to the need for integrated planning of the basin. Also, almost all the projects listed in Table 2.7 are multipurpose water projects which combine the functions of providing water for irrigation, flood control, water storage and hydroelectricity.

Table 2.7 reveals co-riparian competition over the Euphrates waters. Turkey, Syria and Iraq have constructed large dams on the Euphrates, in addition to the

Table 2.7 Water projects on the Tigris-Euphrates system

Dam and location	*Years of construction*	*Storage capacity (billion m^3)*	*Size of dam (metres high)*	*Size of lake (km^3)*	*Functions*
Keban Upper Euphrates (Turkey)	1965–74	30.0	211	680	1,360 MW hydro power, flood control
Karakaya Euphrates (Turkey)	1976–88	9.6	147	300	1,800 MW hydro power

Dam and location	*Years of construction*	*Storage capacity (billion m^3)*	*Size of dam (metres high)*	*Size of lake (km^3)*	*Functions*
Ataturk (Turkey)	1981–90	48.4 (49.0)[a]	176 (169)[a]	817	2,400 MW (8,000 million kWh); also flood control, water storage for irrigation
Tabqa Al-Thawra Euphrates (Syria)	1965–74	11.6–11.9	60	640	Irrigation of 640, 000 ha; 800 MW; currently 136, 000–250,000 ha irrigated
Al-Ba'ath Euphrates (Syria)	1983–8	0.90	15		64 MW; control of Euphrates fluctuation
Khabour	n.d.	0.99	n.d.		Irrigation of 138, 000 ha
Mosul (Saddam) Tigris (Iraq)	Late 1980s under construction	10.7	110		750 MW; irrigation of 250, 000 ha; flood control
Darbandikhan Diyalah (Iraq)	1961	3.0–5.0	128	120	Flood control, water storage, electricity, irrigation
Dukan (Lesser Zab (Iraq))	1959	0.63–0.75			400 MW flood control; storage of water; irrigation
Qadisiyh Dam (Haditha)	Completed				Flow regulation; hydro power 600 MW; irrigation
Dibbis Dam (Lesser Zab)					Irrigation

Sources: Beaumont 1978; Naff and Matson 1984; Saleh 1985; Ockerman and Samano 1985; Kolars 1986; *Newspot* various issues; *MEED* various issues; Beaumont, Blake and Wagstaff 1988; various Arab papers
Note: [a]Tekeli (1990:208).

barrages and storage lakes that Iraq has established for itself. Moreover, the key to the geopolitical competition for Euphrates water can be found in the tremendous storage capacity all three riparians have developed for themselves. Large storage capacity tends to persuade co-riparians to prefer the accumulation of waters within their own territory instead of sharing it with their partners to the basin. Thus, with its three existing dams (Keban, Karakaya and Atatürk) Turkey has accumulated for itself a storage capacity of 90–100 billion m^3 of water (approximately 42.0 billion live storage); Syria has developed a capacity of 12 billion m^3, and Iraq (including barrages) has a storage capacity of 100 billion m^3. These storage capacities should be directly related to the flow discharge of the Euphrates along the Syrian-Turkish border which was 28.0– 29.0 billion m^3 before Turkey embarked on its major development project—the Southeastern Anatolia Project (to be discussed in the next section). The Euphrates flow is simply not large enough to fill all the present and planned reservoirs and, during drought years such as 1974 and 1988–9, Turkey and Syria have preferred to follow their own self-interests by filling their own reservoirs instead of sending water downstream to Iraq.

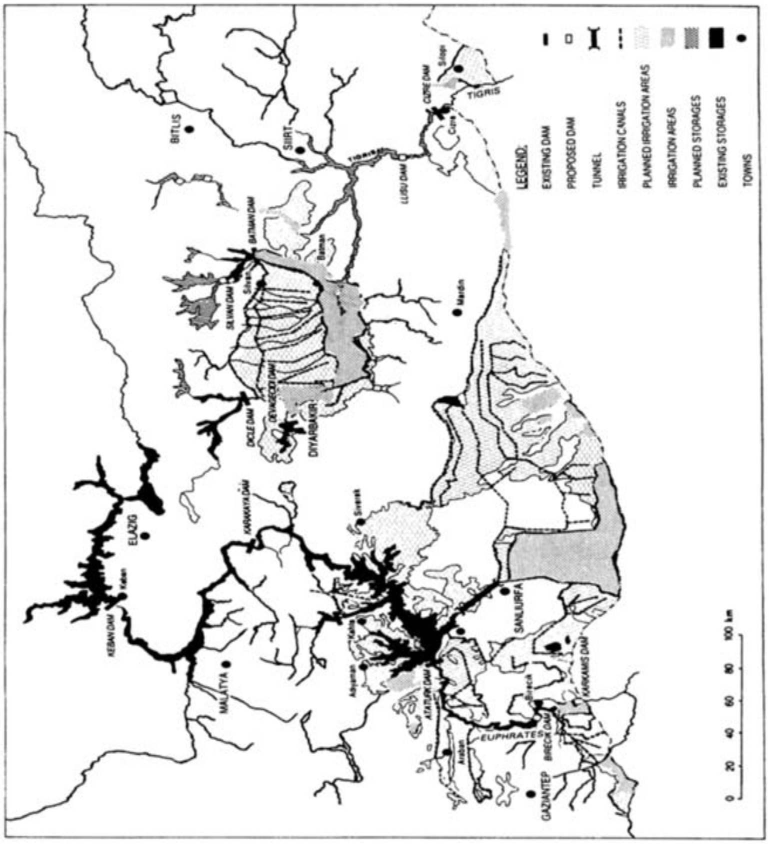
Another important feature of these reservoirs is the amount of water lost due to evaporation rates. The potential water loss for all the reservoirs in Turkey (when completed) is estimated at 1.5–2.0 billion m^3. For example the evaporation rate at the Keban storage is 476 million m^3 per annum when the surface area of the lake is 680 km^2 (Beaumont 1978:39); and the 630 million m^3/year water loss estimated for the Tabqa Dam represents about 2 per cent of the annual flow of the Euphrates (Beaumont 1978). As for Haditha Dam, Beaumont estimates water loss due to evaporation of 602 million m^3/year (Beaumont 1978: 38). Water losses in Iraq are certainly high with Lake Habbaniya, Abu Dibbis and Tharthar being located in regions of high evapotranspiration. In fact water losses from all the water storages of Iraq could reach 4.79 billion m^3, if we calculate the rate of evaporation as 1.45 million m^3/year for each 1 km^2 of the Iraqi reservoirs: Abu-Dibbis, Habbaniya and Tharthar. Estimates of evaporation for the Tigris River between Mosul and Baghdad are 3 per cent, between Baghdad and Kut 2 per cent and between Kut and Amarah an additional 2 per cent (Ionides 1937: 200). The evaporation rate for the Euphrates between Hit and Hindiyah Barrage is 8.5 per cent (Ionides 1937:111).

Concluding remarks

Article V(i) of the Helsinki Rules calls for the avoidance of unnecessary waste in the utilization of waters of the basin. The water wastage due to evaporation, seepage and conveyance losses amounts to more than 10 per cent of the total discharge of the Tigris-Euphrates and this may be interpreted as a violation of the Helsinki Rules. All three co-riparians are involved in plans to expand their utilization of the Euphrates and Tigris, but Turkey is involved in an enormous process of dam construction in the Tigris-Euphrates basin (see the next section). Under construction are the Khata Dam (on the Euphrates) with a total storage capacity of 1.9 billion m^3 and the Birecik and Karkamis Dams with a storage capacity of 1.4 billion m^3 which are supposed to be completed by the end of 1992. On the Tigris River the Kralkizi-Dicle Dam and the Batman Dam are under construction. In Syria, one dam on the Khabour with a storage capacity of only 0.99 billion m^3 has been completed and two more are under construction. Iraq is planning at least four dams: for the Greater and Lesser Zab, for the Adhaim and for the Tigris—the Badush Dam with a planned electricity production of 400 MW is the most important.

The separate development of water projects in Turkey, Syria and Iraq in the absence of any formal agreement on equitable water allocation in the Tigris-Euphrates basin violates the Helsinki Rules. The massive Turkish efforts to develop the Tigris-Euphrates, in particular, violate Chapter 2, Article VII, which states: ‘A basin state may not be denied the present reasonable use of the waters of an international drainage basin to reserve for a co-basin state a future use of such waters’. Syria is in violation of the same article. As a result Iraq, a downstream riparian with prior established rights, has been receiving less water and water of lower quality from its upper-stream riparians.

The directions of separate development also point to a violation of Article V(k) which calls for satisfaction of the needs of one basin state without causing substantial injury to a co-basin state. This norm is repeated in the ILC Rules which also add the principle of conservation, protection and economy of use of water resources. The anticipated deterioration of Euphrates water quality (mainly in Iraq) and the reduction in the Euphrates flow, as a result of massive storage development, do not satisfy the above rules. This situation is probably an outcome of the three co-riparians pursuing rival doctrines of sovereignty. Turkey, according to its plans, intends to adopt the Harmon Doctrine as she considers the Tigris-Euphrates water to be transboundary and not international (Tekeli 1990: 211) (see pages 162–3). Syria pursues the doctrine of



Map 2.3 The GAP in southeast Anatolia

limited sovereignty and Iraq that of absolute territorial integrity. Iraq also insists on its ancient or prior rights, a controversial doctrine which is not accepted by her co-riparians. With such conflicting policies there is a little hope of satisfying the needs of the co-riparians as reflected in patterns of supply and demand.

SUPPLY AND DEMAND FOR TIGRIS-EUPHRATES WATERS

Before turning to patterns of present supply and demand for Tigris-Euphrates waters it will be useful to look at two particular cases—one which will have an impact on demand (the Gap Project) and one which will have an impact on supply (the Peace Pipe).

The impact on water demand in the Tigris—Euphrates basin: the Southeastern Anatolia Project (SEAP) (GAP in Turkish)

GAP, the largest regional development project to be implemented in Turkey in 30–40 years, is a prestigious endeavour with a symbolic value for Turkey no less than that which the Egyptians attach to the Aswan High Dam. Southeastern Anatolia covers an area of 73,863 km^2, or 9.5 per cent of Turkey’s total, and the region comprises six provinces: Adiyaman, Diyarbakir, Gaziantep, Mardin, Siirt and Sanliurfa. The region borders both Syria and Iraq and is mostly settled by a Kurdish population (also settled across the border in Iraq and Syria). The total population of this area is about 4.3 million people with 70 per cent of the working population employed in agriculture, which accounts for 44 per cent of the GDP of the region (*Middle East Executive Report* March 1988). Turkey is determined to turn this region into the breadbasket of the Middle East and the GAP envisages a combination of twenty-five irrigation systems, twenty-two dams and nineteen hydroelectric power plants on the Tigris-Euphrates producing some 7,526 MW of hydroelectric power (27 billion kWh) which will increase the country's existing energy output by 70–80 per cent (Hindley 1990; Tekeli 1990: 207).

Southeastern Anatolia has an economy based on dry farming whose main crops are cereals (the area grows some 11 per cent of Turkey's total cereal production), pulses (the area grows 37 per cent of Turkey's crop), industrial crops, oil-seeds and tuber crops. About 55 per cent of the total land in the region is devoted to grain and 18.6 per cent of it is lying fallow. Productivity is very low since the soil is inadequately watered. When the GAP is concluded some 1.6 million ha (16.3 million dunums) will be irrigated and the region will grow 4.1 million tons of beets, 1.3 million tons of oil-seeds, 117,900 tons of corn, 3.5 million tons of vegetables, 1.1 million tons of grapes, 685,000 tons of pistachio nuts and 660,000 tons of fruit (*Newspot* 19 July 1988:5). In addition, Turkey's total cotton production is expected to rise by 25 per cent. Agrarian reform will accompany the plan as the southeastern region has, until now, been dominated by mainly Kurdish landlords, while some 18.5 per cent of farmers in eastern Anatolia are landless employees or sharecroppers. The dam projects have also involved the relocation of many people and some 25,000 have had to be resettled from the Keban site, 15,000 from Karakaya and 170,000 from the Atatürk area (*MEED* 17 July 1981).

The GAP is considered to be expensive ($21.0 billion is the estimated cost) and there has been a delay in the implementation of the scheme because of shortages in capital and spiralling costs (Hindley 1990:xi). The Turkish Government has pumped some $1.3 million a day into the project—not enough it seems—but Turkish sources have calculated that eventually the GAP will be economically viable in all sectors examined including agriculture and hydro power (Bilen and Uskay 1991). The long and detailed account presented here is necessary to comprehend GAP's political importance in Turkey. GAP, because of its national importance and symbolic value, has been given top priority by the Turkish government and Turkey is unlikely to give up its plans to harness the Tigris-Euphrates. The cost of the project has delayed Turkish implementation— but there are no signs that Turkey is going to give it up. Thus, instead of being completed by the year 2001, one can anticipate that the whole project might end in 2010, if we take into consideration the present pattern of delays.

For Syria and Iraq, the ten year delay period will not change anything if they are not able to reach an agreement with Turkey over Tigris-Euphrates water allocation for themselves, since the GAP, when completed, is not going to leave much water in the river.

Water and power projects in the Southeastern Anatolia Project

The above description of GAP clearly demonstrates its multipurpose nature, for, in addition to hydroelectricity and water storage, the whole economic nature of the region is going to change. Farming in the region is at present characterized by low productivity (as a result of low level technology, lack of training, inefficient use of fertilizers and lack of water). The GAP is going to introduce intensive and profitable farming by bringing irrigation to the region. It will create vast employment opportunities for the local people in agriculture; industry and transport, education and health services will also improve rapidly. The expected twentyfold increase in agricultural production will trigger industrial growth in the region, particularly in agro-industry (*NewSpot* 19 July 1988:5). A resultant rise in income levels resulting from an improvement of the economic structure is a most important aim of GAP.

GAP construction on the Euphrates

The GAP on the Euphrates includes some ten major projects (Table 2.8).

The Keban Dam The only role of the Keban hydroelectric dam, constructed on the Upper Euphrates during 1965–74, with a height of 211 m and a storage capacity of 30.0 billion m^3, is to produce electricity for Ankara and Istanbul. Turkey officially does not include the Kebban as part of the GAP project.

Karakaya Dam Located 165 km south of Keban, this dam was begun in 1967 and completed in 1988 for hydroelectric purposes.

The Atatürk Dam The Atatürk Dam is certainly the 'Jewel in the Crown' and the largest dam in the GAP. According to some sources it is the fifth largest dam of this type in the world (Jansen 1990:11). When it is fully developed, it will produce 2,400 MW or one-third of all the electrical energy envisaged for the whole GAP project and irrigate some half a million hectares of land (see Table 2.8). The construction of the Atatürk Dam, located near Bozova (180 km south

Table 2.8 The GAP projects

Hydro-power stations on the Euphrates	*Capacity*	*Hydro-power stations on the Tigris*	*Capacity*
1 Keban Dam[a]	1,240 MW	8 Devegecidi (Kralkizi)	94 MW
2 Karakaya Dam[a]	1,800 MW	9 Dicle Dam	110 MW
3 Atatürk Dam[a]	2,400 MW	10 Batman Project	198 MW
4 Sanliurfa HPP[a]	50 MW	11 Batman-Silvan Project	300 MW
5 Birecik Dam	672 MW	12 Garzan Project	90 MW
6 Karkamis Dam	180 MW	13 Ilisu Project	1,200 MW
7 Adiyaman-Kahta[b] (5HPP)	196 MW	14 Cizre Dam	240 MW
Total capacity	6,538 MW		2,215 MW
Combined total		8,753 MW	
Irrigated projects on the Euphrates	*Hectares*	*Irrigated projects on the Tigris*	*Hectares*
15 Sanliurfa-Harran	147, 866	23 Dicle[c]	126,000
16 Mardin-Ceylanpinar	328,608	24 Batman[d]	37,744
17 Sivert-Hilvan	160, 105	25 Batman-Silvan	213,000
18 Bozova	85,300	26 Garzan	60,000
19 Surut-Baziki	146,500	27 Silopi Valley	189,000
20 Adiyaman-Kahta	77,409		
21 Adiyaman-GoksuAraban	71,518		
22 Gaziantep	89,000		
Total	1,076,386		557,744
Combined total		1,634, 130 hectares	

Sources: Newspot 18 January 1990; Toepfer 1991
Notes:
[a]Dams that have been completed.
[b]Khata and Batman Dams are under construction.

[c]Kralkizi and Dicle Dams are under construction.

of Karakaya Dam), began in 1983 and is supposed to end (with the Sanliurfa Tunnels) in 1992. In the winter of 1990, Turkey began to fill up the lake behind the dam and the complete filling of the reservoir will take four or five years (Jansen 1990). By January of 1992 the storage had some 18 billion m^3 of water. When the lake is full, it will have a surface area of 817 km^2 and a storage capacity of 48.4 billion m^3 (dead storage being 30.0 billion m^3). The Atatürk is the epitome of the project and reflects the impact that Gap is having on both Turkey and the downstream riparians, Syria and Iraq. Hence its development needs to be portrayed in detail.

In January 1990 Turkey stopped the Euphrates flow for one month in order to start filling the Atatürk reservoir. Turkey chose January and February to fill the dam because irrigation needs and evaporation losses are minimal during these months. Turkey released additional water from its reservoirs on the Euphrates in advance starting from 23 November 1989 until 13 January 1990, and during this period increased the flow from 500 m^3/s to 750 m^3/s. According to Turkey, Syria should have been able to store 3, 438 billion m^3 of water at Tabqa Dam (Turkish Government 1990). During the closure period the Euphrates discharge flow was only 0.321 billion m^3, but immediately after the closure period Turkey again compensated its co-riparians by accelerating the flow to 3.759 billion m^3 (Turkish Government 1990). During the one month closure of the Euphrates 1.5 billion m^3 of water accumulated in the lake and, by the spring of 1990, some 5 billion m^3 of water had accumulated in Atatürk Dam (*Syrie et Monde Arabe* February 1990; *NewSpot* 31 May 1990).

The first Atatürk dam turbine was supposed to start working (according to plan) in May 1991. For this to happen, the level of the Atatürk Lake had to reach 256 m and the storage had to be 36.5 billion m^3 (*al-Qabas,* Kuwait 8 February 1990). An optimistic forecast suggests that four or five years will be needed to fill the reservoir, but considering the recent droughts and the reduced precipitation it is likely to take more than that.

In July 1993, according to Turkish plans the Atatürk Dam will produce 2400 MW. From 1991 onwards 150,000 ha every year will be connected to the irrigation systems and, by 2001, half of the cultivable land of the region will be under irrigation (*NewSpot* 19 July 1990). How is Turkey going to achieve the storage target needed since a volume of 36.5 billion m^3 of water is necessary for activating the first turbine? Turkey could impose more closure periods on its co-riparians; it could release water from Karakaya and Keban to fill the Atatürk Dam (an unlikely alternative), and it could reduce the constant flow to its co-riparians Syria and Iraq. There is also the faint possibility that an unusual flood could fill the Atatürk Dam in one winter, but such rare rainfalls have been known to occur in the Tigris-Euphrates basin. The winter of 1992 was especially rich in rainfall and its impact on the water storage would be evaluated during the spring of 1992.

Meantime, the cutback has been disastrous for both Syria and Iraq. During the one month filling period for the Atatürk Dam, only 120 m^3/s of water were discharged for both Syria and Iraq; this represented only 25 per cent of Syria's normal water supply. The Tabqa Dam power station was reduced to only 12 per cent of its capacity, and water rationing became frequent in Syrian cities. Iraq also had to cut water consumption, although its power production was not curtailed. Iraq reported that the winter crops for that year were seriously affected by the water scarcity. Both Syria and Iraq protested loudly and vigorously about the water closure of the Euphrates.

At the time of this writing, the cost of the Atatürk Dam had reached the enormous sum of $1.9 billion—only part of its estimated cost of $3.0 billion (*MEED* 17 July 1981). There has been a significant delay in implementing the work on the Sanliurfa Tunnels which will convey water from Atatürk to Harran and Mardin; but Turkey has not stopped its work on the Atatürk although there have been difficulties in the recruitment of the necessary capital for the project. One can probably assume that, by the mid- 1990s, the Atatürk will be fully working, and Syria and Iraq will have less water for their development.

The other projects on the Euphrates whose total active storage capacity will be 89.0 billion m^3 are as follows.

The Sanliurfa Tunnels This major unit of the GAP project consists of two tunnels, each with a diameter of 7.62 m and a length of 26.4 km. The tunnels will discharge water from the reservoir of Atatürk Dam at a rate of 328 m^3/s. The discharged water will run for 4 km on the north of the Sanliurfa-Harran plains and will be able to be converted into electrical power at Sanliurfa Hydroelectric Power Plant (50 MW). The water will be divided into two at the power plant: the Sanliurfa main irrigation canal will irrigate 48,000 ha and the Harran Canal will irrigate 99,866 ha. The Sanliurfa system is going to be the longest irrigation system in the world.

The Birecik Dam The fourth major dam on the Euphrates (see Map 2.3).

The Karkamis Dam The 180 MW Karkamis Dam will be the fifth dam on the Euphrates and serves as a complementary project to Birecik Dam.

The Adiyaman Kahta Project This six-dam project which is currently under construction includes a power station of 196 MW.

The Adiyaman-Goksu-Araban Project This project will irrigate land totalling 71,598 ha in the Adiyaman-Goksu-Araban region.

The Surut-Baziki Project This project includes a small power station of 44 MW, and 146,000 ha will be irrigated by the water stored in the dam.

The Gaziantep Project The last irrigation project is in Gaziantep where 89,000 ha will be irrigated. The total amount of land irrigated by all the Euphrates water projects will be 1,076,386 ha and the total hydroelectric capacity 6,538 MW. When completed, the projects will reduce the Euphrates flow on the Syrian border by 30 per cent according to the Turkish Government, or by 17.5–34 per cent of the total flow (Istanbul Chamber of Commerce 1989; Hindley 1990:xi).

Technical, financial and political problems have accompanied the construction of the Keban, Karakaya and Atatürk Dams, and most probably will accompany the construction and development of the other dams. First, sudden floods in April 1988 filled up the dams of Karakaya and Keban, and endangered the Atatürk. Second, the construction of the Atatürk had to be stopped a few times because of capital shortage (Tekeli 1990:208). Third, there is a danger of inundating close to 200 archaeological sites and 236 urban centres. Fourth, the full realization of the agricultural benefits of the project depends on the timely implementation of land reform in the areas to be irrigated (Tekelì 1990:208). Fifth, there is tension, and perhaps an emerging conflict, arising out of the Iraqi and Syrian opposition to the GAP development. This issue will be reviewed in detail on pages 161–3. Suffice it to say that Turkish developments will leave only small quantities of the Tigris-Euphrates waters for the co-riparians, and they are entitled to feel that their rights in the Euphrates are being severely curtailed by Turkey.

GAP construction on the Tigris (Table 2.8 and Map 2.3)

In addition to the ten Euphrates projects the GAP also includes the following six projects on the Tigris.

Dicle Kralkizi Project This project includes two dams: the Kralkizi Dam which will produce 90 MW and the Dicle Dam which will produce 110 MW. These dams will irrigate 126,080 ha on the right bank of the Dicle.

Batman Project This project includes two dams and hydro-power stations with the Batman Dam producing 185 MW and irrigating 37,744 ha on both the right and left banks of the Batman.

Batman-Silvan Project This dam is planned for a production of 300 MW and irrigation of 213,000 ha.

The Garzan Project It includes a dam with 90 MW and irrigated land of 60,000 ha.

The Ilisu Dam This is a very large dam of 1,200 MW. Its purpose is only to produce electricity and no irrigation project is attached to it.

Cizre Project This project includes the Cizre Dam and power station of 240 MW and 121,000 ha of irrigated land in the Silopi-Nusaybin-Cizre region.

The total area to be irrigated by the Tigris is 557,741 ha and that usage will probably consume some 35 per cent of the average river runoff (5.5–7 billion m^3) of the Tigris flow on the Syrian border which is 20.0 billion m^3. The Tigris hydro-power stations will produce 2,215 MW.

GAP: concluding remarks

The importance of GAP for Turkey can be summed up by the following:

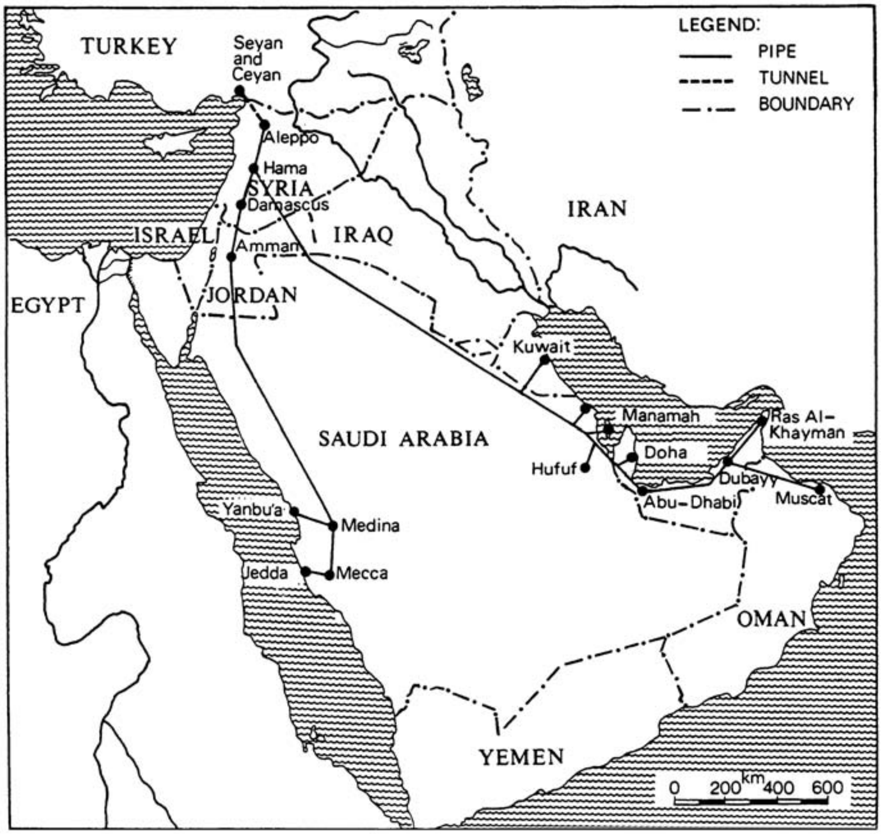
- GAP will add 70 per cent to Turkey's existing energy output (Hindley 1990).
- Gap will add 1.7 million ha to the current 3.2 million ha of irrigated land in Turkey (Istanbul Chamber of Commerce 1989).

The irrigation projects in the region will contribute Turkish lira (TL) 442 billion to the Turkish economy whereas the energy projects will produce an added value of TL 940 billion (Istanbul Chamber of Commerce 1989). But the implementation of the various projects of GAP is facing three major barriers.

First, as far as we know, some of the projects on the Tigris are still in the planning stage and all the GAP projects are behind schedule; thus the whole scheme looks certain to be seriously delayed. Keban was completed four years late, Karakaya three years behind schedule, and the same is true for the Atatürk, most of the delays being caused by financing problems (*MEED* 17 July 1981).

Second, the financial difficulties are enormous. The Keban Dam's cost was $85 million at 1970 prices, the Karakaya's total cost is estimated at $500 million (1981 prices) and the Atatürk Dam's cost is estimated at $3.0 billion (*MEED* 17 July 1981). The World Bank and, following their lead, most international funding agencies are not prepared to lend money for water projects involving possible infringements of international riparian rights unless the interested nations have come to an agreement. Thus, no funds are likely to be made available until Turkey can agree on the question of sharing the waters with its neighbours.

Third, downstream neighbours are reluctant to let Turkey take a sizable proportion of the Euphrates annual flow for irrigation purposes (*MEED* 17 July 1981). According to various estimates the GAP will reduce the Euphrates flow by approximately 30–50 per cent (30–40 per cent will be consumed by irrigation and 10 per cent will be lost due to evaporation). By the year 2000 only 20 per cent of the Euphrates flow will disappear but this could be very harmful to both Syria and Iraq (US Army Corps of Engineers 1991). Eventually, they may consider legal or other international measures in order to convince Turkey to allocate more water to them. Turkey, on the other hand, claims that the experience with the Keban Dam shows that high volume water releases from the Atatürk Dam will be possible. Thus, according to this argument, the storage capacities it develops will benefit Turkey's co-riparians by alleviating flooding damages and by releasing water from the storages in years of drought (Tekeli 1990:15). Turkey has also suggested an increase in water supply for her neighbours via water pipes.



Map 2.4 The Peace Pipe

The Peace Pipe and water transfers as a means of increasing water supply

One segment of development in the water sector which, if implemented, may affect water supplies are the various plans to convey water from areas of surplus water to areas with water shortages.

The most publicized plan is Turkey's 'Peace Pipes' plan as it has been called. The idea was first aired in 1987 and a feasibility study was made in 1988. The $21.0 billion project's aim is to pipe water from southern Turkey to the Arabian Peninsula through a pipeline which will originate in the Seyhan and Ceyhan Rivers in Anatolia. The Seyhan and Ceyhan have a total discharge of 39.1 million m^3/day of which Turkey plans to utilize approximately 23.0 million m^3/day for irrigation or hydroelectric power generation. A further 16.1 million m^3/day which flows into the Mediterranean could be used in the Peace Pipe (Duna 1988: 119). The proposed pipe will have two branches. The first is the western pipeline which will have a total length of 2,650 km and will start in Turkey, traverse the Nur mountains through a tunnel, continue to Syria (Aleppo, Hama, Homs and Damascus) and Jordan (Amman) and reach Saudi Arabia (Tabuk, Medina, Yanbu, Jeddah and Mecca). The total quantity of water to be delivered will be 3,500,000 m^3/day or 1,277 billion m^3/year. The second branch, the 3,900 km Gulf pipeline, will serve Kuwait, Saudi Arabia (Jubail, Damman, Hofuf) and then Bahrain, Qatar, United Arab Emirates and Oman, and its total discharge will be 2,500,000 m^3/day or 0.912 billion m^3/year (*MEED* 26 March 1988).

The second branch, the eastern pipeline (or Gulf line) will pump water up to 900 m to cross the high Jordan plateau parallel to the Iraq-Jordan border. The route will then follow the trans-Arabian Pipeline (Tapline) to the Gulf (*MEED* 26 March 1988).

Eleven pumping stations using a total of 900 MW will be needed on the western line and five pumping stations using 600 MW on the Gulf line. The scheme should take eight to ten years to complete and have an economic life of fifty years. The cost for the western pipeline is estimated at $8.5 billion and it is expected to provide 8 to 9 million people with up to 400 litres of water per person per day (Duna 1988:120). An additional estimated 6 to 7 million people could be served with 400 litres per day by the eastern or Gulf pipelines which will cost $12.5 billion (Duna 1988:120). Turkey will obtain $2 billion annual revenue from these pipelines. The average cost of water delivered has been calculated at $0.84 per cubic metre for the western pipeline and $1.07 per cubic metre in the Gulf pipeline, compared with $5 per cubic metre for desalinated water. Finance for the project will come from the International Bank for Reconstruction and Development (IBRD) and the Islamic Development Bank. Technically, financially and ecologically the project is feasible and the only obstacle is political (Duna 1988:121).

The political aspect is reflected by the fact that, in the first announcement made by the Information Department of the Turkish Ministry of Foreign Affairs, mention was made of a plan to use this pipeline to give water to Israel as well, but this plan was never mentioned again. The rivalry and conflicts that exist among the prospective clients play an important role in the possibility for implementation. It is not clear how many of the states which are to benefit from the pipeline will be completely ready to rely on Turkish water provision. As has been shown before, their sovereignty imperative will not allow this, especially in the case of Syria with its complicated relations with Turkey (*Gulf Report* 1989:13). In the areas studied in this book the Peace Pipeline will affect Syria, which will be provided with 1.1 million m^3 of water a day, and Jordan, which will be provided with 600,000 m^3 a day (*NewSpot* 29 April 1988).

Finally, a plan to provide Israel with water by transporting it in huge plastic bags (Medusa Bags) has also been reported. The plan envisaged that these bags would be hauled slowly by boat from southern Turkey to Israel loaded with water. None of the above plans have been implemented or is in the process of being implemented.

Water supply and demand in Turkey

Turkey is rich in water resources both in absolute terms and relative to its neighbours. Its total surface water supply has been estimated at 95 billion m^3 of which only about 25 billion m^3 are currently used (Pope 1990: 14; Bilen and Uskay 1991). According to Kolars (1992c) Turkey's surface water reserves are 184.930 billion m^3 but only 94.930 billion m^3 are available for consumption (Kolars 1992a: 117). The Tigris-Euphrates system constitutes about 50 per cent of this total (Beaumont, Blake and Wagstaff 1988:84). To the surface waters available to Turkey we have to add underground water sources which amount to a total of 10.0 billion m^3 of which it is safe to utilize 5.0 billion m^3. Thus, the total water resources available for Turkey are 100.0–104.4 billion m^3 of which Turkey was using about 14.0 billion m^3 in 1982 and is currently using 26 per cent (Bilen and Uskay 1991; Kolars 1992a:117).

More than 149 large dams have been constructed for the production of electricity and for irrigation purposes all over Turkey. The largest is Hirfanli Lake on the Kizil Irmak (320 km^2) followed by the Seyhan Dam Lake (90 km^2), Sanyar (80 km^2), Almus Demirkopru and so on. In addition many small dams have been constructed near Ankara and Istanbul in order to provide these cities with drinking water. Five dams, among them the Sanyar Dam on the Sakaraya, supply water to Ankara alone. The Hirfanli Dam on the Kizil Irmak produces 400 million kWh a year, in addition to irrigation waters and flood control. Water resource development in Turkey has been multipurpose although, being a country which stresses industrialization, hydroelectric power has always received priority over other aspects of water resource development and irrigation has mostly been secondary.

Water demand in the agricultural sector

Table 2.9 shows that the demand for irrigation water in Turkey for 1990 was only 1.62 billion m^3. Within the Tigris-Euphrates basin the utilization of irrigation water is currently a localized phenomenon but it will expand rapidly in the next decade, especially in the areas surrounding the Atatürk Dam. The total arable land in Turkey in 1990 was 27,000,000 ha, but only 8,500,000 ha were irrigable (Beaumont 1985:6; Bilen and Uskay 1991:4.2). Within the Euphrates Turkey irrigated 150,000 ha using 1.62 billion m^3 of water. After the year 2000 about 1,250,000 ha will be irrigated and about 13.7 billion m^3 of Euphrates water will be utilized (Chalabi and Majzoub 1992). By the post-2000 years, the consumption of irrigation water in the Tigris-Euphrates basin in Turkey is projected to be 21.5 billion m^3 (including evaporation losses).

Hydro power and hydropolitics in Turkey

There is no doubt that 'hydropolitics' suit Turkey's policy within the Tigris— Euphrates basin very well. This policy, also termed the 'hydro imperative of Turkey' stresses the supreme value of hydro power in Turkish energy policy (Kolars 1986:53). The problem put in simplistic terms is that Turkey's demand for energy, based on its population growth and impetus for industrialization,

Table 2.9 Water supply and demand for Turkey 1990 and post-2000 (within the Tigris-Euphrates basin) (billion m^3)

Supply and demand	*1990*	*Post-2000 (2040)*
Supply[a]		
Euphrates flow	28.2	28.2[b]
Tigris flow	18.5	18.5[b]
Total supply	46.7	46.7
Demand		
Euphrates		
Irrigation	1.62	21.500[c]
Storage evaporation	0.8	
Tigris		
Irrigation	0	6.7
Storage evaporation	0	
Domestic/urban industry	0.2	0.5
	2.8	28.7
Balance	+43.9	+18.0

Sources: Beaumont 1985; Bilen and Uskay 1991; US Army Corps of Engineers 1991; Shahin 1989

Notes:

[a]To the amount of water supplied by the Tigris-Euphrates we have to add other surface water (some 48.3 billion m^3) and underground water (5.0 billion m^3), all available for development.

[b]Some of the flow of the Tigris-Euphrates is used twice with the water from the irrigation canals returning to the main river channel. This comprises some 5.6 billion m^3 for the post-2000 years.

[c]By 2005 Turkey will use only 14.0 billion m^3 according to Waterbury (1992).

cannot be provided for by such local energy sources as coal or oil since Turkey is very poor in these energy sources. From 1975 to 1982 the total energy used in Turkey increased by 30 per cent while production from all Turkish sources increased by only 24 per cent, resulting in Turkey needing to import oil, coal and electricity from external sources (Kolars 1986:53). The need for energy is still increasing and energy consumption grew between 1987 and 1988 by 10.5 per cent (*Turkey Economic Report 1988* 1989). This is the reason for Turkey's almost obsessive drive to expand hydro power as a cheap source of energy totally owned by Turkey. It can be seen in Turkey's expansion of hydro-power production which reached 140 per cent during the late 1970s and early 1980s (Kolars 1986:53). The hydro power to be generated from GAP will step up Turkey's electricity supply by 80 per cent (US Army Corps of Engineers 1991); but this will, of course, be conditioned by Turkey's ability to accumulate an enormous quantity of water in the Atatürk reservoir (some 30 billion m^3). In 1992 the Euphrates dams were producing 3,040 MW. The completed Atatürk power stations will add 2,490 MW (Kolars 1992b). Although hydro power constituted 9.7 per cent of the total energy consumed in Turkey in 1982 by 1990, hydro power comprised 40 per cent of the electric power supply (Bilen and Uskay 1991:4.3). As only 20 per cent of Turkey's hydro-power potential has been developed one can expect a rise to about 33 per cent during the years 1991–6 (Bilen and Uskay 1991).

Turkey is hard pressed for energy and it does not seem likely to give up plans to produce large amounts of hydroelectricity; but perhaps to enter some sort of agreement it might be prepared to give up part of its plan for consumptive usage of the Euphrates waters, such as irrigation water. After all, hydro power is thought to be a non-consumptive form of water use and, after a period of storage (which could be very harmful to its co-riparians), Turkey could release large amounts of water for the consumptive usage of its neighbours.

It has been suggested that the economically exploitable energy potential of the Euphrates is 40,000 million kWh or 100 billion kWh per year, which represents about 45 per cent of Turkey's hydroelectric power potential (Ozal *et al.* 1967, quoted in Beaumont 1978:38; Kolars 1986:54).

How are the above utilization patterns going to affect the particular present and future usage patterns of the Tigris-Euphrates basin? Until the construction of the Keban Dam, Turkey used 3 per cent of the Euphrates waters (*al-Qabas,* Kuwait 12 March 1990) and the first two dams of the GAP-SEAP have caused only minor water loss from the Euphrates River. In fact, these two dams have even regulated the fluctuations of Euphrates discharge.

In 1974, however, when both Turkey and Syria began to fill the reservoirs of the Keban and al-Thawra (Tabqa) Dams, the water flow into Iraq was reduced to a trickle. In 1980, the Kebban waters were depleted as a political bribe to Turkish voters who complained of electricity shortages. When the Keban reservoir was refilled, a small but dangerous water shortage again occurred in Syria and Iraq (Kolars 1990). Inevitably, these occurrences have been repeating themselves during the long process of impounding water in the Atatürk Dam.

Approximately how much water is, in fact, going to be lost due to evaporation in the large water storages that Turkey is developing for both hydro power and irrigation? Estimates are that, in Turkey alone, 4.4 billion m^3 will be evaporated in water storages within the Tigris-Euphrates system (US Army Corps of Engineers 1991). Another estimate for the Euphrates reservoirs put evaporation volume at 3.1 billion m^3 (Chalabi and Majzoub 1992).

Water supply and demand in the urban sector

Another sector of the society which is rapidly expanding its water demand is the urban sector. Turkey's urbanization rate was 3.59 per cent for 1985–90 and it is expected to continue to grow, so water shortages in urban areas will be getting worse. Water consumption in rural areas is 50 litres a day whereas in urban areas it has reached as much as 200 litres per day, placing an enormous strain on water resources (Bilen and Uskay 1991). In the Euphrates basin water consumption in the domestic sector was 158 million m^3 (Chalabi and Majzoub 1992). Istanbul, with a population of 7 million people in 1990, has insufficient water supplies. Total demand for water in the urban sector in 1990 was 5.9 billion m^3, and it is expected to expand to 9.0 billion m^3 in 2000 (see Table 2.9).

Water supply and demand in Turkey—concluding remarks

Turkey is well endowed with water resources and its current and future demands are going to be satisfied quite easily from all its available resources. Turkey is expected to have localized water problems, and even shortage problems, during drought years. Other problems are the deterioration of water quality, and bitter conflicts over water allocation to different sectors; so measures to increase the efficiency of the water sector are important (Bilen and Uskay 1991).

Within the Tigris-Euphrates basin Turkish plans for water usage are going to reduce the amount of water available to its co-riparians significantly. Turkey has committed itself to an annual Euphrates flow of 16.0 billion m^3 and is going to use some 14.4–15.0 billion m^3 of water for irrigation by the post-2000 (Allan 1987:29; US Army Corps of Engineers 1991). Some of this water, estimated at 2.8 billion m^3, is going to be available to Syria as return flow, and it will cause significant deterioration in the quality of water that Syria will be getting. Turkey is going to use 8.5 billion m^3 of Tigris water for irrigation and 2.8 billion will constitute return flow. In addition, Turkey will impound some 4.0 billion m^3 of Euphrates waters in the Atatürk Dam between 1991 and 1996, and may start impounding water for the other new dams during 1996–2000. Syria believes that impounding water in the Atatürk will cut the Euphrates flow by two-thirds. The Euphrates flow will thus be gradually reduced over the next decade, and when Turkey completes its GAP programme around 2040 the average natural flow of the Euphrates to Syria will be 6.7 billion m^3. Return water of 4.6 billion m^3 will be supplemented to this, giving a total of 11.3 billion m^3. By 2040 the Tigris flow to Iraq will be 11.8 billion m^3 of natural flow and 28 billion m^3 of return flow (US Army Corps of Engineers 1991).

Thus, as already noted, the total depletion of water from the Tigris-Euphrates system (for all uses) will amount to 50 per cent. By the year 2000, depletion might already reach 20 per cent of the Euphrates flow. On the other hand, there is a possibility that the storages in Turkey will have a positive effect on Turkey's co-riparians. The 1988–9 water year was the driest of the last half century, and the deficiency in natural flow was made up by water from the Keban and Karakaya reservoirs protecting Syria and Iraq from the consequences of the drought (US Army Corps of Engineers 1991).

Supply and demand for Tigris-Euphrates waters in Syria

Syria has an arid and semi-arid climate in 50–60 per cent of its territory and its surface water resources, apart from the Tigris and Euphrates and their tributaries, amount to 3.9–6.6 billion m^3 of water. The most important source is

Table 2.10 Major Syrian rivers: mean discharges (million m^3)

River	*Total length (km^2)*	*Kilometres (in Syria)*	*Annual discharge (in Syria) (million m^3)*
Euphrates	3,000	710	28.000–29.000

River	*Total length (km²)*	*Kilometres (in Syria)*	*Annual discharge (in Syria) (million m³)*
Khabour	300	260	1.500–1.780
Balikh	160	80	0.200
Orontes	571	325	2.280
Afrine	129	85	
Barada	71	71	0.400 (0.350)
Awaj	66	66	0.100
Yarmuk	57	47	0.450
Other rivers			1.191
Total surface water			34.121–35.121

Sources: Khader 1984; Gischler 1979; Naff and Matson 1984; Kolars 1992c

the Khabour (a tributary of the Euphrates), the Orontes (or Asi as it is called in Lebanon and which is an international river shared by Lebanon, Syria and Turkey) and the Yarmuk (a tributary of the Jordan, to which the kingdom of Jordan and Israel are co-riparians) (Table 2.10). Syria has few of its own water resources.

The Tigris has 45 km of its west bank within Syria and discharges 23.0 billion m^3 of its water there. The Syrians' 1989 Plan to tap the water of the Tigris through the use of pumps for a project whose goal is to irrigate 150,000 ha of land is going ahead (*Tishreen,* Syria 12 November 1989). The total surface waters of Syria are 34.121–35.121 billion m^3 of which the Euphrates provides 26–28 billion m^3 (Nimrod 1966:12; Gischler 1979:114; Shahin 1989). Kolars (1992c) does not include the Euphrates river among the surface water resources of Syria and thus estimates only 8.715 billion m^3 of surface water for that state. The variation is totally dependent on Euphrates fluctuations but, from any point of view, the Euphrates is extremely important for Syria's water supply budget as it constitutes some 80–90 per cent of the surface water supply.

In addition to surface water, Syria has a good supply of groundwater (between 1.78 and 2.67 billion m^3) which is utilized through 30,000 wells mainly in the Damascus basin, the Orontes Basin and the Aleppo Basin (Gischler 1979:114; Shahin 1989:216; Kolars 1992a, c). Unfortunately they are over-utilized, especially in the Orontes basin and around Aleppo and Damascus. The total storage capacity in Syria is about 12.0 billion m^3 with Tabqa al'Thawra (in the Euphrates) storing 11.9 billion m^3 or 7.5 billion m^3 in live storage and other small reservoirs storing the remainder (*al-Aharam,* Egypt 19 February 1990; Gischler 1979:114). The Baath Dam which was completed in 1986 has a storage capacity of 90 million m^3 and the Tishreen Dam upstream from Lake Assad will have a reservoir holding 1.3 billion m^3 (Kolars 1992a).

Water supply and demand in agriculture

Agriculture is extremely important for the Syrian economy and the cultivable land is estimated at 6,029,000 ha, of which 5,503,000 ha are under cultivation (out of Syria's total area of 18.5 million ha). Rain-fed areas amount to 3,336,000 ha whereas irrigated areas range between 531,000 and 620,000 ha (Shahin 1989: *Syria Statistical Abstracts* 1990). Other Syrian sources have estimated the irrigated areas for the mid-1980s as 621,700 ha (*Rapport Economique Syrien 1986–7* 1988; *Syrie et Monde Arabe* 1987; US Army Corps of Engineers 1991), with the area irrigated from groundwater sources in 1980 representing 44 per cent of the total irrigated area (Manners and Sagafi-Nejad 1985:263).

The Syrian Government's own figures suggest that there has actually been a net loss of irrigated land since the early 1960s, variously attributed to inundation, waterlogging and salinization and to the impact of the land reform (Manners and Sagafi-Nejad 1985:263). About a 20 per cent net loss of irrigated land between 1960 and 1986 has also been suggested elsewhere (Beaumont, Blake and Wagstaff 1988:383).

Within the Euphrates basin the estimated amount of land which Syria plans to irrigate amounts to 397, 000 ha. The latest report on irrigated areas in the Syrian districts which are located within the Euphrates basin are as follows: Deir-ez-Zor, 178,000 ha; Al-Hassakeh, 130,000 ha; Al-Rakka, 65,000 ha; and the total amounts to 373,000 ha (*Syria Statistical Abstracts* 1990). Other sources put Syria's irrigated land for the late 1980s within the Euphrates basin as ranging between 136,000 and 250,000 ha, which consumed between 2.7 and 4.7 billion m^3 of water (*al-Qabas,* Kuwait 12 March 1990; Chalabi and Majzoub 1992).

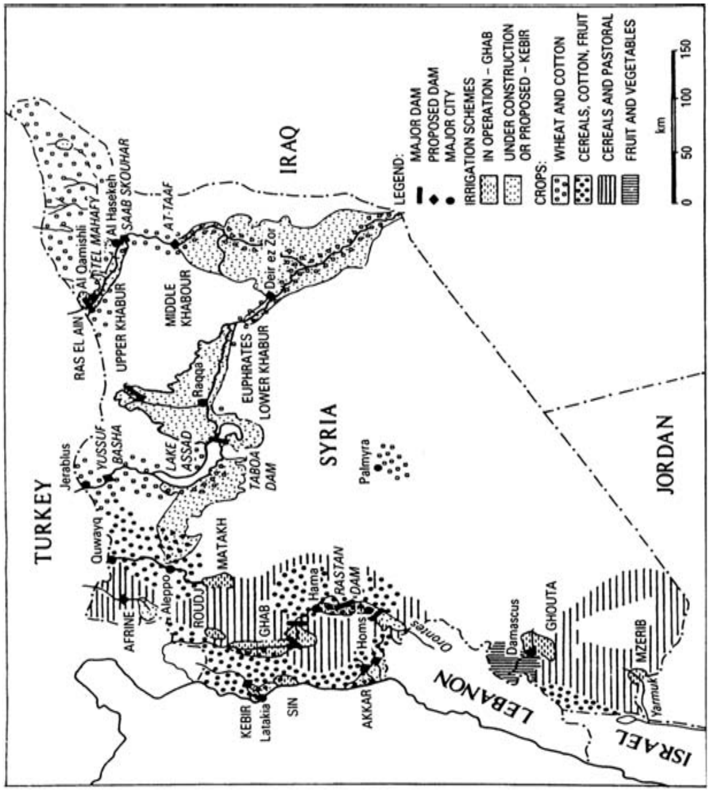
Syrian officials originally estimated that the Tabqa-al Thawra Dam would increase the irrigated area within the basin to 600,000–650,000 ha (Naff and Matson 1984:91). According to reports for 1983, however, only 35,000 ha were prepared for irrigation in the new reclaimed lands, utilizing only 350 million m^3 of Euphrates waters (Allen 1987:22). The major problem here is that the cost of reclamation for the project has been enormously expensive, absorbing nearly a quarter of all public investment in Syria between 1971 and 1975 (Beaumont, Blake and Wagstaff 1988:383). Land reclamation is especially expensive in the Khabour region as unwanted salt and gypsum have to be removed from the soil. Kolars (1990) estimates that only 300,000 ha will eventually be reclaimed and irrigated within the Euphrates basin by the Tabqa-al Thawra Dam and this has been confirmed by another source (US Army Corps of Engineers 1991).

Syria was extracting 2.7–3.0 billion m^3 of the Euphrates flow in the mid-1970s and the same amount in the 1980s, and its current water consumption for agriculture ranges between 3.0 and 5.0 billion m^3 according to various sources (Clawson *et al* 1971; Naff and Matson 1984; *al-Qabas,* Kuwait 12 March 1990). Currently Syria has more than enough water in Lake Assad for agricultural development in the near future, but will need some 5–10 billion m^3 of

Table 2.11 Water supply and demand in the Tigris-Euphrates system in Syria, 1990 and post-2000 (billion m^3)

Supply and demand	*1990*	*Post-2000 (2040)*
Supply		
Euphrates flow	28.0–29.0	6.7–9.2 natural flow
		4.6 return flow
Khabour	1.500	1.780
Balikh	0.200	0.200
Underground	0.400	0.400
Total supply	30.1–31.1	13.6–16.1
Demand		
Irrigation[a]	3.0–5.0	10.2[b]
Storage evaporation	0.630–0.830	1.7
Urban and industry	0.100[c]	1.5
	0.010	
Total demand	3.740–5.940	13.4[d],[e]
Balance	+25.2–26.4	+0.0–2.7

Sources: Shahin 1989; US Army Corps of Engineers 1991; Kolars 1990
Notes:
[a]This is calculated on estimated irrigated areas of 300,000–500,000 ha within the Euphrates and Khabour basins.
[b]Return flows will consitute about 50 per cent of the water supply of Syria.
[c]This includes 80 million m^3 diverted to Aleppo.



Map 2.5 Irrigation areas and water projects in Syria

Supply and demand	*1990*	*Post-2000 (2040)*

[d]Return flow will amount to 3.7 billion m^3 out of the flow to Iraq (6.9 billion m^3).
[e]According to Waterbury (1992) total demand of 13.0 billion m^3 is expected in 2005.

Euphrates flow if all her planned projects are to be carried out (Beaumont 1978: 40) (Table 2.11). By the year 2000 Syria plans to irrigate 795,000 ha within the Euphrates basin and will need 10.3 billion m^3 of water to carry out this plan (Chalabi and Majzoub 1992). By the year 2040, if all the GAP plans are implemented, Syria will only have 13.4–15.9 billion m^3 of water available of which 4.6 billion m^3 will be return flow from the irrigation projects of the GAP. According to Kolars (1992c) only 9.0 billion m^3 can be expected in 2005.

The Khabour will be heavily inundated with irrigation return flows, originally diverted off-stream from the Atatürk Dam to the Urfa-Harran Mardin Plain.

The pressure on Syrian agriculture is not going to be immediate unless there are a number of consecutive droughts or unless Turkey increases the pace of accumulation in its storages. Syria has plans to complete its dam constructions on the Euphrates and Khabour over the next five to ten years, in order to increase its storage capacity by 2.8 billion m^3 (1.0 billion m^3 in the Khabour Dams and 1.3 billion m^3 in the six

Tishreen Dams). This storage capacity could protect Syria from a shortage of water for irrigation, but filling the storages will be very difficult as Turkey is releasing less water and downstream Iraq will not allow both Turkey and Syria to restrict its own agricultural development. The only comforting thought for Syria must be that the GAP will probably never be fully implemented, and whatever is implemented will not materialize until decades after the projected date of completion (Allan 1983:243). Probably not more than 10.8 billion m^3 of water will be removed from the Euphrates by 2010 (Kolars 1992a). To this probably reasonable observation we can add another unlikely plan: Syria's own plan to reclaim 640,000 ha of land within the Euphrates basin.

Hydro power and hydropolitics

Syria needs the Euphrates waters for much desired hydro power and the imperative of hydro power is as valid a concept for Syria as it is for Turkey. In the early 1980s, hydro power contributed 30.5 per cent of the total installed electricity capacity (*Rapport Economique Syrien 1986–7* 1988: B-51). Currently, Tabqa Dam contributes a hydroelectric capacity of 800 MW, the Baath Dam 64 MW and the Tishreen will produce 1.6 MW (Kolars 1992a). Hydro power constitutes about 25 per cent of Syria's installed capacity (*EIU* 1992c; *Syrie et Monde Arabe* August 1989:6). The electric power utilities which supply the rest are oil-fired and gas-fired stations with effective generating capacities of 2,589 MW (*EIU* 1992c).

Tabqa al-Thawra exerts significant influence on electricity production. Thus, fluctuations in the surface water levels of the Euphrates have made hydroelectric power an unreliable source of energy for Syria. Between 1975 and 1987, Syria's electricity consumption grew by about 17.7 per cent annually and so the delays affecting generating capacity expansion led to a deficiency in supply, thus increasing the number of blackouts all over the country (*Syrie et Monde Arabe* August 1989:13). This was highlighted in 1989 when, because of a drop in the Euphrates flow, the al-Thawra Dam reportedly operated at only 10 per cent of its nominal capacity (Hindley 1990: viii). Syrian newspapers reported public complaints about electricity failures of seven hours and more during that year (*Tishreen,* Syria 2 December 1989). More than it needs irrigation water, however, Syria needs the Euphrates waters for hydro power as a cheap and non-depleting source of energy.

Syria's other uses for water: urban (municipal) and industry

In the mid-1970s Syria utilized 400 million m^3 of water for urban and domestic needs (Gischler 1979:114). Future demands are expected to grow to 1.5 billion m^3 by 2000 (Gischler 1979:114). The Syrian urban sector has already been exposed to water shortages as a result of a combination of factors: drought, an accelerating population growth in the urban sector, and the lack of development of a reliable potable water supply. Aleppo, for example, depends on Lake Assad for municipal, industrial and irrigation supplies (US Army Corps of Engineers 1991) and some 80 million m^3 of water for both agriculture and municipal needs are directed to Aleppo each year. In 1990 62 million m^3 was consumed by the domestic sector within the Euphrates basin. Approximately 1.5 billion m^3 of water will be utilized by the urban sector in the Tigris-Euphrates basin within the next decade and up to 1.0 billion m^3 is going to be used by industry in the next decade. Syria may also have to consider water transfers as half of northern Syria's industry and agriculture suffers from daily water shortages and electricity quotas (*al-Yum al-Sabbah,* Syria 18 December 1989).

Concluding remarks

Syria is certainly in an unfavourable hydrological position within the Euphrates because of its midstream location and high dependence on the Euphrates and its tributaries for hydro-power production and irrigation. Experts predict that Syria will face an annual water deficit of about 1.0 billion m^3 by 2000 (Hindley 1989: 5) and when Turkey completes its GAP plan Syria could lose 40 per cent of its Euphrates waters (Jansen 1990:11). The geopolitical meaning of this process is that Turkey will have significant leverage over Syria (and Iraq). In addition, when Syria completes its plans for water withdrawals from the Euphrates, as much as about 30 per cent of the Euphrates flow will be reduced, thus leaving Iraq with less than 20 per cent of the Euphrates flow. Thus the possibility for conflict in the area is extremely high.

Supply and demand for Tigris-Euphrates waters in Iraq

The climate of Iraq is also mostly arid, and Iraq relies heavily on the Tigris-Euphrates waters. Total surface water in Iraq is between 76.0 and 84.4 billion m^3 and this is 98 per cent related to the Tigris-Euphrates and their tributaries (Ubell 1971:3; Gischler 1979:100; Beaumont, Black and Wagstaff 1988:84) (Table 2.12). According to Kolars (1992c) Iraq's surface water resources are only 15.6 billion m^3. Iraq also has underground waters of about 1.2 billion m^3 but, in 1975, the total water available for Iraq (before Turkey and Syria expanded their use) was about 81.2 billion m^3. By 1990, after Turkey and Syria withdrew 1.8 billion m^3 and 3.7–5.9 billion m^3 respectively (from the Euphrates), the total water supply was only 73.7–75. 7 billion m^3.

Water demand and supply in agriculture in Iraq

The total area cultivated in Iraq at the beginning of the 1960s was 6.0 million ha and in the early 1970s 7.6 million ha (Cressey 1960; Gischler 1979). In 1988 the total land suitable for agriculture in Iraq was estimated at 11,500,000 ha (Shahin 1989). According to some, the area under rain-fed farming in Iraq comprised 25 per cent of the total arable land which is about 40 million ha (Fisher 1978: 388; Gischler 1979: 99). Data relating to irrigated areas in Iraq are often

Table 2.12 Water supply and demand in Iraq, 1990 and post-2000 (billion m^3)

Supply and demand	*1990*	*Post-2000 (2030–2040)*
Supply		
Euphrates flow	27.9–29.0[a]	6.9 3.7[b]
Total	27.0–29.0	10.6
Tigris	21.8–23.2	11.8
Tigris tributaries	26.4–29.4	28.7
Total Tigris	48.2–52.6	40.5
Total Tigris and Euphrates	75.2–81.6	51.1
Demand		
Irrigation[c]		
Euphrates	13.0–15.0	16.0
Tigris and tributaries	28.0–32.0	40.0

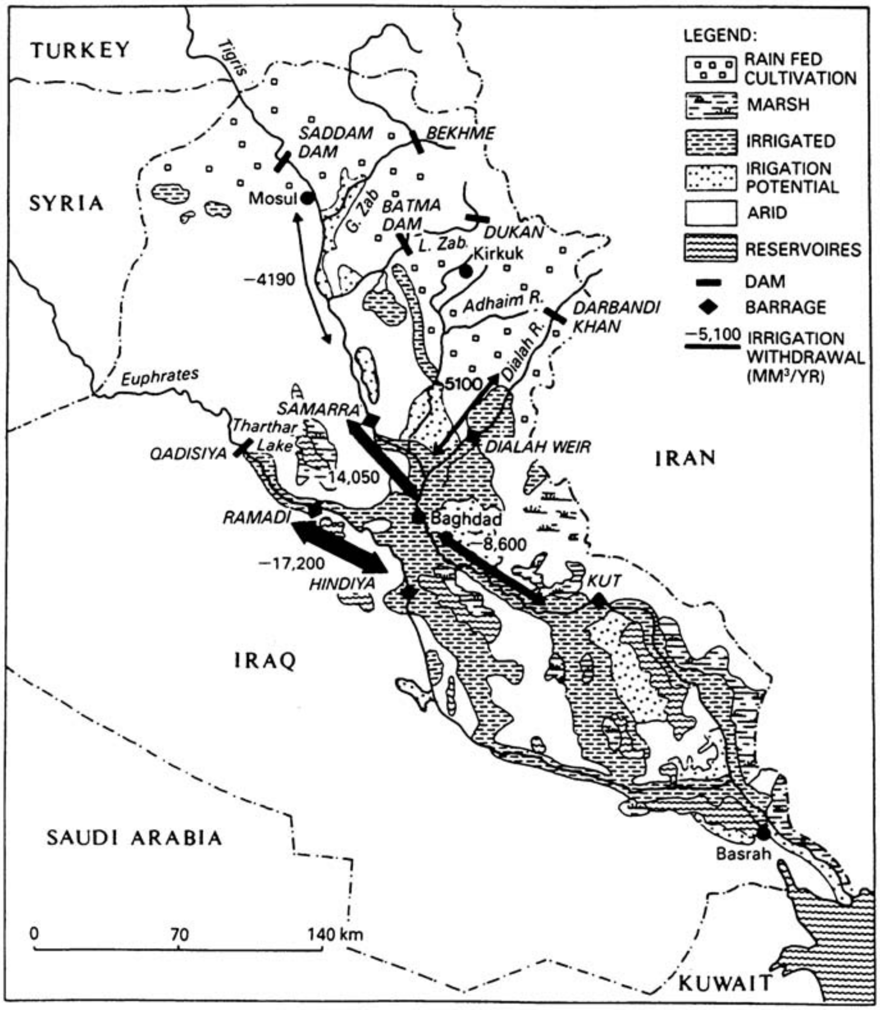
Supply and demand	*1990*	*Post-2000 (2030–2040)*
Storage evaporation		
(in both rivers)	1.2	9.6
Urban/municipal	1.5	2.5
Industry	3.0	3.6
Total	46.7–51.7	61.7
Balance	+28.5–29.9	−10.6

Sources: Shahin 1989; US Army Corps of Engineers 1991; Beaumont, Blake and Wagstaff 1988
Notes:
[a]Euphrates flow to Iraq is calculated as the Euphrates flow from Syria minus Syrian utilization.
[b]The 3.7 billion m^3 is return flow from Syria in addition to the river's natural flow.
[c] According to Shahin, Iraq's demand for irrigation water in 2030 will amount to 68 billion m^3 of which about 60.0 billion m^3 will be provided (32 billion m^3 from the Tigris and 17.0–28.0 billion m^3 from the Euphrates). However, it is very unlikely that this amount of irrigation water will be available in the Euphrates. According to US Army Corps of Engineers (1991) the Iraqi withdrawals for agriculture will amount to 17.6 billion m^3 within the Euphrates and to 32.0 billion m^3 within the Tigris, bringing the demand for irrigation water to 49.6 billion m^3.

contradictory. Irrigated land has been estimated as ranging between 1,750,000 and 5,900,000 ha (United Nations 1985; Adams and Holt 1985:64, respectively). Recent estimates have put the irrigated land at about 1.0–1.29 million ha in the Euphrates basin and about 2.0 million ha in the Tigris basin or a total of 2,777, 000 ha (Shahin 1989; US Army Corps of Engineers 1991; Kolars 1992a). This seems a reasonable estimate since Iraq reduced its farming during the Iran-Iraq war (*al-Qabas,* Kuwait 12 March 1990).

Water extraction estimates vary too. Iraq was consuming 16.3 billion m^3 of the Euphrates waters in 1970 and between 13.0 and 15.0 billion m^3 in 1990 (Ubell 1971:4; Ockerman and Samano 1985:192; *al-Qabas,* Kuwait 12 March 1990; Kolars 1992a, c). This probably includes all of Iraq's use of the Euphrates water. By the year 2000 Iraq's water requirement from the Euphrates will be 16.0 billion m^3.

Average water use per hectare in Iraq ranges between 13,300 and 15,900 m^3/ year (Ubell 1971; Ockerman and Samano 1985). In order to irrigate all its irrigable land within the Euphrates drainage basin, an area amounting to 1,833,000 ha, Iraq will need about 24–27 billion m^3 of water (according to the above figures) either from the Euphrates or, more probably, from the Tigris. By 2000 if Turkey releases only 15–16 billion m^3 of water to the Euphrates flow, as she has committed herself to do, then the Euphrates flow to Iraq is going to be no more than 6.5 billion m^3 after Syrian withdrawals. If the Iraqi use the water, the deficit in the Shatt al-Arab will amount to −6.4 billion m^3 (Kolars 1992c). This of course is an impossible scenario. This means that during the next two decades Iraq may lose about 80–90 per cent of the Euphrates water that has been available to her until now (Jansen 1990). A shortfall of 10.0 billion m^3 might take place. Iraq's sources have estimated that such a reduction will affect 5.5 million Iraqi farmers living in the Euphrates basin and jeopardize 1.0–1.8 million ha of farmland which may have to be abandoned (*Middle East International* 16 February 1990:12, Kolars 1990). Iraq's situation in the Tigris basin is significantly better owing to the fact that the Tigris and its tributaries are not yet being used by Turkey or Syria. Iraq consumed 31.9 billion m^3 of water from the Tigris and its tributaries at the end of the 1960s in order to irrigate 1.1–1.3 million ha within the Tigris basin (Brawer and Karmon 1968; Ubell 1971:4). Current Iraqi withdrawals of irrigation water from the Tigris and its tributaries are estimated at 25.0–32.0 billion m^3 (US Army Corps of Engineers 1991). However, one estimate of Iraq's water extraction from the Tigris is only 18.5–22.9 billion m^3 (Kolars 1992c). Iraq will be able to irrigate irrigable lands in the Tigris basin



Map 2.6 Irrigation projects, water withdrawals and irrigation areas in Iraq

(amounting to 2.8–4.0 million ha) with Tigris water and divert water through the Tharthar link to the Euphrates, thus compensating herself for the water deficit of the Euphrates. This is more or less what Turkey would like Iraq to do. Since consumptive water use on the Tigris (as foreseen by Turkey) will be limited, Iraq would be able, in this way, to supplement the Euphrates decreased flow with Tigris waters (Tekeli 1990:215).

To sum up, Iraq's water extraction in the 1970s was 49.0 billion m^3 from the combined discharge of the Tigris-Euphrates, which comprised 60 per cent of the flow. By 1990 Iraq's extraction ranged between 34.0 and 50.7 billion m^3 (Beaumont, Blake and Wagstaff 1988:365; *al-Qabas,* Kuwait 12 March 1990, US Army Corps of Engineers 1991; Kolars 1992c). Kolars believes that Iraq's extraction of water from the two rivers was not more than 39.9 billion m^3. By the year 2040, if Turkey completes her development plans, Iraq will have only 42.0– 44.0 billion m^3 of water for use in the Tigris basin, and probably no water in the Euphrates basin (Kolars 1992a, c). This reduced water supply is the reason for Iraqi demands that Turkey release 21.9 billion m^3 of water from the Euphrates, instead of the 16.0 billion m^3 which Turkey has obliged herself to send to both Syria and Iraq.

A final point in this matter has to do with irrigation patterns in Iraq such as flooding and over-irrigation. There are great water losses (up to 40 per cent) due to the methods of irrigation, high evaporation rates, seepage and lack of a proper drainage system (Ubell 1971; Ockerman and Samano 1985:194; Beaumont, Blake and Wagstaff 1988:364; Tekeli 1990). Over the last decade Iraq has invested in modern drainage systems which are crucial to saving the soil since much of it has been degraded by salt concentration. There is no available information yet on the state of the project in 1992 in the aftermath of the Gulf War.

Hydro power and hydropolitics in Iraq

Iraq is extremely rich in oil and there has not been an urgent need to develop hydro power as in the case of Turkey and Syria; yet, Iraq is accelerating the development of hydro-power electricity and all its new dams have large hydroelectric capacities. According to Gischler (1979:100), half of Iraqi electricity, in the mid-1970s (1,300 MW), was provided by hydro power. Iraq's total electricity for 1987 was 8,538 MW with Qadisiya-Haditha on the Euphrates producing 600 MW, Saddam-Mosul Dam 300–400 MW and Dukan 400 MW (*The Middle East and North Africa Yearbook 1990* 1990:132–5). This hydro-power capacity constitutes about 2.5 per cent of Iraq's total estimated electricity capacity (1989). Since there is a trend in Iraq (as in Syria) towards enlarging its hydro-power capacity the Iraqis, like the Syrians, have to be concerned with any reduction in the Euphrates flow, not only because this will reduce irrigation water but because Iraq's electricity capacity is going to be affected by it. This is also true of evaporation in the water storages of these hydro-power dams which will be about 1.2 billion m^3.

Urban, municipal and industrial water supply and demand

According to Gischler (1979:100) Iraq, in the 1970s, was using 0.58 billion m^3 of water for domestic purposes and 2.24 billion m^3 for industry. Today the urban sector is in urgent need to expand the amount of water available to it. Not only have Istanbul and Damascus been experiencing a shortage of potable waters in recent years, but so have Baghdad and Mosul. Mosul is projected to increase its demand from 83,950 litres per capita per year to 120,000 litres per capita per year (US Army Corps of Engineers, 1991). Four water storages for domestic usage were completed around Baghdad between 1981 and 1986 and have a storage capacity of 465 million litres. Currently Iraq extracts about 181 million m^3 of water from the Euphrates for domestic use as well as 1.2 billion m^3 from the Tigris. In the next decade Iraq's water needs for the urban and industrial sectors will probably surpass 2.5–3.0 billion m^3. By the year 2000 Iraq's total estimated water demand will be 47.3–49.0 billion m^3. Of this amount about 90– 92 per cent will be diverted to agriculture, 3 per cent (1.4–1.9 billion m^3) to the domestic/urban sector and 5 per cent (2.35–3.4 billion m^3) to industry (Shahin 1989:217; US Army Corps of Engineers, 1991).

The Helsinki and ILC Rules and water balance in the Tigris—Euphrates system, 1990, 2005, 2040

Table 2.13 estimates water withdrawals from the Tigris-Euphrates for the years 1990, 2005 and 2040 (after the completion of the GAP projects). The data are separated for the Tigris and Euphrates in order to examine whether a surplus in one river might be used as compensation for a deficit in the other. The table is

Table 2.13 Water abstraction from the Tigris-Euphrates system, 1990, 2005, 2040 (billion m^3)

Country	*Euphrates*			*Tigris*			*Total*		
1990	*2005*	*2040*	*1990*	*2005*	*2040*	*1990*	*2005*	*2040*	
Demand									
Turkey	2.8	7–11	21.5	0	3.7	7.2	2.8	10.7–14.7	28.7
Syria	5.9	6–7	13.4	0	0.5?	0.5?	3.7–	6.5–7.5	13.4–13.9
Iraq	13–15.0	16.0	16.0	28.0–32.0	40.5	40.0	38.0–45.0	59.5	61.7
Supply									
Turkey	28.2	28.2	28.2	18.5	18.5	18.5	46.7	46.7	46.7
Syria	30.1–31.1	16–20	13.6–16.1	–	–	–	30.1–31.1	16.0–20.0	13.4–16.1
Iraq	27.0–29.0	10–13	10.6	48.2–52.6	45.0	40.5	75.0–81.6	47.0–53.0	47.6–51.1
Balance	1990			2005			2040		
Turkey	+43.9	+44.9		+32.0	+36.0		+18.0		
Syria	+24.2	+27.4		+9.5	+13.9		–0.5	+2.7	
Iraq	+30.0	+37.0[a]		–12.5	–6.5		–14.1	–10.6	

Sources: Beaumont 1978; Allan 1987; Turkish Government 1989; Gischler 1979; Shahin 1989; US Army Corps of Engineers 1991

Note: [a]This balance includes water losses.

based on the following premises: first, total withdrawals for all uses are taken into account; second, water supply is taken as 31.0 billion m^3 for the Euphrates and 48.0–52.6 billion m^3 for the Tigris, making the total amount in the Tigris-Euphrates 79–83.6 billion m^3 (these values may be an over-estimation but since there is a constant lack of better data, we shall use the existing data); third, the balance account for the Tigris-Euphrates is based on extremely optimistic premises, namely that there will be no droughts and that Turkey is not going to stop the Euphrates flow (as she has already done). Any change in these conditions will very quickly cause both Syria and Iraq to be acutely water deficient in the Tigris-Euphrates basin. In any case, Iraq is most likely to face water shortages within a decade and Syria will do so within twenty to thirty years (Table 2.14). They may both face this even earlier if Turkey continues to release only 16.0 billion m^3 of water for both their needs. In this case, water shortages will occur within the next decade, leaving Turkey as the only state not facing any water scarcity. The picture presented here clearly shows that the patterns of

Table 2.14 Total water supply and demand in Turkey, Syria and Iraq, 1990 and post-2000 (billion m^3)

Country	*1990*			*Post-2000*		
Ground	*Supply surface*	*Demand*	*Ground*	*Supply surface*	*Demand*	
Turkey	0.500	95.0	43.3	0.5	95.0	56.3
Syria	2.0–3.6	28.0–34.0	7.8	2.0	19.0–20	14.9
Iraq	0.400	75.2–81.6	43–44	0.400	47–53.0	59.5

Sources: Shahin 1989; US Army Corps of Engineers 1991; Beaumont, Blake and Wagstaff 1988; Gischler 1979; Bilen and Uskay 1991 utilization within the Tigris-Euphrates basin are inconsistent with reasonable and just water utilization in both spirit and practice.

The first issue at hand is the separate development of consumptive water usage in all three co-basin states. Consumptive usage of Tigris-Euphrates waters began in Iraq in ancient times when it acquired significant rights to the Tigris-Euphrates waters. Syria was the second to utilize the water of the Euphrates during the 1960s and 1970s. Turkey embarked on its mammoth effort to develop the Tigris-Euphrates in the 1970s and almost all its current efforts are aimed at impounding the Tigris-Euphrates water in the gigantic Atatürk reservoir and others. There is agreement among the co-riparians as to the following: Turkey is committed to send no less than 16.0 billion m^3 of water downstream; Syria and Iraq have agreed that this (or any quantity of Euphrates waters) will be divided with 42 per cent to Syria (6.72 billion m^3) and 58 per cent to Iraq (9.28 billion m^3).

Not all this quota is available for use since 5.0 billion m^3 of water has to be left in the Euphrates channel to guarantee the ecological equilibrium of the system. Thus Turkey, the upper co-riparian who contributes most of the water to the Euphrates, also believes it has the sovereign right to utilize most of its water. This causes damage to its co-riparians in violation of the Helsinki Rules, Chapter 2, Article V(k), and both Iraq and Syria are forced to curtail their current pattern of utilization as a direct outcome of Turkey's development projects. Moreover, Turkey will cause injury to its co-riparians in due time, with regard not only to the quantity of the Euphrates and Tigris water flow but also to the quality of the water. The return flow, comprising low grade water, will eventually constitute some 40 per cent of the Euphrates flow to Syria and 25 per cent of the Tigris flow to Iraq. Syria will continue to degrade the water of the Euphrates by shipping its own return flow to the Euphrates downhill to Iraq and some 50 per cent of the flow to Iraq will be return flow by 2030. Thus Iraq will have less and much more polluted water—a violation of her right to reasonable and just water use of the Tigris-Euphrates. ILC Rules stress similar principles calling for the prevention of appreciable harm to other water-course systems (Article 7).

Another violation of the ILC Rules is the norm specified in Article 6(f) which calls for examining the availability of alternatives, of corresponding value, to a particular planned or existing use. The equivalent Helsinki Rule is Article V(h) which stipulates the availability of other resources as a basic rule for equity in the process of water allocation. An examination of the water resources of all three major riparians clearly shows Turkey's superior water supply in comparison with her co-riparians.

Turkey has very rich water resources which could be developed for irrigation, thus leaving large amounts of the Euphrates flow for her co-riparians. The Tigris-Euphrates discharge comprises 40 per cent of the total water supply of Turkey as compared with 80–85 per cent in Syria and 98 per cent in Iraq.

This factor should receive high ranking in the process of sharing the water of the Tigris-Euphrates basin. Perhaps more weight should be given to it to satisfy the principles of equity and justice than to the Turkish contribution to the water balance of the Tigris-Euphrates. A final point to mention in relation to the Helsinki Rules has to do with the prevention of water wastage and economy of use. There is enough evidence that there is wastage related to inefficient and poorly maintained irrigation systems in Syria but the situation is worse in Iraq. Turkey has referred to this matter by mentioning Syria and Iraq's wastage of water on non- or low-productive lands: Turkey carries out irrigation by channel system while Iraq and Syria use less sophisticated methods' (*Studies on Turkish-Arab Relations* 1990; Tekeli 1990:15).

What, then, will be an equitable water division of the Tigris—Euphrates waters? A compromise will be based on a reduction in Turkey's planned utilization of large amounts of the Euphrates flow, which will leave more water for Syria and Iraq who are clearly more dependent on it. Both the Euphrates and the Tigris will be used for hydro-power production in Turkey as this is a non-consumptive use. Iraq will be able to use water from the Tigris and its tributaries and divert the water to the Euphrates River. An increase of the

Euphrates flow to a constant 19.0–20.0 billion m^3 will leave Turkey with 6–8 billion m^3 for impoundment in Atatürk Dam and other storages and will leave Syria and Iraq enough irrigation water in their sections of the Euphrates basin. Iraq might discover that she also needs to reach an agreement with Iran on the water utilization of the Diyalah and Lesser Zab.

As is the case with the Nile system, the high demand for water within the Tigris-Euphrates system is related to high population growth rates and to farming economies, which are greatly dependent on irrigation. We shall explore these issues next.

THE SOCIAL AND ECONOMIC IMPLICATIONS OF WATER SCARCITY IN THE TIGRIS-EUPHRATES BASIN

Social and economic facets of development

Tables 2.15 and 2.16 show that the countries in the Tigris-Euphrates basin all belong to the category of least developed countries in the major social indicators of life expectancy (on average, ten years shorter than Western European standards) and rates of infant mortality (five to seven times higher than the norm in Western Europe). The economic problems of the four partners to the Tigris-Euphrates are very large, partly because of their rapid population growth and their reliance on agriculture.

Turkey is highly dependent on the contribution of agriculture to its GDP and on hydro power as an alternative source of income. Although Turkey does produce steel based on local sources such as coal, lignite and iron ores, chromite ores, lead and zinc, its other resources are meagre. Turkey has a well-developed manufacturing industry accounting for 40 per cent of its export and contributing 22 per cent of the GDP which, itself, grew by an average of 5.8 per cent per annum between 1960 and 1969, by 6.0 per cent during the 1970s and by 3.0 per cent between 1980 and 1988. Turkey has adopted a policy of self-sufficiency in most basic and technical commodities and has established a well-developed steel industry, a petrochemical industry and consumer goods industries, such as textiles and clothing. But the country is still dependent on oil importation and oil constitutes the most important commodity in its trade with Iraq. Iraqi oil pipes carry Iraqi oil to foreign markets through Turkey but also provide oil to Turkey. The closure of the pipes in the fall of 1990 as part of Western sanctions against the Iraqi occupation of Kuwait is hurting Turkey very much since both transit fees and oil from Iraq have stopped. Turkey has a very high long-term debt and its general level of per capita income places it among the less developed countries and not in the developed world of the European Community with which Turkey aspires to affiliate itself.

Syria's most important mineral resources are oil and phosphates, but by world

Table 2.15 Selected social indicators of the Tigris-Euphrates basin countries

Country	*Life expectancy (years) (1990)*	*Infant mortality per 1,000 live births (1990–5)*	*Average adult illiteracy (%) (1991)*	*Annual population growth (%) (1995–2000)*
Turkey	67	62	19	1.63
Syria	66	39	36	3.45
Iraq	63	56	40	3.23
Iran	63	40	46	2.62

Sources: World Bank 1992; World Resources Institute 1992–3; *Human Development Report* 1992

Table 2.16 Selected economic indicators of the Tigris-Euphrates basin countries

Country	*Real GDP per capita*	*GNP per capita*	*Average GNP growth rate*	*Percentage of labour in agriculture*	*Agriculture as % of GDP*	*Total debt as % of GNP*
	1985-8	*1990*	*1965-90*	*1985-8*	*1990*	*1990*
	$	*$*	*%*	*%*	*%*	*%*
Turkey	3,900	1,630	2.6	45.3	18	46.1
Syria	4,460	1,000	2.9	24.9	28	118.1
Iraq	3,510	3,020	n.d.	12.5	n.d.	n.d.
Iran	3,560	2,490	0.1	36.4	21	7.6

*Sources: World Bank 1992; World R*esources Institute 1992-3; Human Development Report 1992

standards Syria's oil reserves are small, comprising only 0.2 per cent of the proven world oil reserves at the end of 1985. At the present rate of extraction, Syria's known oil reserves will be enough to keep it self-sufficient for twenty-five years, but it has had to import oil from Iraq and Saudi Arabia because its oil is of a poorer quality. In the early 1980s Syria was exporting oil (Kanovski 1985: 15), but the oil depleted rapidly and, in 1988, Syria was extracting only 65 per cent of the oil it extracted in 1975 (*Syrie et Monde Arabe* August 1989: 3). Apart from this Syria also has reserves of gas and shale-oil, and its total phosphate reserves are estimated at 500 million tons. Output in recent years has been 1.2–1.5 million tons and has brought in an income of $20-30 million a year. The contribution of mining and manufacturing, together, to the GDP is only 16 per cent (Meyer 1987: 46). Most Syrian industry is closely related to agriculture which, as the most important sector of the economy, contributes 28 per cent to the GDP.

In the late 1980s the economic performance of the Syrian economy has considerably weakened and the real GDP has declined as a result of poor agricultural production, lack of raw materials, inefficiencies in the manufacturing industries and lack of electric power (Meyer 1987: 41-9). Other factors which have contributed to the deterioration of the Syrian economy are the slump in oil prices, dwindling financial aid from other Arab countries and the need to increase food imports. Syria lacks the foreign exchange needed for large-scale imports, and by the end of 1990 Syria had only $100 million of foreign currency reserves—not enough for the purchase of food (*Middle East* March 1990: 46). To summarize, the Syrian economy is weak and vulnerable and, judging from its dependence on the agricultural sector and hydro power, there is no doubt that Syria's economic dilemma should give it priority for the supply of Euphrates waters. The chaotic Syrian economy needs any support it can get.

Iraq's economy has one giant asset—oil—and the country's fortunes and misfortunes are tied to oil prices. 1986 was the worst year ever for the Iraqi economy when earnings from oil slumped to $7 billion. In 1988 oil revenues were more than $15 billion (*Mideast Markets* 7 March 1988:12), but by then Iraq had accumulated a war debt of more than $780 million (*Economist* 28 July 1990). Iraq's civilian debt is $25–30 billion, but the balance of payments for 1987 and 1988 showed a small surplus. Iraq also believed that the occupation of Kuwait would allow her to write off the Kuwaiti loans and the interest on these loans. This did not happen and Iraq's hopes that it would be able to overcome the boycott and threat of war and that $80 million a day of oil revenues (95 per cent of Iraq's foreign exchange) would continue to revive the Iraqi economy proved to be misplaced. At the end of the war Iraq faced a devastated economy and, by the summer of 1991, was only allowed to export very small amounts of its oil. Of all the Tigris-Euphrates partners, Iraq is most dependent on the Tigris-Euphrates, but it is rich enough in resources to sustain a reasonable standard of living for its people.

Finally, Iran's economy is also in a shambles after the long war with Iraq, but by 1988 its oil revenues had reached $11 billion; and, even though it has embarked on a very ambitious development plan which aims at tripling electricity production, it does have enough oil to support such a plan.

In conclusion, Syria is the least economically viable state and should receive high priority in the apportionment of Euphrates waters, because of its economic situation. Turkey is second in this respect, while Iraq and Iran have alternative economic bases.

Population growth and food supply

The group of co-riparians to the Tigris-Euphrates is extremely varied with regard to size, population and state of the economy, amongst other things. Table 2.17 represents the gap between population growth and food production, and it is just as wide within the Tigris-Euphrates basin as it is within the Nile basin. Only

Table 2.17 Population growth and agricultural productivity

	Total population		*Average annual population growth (%)*		*Average annual growth rate in agriculture (%)*	*Average index of food production per capita (1979–81 =100)*
	1990	*2000*	*1980–7*	*1990–2000*	*1980–90*	*1988–90*
Turkey	55.9	67	2.3	1.8	3.0	97
Syria	12.5	18	3.6	3.6	–0.6	80
Iraq	15.6	26	3.6	3.4	n.d.	92
Iran	54.6	69	3.0	2.3	4.0	104

Sources: World Bank 1989; World Resources Institute 1992–3; US Army Corps of Engineers 1991; *Human Development Report* 1992

Turkey is lower than its neighbours in its population growth rates and, what is even more significant, Turkey aims to reduce its growth rate to less than 1.8 per cent by the year 2000 (*Human Development Report* 1992). There has been no similar move to reduce population growth in Syria, Iraq and Iran, however, and all three will be hampered by the urgent need to provide food for their rapidly growing populations. Iran already has a very large population and any addition is going to have a negative impact. In the past Iraq and Syria were not densely settled countries and, with controlled population growth, managed to provide the food needs of their populations. The 'Malthusian gap' is severe in Syria, a country which, until now, has been able to grow most of its own food, but with a growth rate higher than 3.0 per cent from 1968 to 1990 it is at present unable to sustain self-sufficiency. It should be stressed that both Syria and Iraq do pursue a policy of food self-sufficiency although both have other resources (oil, for example) which could cover food importation. Iraq has been defined as a country 'potentially self-sufficient' based on irrigated farming and Syria has been classified as potentially self-sufficient with rain-fed and range-land farming (Allan 1985:57). The average annual growth in agriculture is favourable only in Turkey which has an agriculture growth rate of 3.0 per cent. Syria has had a negative average annual growth rate in agriculture in recent years and its index of food production (per capita 1988–90) is 80. There are no data on Iraq's performance in agriculture but its index of food production for 1988–90 points to possible failure in its efforts to increase food production. There are no reliable data for agricultural production for both countries for the 1980s, and hence the index of food production should be taken very cautiously. This impression is reinforced by data presented in Table 2.18 which show large imports of cereals.

Table 2.18 shows the expansion of external food sources for all the countries studied. Food imports have grown significantly in Turkey, a country which, unlike the other co-riparians to the Tigris-Euphrates basin, is classified as self-sufficient in food production. The drought of 1988–9 and the failure of crops led to a reduction in agricultural exports (*NewSpot* 28 June 1990). Syria has had to

Table 2.18 Food and agricultural product export and import in the Tigris-Euphrates basin

Country	*Cereal imports (thousands of metric tons), 1990*	*Food aid in cereals (thousands of metric tons), 1989–90*	*Food aid (million $) 1989–90*	*Food imports as percentage share of merchandise imports, 1990*
Turkey	3.177	13	0	7
Syria	2.091	22	4.0	17
Iraq	2.834	n.d.	n.d.	15
Iran	6.250	22	n.d.	12

Sources: Human Development Report 1992; O'Sullivan 1990:4–5

increase its food importation because of rapid population growth, the recent drought which caused crop failure, and the practice of subsidizing imported cereals (which functions to keep bread prices low and its consumption very high). In recent years Syria's population has been expanding by more than 400,000 per annum and independent economists and World Bank analysts say that, in 1986– 8, cotton and wheat production have both fallen. Exploitation and corruption in agricultural management is also blamed for the poor performance of the agricultural sector (*Mideast Markets* 16 May 1988:15). Iraq's record of agricultural production is not very good; it produced fewer crops in 1977 than it did in 1961 and agriculture's contribution to GNP is still dropping. In 1980 $1.4 billion was allocated for food imports while during the late 1980s, or more particularly between 1988 and 1990, Iraq purchased food for more than $2.0 billion in the USA. One of the most striking developments of the 1980s was the emergence of Iraq as the USA's largest trading partner in the Middle East after Saudi Arabia (*MEED* 2 June 1990:4–5). Again, the data on Iraq's food production capability show that such reports are highly questionable, but one fact is clear: Iraq at present imports 80 per cent of its food from abroad (*Economist* 8 September 1990). Iraqi farming, like Turkish and Syrian farming, has suffered from a lower than average precipitation over the last two years and crop production has dropped. It is also important to record the effect of the intense competition between the USA, Europe, Australia and New Zealand for the food markets of the Middle East since such competition encourages the Middle Eastern countries to buy food (US food sales to the Middle East are worth $4.3 billion (1990), and the European Community provided $8.3 billion of food in 1989 (O'Sullivan 1990:5)). Baghdad, which owes the USA about $2 billion, was able to store wheat for six months according to one source (Reuters 10 August 1990). The clear implication of the widening gap between food production and population growth is that competition over the Tigris-Euphrates waters is going to increase in the near future, if all the co-riparians pursue their current agrarian policies. Iraq is expected to press for agricultural expansion as a result of the economic boycott that the United Nations issued against Iraq following the Gulf War.

Potential for food security within the Tigris—Euphrates basin

Policies pursued by the co-riparians of the Tigris-Euphrates concerning agricultural development and food security make a discussion of the agricultural potential of the co-basin states necessary.

Agricultural potential in Turkey

There is no doubt that Turkey's achievements in agriculture have been impressive. In terms of employment, 79 per cent of the labour force was employed in the farming sector in 1960, 55 per cent in 1975, 45 per cent between 1985 and 1988 and 40 per cent in 1990 (*The Middle East and North Africa Yearbook 1990* 1990: 506–8; McLachlan 1985:34). Turkey is the largest producer of cereals in the Middle East, producing over 20 million tons per annum in recent years. Turkey is a large producer of wheat and cotton, tobacco, and hazelnuts, but the contribution of agriculture to the GNP is not so important. In the 1970s agriculture contributed about one-third of the Turkish GNP but this has dropped to less than 17 per cent at present (*NewSpot* 19 July 1990). Per capita income in Turkey is only $1,630 (1990), but the average income of a farmer is little more than 40 per cent of the average; thus the farmers constitute one of the poorest sectors of society. Agriculture's contribution to exports in 1982 was about 36.5 per cent, the main export crops being cotton, tobacco, fruit and nuts (United Nations 1985; Dewdney 1981:214).

The productivity of Turkish farming has increased in recent years. For instance, although the cultivated area increased by 7 per cent between 1960 and 1980, production doubled in some cases. The physical constraints affecting the expansion of agriculture are mainly relief, altitude and climate with some regions having favourable climates but being characterized by steep slopes and high altitudes—the interior of the Anatolian plateau, for example, which is dependent on rain-fed farming is susceptible to rainfall fluctuations. Thirty-six per cent of Turkey's land is cultivated, 21 per cent is used for grazing and 26 per cent is classified as forest (Dewdney 1981:214).

Another obstacle to agricultural expansion is soil erosion with about half the farmland affected, to a greater or lesser degree, and Turkey will have to employ appropriate measures to reduce this.

A major thrust of Turkish agricultural policy has been to extend the irrigable area, mainly in southeastern Turkey where there is not enough precipitation but the topography is favourable. In addition, Turkey's efforts at the intensification of farming have been enormous with more than 140 small dams already built to help villagers irrigate their land (*NewSpot* 19 July 1990). More important is Turkey's irrigable land potential of 8.5 million ha (of which 1.7 million ha are in southeastern Anatolia).

What is Turkey's potential for the expansion of its cultivated areas? In the past, the production of basic foodstuffs has barely kept pace with population growth and the supply of livestock products has failed to meet the growth in demand (Dewdney 1981:220). The most rapid increases in output have been achieved in industrial crops and high value crops destined largely for export. The GAP will expand the irrigated area of Turkey by adding 1.6 million ha to the current 3.2 million ha irrigated at present (a 50 per cent increase). The GAP is planned as an agri-business which will attract foreign and domestic investment and the most modern farming technologies are going to be adopted for the region in order to increase production. Turkey's only obstacle to agricultural expansion is probably lack of capital. It does not seem that Turkey in its efforts to expand agricultural production will give much weight to the international position of the Tigris-Euphrates when it makes its decisions.

Agricultural potential in Syria

Syria's dependence on agriculture is very high, and agriculture has always been the most important sector of the economy. In the mid-1950s agriculture accounted for 45–50 per cent of national income and 65–75 per cent of the population derived their living from it (Manners and Sagafi-Nejad 1985:257). At present (1985–8) 50 per cent of the population is rural, one-quarter of the labour force is employed in agriculture, and only about 28 per cent (1990) of the GDP is contributed by the agricultural sector (see Table 2.16).

In 1981 the arable land in Syria amounted to 5,759,000 ha with 9.85 per cent of it irrigated (Beaumont 1985:6). At the end of the 1980s, the proportion of irrigated land remained almost the same: 531,000 ha (Shahin 1989).

By the late 1970s the relative contribution of agriculture to the GDP had fallen to around 20 per cent, although the total value added by the agricultural sector was growing at an annual average of 3.5 per cent between 1963 and 1978 (USAID 1980, quoted in Manners and Sagafi-Nejad 1985:257). Although agricultural production has expanded and the Assad regime's policies have been favourable towards this sector, agriculture cannot provide for Syria's needs, mostly because of the rapid population growth. Per capita production, in fact, has lagged in relation to the accelerated population growth. In 1974, a year of bumper crops, the agricultural imports ($336 million) exceeded agricultural exports ($253 million); and in 1983 imports almost doubled to $625 million while farm exports fell to $230 million (Kanovski 1985:10).

The major reasons for Syria's inability to expand its agricultural production are varied. First, land reforms in the 1980s further reduced the size of maximum land holdings, leading to a greater fragmentation of land holdings and lower production (Kanovski 1985:11).

Other reasons for Syria's slow development of its agriculture are related to the fact that the agricultural resources are limited and difficult to exploit (Allan 1987:24). For example, Syria's record of increasing areas of irrigated land and reclaiming land for irrigation has not been very good (Manners and Sagafi-Nejad 1985:259).

Syria's options for agricultural expansion are thus very limited and its dependence on food importation will increase. As was the case in the Nile basin, investment must be made in land reclamation and irrigation projects before development in the Tigris-Euphrates basin can take place—it is difficult to see where Syria will be able to find the necessary funds for such investment (*Middle East* March 1990:7).

Agricultural potential in Iraq

Iraq is a country with a very favourable population density and has been classified as having great agricultural potential (Beaumont, Blake and Wagstaff 1988:348). We have seen that there are major limitations to the potential water available to Iraq and we shall discuss the serious environmental restrictions which affect Iraq's agricultural sector. About 26 per cent of the land of Iraq is classified as potentially useful agricultural land, and, of this, 30–40 per cent (4– 5.45 million ha) is currently being cultivated. Agriculture employs only 12.5 per cent of the labour force (1985–8) although only 29 per cent of the population is rural (*Human Development Report* 1991:136). The major contribution to the economy comes from oil exports and not from the agricultural sector.

The contribution of agriculture to the GDP, estimated at 21 per cent in 1972, dropped to only 7 per cent in 1980 (Gabbay 1978:182; *Middle East* 14 March 1981). Agriculture, once the most important sector of the Iraqi economy, has declined in recent years mostly because of lack of investment, receiving 38 per cent of the expenditure allocations between 1951 and 1964 but only 32.4 per cent between 1965 and 1970 (Fisher 1978:376). Under the plan of 1976–80 the agricultural sector was supposed to receive an appreciable increase in financial investment in order to achieve self-sufficiency in food production (Ockerman and Samano 1985:191). By 1981, however, only 10 per cent of the budget had been allocated to agricultural development, including irrigation projects (*Middle East* 14 March 1981).

Iraq's record for implementing its development projects, like Syria's, has not been good and projects have chronically lagged behind planning. For example, an expenditure of $11.5 billion was planned for the agricultural sector in 1976– 80 (representing 34 per cent of the total development budget) (Gabbay 1978: 183); in reality Iraq never implemented these plans partly because of the enormous cost of major water projects—requiring $6 billion (at the 1980 price level). By 1984 Qadisiyah Haditha Dam alone had cost more than $830 million, and the Saddam Mosul Dam will cost more than $2 billion. During the 1980s Iraq invested its oil revenues in its war with Iran—not in water projects—and as a result there has been a great delay in implementing the above projects.

Iraq has been inefficient in its agricultural performance in the past, actually producing fewer crops in 1977 than in 1961. Land is generally not intensively cultivated and crop yields are lower than in neighbouring regions (*Middle East* 14 March 1981; Fisher 1978:378). Fisher related the low yields to a combination of natural, social and economic factors including archaic methods of land tenure (Fisher 1978: 378). Cropping intensity is low—in winter estimated at 37 per cent and in summer at 6 per cent (Aart 1974: 17). As has been pointed out, 'an unknown area [of land] remains fallow each year' (Beaumont, Blake and Wagstaff 1988:352). According to another source, at least one-third to a half of the land was (and probably still is) left fallow every second year (Ubell 1971:3). One explanation for large tracts of land being left fallow is to prevent the rapid build-up of salinity in the irrigated soils.

Another factor which has influenced Iraq's agriculture performance is land reform. The first stage of agrarian reform took place in 1958 and was accompanied by political resistance and delays in the redistribution of land (Fisher 1978:379). A more comprehensive Agrarian Reform Law was enacted in 1970, further reducing the permissible size of holdings. The Iraqi Government, however, was very slow in both redistributing the land and implementing the collectivization programme which aimed at reducing the average farm by 38 dunums (3.8 ha)—partly because of fear that further fragmentation of the land might hamper development (Gabbay 1978:179). In the late 1980s a new policy of granting commercial incentives aimed at improving the performance of the public sector was adopted in Iraq and the Government encouraged the private sector to become more involved and invest more in agriculture (*Mideast Markets* 7 March 1988:14).

The greatest barrier to expanding agricultural production in Iraq is soil salinity, and as early as 1949 an estimated 60 per cent of the land irrigated by flow water was seriously affected by salt. It is said that, while nearly 20–30 per cent of the cultivable land has been abandoned over the last few decades owing to a high water table, the yield on the remaining lands has declined by 30–50 per cent (Alii 1955:31; Fisher 1978: 387). The salt content of the upper ground-water, high all over the plain, increases towards the south of Iraq (Aart 1974: 14), and vast amounts of salt have accumulated in lower Iraq—perhaps 1 billion tons according to one source (Cressey 1960:390). In the early 1970s, an estimated 80 per cent of Iraqi land was affected by salinity to some degree (Aart 1974).

Of course land use practices such as leaving half of the land fallow each year and choosing crops which survive salinity has been shaping the Iraqi farming system. The major reasons for salinization and waterlogging in Iraq are the inadequate natural and man-made drainage systems. Over-irrigation has stimulated intense evaporation rates causing a high level of salt content in the groundwater (Ubell 1971:9). To reduce this Ubell (1971) has recommended storing surplus (flood) waters away from the alluvial plain with its salted lands, changing the irrigation methods, improving land drainage or reducing the salt content of the soil by using appropriate irrigation methods.

To sum up, despite Iraq having the enormous advantage of a small population and the potential to feed it quite easily, the country has major human-made and natural obstacles to the expansion of its cultivated land and agricultural production. There is a problem of cross purposes within the Iraqi irrigation sector because, although efficient methods of irrigation may save water wastage, large amounts of water are still needed (and wasted) in the process of getting rid of the accumulated salt in the land. Iraq has to seek a compromise solution to this problem.

During the decade of the 1980s Iraq was involved in its war with Iran and investments in agriculture were kept to a minimum. The decade of the 1990s began with the Iraqi occupation of Kuwait—an occupation which ended with Iraq's defeat and a ruined infrastructure. With a foreign debt of more than $80 billion before this war, it is difficult to see how Iraq is going to finance food importation even with higher anticipated oil incomes.

Concluding remarks

The Helsinki and ILC Rules both place great importance on the social and economic conditions prevailing in co-basin states. More precisely, they stress the need to consider the size of the population dependent on the water of the international water course, the economic and social needs of the co-riparians, the availability of other resources and even the practicality of compensation.

An examination of social and economic conditions reveals four main features.

1 All the populations of the co-riparians to the Tigris-Euphrates are growing rapidly and only Turkey, with its giant population, is going to reduce its natural growth by the year 2000. Social indicators such as life expectancy, infant mortality and so on show that all the co-riparians have great needs and must invest in improvements for their human resources. However, Turkey needs to maintain an annual growth rate of around 3.5 per cent to meet the requirements of domestic markets. If export targets are to be met as well, then the Turkish agriculture needs to grow by 4 per cent annually for the decade' (Bilen and Uskay 1991:4.1).

   This stated policy, a quotation from Turkey's recent development plan, demonstrates the difficulties arising, not directly from the scarcity of water resources, but as an outcome of conflicting development policies.

2 A more difficult task is to judge the levels of dependence on the water of the Tigris-Euphrates for food provision. Turkey, Syria and Iraq are pursuing policies of food self-sufficiency and politics of food security although Iraq and Iran can buy all the food they need with their oil incomes. Iraq, following the recent Gulf War, is under a boycott imposed by the United Nations and one can expect it to emphasize an expansion of food production. Food importation is crucial for Iraq, Iran and Syria.

3 Dependence on agriculture as a source of livelihood is high in Turkey and Syria where agriculture contributes 18 and 28 per cent, respectively, of the GDP and employs 45 per cent of the labour force in Turkey and 25 per cent in Syria. Iran is third and Iraq fourth and less dependent on agriculture, her per capita GNP being almost double that of her co-riparians.

4 Ranking the co-riparians of the Tigris-Euphrates might then be as follows: Turkey would receive first priority in water apportionment from the Tigris-Euphrates because of its population needs and dependence on agriculture. Syria and Iran would follow and Iraq would be last. Equal weight given to all the Helsinki or ILC Rules might be harmful in this case because this does not give proper weight to Iraq's total dependence on the Tigris-Euphrates, or to Turkey's abundance of alternative water resources. In addition, as most of the economic and social characteristics are provided for countries as a whole, it is difficult to calculate what the economic and social needs of the population living within the Tigris-Euphrates basin are. The Helsinki and ILC Rules do not refer to the role of transfer of water or to benefits related to water outside the particular basin. We may then question the validity of taking the economic and social conditions of a country as a whole as any indication at all for that country's needs in a particular drainage basin. There is great difficulty in isolating social and economic data for the

river basin alone and its population; hence we can anticipate a constant bias to derive the application of the Helsinki Rules to the Tigris-Euphrates co-basin states.

THE LEGAL AND GEOPOLITICAL SETTING OF THE TIGRIS-EUPHRATES BASIN

Agreements over water allocation

Until the 1970s no overt or covert conflict had ever evolved around water usage of the Tigris-Euphrates since water withdrawal was only partial. Since the beginning of the 1970s, when both Turkey and Syria embarked on their separate development of the river's resources, conflict situations have been constantly arising.

Formally, there is no legal official agreement over water allocation among the co-riparians, but certain agreements were arrived at when Iraq and Syria were under British and French mandatory rule. During that period the mandatory powers agreed to establish a committee to examine and co-ordinate the water utilization of the Euphrates. There is also a French-Turkish protocol from 1930 which commits the two parties to co-ordinating any plans to utilize the Euphrates waters and a Friendship Agreement between Turkey and Iraq from 1946 (Caelleigh 1983:121). According to this Friendship and Neighbourly Relations Agreement, Turkey not only obliged itself to report to Iraq on all its plans to utilize the Tigris-Euphrates but it even gave Iraq the right to construct dams within Turkish territory when the purpose was to improve Euphrates water flow within Iraq (Bilen and Uskay 1991).

However, the most recent agreements are the current oral and/or written agreements among the co-riparians or pairs of co-riparians to the Tigris-Euphrates. All these agreements refer directly only to the Euphrates—not to the Tigris. In 1964, for the first time, Turkey pledged to release 350 m^3/s from the Euphrates downstream for her co-basin partners. In 1976, during Syria's impoundment of water for the al-Thawrah Dam, Turkey increased the minimum flow to 450 m^3/s in order to prevent a conflict between Syria and Iraq. A year earlier Iraq and Syria came to a near clash when Syria completely cut off the Euphrates flow (Bilen and Uskay 1991).

The first crisis between co-riparians of the Tigris-Euphrates took place in 1974 as a result of a combination of several negative factors. It was a poor year for precipitation and it was the first year that both Turkey and Syria had begun to store water in the Keban Dam and Tabqa Dam, respectively. In the winter of 1974, Iraq suffered from a severe water shortage for which she blamed Syria; the Arab League failed in its mediation efforts, and Iraq mobilized its army near Syria's Iraqi border. Syria finally submitted to pressure and released 200 million m^3 of water from the Tabqa Dam (Naff and Matson 1984:94). In 1980, the three co-riparians signed a Protocol which established the Joint Technical Committee for Regional Waters. In 1982 the Joint Technical Committee held its first meeting between Turkey and Iraq with Syria joining the Committee in 1983 (Bilen and Uskay 1991; US Army Corps of Engineers 1991). This body has evolved into an active organization which deals with all the water issues among the co-riparians and there is no doubt that it reflects a co-operative trend among the co-basin states of the Tigris-Euphrates. This co-operation was necessary as in 1983 a new crisis situation between Turkey and Syria evolved when the water level in Lake Assad, and consequently electricity production, was dramatically reduced. Syria blamed Turkey for this shortage.

The next significant event in this chronology of Euphrates flow agreements and events took place in 1987, when Turkey agreed to increase the flow of the Euphrates from 450 to 500 m^3/s—a quantity equal to 15.7 billion m^3/ (*al-Yum al-Sabah,* Syria 18 December 1989; US Army Corps of Engineers 1991; Tekeli 1990:

210). A crisis situation again arose in the winter of 1990 when Turkey was filling the Atatürk Dam and both Syria and Iraq, deprived of water for their needs, protested and demanded that Turkey moderate its enormous GAP development.

As one of the measures to prevent damage to its co-riparians, Turkey released 13.269 m^3/s between 23 November and 13 January, the stoppage date for water impoundment in the Atatürk Dam. Together with an additional 90 m^3/s of Euphrates waters originating from the catchment below the Atatürk Dam, the release during the 82 days from 23 November to 13 February averaged 515.6 m^3/s, a quantity which was higher than the minimum flow originally promised by Turkey (Tekeli 1990).

The next development occurred on 16 April 1990 when Iraq and Syria signed a bilateral agreement for sharing Euphrates waters at 58 and 42 per cent respectively (US Army Corps of Engineers 1991; Tekeli 1990). At a Joint Technical Committee meeting on 6–7 May, Iraq demanded an increase of the Euphrates flow to 700 m^3/s. This demand was repeated in Ankara in June 1990 at a summit meeting of the Foreign Ministers of Turkey, Iraq and Syria (US Corps of Engineers 1991; Tekeli 1990:210). Turkey would not agree to the Syrian-Iraqi demand for an increase to 700 m^3/s except for certain critical periods and subject to the maintenance of 500 m^3/s flow as an average (Tekeli 1990:210). But the most important issue which was raised at this summit was the fact that Syria defined the Euphrates flow as ‘transboundary waters’ whereas Syria and Iraq consider the Euphrates River to be ‘international’ (Tekeli 1990: 212; US Army Corps of Engineers 1991). This distinction needs further clarification. The Turkish formal definition of a ‘transboundary water course’ is a river which crosses common political borders, whereas an ‘international water course’ has its opposing banks under the sovereignty of different countries. Turkey maintains that waters of international rivers must be shared by the riparians through the median line while waters of transboundary water courses have to be utilized in an equitable, reasonable and optimal manner (Tekeli 1990:213). Accordingly, the Euphrates and Tigris Rivers must be considered to be one transboundary water course system since they are linked by the Tharthar Canal, thus allowing Euphrates waters to be used as a substitution for Tigris waters.

This Turkish classification of the Tigris-Euphrates clearly contradicts the definition of international river basins according to both the Helsinki and the ILC Rules and it is unacceptable to the body of international law. It clearly shows that there is a cognitive conflict among the Tigris-Euphrates co-riparians, namely that the states are split on the fundamental facts of what represents, legally, an international river basin.

One striking feature characterizing the negotiations and contacts between the three countries is the very conciliatory stance adopted by Turkey. Turkey has been projecting the image of being a peaceful and co-operative nation seeking agreed solutions to the problems of water division. Thus, Turkey has stressed that she believes that technical solutions exist for the distribution of water in the basin of the Tigris-Euphrates and, if the three partners to the basin co-operate, a solution can eventually be achieved (*NewSpot* 28 June 1990). Syria and Iraq, according to Turkey, have rejected the Turkish plans for optimal utilization of the Euphrates and Tigris (*NewSpot* 12 July 1990). Turkey, for example, has complained that Iraq and Syria are wasting waters on non- or low-productive lands. It has suggested that both Syria and Iraq adopt more sophisticated irrigation methods and cultivate crops according to the nature of the region and the amount of water available to them (*Studies on Turkish-Arab Relations* 1990; Tekeli 1990:214). Turkey has also formulated a three-stage plan comprising inventory studies for water resources and land resources within the Tigris-Euphrates basin in order to judge better the exact needs of the co-basin states (*MEED* 20 July 1990:23). Turkey made an enormous effort to inform her co-riparians about the approaching impoundment of the Atatürk Dam, giving frequent briefings in which she assured her co-riparians that they would receive an increased Euphrates flow before the impoundment period began. As a country which aspires to join Europe and the European Community, Turkey cannot allow itself to be perceived as the ‘town bully’ and it is within this framework of image building that one has to look at the Turkish proposal for ‘Peace Pipes’—a plan which presents Turkey as a co-operative state, ready to share precious resources (for a price) with its neighbours.

Turkey has also offered to sell electricity to both Syria and Iraq (Tekeli 1990: 213). One may find a tendency in the Turkish legal and political postures towards stressing neighbourly policies with mutual benefits and perhaps a form of compensation (Peace Pipe) for the decreased amount of waters in the Euphrates. Turkey has also raised another interesting legal principle during negotiations with Syria and Iraq, who have demanded a constant Euphrates flow of 700 m^3/s. Turkey has stated that the demand for 700 m^3/s is like asking for a regulated release of Euphrates flow without any (Syrian/Iraqi) investment in the facilities required for such a regulation (Tekeli 1990:15). Perhaps Syria and/or Iraqi compensation for Turkey’s investments in dam construction for the Upper Euphrates, a compensation which falls well within the Helsinki Rules, might convince Turkey to release larger amounts of water to her co-riparians. Turkey has also expressed its view that upper catchment areas of rivers are generally more suitable for the construction of dams, especially since evaporation losses in low-lying downstream plains are very high. But water abstraction from an upstream dam may lead to disputes (Bilen and Uskay 1991). This Turkish position is also consistent with the Helsinki Rules which call for the efficient management of river basins and prevention of water wastage. There are enough data which clearly show enormous water loss in the various water storages in Iraq due to its hot climate. Reasonable and equitable water use probably entails water storage in the Upper Euphrates where there are plenty of suitable sites for storage and the climate guarantees lesser rates of evaporation. Nevertheless, it does not seem that Iraq and Syria have the trust needed to allow such a co-operative endeavour to take place.

There is also the legal issue of water quality in the Euphrates. Turkey, and eventually Syria, with their massive irrigation schemes will cause a significant deterioration in water quality. About half of the water which will reach Iraq will be irrigation return flows polluted with pesticides and fertilizers as well as being saline (US Army Corps of Engineers 1991). The Helsinki Rules forbid co-riparians to cause such damage to the water flowing downstream and Iraq may demand compensation for this deterioration.

Finally, it is important to note that, in addition to the Euphrates, Turkey and Syria have additional conflicts over the water of other international rivers with Turkey raising the issue over Syria’s full utilization of the Orontes (Asi) which flows into the sea in Turkish territory. Turkey has reminded Syria that the Orontes should be included in the Joint Technical Committee discussions (Tekeli 1990).

Syria, on the other hand, expressed its dissatisfaction over the Turkish diversion of the waters of the Quwaige River in the 1940s which made the river, which used to flow into the Aleppo district in Syria, useless. The Helsinki Rules maintain that negotiations over the Euphrates flow should include discussions about other water resources—even minor ones. There has been a suggestion that hydropolitics in the Tigris-Euphrates river basin tend towards a cynical use of water issues as a political weapon (the water weapon) (Hindley 1990; *MEED* 19 January 1990:v–xv). Hindley has stated that the use of water as a political weapon is increasing and that Turkey has continually threatened to cut the flow of the Euphrates in an attempt to force Syria into curtailing its support for Kurdish activists in southeast Anatolia (Hindley 1989:4–5; Hindley 1990: i-xv). An implicit threat to use water as a political weapon appeared in Foreign Minister Yilmaz’s message to Syria, when he urged it to take steps to address Turkey’s security concerns and promised that ‘then Turkey would be willing to go a long way in addressing Syria’s concerns’ (*Briefing* 744, 10–17 July 1989). Turkey denies that there is any political motivation behind its appropriation of the Euphrates waters, but Syria clearly doubts this (*Middle East International* 16 February 1990:12).

The geopolitical setting in the Tigris—Euphrates basin

As in the case of the Nile, the relations among the co-riparians are not limited to water issues since there are other sources for tension and even conflict. Syria and Turkey have several areas of tension which exacerbate their conflict over the Euphrates waters. First, there is the old conflict over the Hatai-Alexandretta-Iskanderun region which France, as a mandatory ruler of Syria, handed over to Turkey in 1939 as a bribe for entering the Second World War on the side of the Allies. Syria has never accepted this territorial loss and Syrian maps still show the territory as part of Syria (Jansen 1990:12–13). Not surprisingly, Syria is also angered by Turkish textbooks which show part of Syrian territory as an integral part of Turkey (*al-Yum al-Sabbah,* Syria 18 December 1989).

A second concern and source of conflict for Turkey, Syria and Iraq is the insurgent Kurdish minority. Turkey, which severely suppresses its own Kurdish minority, criticizes Syria for its support for the Kurdish Marxist guerrillas affiliated to the PKK Party (*Middle East International* 8 June 1990; *MEED* 13 October 1989). From the Turkish standpoint, the Kurdish revolt endangers Turkey's efforts to develop southeast Anatolia, the very region where most of the Kurds live, and where border crossings by Kurdish rebels cause turmoil (Jansen 1990:12–13). The GAP's goal is to bring development and tranquillity to this region which has been in the past, and still is, a centre of rebellion against the Turkish Government. Both Turkey and Iraq have a common interest in suppressing the Kurdish dissidents along their common frontier areas and Iraq has even granted the Turkish army the right of hot pursuit across its border. According to Turkish sources, Turkey and Syria signed a security protocol in 1987 which provided that the parties would co-operate against all activities directed against each other emanating from each other's territory. One of the results of this protocol was the Syrian Government's removal of PKK camps from Syria to Lebanon. Turkey, for its part, agreed to supply Syria with a Euphrates water flow of no less than 500 m^3/s (*Briefing* 10–17 July 1989).

There are other problems as well with Turkey, for instance, criticizing Syria for its support of anti-Turkish Armenian terrorists (*Economist* 16 December 1989:56) and Syria being upset by Turkey's membership in the Baghdad Alliance. Another minor source of tension is the Syrian confiscation of all Turkish property (mainly land) in northern Syria, and Turkey's response of taking the same measures against Syria (1960s) (*al-Yum al-Sabbah,* Syria 18 December 1989).

Turkey and Iraq, at least until the Iraqi invasion of Kuwait, have excellent relations. In addition to their co-operation over the suppression of the Kurdish minority, the two countries have well-developed trade relations and Turkey has become Iraq's most important trade partner mostly because of the oil it buys there. During the Iran-Iraq war and the closure of the port of Basrah, road and rail links across Anatolia and from Iskanderun became Iraq's (and also Iran's) back door for supplies. The new and enlarged pipelines carrying Iraqi oil to the export terminal near Mersin made it possible for some 60 per cent of Iraqi oil to flow across Turkey before Turkey had to shut them down as part of the general boycott against Iraq (*Middle East International* 16 February 1990:12). The only point of tension between Turkey and Iraq before the current Gulf crisis was the Turkish claim that the oil-producing area of Mosul should have been allotted to Turkey after the First World War.

Finally, the matrix of hostile relations between Iraq and Syria has had a long history. The two Ba'ath regimes are in competition for hegemony in the Arab world. The 'almost war' situation in 1974–5, when Syria closed its airspace to all Iraqi aircraft and transferred troops to its border with Iraq, was just one of the tense moments between the two countries. The Euphrates flow is not the only obstacle to any improvement in the relations between the two countries which have, in fact, deteriorated since the Iran—Iraq war began in 1980, when Syria sided with Iran (while Turkey tried to keep its good relations with both countries). Syria has good reason to fear Iraq since the Iraqi army of 1.2 million soldiers has become the strongest army in the Arab world, but the Gulf War has left Iraq with a huge foreign debt and with no gains at all. The Iranian territories it occupied have been returned to Iran and Iraq recognized Iranian sovereignty over the east bank of the Shatt al-Arab during the fall of 1990 to pacify Iran at the time when Iraq was preparing for war (in Kuwait).

It is important to note that Iraq's situation in the Kuwait crisis is totally different from the war situation with Iran. During the Kuwait crisis Iraq did not enjoy the strategic and benevolent support of Saudi Arabia, Kuwait and Turkey and the only country which supported Iraq in this crisis was Jordan. Since Turkey, Syria and even Iran adopted anti-Iraqi postures in the Gulf crisis, the relations among the co-riparians of the Tigris-Euphrates are probably going to change significantly.

As for Iran, even a decade of war has not led it to try and curtail the water flow of the Tigris tributaries from its territory and there are no signs that it is ready to use water as a military weapon. However, Iran is in the process of economic and social reconstruction, the major aim of which is to increase hydroelectricity production considerably. If Iran decides to use the upper Tigris tributaries as sites for hydro-power stations, this will have a direct effect on Iraqi utilization of these presently unaffected waters.

Concluding remarks

All in all, the present agreements (formal or informal) over water allocation of the Tigris-Euphrates, together with the enormous drive for development, will probably lead the co-riparians of this basin to a certain degree of conflict, though not to war. Kolars, a specialist on Turkey and its water projects, attested in his testimony before the Committee on Foreign Affairs of the US House of Representatives (20 June 1990) that he believes that a big crisis will take place in the Euphrates river basin within ten to twenty years and a 'small' crisis in about 1994 (Kolars 1990: Testimony; 61). But Kolars did not consider a 'water war' to be inevitable and referred to the Turkish 'Peace Pipe' as a reasonable solution for water scarcity.

As has been pointed out, Turkey maintains the image of a nation which supports legal solutions to the problem of water allocation. Turkey has in the past stressed that the principles of mutual benefits and linkages between different political and economic spheres guide its negotiations concerning the water of the Euphrates. Being a regional power, especially after the weakening of Iraq in the recent Gulf War, may also encourage Turkey to contribute to regional pacification. However, the drive of all the co-riparians to accomplish their agricultural development plans, especially Turkey, may make relationships in the basin difficult to maintain peacefully. One or more consecutive years of drought might accelerate a crisis situation since the Euphrates flow will not suffice for all the current needs of the co-riparians. The combined demand of Turkey, Syria and Iraq (according to their development plans) for Euphrates waters amounts to 41 billion m^3 of water—a quantity which is definitely not available in the Euphrates. Possible solutions might be found in a trade-off of Euphrates water for Tigris waters.

CONCLUSIONS: PRINCIPLES FOR WATER ALLOCATION IN THE TIGRIS-EUPHRATES BASIN

According to the present review, an equitable sharing of the Tigris-Euphrates waters should be founded on the principle of hydrology and climate, past and present utilization, economic and social need, population dependent on the water, the comparative costs of alternative means of satisfying the economic and social needs of a basin state, the availability of other resources, avoidance of unnecessary waste of water and the degree to which the needs of a basin state may be satisfied without causing substantial injury to a co-basin state.

Table 2.19 presents these details for the co-riparians of the Tigris-Euphrates. The three important co-riparians, with respect to both their share of and contribution to the Tigris—Euphrates, are Turkey, Syria and Iraq. Iran is a minor contributor to the Tigris through its tributaries; hence, its rights in the basin are minor.

The partners to the Tigris-Euphrates represent countries with a very peculiar combination of socio-economic features—and this makes it difficult to weigh their rights to the Tigris-Euphrates water. For example, both Iran and Iraq have enjoyed high incomes derived from the oil industry and yet their social profiles are those of typical developing countries which do not control population growth and have low life expectancy and high infant mortality rates. Moreover, both countries have been involved in a futile war which has left them with enormous

Table 2.19 Principles for water allocation in the Tigris-Euphrates basin

Principles for allocation		*Turkey*	*Syria*	*Iraq*	*Iran*
Country share in area of Tigris-Euphrates (%)[a]	Euphrates	28%	17%	40%	–
Tigris	12%	>1%	54%	34%	
Country contribution to river[b]	Euphrates	88–98%	2–12%	–	
Tigris	100%	–	–	–	
Tigris tributaries	70%	–	8–9%	21%	
Climate		Large amounts of precipitation; no desert	Only 10% of area has more than 500 mm	Arid climate over about 70% of its area	Mostly arid and semi-arid climate
Utilization patterns	Past	None	None	Historical rights	None
Present	1.8 billion m^3	4.47–5.9 billion m^3	13.0–15.0 billion m^3	Local use	
Social and economic needs[c]	Income	1,630	1,000	3.020	2.490
Pop. growth	1.63	3.45	3.23	2.62	
Agric. growth	3.3	−1.1	5.37	–	
L. exp.	67	66	63	63	
Inf. mor.	62	39	56	40	
Economic and social evaluation[d]		Middle-income economy Lower-middle income Medium level of needs	Middle-income economy Lower-middle income High level of needs	Upper-middle-income economy High needs in Tigris Medium needs in Euphrates	Upper-middleincome economy Low needs
Level of dependence on agriculture[e]	Food production	97%	80%	92%	104%

index	18%	28%	18%[f]	21%	
Agriculture in GDP					
Availability of other resources		Water, small quantities of coal, lignite, iron ores chromite, tourism and manufacturing	Oil, phosphates in small quantities	Oil (large amounts)	Oil (large amounts)
Treaties and legal agreements concerning the basin		French-Turkish Protocol 1930 to co-ordinate plans between Syria and Turkey; 1946 Agreement with Iraq		1946 Friendship Agreement with Turkey	
Notes and evaluation		Middle-income economy Lower-middle income	Middle-income economy Lower-middle income	Upper-middle-income economy	Upper-middleincome economy

Sources: Ionides 1937; Alii 1955; Cressey 1960; Fisher 1978; Karmon and Brawer 1967; Beaumont 1978; Ockerman and Samano 1985; Beaumont, Blake and Wagstaff 1988; Naff and Matson 1984; World Bank 1992; World Resources Institute 1992–3

Notes:

[a]Data in percentage of country's share in the separate basins of the Tigris and Euphrates.

[b]Data in percentage of water contribution of each state to the separate basins of the Tigris and Euphrates.

[c] Income is GNP per capita ($); Pop. growth is population growth in percentage; Agric. growth is agricultural growth in percentage; L. exp. is life expectancy in years; Inf. mor. is infant mortality per thousand live births.

[d]Middle-income economy and lower income are classifications used by the World Bank; medium/low/high level of needs is author's own classification of a specific country degree of dependence on water, based on their economies.

[e]Food production index is calculated on basis year 1979–81 as 100.

[f] Data for 1965.

foreign debts and bankrupt economies. The hydrology and climate of Iraq and Iran have not been of benefit to these two countries, leaving Iraq, for instance, totally dependent on the Tigris-Euphrates. Iran's usage of the Tigris tributaries is minor and it has better water resources for agricultural development including the Kharun. In addition, Iraq also has unchallenged, established, historical rights to large amounts of the Tigris-Euphrates waters but its need for potable water as an outcome of urban growth is accelerating as are its needs for more water for hydroelectricity generation. The performance of Iraqi agriculture has not been impressive with low productivity and a conspicuous waste of irrigation waters. Iraq used to import 80 per cent of its food but at present, under the food and oil embargo that has been imposed on it to force it to comply with the UN decisions (following its defeat in the war), Iraq is encouraging the expansion of farming to make that country self-sufficient in food. This is a difficult task to accomplish since identical policies are being pursued by Turkey and Syria. Thus, Iraq's dependence on agriculture is expected to rise and, if it is allowed to do so by its co-riparians, it will consume greater amounts of water.

Turkey and Syria have urgent needs of their own and, perhaps, a political motivation to curtail water supply to Iraq. Turkey is making an enormous effort to achieve self-sufficiency in food production and industrialization. The country is poor in mineral resources and is completely dependent on oil imports—almost totally from Iraq. Turkey has the right to large amounts of Tigris-Euphrates waters because of its share and contribution to the river's system, and yet, Turkey has abundant alternative water sources and is lagging behind in its plans for agricultural development. Its current use of Euphrates water is small but, in a decade, it will withdraw large amounts for its GAP projects. Turkey is also entitled to Euphrates and Tigris water from a developmental perspective as it shows all the characteristics of a developing nation in both economic and social features. Turkey has been badly hurt by the Kuwait crisis as the flow of Iraqi oil through its territory has stopped, causing it to lose its source of oil and revenues. Though Turkey now receives oil from Saudi Arabia and financial support from the Gulf States and the USA, its economy has been badly hurt and its needs for Tigris-Euphrares water will grow although its current economic ability to finance development projects is near zero. Finally, there is Syria, with a weak economy, with limited foreign currency reserves, with few mineral resources.

Table 2.20, which ranks the relative position of the co-riparians, reveals that the relative position of Syria in the drainage basin is somewhat better than Turkey on many socio-economic indicators. Syria, for example, has the highest per capita GNP, the second longest life expectancy and the lowest infant mortality rates. It is performing less well on variables connected to population growth and agricultural productivity. If the data provided for Iraq and Iran are accurate, then these two countries show great needs as reflected in their population growth and food importation. Turkey, according to its relative ranking in many of the above indicators (except per capita income), will come probably lower in line for water allocation from the Tigris-Euphrates.

Table 2.20 Relative ranking of the Tigris-Euphrates co-riparians according to the Helsinki Rules

Country	*Turkey*	*Syria*	*Iraq*	*Iran*
Share in drainage basin (both rivers)	2	4	1	3
Country's water contribution	1	4	3	2
Climate	4	2	1	3
Patterns of utilization				
Past	4	2	1	3
Present	3	2	1	4
Social indicators				
Life expectancy	1	2	3	3
Infant mortality	1	4	2	3
Economic indicators				
Per capita income	3	4	1	2
Total debt	3	1	2	4
Total population (1990)	1	4	3	2
Average annual population growth 1990–2000	4	1	2	3
Cereal imports	2	4	3	1
Food production per capita	2	4	3	1

*Sources: World Bank 1992; World Re*sources Institute 1992–3; Human Development Report 1992

What are the possibilities for a conflict over the precious waters of the Tigris-Euphrates? Three factors may exacerbate or prevent crisis.

First, there has been a general failure to implement water and agricultural development projects by all the co-riparians. Because of their weak economies and Iraq's involvement in a new war, the large investment needed for water projects will prevent development—therefore the flow of the Euphrates either will remain unhampered or will be reduced very little. Thus, Iraq and Syria will have enough water and no cause to go to war.

Second, the key to any crisis will almost certainly be the storage capability that the three states develop and the pace of the impoundment of the water to be stored. If Turkey continues in its efforts to fill the Atatürk Dam at a rapid pace, even during drought years, a conflict with its co-riparians will be inevitable. Turkey, and also Syria, may be tempted to use water as a political weapon against Iraq, a step which may bring about a war between Iraq and its co-riparians over the Euphrates.

Third, the co-riparians may make a reasonable change in their demands and priorities for Tigris-Euphrates waters, thus reducing or preventing the danger of conflict. For example, Turkey could abandon its plans for the Tigris and restrict its consumptive use to the Euphrates; in this way, Turkey would limit the development of its most important priority: hydro power. For non-consumptive use such as hydroelectricity only a small amount of the Euphrates should be enough and Turkey should not have to withdraw more than 5.0 billion m^3 for both its agricultural needs and hydroelectricity production in the GAP plan. That would leave some 16 billion m^3 of water for Syria and Iraq, of which 6–7 billion m^3 could be for Syrian development and the rest for Iraq. Iraq would have to give up some of its share in the Euphrates water but would have the total flow of the Tigris at its disposal. Iraq has already transferred waters from the Tigris to the Euphrates.

Though guidance for such water policies seems reasonable, the usefulness of the Helsinki and ILC Rules is limited mainly because the rules do not provide any measures which rank one rule over another. We have seen that giving priority to rules which stress hydrology and geography would give Turkey the lion's share in the water of the Tigris-Euphrates, whereas if dependence on these waters were considered then Iraq and Syria would precede Turkey's right. It seems that the decisive forces for co-operative behaviour inside the water arena can be found in geopolitical, social and economic factors which lie outside the province of water and have to do with a particular country's foreign and internal policies. That makes discussion of water allocation a multi-faceted issue over which it is difficult to negotiate.

3
THE JORDAN-YARMUK WATERS —A CONFLICT OVER SCARCE WATER RESOURCES

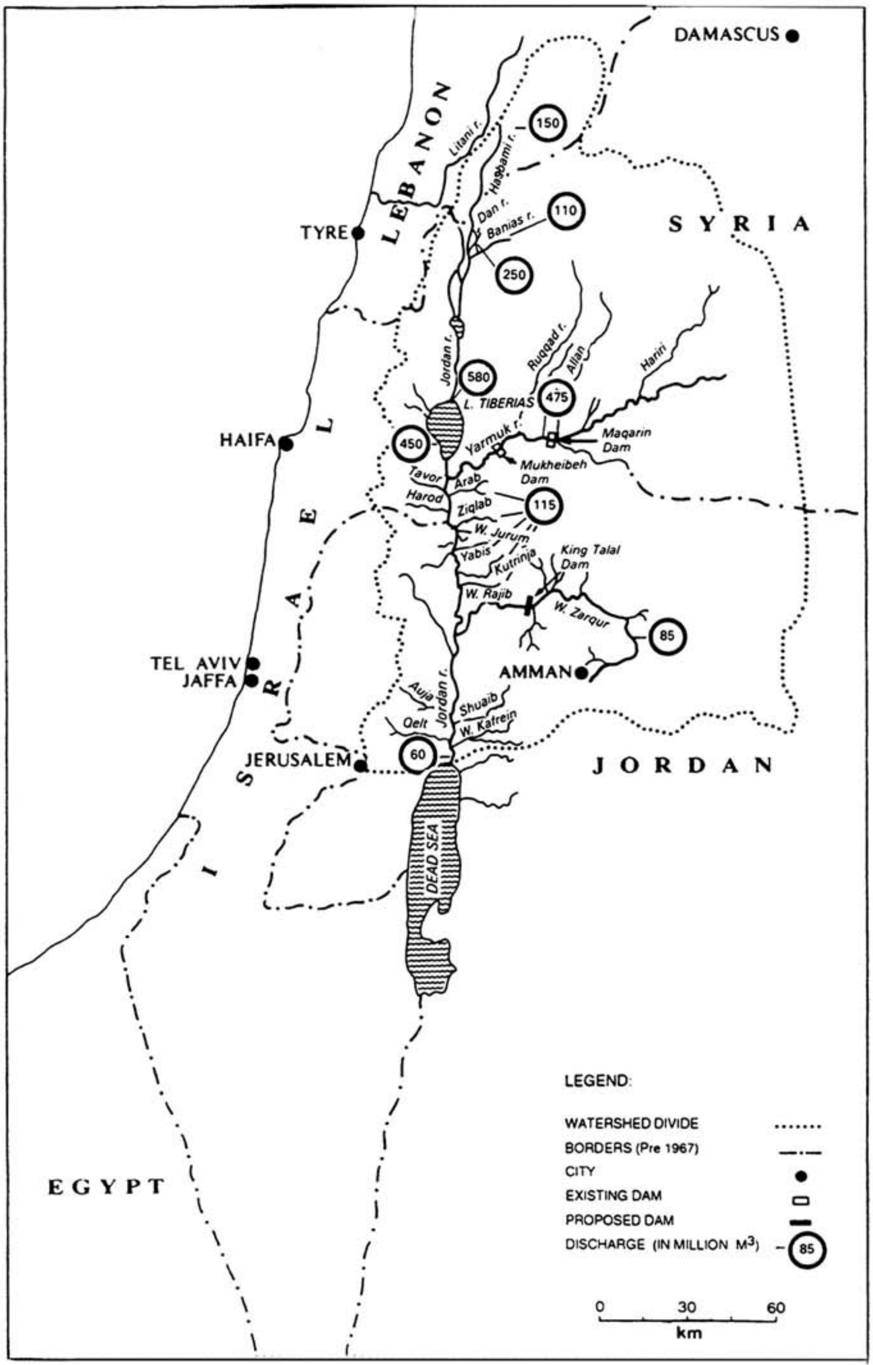
GENERAL

The Jordan River and its major tributary, the Yarmuk, is the clearest manifestation of hydropolitics and the dangers it presents for international river basins. The Jordan has a modest flow discharging only 580 million m^3 of water while an additional 475 million m^3 is discharged by the Yarmuk. However, since (in various degrees) the co-riparians to the rivers are Syria, Lebanon, the Hashemite Kingdom of Jordan, the Palestinians and Israel and since all of them have been in a state of war before and since Israel became an independent state in 1948, the Jordan's waters add another dimension to the multi-faceted conflict between Arabs and Jews. The pressure of the co-riparians for the limited waters of the Jordan-Yarmuk is enormous, and this has led to over-utilization of the drainage basin. As a result skirmishes between Israel and Syria over the utilization of the river were frequent during the early 1950s and early 1960s. There is no all-inclusive agreement common to all the co-riparians over the division of the water from the Jordan-Yarmuk river system, but there are partial agreements and quasi-agreements between pairs of states such as Syria and Jordan and Israel and Jordan. The conflict over the Jordan's water is not one that is in the process of developing, as are the conflicts which are presumed to be inevitable for the Nile or Tigris-Euphrates basins —here the conflict has determined the behaviour of the co-riparians for almost forty years. The worsening situation of water supply among all the co-riparians—the result of consecutive droughts and an accelerated population growth—is only going to increase the magnitude of the conflicting interests of the co-riparians. The scarcity of water in the Jordan-Yarmuk system has made water supply a strategic issue related to the national security of the partners to this basin. We agree with the observation that 'under severe shortage the Jordan basin water becomes a highly symbolic, contagious, aggregated, intense, salient, complicated zero-sum power and prestige-packed crisis issue, highly prone to conflict and extremely difficult to resolve' (Naff 1990).

THE CLIMATE, HYDROLOGY AND GEOMORPHOLOGY OF THE JORDAN-YARMUK BASIN AND THEIR IMPACT ON THE RIVER'S MANAGEMENT

The hydrology, geomorphology and topography of the Jordan basin

The Jordan River is geologically a young river which was formed some 20,000 years ago during the Pleistocene period. The river is incised in the Jordan graben which constitutes an important component of the Syrian-African Rift Valley. The rift valley within Israel is 400 km long extending from Lebanon in the north to the Gulf of Aqaba in the south (Cressey 1960:130; Fisher 1978:413). The three main sources of the



Map 3.1 Hydrology, geomorphology and geography of the Jordan-Yarmuk basin

Jordan are the Hasbani River (named Snir in Israel), the Banias (Hermon in Israel) and the Dan. The

Hasbani rises in southern Lebanon some 30 km north of the border in two groups of springs, Hasbaya and Wazzani, fed from subsurface conduits. The average discharge of the Hasbani is 125 million m^3 per year and its drainage basin extends over 613 km^2. The Dan is the largest of all the streams in the system and it lies totally within Israeli territory close to the border with Syria, but its drainage basin is very small—only 24 km^2 (Karmon 1956:20). This is explained by the simple fact that the stream is fed completely by springs at its source. The Dan Spring has the most stable discharge of all three sources and, on average, it discharges 250 million m^3 per year. The third source of the Jordan River is the Banias (under Israeli control since the 1967 War) which arises in a karstic cave, 1 km north of the pre-1967 border (Israel-Syria); its drainage basin in 175 km^2 and its average discharge is 125 million m^3 per year (Karmon 1956:20; Naff and Matson 1984:17; US Army Corps of Engineers 1991). It should be noted that there is great variation in the discharges of both the Hasbani and Banias.

The Dan, Hasbani and Banias unite 6 km inside Israel at about 70 m above sea level where the Upper Jordan flows into the Hula Valley. In the Hula Valley the Jordan is joined by small tributaries such as the Iyon (which has a drainage basin of 51 km^2 and a discharge of 8 million m^3) with, according to Karmon, the Hula springs and floods adding some 180 million m^3 of water to the Jordan. Before the drainage of the Hula swamps, the Jordan used to flow in swamps and lagoons but, since 1959, it has been flowing in a number of canals which join into one canal. The average flow of the Jordan at its exit from the Hula valley is 540–580 million m^3 (Kolars 1992a; Schwarz, personal communication 1992). The Jordan River leaves the Hula Valley in a deep and narrow gorge, drops from a height of 200 m^3 and enters Lake Kinneret (the Sea of Galilee or Lake Tiberias) through a small delta. Lake Kinneret, 20 km long and 8 km wide, covers 166 km^2 when its level is —213 m^3 below sea level and, at this level, the lake stores 538 million m^3 of water (Fisher 1978:413; Lowi 1984:5).

About 10 km south of the Kinneret the Jordan is joined by the Yarmuk River, its major tributary, which rises on the eastern margin of the Rift Valley in Syria and forms the present boundary between Syria and Jordan for 40 km before it becomes the border between Jordan and Israel for about 12 km (Saliba 1968:32; Naff and Matson 1984:20). Israel does not contribute to the water of the Yarmuk but does share the channel of the river. The Yarmuk's average discharge is about 450–475 million m^3 which is derived from winter precipitation supplemented by spring discharge.

It is important to note that, in the case of the Yarmuk, Syria is an upper riparian to Jordan, and Jordan is an upper riparian to Israel in the channel of the Yarmuk. In the case of the Jordan River, Syria (within the pre-1967 borders) and Lebanon are upper riparians to Israel and Israel is an upper riparian to Jordan (see Map 3.1).

Below Lake Kinneret the Jordan has a depth of 1–3 m^3 and averages 30– 35 m^3 in width. The Jordan is incised deeply in the present flood plain named Zor and within the upper valley named the Ghor. The Ghor is built from marls called the Lisan Formation and the Jordan forms broad meanders in this easily eroded material.

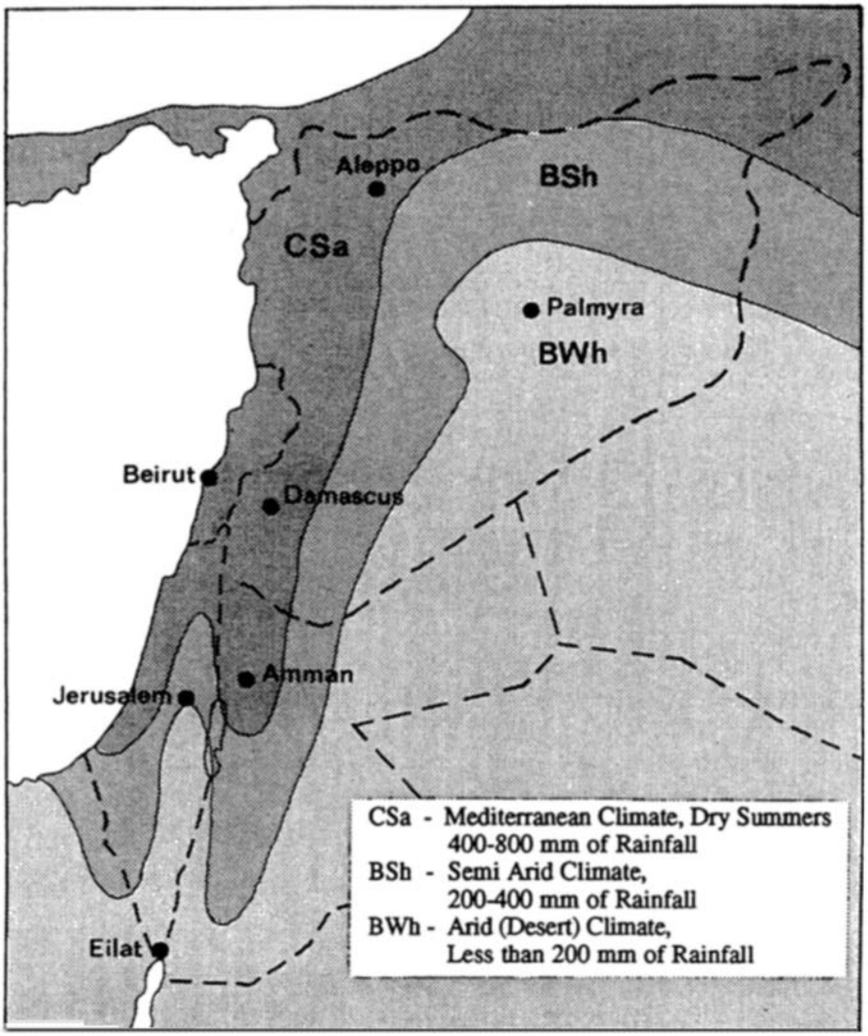
In addition to the Yarmuk several other tributaries flow into the Jordan River from east and west. From the east the tributaries are the Wadis Arab (discharge of 35 million m^3), the Ziglab (13 million m^3), the al-Jurum (13 million m^3), the Yabis (5 million m^3), the Kufrinja (13 million m^3), the Rajib (7 million m^3), the Zarqa (85 million m^3), the Shueib (15 million m^3) and the Kafrein (20 million m^3). Altogether, between 200 and 267 million m^3 of water is provided by the eastern tributaries, although Kolars (1992c) puts the total water contribution of the eastern Wadis at 322 million m^3 which seems too high (Khouri 1981:15; Salik 1988; Al-Weshah 1992). The western drainage basin of the Jordan includes the tributaries Tavor, Yissahar, Harod, Bezek, Al-Malick, Fara'a, Patzael, Auja, Naima and Qelt, altogether discharging some 54 million m^3 of water (Salik 1988:107).

The Jordan River descends from the slopes of Mount Hermon, which is 2000 m above sea level, to the Dead Sea—395 m below sea level (Lowi 1984:5). The total length of the Lower Jordan from Lake Kinneret to the Dead Sea with its meanders is 192 km whereas the direct distance is only 100 km. The total length of the river from its furthest source, the Hasbani, to the Dead Sea is 330 km according to Ben-Aryeh (1965) and only 252 km according to the author's calculations, the differences being related to the many meanders of the river. Shahin (1989), on the other hand, has estimated a total length of only 225 km for the Jordan River.

Climate and discharge

Three out of the four countries which share the Jordan-Yarmuk system include desert and semi-arid areas which need irrigation. Only Lebanon has semi-arid areas in its territory, but it has an average annual precipitation ranging between 657 and 1,000 mm and is well endowed with water sources (Fisher 1978:46; Gischler 1979:103; Shahin 1989). All the four Levant countries, Lebanon, Syria, Israel and Jordan, have large areas in which a Mediterranean type of climate characterized by a clear division between summer and winter prevails. The winter, from November to March, is the rainy season, but most of the rainfall drops during the months of December to February. In the Mediterranean regions of Lebanon rainfall ranges between 500 and 750 mm with peaks of 900– 1,000 mm in the mountains; the total amount of precipitation in Lebanon is estimated as ranging between 6.8 and 9.2 billion m^3 (Shahin 1989; Amer 1971). Syria also has a belt of rainfall ranging between 500 and 750 mm and, as in the case of Lebanon, this includes the mountainous region of Ansariya (Cressey 1960:400; Fisher 1978:46). The total amount of precipitation in Syria is 52.7 billion m^3 (Shahin 1989). Israel in the north has 500–750 mm of rainfall and some elevated portions of Jordan receive some 500 mm of rainfall—mostly in the mountain ranges of Amman Ajlun highlands. The total amount of rainfall in Israel is 8–10 billion m^3 and in Jordan 6.7 billion m^3 (Shahin 1989; *Israel State Comptroller Report* 1991). The belt of Mediterranean climate is surrounded by a belt of steppe or semi-arid zones in which precipitation is below 400 mm— insufficient for permanent farming. The belt of semi-arid climate includes Aleppo, Hama, Homs and Damascus in Syria, the area around Be'er Sheba in Israel and almost all the territory of Jordan. In addition, Jordan, Syria and Israel all have areas which have a total desert climate. All in all, territory classified as arid in Jordan reaches 80–85 per cent, in Israel 60 per cent and in Syria 50–65 per cent (Ben-Aryeh 1965; Karmon 1968; Gischler 1979:100). The variation in classifying what constitutes 'arid areas' is the greatest for Syria, where some researchers define areas with less than 200 mm as arid whereas others include all areas with precipitation of up to 400 mm as arid and semi-arid and, as such, limited for agricultural use. The total annual surface water supply (after evaporation and seepage) in Lebanon is 3.7–4.38 billion m^3 in Jordan 0.85– 0.90 million m^3, in Syria 34.2 billion m^3 and in Israel 0.7–0.8 billion m^3 (Gischler 1979; *Israel State Comptroller Report* 1987:549). In addition, groundwater resources are also available: Lebanon has 0.60 billion m^3, Syria 3.67 billion m^3 Israel 0.850 billion m^3 and Jordan 0.357–0.410 billion m^3.

Because of the high summer temperatures evaporation is relatively high throughout the region and it has been estimated that 65 per cent of the average annual amount of rainfall is lost through evaporation (Lowi 1984:4). As rainfall declines from north to south and from west to east, the greatest water surpluses (i.e. precipitation minus evaporation) are surprisingly small and confined entirely to the northern coastal uplands of Syria, Lebanon and Israel (Beaumont 1981: 41; Beaumont, Blake and Wagstaff 1988:83). Finally, the climate and the rainfall in Syria, Jordan and Israel is susceptible to irregularities and variabilities. The rainfall throughout the Jordan Valley itself is meagre and highly irregular and the amount of rainfall declines sharply towards the south (Saliba 1968:34).



Map 3.2 Climate types in the Levant countries

In conclusion, the Syrian, Jordanian and Israeli need for drinking and irrigation water is large. While Syria has alternatives to the Yarmuk, mainly in the Euphrates tributaries, both Israel and Jordan are highly dependent on the Jordan-Yarmuk waters, and this also includes the fast-growing Palestinian population of Gaza and the West Bank. In Israel, Jordan and Syria 1987–90 were drought years, and the resultant water shortages are grave. As a result of the drought the water discharge of the Jordan River was reduced by 40 per cent, the Dan discharge was reduced from 8 to 5 m^3, the Banias from 2 to 1 m^3/s and the Hasbani from 1.5 to 0.8 m^3/s. Severe drought also hit Jordan which anyway has an annual water deficit of about 200–300 million m^3. Water deficit is defined as an unbridged gap between water supply and demand. Generally water scarcity is

Table 3.1 Riparian share in the drainage basin and discharge of the northern Jordan basin

	Area of basin (km^2)	*Constituent countries*	*Share per country in area of drainage*			*Length of rivers (km)*	*Average annual rainfall (mm)*	*Average annual discharge*	
million m^3			*per cent*						
km^2		*per cent*							
Northern basin	2,730 (1,630 without Kinneret)	Lebanon	640[b]		24			146	25.6
Syria	1,045[c]	1,120	38			156	500–574[d]	27.1	
Jordan	–		–			–	–		
Israel	1,037	997	38			272		47.3	
Hasbani (Snir)	613 (640)[e]	Lebanon	587	(620)[e]		22	1,123	117–138	
Israel	26	(23)[e]	11						
Banias (Hermon)	175	Syria	120			1	1,250	122–125	
	Israel	55		10					
Dan	24	Israel	24		(100)[f]	13	820	250–260	
Ayun	51	Lebanon	48			8	955	8	
	Israel	3		10					
Eastern rim	925 (203)	Syria	925				837	34	
Western rim	226	Israel	765				817	12	
Rain over the Hula Valley	177	Israel	177					60	
Springs in the Hula Valley		Israel						90	

Notes:
[a]There are legal and political problems connected with sovereignty over the Banias and Hasbani (see pp. 184–5).
[b]Including the Hasbani drainage basin.
[c]Including the Golan Heights tributaries and Banias.
[d]This volume discharge does not include rain and springs in the Hula Valley and Kinneret.
[e]640 km^2 for the drainage basin of the Hasbani includes minor wadis.
[f]Percentages refer to the division of Jordan tributaries, not the Jordan basin.

produced by droughts but it is also produced by over-utilization of the existing water resources such as groundwater resources. As a result the water quotas in both Israel and Jordan were strict and in the summer time water is provided sometimes only once or twice a week in Jordanian cities. In the spring of 1990 Jordanian newspapers reported that water storage in the Jordanian state was only half the amount needed (Dougherty 1990:180). Water rationing has been operative since 1988 in both Jordan and Israel and severe water shortages resulting from the drought are also apparent in Syria—as has been pointed out in Chapter 2.

Table 3.1 presents the data on the northern portion of the Jordan basin water discharge (which includes the Jordan sources) and the water sources of the Hula Valley (including the Golan tributaries) and covers a total area ranging between 2,730 and 2,735 km^2 including Lake Kinneret (Ben-Aryeh 1965:67; Salik 1988: 117). The drainage basin area of the Upper Jordan is only 1,469 km^2 or 1,630 km^2 without Lake Kinneret according to various sources (Karmon 1971: 163; Orthenberg interview, 15 May 1991).

Mount Hermon, made up of Jurassic limestone (carboniferous rocks), mostly dolomite and chalks from the Jura era, is the major catchment area of the Jordan River. The annual average rainfall which Mount Hermon receives is 1,300 mm and its water crop appears in the drainage basin of the Jordan in the form of springs. The total water volume of the Jordan river basin which is related to the Hermon aquifer is estimated at 440 million m^3 (Gilead 1988:39) but the Hermon aquifer is also the source of 260 million m^3 of the Dan, 75 million m^3 of the Banias and 55 million m^3 of the Hasbani waters (Gilead 1988:40). The Hermon is the regional source for the water springs in the Hula Valley and Kinneret, and is also responsible for the 425 million m^3 of waters which feed the oasis of Damascus, especially the Barada and Awaj Rivers. In addition, the Hermon aquifer feeds 80 per cent of the Yarmuk sources estimated at 340 million m^3 (Burdon 1954a; Colton, Miro and Rosner 1984).

The sources of the Jordan, the Dan, the Hasbani and the Banias together provide some 500–600 million m^3 of water. The water supply of the Dan is relatively stable and its average discharge ranges between 245 and 260 million m^3 of water with a frequent average of 260 million m^3 (Karmon 1971: 163; Naff and Matson 1984:17; Gilead 1988:107). The Dan typically represents 50 per cent of the discharge of the Upper Jordan and in a dry year may make up as much as 70 per cent of the flow of the Upper Jordan (Naff and Matson 1984:17, 19). However, the Banias and the Hasbani manifest relatively great variability in their discharge with the Banias having an average discharge of 125 million m^3 which ranges between 63 and 197 million m^3 a year (Karmon 1956:20; 1971:163). According to another source, the average quantity of water provided by the Banias is only 114 million m^3 (*Tahal,* quoted in Nimrod 1966:22). The Hasbani's flow ranges between 117 and 138 million m^3 with an average of 125 million m^3 (Karmon 1971; US Army Corps of Engineers 1991). The average flow of the Jordan at its exit from the Hula Valley ranges between 560 and 640 million m^3 (Karmon 1971:163). The Upper Jordan contributes an average of 660–770 million m^3/year to Lake Kinneret or about 40–45 per cent of Israel's total identified usable water budget (Naff and Matson 1984:19; Orthenberg interview, 15 May 1991). The level of the lake lies at an average of 210 m below sea level, but it shows fluctuations of about 0.80–3.50 m according to levels of precipitation and levels of utilization.

The Lake Kinneret water comprises the following sources: (a) direct rainfall of 65–70 million m^3 (Gal 1987; Orthenberg interview, 15 May 1991); (b) water from springs and wadis, 135–200 million m^3 (Orthenberg interview, 15 May 1991); (c) the underground springs in the Kinneret which are estimated to contribute 50–70 million m^3 (Avnimelech and Lecher 1978:104; Gilead 1988; Orthenberg interview, 15 May 1991); (d) the Jordan River which discharges 550–570 million m^3 into the Kinneret; and (e) 17 million m^3 of return irrigation waters (Ben-Aryeh 1965:68; Karmon 1971:164; Orthenberg interview, 15 May 1991). Thus, the total inflow into Lake Kinneret is 800–910 million m^3 (Karmon 1971; Kally 1978:31; Gal 1987:9). On average, the inflow is 870 million m^3. One-third of the water discharged into Lake Kinneret evaporates and the evaporation rate is estimated at an average of 162–270 million m^3 of water a year

(Karmon 1971:164; Naff and Matson 1984:20; Orthenberg interview, 15 May 1991). In addition, some 350–500 million m^3 of water is utilized by the Israeli National Water Carrier (see pages 212–16).

The live storage capacity of the Kinneret is 550–700 million m^3 at various levels, whereas the total storage capacity is 3,985 million m^3 (Nimrod 1966:22; Gal 1987:9; Orthenberg interview, 15 May 1991).

From 1921 to 1945 the average discharge at the exit from the Kinneret was 557 million m^3 of water (Ben-Aryeh 1965:70). The total annual flow of the Jordan near its mouth into the Dead Sea was at one time estimated (before utilization) at about 1,200 million m^3 (Karmon 1971:165). According to Salik, the Lower Jordan used to discharge 1,359 million m^3 of water into the Dead Sea in its natural state, before its utilization by Israel and Jordan began. At present, the Jordan discharges only 60 million m^3 of water, mostly salty and sewage waters (Salik 1988:118). Today, only small quantities of Kinneret waters are allowed to flow downstream into the Lower Jordan and the water which does flow downstream includes chloride spring waters which are diverted from the Kinneret (24 million m^3) and sewage water (6.0 million m^3). Only in flood years, which occur once in five to ten years, is fresh surplus water released into the Lower Jordan. Thus, the Lower Jordan up to the point of its meeting point with the Yarmuk discharges 30 million m^3 of saline and sewage waters.

The southern drainage basin of the Jordan-Yarmuk river system covers an area of 13,600 km^2 or 14,935 km^2 (Ben-Aryeh 1965:67; Salik 1988:119). It includes all the area south of the Kinneret including the Yarmuk River and all the tributaries which flow into the eastern and western parts of the Jordan River. Table 3.2 presents the major sources of this basin.

Table 3.2 Riparian share in the drainage basin and discharge of the southern Jordan basin

	Area of basin (km^2)	*Constituent countries*		*Share per country in area of drainage*		*Length of rivers (km)*	*Average annual rainfall (mm)*	*Average annual discharge*			
million m^3			*per cent*								
km^2	*per cent*										
Southern basin	14,935	Syria		6,135	41.0			374			50.0
		Israel		2,005	13.6		330	54	749	7.2	
		Jordan		6,795	45.4			321		42.8	
Yarmuk[a]	6,800[b]	Syria		6,135	89.25	36[a],[c]		374		450	79
		Israel		45	0.75	12[a],[c]	360	–	475	–	
		Jordan		620	10.0	40[a],[c]		85–101		21	
Arab	267	Jordan		All the tributaries are located in Jordanian territory 6,175		25	360	35			
Al-Jurum	205	Jordan	20	300	13						
Ziglab	106	Jordan	17	300	13						
Yabis	125	Jordan	17	300	5						
Kufrinja	111	Jordan	35	300	13						
Rajib	84	Jordan	25	300	7						

	Area of basin (km^2)	*Constituent countries*		*Share per country in area of drainage*		*Length of rivers (km)*	*Average annual rainfall (mm)*	*Average annual discharge*	
million m^3			*per cent*						
km^2	*per cent*								
Zarqa (Yabok)	3,490	Jordan	60	300	85				
Shueib	178	Jordan	39	250	11				
Kafrein	176	Jordan	12	250	13				
Husbun	60	Jordan	15	250	5				
Other areas	1,373	Jordan					300	20	
Total Jordanian tributaries	6,175							220	220
Total eastern branch	12,975						332	667	
Tavor	211	Israel		860 km^2 of the tributaries are located in Israeli territory, 1,100 km^2 in the West Bank		15	400	6	
Harod	182	Israel	19	370	8				
Tirza	330[d]	Israel	37	330	16				
Auja	270[d]	Israel	28	300	10				
Qelt	178[d]	Israel	24	250	4				
Other areas	789						300	10	
Total western branch	1,960						319	54	54

Sources: Gilead 1988; Salik 1988; Khouri 1981; Burdon 1954a, b; Ben-Aryeh 1965; Karmon 1956, 1971; The National Atlas of Jordan 1984 1986

Notes:

[a]Including Wadi Harir, the longest of the Yarmuk tributaries. The Yarmuk is commonly shared by Jordan and Syria for 40 km and by Jordan and Israel for 12 km. Forty-three per cent of the Yarmuk's length is owned by Syria alone and the rest is shared by Syria and Jordan (45 per cent) and Israel and Jordan (12 per cent). After 1967 Israel expanded its share in the Yarmuk to about 23 km. According to one source, the Yarmuk average discharge is only 400 million m^3 (US Army Corps of Engineers 1991).

[b]According to US Army Corps of Engineers (1991) the drainage area of the Yarmuk is 7,252 km^2 whereas Shahin (1989) puts it at 9,300 km^2.

[c]Author's own calculations.

[d]These tributaries have been located within the Israeli-occupied West Bank since 1967:860 km^2 of tributaries in Israel and 1,100 km^2 of tributaries in the WestBank.

The Yarmuk

The catchment area of the Yarmuk amounts to 6,800 km^2 with most of its drainage basin in Syria and the rest in Jordan. Its average annual discharge is 450–475 million m^3, but this is very variable and severe flooding sometimes occurs. For example the Yarmuk discharged the enormous quantity of 874 million m^3 of water in 1928 but only 271.4 million m^3 in 1927–8 (Ben-Aryeh 1965:77). The Yarmuk discharge ranges between 200 and 900 million m^3 with the river discharging some 175 million m^3 of water during the summer and the rest in the winter. Controlling the floods of the Yarmuk is one of the most important goals of the Maqarin Dam plan, whose purpose is to store the Yarmuk's flood waters for the benefit of Jordan and Syria.

The total water contribution of the eastern branch of the Jordan's southern drainage basin in 695 million m^3 of water (see Table 3.2) (Salik 1988:117). The western branch of the southern basin provides only 54 million m^3 and the total water crop of the southern basin is 749 million m^3 with 40 million m^3 of water being lost due to evaporation.

To summarize, the northern basin of the Jordan River provides some 800–910 million m^3 of water (before evaporation) whereas the southern drainage basin of the Jordan-Yarmuk supplies 749 million m^3 of water. In both relative and absolute terms this is not a large amount of water and the reduction in water supply in recent years has increased pressure on both these and other water sources by all the riparians to the Jordan-Yarmuk river system.

The meeting point between hydrology and politics

The total area of the Jordan-Yarmuk ranges between 16,335 km^2 and 18,300 km^2; the northern part of the basin is 2,735 km^2 and the southern drainage basin is 14,935 km^2 (according to Table 3.2) (Ben-Aryeh 1965: 67; Salik 1988:119; US Army Corps of Engineers 1991). According to the *Register of International Rivers* the total area of the Jordan is only 11,500 km^2 but Naff and Matson (1984) put it as high as 18,300 km^2 (United Nations 1978:15; Naff and Matson 1984:21). According to the *Register of International Rivers,* 53. 9 per cent of the drainage area of the Jordan is in Jordan, 29.6 per cent in Syria, 10.4 per cent in Israel and 6. 1 per cent in Lebanon (United Nations 1978:15).

There are certain difficulties in the above calculations since the legal ownership of the Hasbani and Banias is not clear-cut. First, the Hasbani appears in all the documents and books as a Lebanese river; however, the lower source of the Hasbani, Ein Wazzani, is located in the village of El-Ghajar and may once have been Syrian. Before the 1967 War the village was part of Syria, not Lebanon, and if this is so Syria may claim ownership to at least half of the Hasbani sources (*Ha'aretz* 24 July 1991).

Even more complicated is the ownership of the Banias. The foundation for Syrian ownership of the Banias lies in an agreement made between the mandatory powers France and Britain, who divided and demarcated the Palestine-Syria-Lebanon border between 1922 and 1924. According to this agreement which was based on the work of the Newcomb Paulet Committee, the Banias Springs have to remain only temporarily within French mandatory rule (i.e. Syria and Lebanon) and Britain preserved the right to raise this problem again before a final demarcation of the boundary near the Banias took place. However, during years of Britain's rule it never initiated any discussion on this matter. Theoretically Britain thus never gave up its demand for the Banias Springs to be included in Palestine (Brawer 1988:114). The importance of this negligence became apparent in the late 1950s when the Syrians wanted to divert the Banias waters into their territory, thus preventing the flow of the water into Israel (see pages 204–7). As long as these issues are not resolved, the *de facto* past ownership of the Banias by Syria and the Hasbani by Lebanon will guide this book.

In this book we adopt a value of 16,335 km^2 as the total area of the basin. Table 3.1 shows how the area of 2,735 km^2 of the northern basin is divided among the co-riparians and the following characteristics are presented. First, the Kingdom of Jordan is not a co-riparian in the northern basin of the Jordan River. Out of the total area of this basin Lebanon owns 24 per cent, Syria 38 per cent (40 per cent in the pre-1967 borders) and Israel 38 per cent (according to the author's calculations). According to other sources, 55 per cent of the drainage basin of the Upper Jordan is within Israel and 45 per cent is in the territory of Lebanon (Paldi 1987:21).

It is important to note that all calculations are presented for the pre-1967 State of Israel and that the Banias and the Golan tributaries are included as the Syrian portion of the basin. Since 1967, however, Israel has had full control of the Golan and the Banias. Ownership of the river channel itself points to Israeli primacy since Israel controls the river channel of the Upper Jordan.

The discharge contribution of the partners to the Upper Jordan is difficult to assess and the author's own calculations indicate that approximately 26 per cent of the Jordan's discharge in its upper part is provided by Lebanon, 27 per cent by Syria and 47 per cent by Israel, but this calculation does not account for Israel's direct contribution through rainfall and springs which would raise its contribution to the Upper Jordan to 55 per cent. Jordan, according to its status, is not entitled to any water from the Upper Jordan but, as the Helsinki Rules have pointed out, this should not be the sole criterion for water allocation.

Syria is in very good standing in relation to the southern basin of the Jordan-Yarmuk system, and owns almost 89 per cent of the area of the drainage basin as well as a large amount of the discharge. Other sources also specify Syria's share in the drainage basin of the Yarmuk as 80 per cent—5,828 km^2 out of 7, 252 km^2 (Naff and Matson 1984:20).

Syria is a co-riparian through its ownership of large amounts of territory in the Yarmuk basin and by providing 80 per cent of its waters. Table 3.2 also indicates the very minor position of Israel which only controls tiny portions of the basin of the Yarmuk and the Lower Jordan (and makes a minor water contribution). Israel has expanded its role as a co-riparian to the Yarmuk since 1967 by sharing part of its channel with Jordan and by its portion in the drainage basin. The intermittent tributary wadis incised in the walls of the Jordan Valley south of the Yarmuk, primarily in the east (within the Jordanian state), provide an additional 274 million m^3/year, only 20 per cent of which originates in Israel. Together with the Yarmuk, the total discharge of the southern basin is 721–749 million m^3.

Table 3.2 also points to the very complicated situation of Jordan in the basin of the Yarmuk. Jordan does not contribute a large amount of the Yarmuk's waters (only 21 per cent of the discharge), but it has a small portion of the drainage basin and a relatively large portion of the channel of the Yarmuk. As we shall show (pages 200–202), the *de facto* agreement over the division of Jordan-Yarmuk water assigns a large amount of water to the Jordanian state and Israel but a relatively small amount to Syria. The total contribution by the Arab countries to the Jordan-Yarmuk system is estimated at 77 per cent while the Israeli contribution is 23 per cent (Saliba 1968:37; Naff and Matson 1984:23). However, the hydrological and geographical data presented above point to Syria as the state which is entitled to most of the Yarmuk water.

Conclusions: the Helsinki Rules in the Jordan—Yarmuk system

The application of Helsinki Rules to the Jordan-Yarmuk basin is exceptionally difficult because of the continuous conflict prevailing in the basin. In the complete absence of any measures of co-operation even in such matters as collection of information, the data provided by the co-riparians on water flows and water utilization are either entirely absent, partial or biased. In addition the hydrology and geomorphology of the basin have become another weapon in the hands of the adversaries. The conflict situation is thus the main reason for the suggestion that the Helsinki Rules be separately applied to the Upper and Lower Jordan and to the Yarmuk. Such a policy will minimize the number of co-riparians in each sub-basin and perhaps reduce probable areas of conflict, making a rational approach more accessible.

In the upper basin of the Jordan there are only three co-riparians: Lebanon, Syria and Israel. Lebanon according to its share in the area of the drainage basin and its water contribution is entitled to some 20–25 per cent of the water resources of the upper basin; Syria is entitled to 30–35 per cent; and Israel to 40– 50 per cent. Jordan is not entitled to any water from the Upper Jordan and its tributaries.

In the lower basin, on the other hand, Jordan has some 45 per cent of the drainage basin area, syria has 41 per cent and Israel has only 13 per cent. By virtue of water contribution, Jordan contributes some 43 per cent to the total water budget of the southern basin, Syria 50 per cent and Israel less than 7 per cent, mainly through the western tributaries. Lebanon is not a co-riparian to the southern basin. Equitable water allocation from the southern basin will place Jordan's and Syria's needs first and apportion almost all the water to them with Israel being entitled to very little water in the southern basin (mainly in the Yarmuk as Israel has a very small portion in the river channel and its basin). Israel's position in the Yarmuk is similar to the Syrian position in the Tigris River.

As for the Helsinki Rules which call for full consideration of water contribution, we have seen that full application of this rule could leave Egypt and Iraq without water. Israel's and Jordan's water contribution to the southern basin is small, but this also should not be the single factor for allocating water.

The southern basin has a semi-arid and arid climate and the population residing in this region, especially in Jordan, has justifiable needs for water. Moreover, the Palestinian population of the West Bank may have legitimate claim to these waters and, in the future, a Palestinian autonomous or independent entity may demand portions of the Lower Jordan waters. Thus, in the future, a new equitable water division should be offered for the southern basin.

Finally, we should again look at the contradictory data. For example, Naff and Matson (1984) give Israel's share in the whole Jordan basin as 3 per cent whereas the *Register of International Rivers* (United Nations 1978) puts it as 10.4 per cent. There is also a trend in various sources to reduce Israel's water contribution. Out of a total of 1,491 million m^3 of water in the Jordan-Yarmuk basin, Israel in its pre-1967 territory contributes some 510 million m^3 (one-third) while various sources estimate Israel's contribution as only 23 per cent (Stevens 1965; Naff and Matson 1984; US Army Corps of Engineers 1991). The discrepancy may be interpreted as reflecting a lack of directly measured data or it may mirror politicized writing by both the co-riparians to the Jordan and outside spectators. This issue will be discussed again on page 259.

PATTERNS OF UTILIZATION OF THE JORDAN-YARMUK SYSTEM

Past planning for the Jordan—Yarmuk system

Because of its concern over water resources the British Mandatory Government of Palestine ordered surveys and hydrological studies to estimate the water potential of Palestine and, more specifically, how many people could live in Palestine based on its water reserves (Nimrod 1966:26). As a result the size of the population that Palestine could support with its available water became one more issue of debate between Jews, Arabs and the British Mandatory Rule.

Table 3.3 presents sixteen different plans for the utilization of the Jordan-Yarmuk sources—by no means all the plans for the Jordan-Yarmuk system but just the best known. Seven of these plans were proposed before the late 1940s, when Israel and Jordan became independent states, and nine plans afterwards. Most of the plans have one purpose: the irrigation of land in the Jordan Valley, including some irrigation outside the drainage basin itself. The major components appearing in most of the plans are dams and storages on the Yarmuk and (sometimes) on the Hasbani and Banias for the purpose of impounding water for irrigation and hydro-power production. Another element which is common to almost all the plans is the proposal to create one or two canals, parallel to the Jordan River, through which the Jordan-Yarmuk waters can flow by gravity to irrigate cultivable land on both sides of the Jordan from Lake Tiberias to the Dead Sea. The table also shows that the Jewish-Arab conflict has generally prevented planners from producing a multipurpose integrated plan for the whole drainage basin and that only very few of the plans adhere to standards of equitable water allocation for all the co-riparians. Most of the plans 'tilt' in the direction of either Israel or the Arab countries, sometimes completely ignoring the rights of the other co-riparians. Specifically, the variation in water allocation of the Jordan-Yarmuk is reflected in the data presented in Table 3.4.

1 The table shows that the Arab states were allotted a water share in the Jordan-Yarmuk sources ranging between 40 and 87 per cent with Israel subsequently getting between 13 and 60 per cent (Stevens 1965; Nimrod 1966; Khouri 1981; Naff and Matson 1984).
2 Most of the plans reflect geopolitics as well as the power struggle between Jews and Arabs and between colonial powers. No principles of one kind or another emerge from the plans. Hence, no equitable water allocation is expected to result from them.
3 There is a great variation in the quantities of water allotted to Arab countries. Lebanon is ignored in many of the plans and, when a water quota is allotted to it, it is significantly lower in relation to the share and water contribution it makes as presented in this volume. Syria also receives water quantities which are lower than the quantities to which it is entitled according to its share, hydrology and water contribution to the Jordan-Yarmuk basin. In some of the plans, Jordan and Israel are allotted more water than their share or hydrological contribution would justify. However, as we have seen, the Helsinki Rules consider not only geography and hydrology but also other factors such as economic needs or the absence of other alternatives; and some of the above plans stress the needs of Jordan and Israel (particularly for irrigation waters) when designating water quotas to the co-riparians.
4 Most of the plans emphasize irrigation. Only very few are multipurpose plans which emphasize drainage, irrigation and hydro-power production (Bunger Plan, Unified Plan, Lowdermilk, Blass). The Mavromatis Plan, the Henrich Plan, the Ionides and MacDonald Plans deal only with irrigation. The Ruthenberg Plan deals only with hydropower.
5 Many of the proposed plans favour out-of-basin irrigation development. The Helsinki Rules, as mentioned before, give priority to water allocation for development within the drainage basin. All the

Israeli plans stressed usage of water for irrigating the Negev and Wadi Araba (Johnston, Cotton, Blass and Lowdermilk Plans). This issue will be more extensively treated in the analysis of water utilization in Israel in the next section.

Table 3.3 Plans for the utilization of the Jordan-Yarmuk sources 1913–56

Plan	*Principles*	*Goals*	*Water division among riparians (million m^3)*				*Aspects of international law and territories of plans*
			Syria	*Jordan*	*Israel*	*Lebanon*	
Franjieh (1913)	Diversion of the Yarmuk to the Kinneret through a western canal flowing 100 million m^3	Irrigation of the Jordan Valley on both sides. Twenty-one hydro-power plants		No specific reference			Plan intended mainly for the East Bank of the Jordan, Multipurpose plan. In-basin development
Mavromatis (1922)	The diversion of the Yarmuk to the Kinneret and construction of two dams for hydro power. Two canals for irrigation and for sailing. Power plants on the Yarmuk and Jordan	Irrigation of the Hula Valley, drainage of the Hula swamps. Irrigation of both sides of Jordan Valley		No specific reference			Plan aimed at the whole of Palestine. Multipurpose plan, In-basin development
Henrich (1928)	Irrigating the Yarmuk Triangle with Yarmuk waters	Irrigation of 30,000 dunums (3,000 ha)		No specific reference			East Bank of the Jordan. In-basin development
Ruthenberg (1926)	Using the waters of the Yarmuk and the Jordan to produce 173 million kWh of electricity	Only hydro power		No specific reference			Palestine

Plan	*Principles*	*Goals*	*Water division among riparians (million m³)*				*Aspects of international law and territories of plans*
			Syria	*Jordan*	*Israel*	*Lebanon*	
Ionides (1939)	Diversion of Yarmuk waters in two main canals to irrigate the Ghor plains east and west of the Jordan River	Use of 460 million m^3 of water for irrigation of 200,000 dunums in the Jordan Valley and 105,000 dunums in Hula Valley		No specific reference			Jordan Valley
Lowdermilk (1944)	Integrated development of the Jordan-Yarmuk basin and the Litani in Lebanon. Following Tennessee Valley Authority. Diversion of the Jordan and Yarmuk waters in channels or pipes parallel to the Jordan Valley. Hydro-power production by diverting water from Mediterranean Sea to the Jordan Rift Valley and the Litani to the Hula Valley	Agriculture, hydro power, industry. Estimates on production of billion kWh. Settle 4 million refugees in addition to 1.8 million Arabs and Jews living in Palestine		No specific reference			Usage of the Jordan-Yarmuk waters mostly for use *within* drainage basin. A multipurpose plan. The plan also included the utilization of the Litani River which is not connected to the Jordan-Yarmuk system
Blass (1944)	Integrated regional development of the Jordan sources, Yarmuk, Hula floods and part of	Convey the waters of the north to the wastelands of the south. 450 million m^3 of water to irrigate	No specific reference				Irrigation of areas *outside* the drainage basin of the Jordan-Yarmuk. The Litani is included

	the Litani. Construction of water reservoirs in the upper reaches of the Yarmuk. Some 400 million m^3 of water would be diverted from the Litani to the All Palestine Irrigation Project. Water conduits would run on both sides of the Jordan Valley	the Jordan Valley, Ghor, Araba, Beisan and Hula and Esdraelon Valleys			although it is not one of the Jordan tributaries
Hays-Savage (1948)	Following the Lowdermilk Plan, it was based on conveyance from Mediterranean Sea to the Dead Sea for a hydro-power storage lake on the Hasbani. Yarmuk waters to be diverted to the Kinneret	Supply of 2 billion m^3 of water for irrigation of 2.4 million dunums (240,000 ha). The Mediterranean-Dead Sea Canal to produce 165, 000 kWh	50% of Yarmuk water to Jordan	50% of Yarmuk water and all the Jordan water to Israel	The Plan ignored Lebanon and Syria as co-riparians. The plan favoured Israel and permitted out-of-basin usage. Multipurpose plan

Plan	*Principles*	*Goals*	*Water division among riparians (million m^3)*				*Aspects of international law and territories of plans*
			Syria	*Jordan*	*Israel*	*Lebanon*	
Israel's Total Plan (1951)	Three networks of canals to lead water to the Negev. Water carrier from Jisr Banat-Yaqub to the Negev with storage at Beit-Netufa Valley of 494.4 million m^3. Tunnel from Mediterranean	Drainage of Hula swamps. Irrigation of the Negev. Hydro-power production	No specific water allocations				The plan allowed out-of-basin usage, Multipurpose plan

Plan	*Principles*	*Goals*	*Water division among riparians (million m^3)*				*Aspects of international law and territories of plans*
			Syria	*Jordan*	*Israel*	*Lebanon*	
	to Dead Sea for hydro power						
MacDonald (1951)	Kinneret as common storage for Israel and Jordan. Canals on both sides of Jordan River to irrigate the valley	650,000 dunums (65, 000 ha) will be irrigated within the Jordan Valley between Tiberias and the Dead Sea	No specific water allocations				Plan stressed need to agreement between Israel and Jordan, Allowed only usage within basin limits
Bunger Plan (1952)	Construction of a high dam in Maqarin with storage of 480 million m^3 and a small diversion dam at Addassiya to use the Yarmuk for the benefit of Jordan and Syria. Two canals east and west of the Jordan River to flow water to irrigate the Ghor	Irrigation of 435,000 dunums in Jordan (43,500 ha) and 60,000 dunums in Syria (6,000 ha). Hydro power of 40, 000 kWh to be allocated to Syria and Jordan	No specified water allocations				Bunger Plan ignored Israeli rights as a co-riparian. Israel demanded that the USA secure Israeli rights. USA supported Israeli stand. Plan had to be abandoned. Led to Jordan-Syria 1953 Yarmuk Agreement. Bunger Plan is not an integrated plan
Main Clap Plan (1953) (The Unified Plan)	The Plan suggested two gravity flow canals parallel to the Jordan Valley to convey water from the Upper Jordan south. Lake Kinneret to be used to store waters of the Jordan and Yarmuk. The plan proposed to use the waters of the Jordan, Kinneret, Yarmuk. The Main Plan proposed:	410,000 dunums to be irrigated in Israel, 490,000 dunums in Jordan and 30,000 dunums to be irrigated in Syria	45 (4%)	774 (63%)	394 (33%)	–	The Main Clap Plan ignored political boundaries and dealt with the Jordan-Yarmuk basin as one unit (integrated in-basin development), It was also a multipurpose plan

(a) a dam on the Hasbani to provide power and water for irrigation for Galilee
(b) dams on the Dan and Banias Rivers to irrigate Galilee
(c) Drainage of the Hula swamps

Total water resources 1,213

Plan	*Principles*	*Goals*	*Water division among riparians (million m^3)*				*Aspects of international law and territories of plans*
			Syria	*Jordan*	*Israel*	*Lebanon*	
	(d) a dam at the Maqarin with storage capacity of 175 million m^3 for power generation (e) a dam at Addassiyah to divert water to Lake Tiberias (Kinneret) and into the East Ghor Canal (f) a small dam at the outlet of Lake Tiberias (Kinneret) to increase the lake's storage capacity						
The Arab Plan (1954)[a]	Water storage on the Yarmuk at Maqarin of 400 million m^3, at Addassiyah to store 100 million m^3. Water to feed East Ghor Canal. West Ghor	Irrigation of 119,000 dunums (11, 900 ha) in Syria. Irrigation of 490,000 dunums (49, 000 ha) in Jordan. Irrigation of 234,000 dunums (23, 400 ha) in	132[b,c,d]	1,047[b] (975[d])	182[b] (287[d])	35[b,d]	Utilization within the Jordan-Yarmuk basin only

Plan	*Principles*	*Goals*	*Water division among riparians (million m^3)*				*Aspects of international law and territories of plans*
			Syria	*Jordan*	*Israel*	*Lebanon*	
For Arab usage			80%				
For Israeli usage			20%				
Total water available 1,396–1,429							
	Canal to irrigate the western valley. A dam on the Hasbani and irrigation canals from the Banias	Israel. Irrigation of 35,000 dunums (3,500 ha) in Lebanon. Hydro power only for Arab countries					
Israeli Plan (Cotton Plan) (1954)	Conveying of Jordan's water from a point near Jisr-Banat Yaqub in canal to Kinneret. From Lake Kinneret to Zalmon and Beit Netufa storages. Hydro power to be produced by the drop of the Jordan's water to Lake Kinneret. The Litani to be used for electricity	Irrigation of 2.6 million dunums within the four riparians (1% in Syria, 14% in Lebanon, 16% in Jordan, and 69% in Israel)	39 (1%)	575 (24.5%)	1,290 (50.5%)	450.7 (19%)	The Cotton Plan included the Litani, in addition to the Jordan-Yarmuk. It was based on separate development or irrigation projects in Israel and Jordan. It was a multipurpose plan which permitted out-of-basin development
	Total water available 2,354.7						
Baker-Harza Plan (1955)	Construction of dams on the Yarmuk to store 47 million m^3 of waters. Surplus waters from the Yarmuk to be stored in the Kinneret. Canals east and west of the Jordan River to convey water to irrigate the Jordan Valley	Irrigation of 514, 000 dunums in the Jordan Valley with 760 million m^3 of Jordan and Yarmuk water (605 million m^3) and Kinneret (155 million m^3)	No specified allocations				The plan favoured Jordan. The plan aimed at irrigation only and did not refer to other co-riparian rights to the Yarmuk waters

Plan	*Principles*	*Goals*	*Water division among riparians (million m^3)*				*Aspects of international law and territories of plans*
			Syria	*Jordan*	*Israel*	*Lebanon*	
The Johnston Plan (First Version)[e] (1953)	(1) A dam on the Yarmuk near Maqarin to store 300 million m^3 (2) The Kinneret as major storage for both the Jordan and Yarmuk Rivers	Irrigation, hydro power at Maqarin (150 million kWh per year)	50 (4%)	829 (63%)	429 (33%)	–	The Johnston Plan was a multipurpos e plan which sought equitable water allocations for the riparians. It was based on separate development of water resources
Total water available 1,308							
The Second Johnston Plan[f] (1956)	(1) and (2) as in the first version of the Johnston Plan (3) Diversion dam at Addassiyah for diverting water to the East Ghor Canal (4) A feeder canal from Lake Kinneret to the East Ghor Canal (5) A siphon across the Jordan for conveying water from the East Ghor Canal to the west		20 from Banias, 22 from Jordan, 90 from Yarmuk	377 from Yarmuk, 100 from Kinneret, 243 from southern tributaries	375[g] from Upper Jordan, 25 from Yarmuk	35	Each of the countries could utilize waters outside the basin of the Jordan-Yarmuk
132	720	400	35				

Plan	*Principles*	*Goals*	*Water division among riparians (million m^3)*				*Aspects of international law and territories of plans*
			Syria	*Jordan*	*Israel*	*Lebanon*	
(10.3%)	(56%)	(31.0%)	(2.7%)				
Total 1,287							

Sources: Blass 1944, cited in Blass 1973; Lowdermilk 1944; Kally 1965; Nimrod 1966; Stevens 1965
Notes:
[a] According to Stevens (1965), the Arab Plan of 1954 allotted 20 per cent to Israel and 80 per cent to the Arab States.
[b] According to Khouri (1981), Doherty (1965).
[c] According to Naff and Matson (1984).
[d] According to Saliba (1968).
[e] The principles of the Johnston Plan are more or less identical. The two versions differ in the quantities of water allotted to the co-riparians. The first Johnston Plan allotted some 33 per cent of the water to Israel whereas the Second Plan accorded 31.0 per cent of the water to Israel.
[f] According to Stevens the Final Plan divided the water as follows: 40 per cent to Israel and 60 per cent to the Arabs.
[g] According to Taubenblatt (1988:46), the water allocation to Israel was computed as 361 million m^3.
[h] According to Stevens (1965) and Kally (1986) the final Johnston Plan allotted 40 per cent of the Jordan waters to Israel and 60 per cent to the Arab states. According to our calculations Israel's share is only 31 per cent.

Table 3.4 Water division in the various plans (per cent)

Plan	*Lebanon*	*Syria*	*Jordan*	*Israel*
Hays-Savage	–		50	50
Main Clap	–	4	63	33
The Arab Plan	3	10	74	13
Cotton Plan	19	5	24.5	50.5
Johnston Plan (1st version)	–	4	63	33
Johnston Plan (2nd version)	2.7	10.3	56	31.0
Proposal in this volume	10–12	35–37	29–30	21–23

Sources: As in Tables 3.1, 3.2 and 3.3

6 Development plans for the Jordan-Yarmuk waters also reflect the deep schism between Arabs and Jews through their presentation for the separate development of water resources for Israel and the Arab states which does not allow for the most efficient usage; here, too, there is a clear-cut violation of the Helsinki Rules. The Johnston Plan which, more or less, serves as an acceptable formula for water sharing (or, more precisely, for water allocation between the Arab states and Israel) is the best example of a separate development policy.

7 The 'Internationalization' of the Litani River: the Litani is a Lebanese river, completely within the territory of Lebanon, which has a discharge of 920 million m^3 of water. The largest water withdrawal from the river is for power generation and this amounts to 236 million m^3. Two major irrigation projects utilize 120 million m^3 of water (the Beqqa Project) and 77 million m^3 (Qasimiyah Project); but, at present, about half of the runoff generated in the basin is unused (US Army Corps of Engineers 1991). The Litani River is not connected in any way to the Jordan-Yarmuk system, yet three past plans

—the Lowdermilk and Blass Plans from 1944 and the Cotton Plan of 1954—have called for the incorporation of the Litani into the development plan for the whole Jordan-Yarmuk system, thus turning it into an 'international' river.

The Litani was mentioned by Jewish leaders such as Ben-Gurion, Sharret and others as a target for development which added an 'international' aura to the river. Although the Litani disappeared from Israel's grand plans after that country became independent, it once again became 'internationalized' during the 1980s and Israel has been blamed for wanting to steal Arab waters or of actually stealing the waters of the Litani (see, for example, Cooley 1983:2–3; Stauffer 1984:12–13; Naff 1990). The major reason for these accusations is Israel's establishment of a 'security belt' in southern Lebanon which indicates that interest in the Litani still exists (US Army Corps of Engineers 1991). Naff, in his 1990 testimony before the subcommittee on Europe and the Middle East of the US House of Repre sentatives stated: 'In fact, owing to serious shortages, Israel is presently conducting a large-scale operation of trucking water to Israel from the Litani River which lies entirely within sovereign Lebanese territory'. Kolars (personal communication, 5 March 1992), on the other hand, has suggested that, even if Israel is trucking water into its territory, the quantities are insignificant. It is important to note that the Litani and the areas south of the Litani are under the control of UNIFIL forces and these forces have not filed any complaint against Israel in this matter. Any large-scale water pumping from the Litani would be obvious and would be known to the United Nations and other international bodies. We would like to suggest that Israel's interest in southern Lebanon is based on the 'security imperative', not on the 'water imperative'. Moreover, among the other Israeli efforts to pacify southern Lebanon we may also find water transfer from within Israel to villages in southern Lebanon which lack drinking water. These water transfers are very small but reflect the core of Israel's policy of intervention in Lebanon which focuses on security for northern Israel—not on a desire for water.

Arab and Israeli claims have emerged before, especially during and after the appearance of each plan, and certainly during the separate implementation of the plans. The Arab legal standing is based on the following principles.

1 Israel is not a legal sovereign entity because the United Nations did not have the authority to partition Palestine in 1947.
2 The principle of sovereignty does not allow Israel the right to divert the Jordan's water or to use it as if she were the sole owner of the water, thus causing damage to the other co-riparians. The Arab states are opposed not only to the water quota that Israel demands for itself, but to Israeli demands to utilize the water outside the Jordan-Yarmuk drainage basin.
3 The Israel Water Carrier has enhanced Israel's capacity to absorb immigrants to the detriment of Palestinian refugees (Saliba 1968:74–5; Naff and Matson 1984:44). Thus, they consider their opposition to Israeli development plans to be justified.

Israel's response to this is to insist that any agreement on the division of the Jordan-Yarmuk waters will have to be signed by both Israel and the Arab countries. Israel is determined to implement all its plans to develop water resources with or without Arab consent.

Some observations based on the Helsinki and ILC rules may be drawn at this point.

First, the co-riparians of the Jordan-Yarmuk Basin are far removed from any principles of equitable water allocation. No basin-wide integrated planning has received any general support and many of the plans (such as the diversion plan) violate Helsinki Rule V(k) which calls for satisfying the needs of a basin state without causing substantial injury to a co-basin state. Because of the inherent conflict between Israel and Syria, Lebanon and Jordan, multipurpose integrated development of the basin has been prevented and the separate planning and development going on is harmful. In this situation there is no chance that the fundamental principle of equitable and reasonable usage will be able to be applied in this basin (Article 6, ILC Rules).

Second, there is a tendency to violate the basic rule of both the Helsinki Rules and the ILC Rules which treat the drainage basin of a water-course system as one whole unit. There has been an attempt to incorporate rivers from outside the related river basin (such as the Litani) into the development projects but underground resources within the basin have not been included in the plans.

Third, some of the plans postulate water utilization outside the basin itself. This is true for Israel which, eventually, drew Jordan waters to outside the basin. It is curious to note that neither the Helsinki Rules nor the ILC Rules prohibit water transfers outside the basin, but the legal spirit of the two sets of principles calls for satisfying the needs of the population inside the basin first before diverting water outside the basin.

Fourth, it seems that sometime during the 1990s the Arab states will acknowledge Israel as a legal entity but will still not accept its occupation of Arab lands. The core of the conflict is the future of the Palestinians and how the scarce quantities of water are going to be secured for all sides in the conflict.

In the absence of any agreement over water sharing, Israel and the Arab states have proceeded with their separate and often conflicting development plans. The implementations have been accompanied by military clashes and confrontations as well as frequent United Nations intervention. The final outcome was that both Israel and the Arab states had to change their original plans for their water projects. As a result there is great resource wastage in the separate development and water is not managed in the most efficient way in the Jordan-Yarmuk basin (see pages 204–16).

On the lighter side, the sixteen plans presented in Table 3.3 also repeat the classic pattern of behaviour in which water specialists serve different masters, as was the case with the conflicting interests of the British hydrologists who served the Sudan and Egypt. In our case we have American water specialists serving Israel on the one side and Jordan on the other. As a result they have both produced plans which ignore the needs of the other side. Plans which have experimented with genuine integrated development for the whole drainage basin, such as the Unified Plan and the Johnston Plan, have only attracted criticism from both sides.

The Johnston Plan

The Johnston Plan (the 1956 second version) is considered to be the basic formula for the *de facto* division of the Jordan-Yarmuk waters; hence it will be discussed more thoroughly than other plans. Johnston was an American diplomat sent to the Middle East in the early 1950s when Israel and the Arab states were involved in their ‘water war’. Johnston and the American Government were looking for a plan which would be acceptable to both Arabs and Jews and which would eliminate the dangers of war. The main features of the Johnston Plan were as follows:

1 a 400 million m^3 dam and storage to be built on the Maqarin (Yarmuk) for irrigating the Jordan Valley lands;
2 a diversion dam at Addassiyah for the diversion of water (from the Yarmuk) to the East Ghor Canal;
3 the Kinneret to be used as a storage for both the waters of the Jordan River and flood waters of the Yarmuk;
4 a feeder canal from Lake Kinneret to convey water to the East Ghor Canal;

5 a siphon across the Jordan to carry water from the East Ghor Canal to a canal west of the Jordan (Doherty 1965; Stevens 1965; Saliba 1968; Naff and Matson 1984).

Most of the elements of this plan have not been implemented—specifically all those elements which have necessitated regional co-operation between Israel and the Arab states. But the Johnston Plan did receive the acquiescence of both sides to the formula which allotted the following shares of water to the co-riparians.

Lebanon: a total of 35 million m^3 of water (the Hasbani as the source) amounting to 2.7 per cent of the total.

Jordan: a total amount of 720 million m^3 of water of which 100 million m^3 would come from the Jordan River (Lake Kinneret), 377 million m^3 from the Yarmuk and 243 million m^3 from local (east Jordanian) tributaries.

Syria: a total of 132 million m^3 of water of which 90 million m^3 would come from the Yarmuk and 42 million m^3 from the Jordan River (this includes 22 million m^3 from the Jordan and 20 million m^3 from the Banias).

Israel: a total of 400 million m^3 of which 375 million m^3 would come from the Jordan River and 25 million m^3 from the Yarmuk (Doherty 1965; Stevens 1965; Nimrod 1966; Saliba 1968).

Thus the total of 1,287 million m^3 of Jordan-Yarmuk waters was to be divided as follows:

Israel 31.0 per cent
Jordan 56.0 per cent
Syria 10.3 per cent
Lebanon 2.7 per cent

The Arab countries' share here is 69.0 per cent and the Israeli share 31.0 per cent.

Some sources specify Israeli water allotment as 466 million m^3 which constitutes 37 per cent of the total amount (Stevens 1965:15; Naff and Matson 1984). The differences in the estimates pertaining to Israel's share in the drainage basin originate from the Johnston Plan's definition of the Israeli allotment as constituting the residue waters after Syria, Jordan and Lebanon have received their share. Some evaluate this residue at as high as 36 per cent (Beaumont, Blake and Wagstaff 1988).

Throughout the years, Israel has declared, more than once, that she considers the Johnston Plan water allocations to be legally binding. As long as Jordan and Syria draw water from the Jordan and Yarmuk Rivers according to their quotas, Israel has no objections, and this includes Arab plans to construct dams on the Yarmuk as well. The Arab states have refused to accept the Johnston Plan because acceptance would mean the implied recognition of the State of Israel by the Arabs (Saliba 1968:75). The actual water utilization of Israel and Jordan, however, showed that, in the past, the two countries *de facto* adhered to the Johnston Plan water quotas. This is definitely not the case with Syria (as the Syrian utilization of the Yarmuk waters shows, and currently the Israeli use shows the same trend) and the Johnston Plan components for an efficient integrated development of the Jordan-Yarmuk basin have never been implemented.

Arab plans for utilization of the Yarmuk waters: Mukheiba (Khaled Al-Walid Dam) and Maqarin Dams

The most important Arab plan for utilizing the Yarmuk waters is the Great Yarmuk Project whose original plan for the construction of the Mukheiba and Maqarin Dams was presented in the mid-1960s. Mukheiba is downstream from the Maqarin Dam, about 10 km from where the Yarmuk meets the Jordan, and the dam which was planned as part of the Arab diversion plan was to reach a height of 70 m and have a storage capacity of 200 million m^3 (including Jordan's diverted water) and a hydro-power potential of 60,000 kWh (Kally 1965:90; Nimrod 1965:100; Stevens 1965:49). According to Khouri (1981:87) 20 per cent of the work on the dam had been completed in June 1967 when the war between Israel and the Arab states began. However, observations at the site of work have shown that very little of this project was actually carried out. The June 1967 war resulted in the Israeli occupation of the northern bank of the Yarmuk River and all the preparation work on the dam was brought to a halt. Although the Mukheiba Dam is an important component in the Arab water diversion plan Israel has stated that as long as the Mukheiba Dam stores Yarmuk waters within the Arab states' quota, Israel will not object to its construction (*Ma'ariv,* Israel 2 September 1964; *Ma'arachot,* Israel July 1965).

Significantly more important is the Maqarin Dam (al-Wahda) which, in one form or another, has appeared in most of the plans for utilizing the Yarmuk. The Maqarin was envisaged in detail not only in the Bunger Plan (1951) and the Baker-Harza Plan (1955), but also in the Arab Plan (1954) and the Johnston Plan (1956). The original plan called for the construction of a dam at Maqarin, on the Jordan-Syria border, approximately 35 km east of the Jordan-Yarmuk fork. The initial storage capacity according to the Bunger Plan was to be 500 million m^3 and its height 160 m (Khouri 1981:68); the water to be stored in the Maqarin would irrigate 435,000 dunums in Jordan (43,500 ha) and 60,000 dunums (6,000 ha) in Syria but hydro-power production was also another goal for this development.

The Maqarin Dam reappeared in the Baker-Harza Plan of 1954 but in a smaller version in which only 47 million m^3 of water would be stored and Lake Kinneret would serve as the major source of water (Khouri 1981:76). According to both plans a 24 km canal would carry the water stored at the dam to the East Ghor Canal to irrigate areas in the Jordan Valley. Hydro-power electricity to be produced by the dam was estimated to range between 25,000 and 46 million kWh—according to the various plans (Naff and Matson 1984:44).

In 1974 interest in the Maqarin was revived. This time the plan envisaged a dam with a height of 150 m and a storage capacity of 350 million m^3 of the Yarmuk's waters. Jordan received a loan of $1 million from USAID to carry out a feasibility study for the Maqarin (Taubenblatt 1988:47). In the design stage this plan was to have a 170 m high dam with a storage capacity of 486 million m^3, a diversion weir at Addassiyah, diversion of the water of Wadi Raqqad in Syria to the Maqarin reservoir and an electricity generating capacity of 20 MW (Taubenblatt 1988:47). During the late 1970s when the new version of the Marqarin was discussed, it became clear that the plan depended on an agreement being reached between Jordan, Syria and Israel with Israel, in particular, seeking assurance from the USA that the Maqarin would not affect its share of Yarmuk water (Khouri 1981:214; Naff and Matson 1984:46). The US mediation between Syria and Jordan increased in importance during the latter part of the 1970s when relations between these two countries deteriorated (Taubenblatt 1988:47). According to various sources Jordan planned to irrigate 125, 000– 150,000 dunums (12,500–15,000 ha) with the water stored at the Maqarin Dam —but the dam estimated at between $600–800 million was too expensive a venture for Jordan which had to cover most of the cost (Khouri 1981; Naff and Matson 1984).

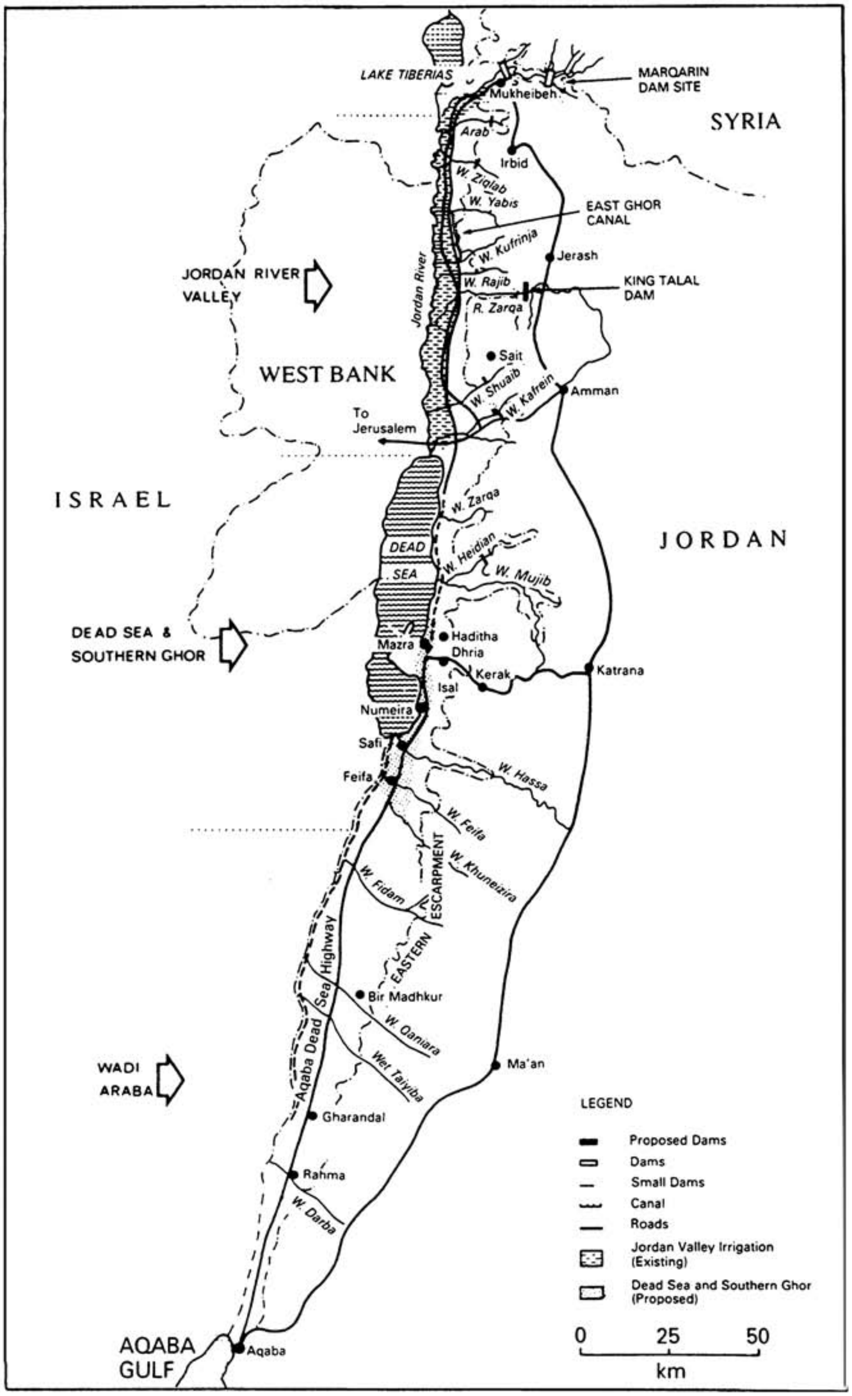
The most recent information on the Maqarin Dam indicates that it has been planned as a smaller dam with a height of 100 m, to have a total storage capacity of 250 million m^3 and a live storage of 150–170 million m^3. The project could provide Jordan an additional 100 million m^3 of water (Al Weshah 1992:130; Kolars 1992a). The cost of this smaller project has been estimated at about $250 million (*Jordan Times* 5 September 1985; *South Al Sha'ab,* Jordan 1 November 1989; *South Al Sha'ab,* Jordan 27 June 1989; *Ha'aretz,* Israel 26 July 1990; US Army Corps of Engineers 1991). Syria will benefit from 75 per cent of the 46 million kWh of electricity generated each year and from a small quantity of irrigation water, and Jordan will convey some of the water to its fast growing cities: Amman and Irbid. Syria and Jordan signed an agreement to construct the newly named Maqarin-Al-Wahda Dam (Unity Dam) on 3 September 1987. Additional points which need to be considered regarding this dam are that Jordan will also pay compensation to Syrian villagers whose lands will be flooded and that the dam may receive World Bank financial aid depending on Israeli consent to the Jordanian-Syrian Agreement (conditional upon an enlarged quota of Yarmuk waters). Israel is not a party to this agreement and objects to its implementation as long as its own riparian rights are not secured. The smaller version of the Al-Wahda Dam no doubt reflects the fact that Syria and Israel have expanded their utilization of Yarmuk waters significantly, leaving smaller water quotas for Jordan. Jordan has such a severe water shortage that it is ready to pay for the whole project and expose itself to the 'goodwill' of Syria—a geopolitical limitation which sovereign nations only reluctantly take upon themselves. The broader geopolitical issues concerning the dam will be discussed on pages 255–9.

The Arab diversion plan

The Arab diversion plan, the most extreme outcome of the Jewish Arab conflict over scarce water resources, also violates many of the Helsinki Rules for the equitable sharing of water resources. The Arab states have always considered the Israeli plan for a National Water Carrier as a step which would rob the Arab states of their share in the Jordan's sources (the Israeli National Carrier and its geopolitical implications are discussed on pages 212–16). The first version of the diversion plan was a 1959 Lebanese plan to divert the Hasbani, one of the three Jordan river sources (totally located in Lebanon) to the Litani River in Lebanon (Nimrod 1966:92; Saliba 1968). The plan also called for the diversion of the Banias waters to the Litani, but diverting both the Hasbani and Banias northward would deprive not only Israel but also Jordan of its share of the headwaters of the Jordan (Khouri 1981:74; Naff and Matson 1984:44). Jordan expressed firm opposition to this diversion plan and in 1960 put forward a counter-proposal in which the waters of the Hasbani and Banias would be diverted eastwards, via a long, open canal across southwestern Syria, into the Wadi Raqqad and then to the Yarmuk. With a storage dam at Nahila, Syria would hold these diverted waters, while the joint Syrian-Jordanian-Yarmuk Project would be fully implemented, including the construction of the Maqarin Dam. There is evidence from some sources that between 1960 and 1964 the Arab states were reluctant to implement their plans to divert the Jordan's sources because the USA had warned them that it would fully support Israel if the latter retaliated militarily in response to such an Arab diversion plan (Nimrod 1966: 97).

The Arab summit of 1964, however, decided both to implement the Hasbani-Banias diversion scheme and raise the level of the newly built East Ghor Canal in order to prepare it for receiving the new supplies of water that would reach the valley from the diverted Jordan headwaters in Lebanon and Syria (Khouri 1981: 74; Inbar and Maos 1984:50). The final diversion plan included the following: a diversion structure on the Hasbani which would divert the Hasbani water by gravity to the sources of the Banias; the Wazzani Springs, another source of the Hasbani, would also be diverted to the diversion canal and some of the diverted Wazzani Springs water would be divided between Lebanon (10 million m^3) and Syria (5 million m^3). The planned Hasbani-Banias diversion canal was to have been 70 km long, and would have had to overcome heights of more than 320 m a very short distance from the Israeli border (Kally 1965:137; Saliba 1968; Inbar and Maos 1984:50).

The planned alignment had many more geographical and hydrological problems. First, the permeability of fills or dams made from local rock in the Hasbani basin would have required expensive lining, and without the construction of dams they would not have been adequate to hold the flood waters of the Hasbani



Map 3.3 Water projects (planned and realized) and irrigation areas in Jordan

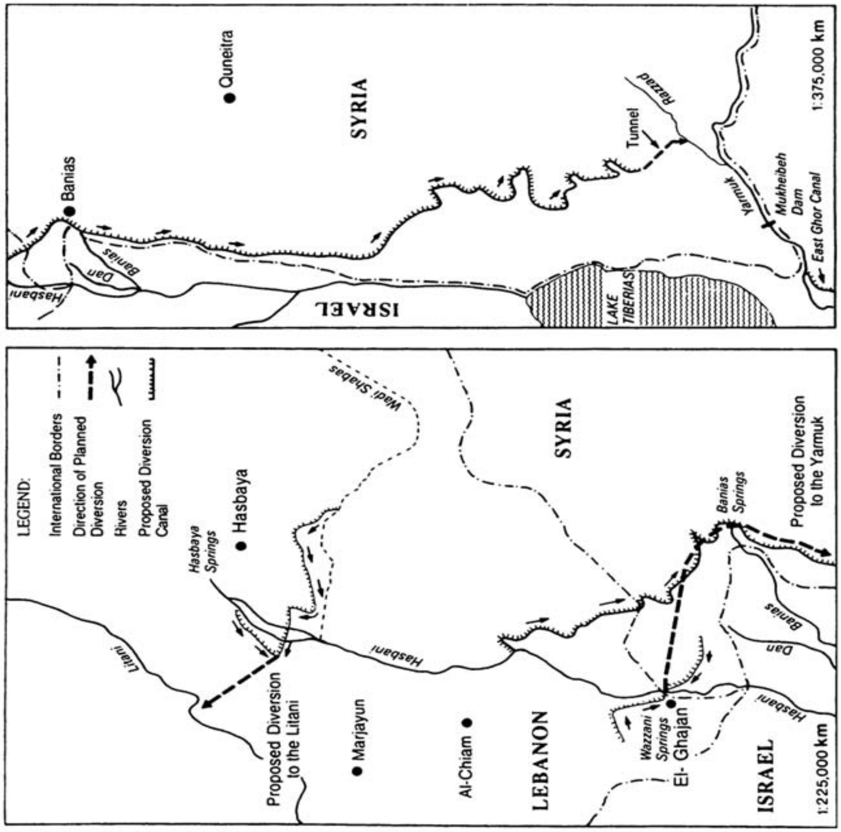
(Stevens 1965:64). As for the Banias, Stevens also pointed out that there were no natural sites suitable for a big dam or for building canals deep enough to carry seasonal flood waters from Israel towards Jordan. A second disadvantage of the proposed diversion was that it would have had to bridge steep gorges using siphons that would have necessitated digging a tunnel to the Raqqad branch of the Yarmuk. The diverted waters were to have flowed into the Mukheiba Dam, a dam nearer than the proposed Maqarin and topographically located at a lower more convenient site for the collection of the diverted waters (Kally 1965: 136). The carrying capacity of the planned diversion canal was to have been 17 million m^3 per month or 100–125 million m^3 per year. Had this plan been implemented, it would have deprived Israel of 33–35 per cent of the water it contemplated withdrawing through the Israeli National Water Carrier (Kally 1965:139; Khouri 1981:86; Naff and Matson 1984:45).

The above detailed account illuminates the only aim of the diversion plan which was to implement the following three major political goals as set out by Arab newspapers: first, to prevent any Arab waters from reaching Israeli territory; second, to push Israel (by diverting the headwaters of the Jordan) into military action, which would be responded to by a massive Arab military campaign; third, to implement regional Arab water projects which would be well within the regional water plans which were supposed to have included Israel as well as the Arab states (but without publicly admitting to any recognition of Israeli needs) (Nimrod 1966:103). The Arab diversion plan also showed that there was almost no agricultural potential waiting to be served by the diverted irrigation waters because Jordan was not at a stage where she could take advantage of the surplus waters. Technically and economically the cost of the plan was very high but it was not completely unfeasible (Nimrod 1966:104–5; Inbar and Maos 1984:50). It was the inter-Arab political struggle for hegemony, which took place at the end of the 1950s and the beginning of the 1960s which formed the background to the Arab diversion plan. The Israeli National Carrier had become a unifying factor for the Arab states—a symbol of the Arab states' efforts to prevent Israel from developing its agricultural and settlement potential in the Negev. The inter-Arab rivalry to have the honour of being recognized as best defender of Arab interests gave the diversion plan clout far beyond its inherent fundamental merits. By initiating military action, Israel halted the work of Syrian heavy equipment on the diversion canal three times (Nimrod 1966; Naff and Matson 1984:108). The final blow to the diversion plan was the 1967 War which put Israel in territorial control of part of the proposed alignment for the diversion canal and improved Israel's hydrostrategic position since the occupation of the Golan Heights made it impossible for the Arab states to divert the Jordan headwaters. The 1967 ceasefire lines gave Israel control of half the length of the Yarmuk River (between Israel and Jordan), compared with the 10 km which she had controlled before the war (Naff and Matson 1984:44).

The Helsinki Rules which stipulate equitable utilization of international river basins advocate principles such as 'the avoidance of unnecessary waste in the utilization of waters of the basin' (Article VI) and 'the degree to which the needs of a basin state may be satisfied without causing substantial injury to a co-basin state' (Article V(k)). These two principles were clearly being violated by the above diversion plan; but Israel was also in violation by virtue of the wrong unilateral implementation of the plan to carry Jordan waters to irrigate areas outside the boundaries of the drainage basin, a project which triggered angry calls for action such as the diversion plan (Khouri 1981:73).

Past utilization of the Jordan-Yarmuk River system

The utilization of the water resources of the Jordan and Yarmuk has expanded rapidly over the last 30 years (1960–90) with major water projects, proposed and planned during the 1950s, being implemented in the mid-1960s in Israel and Jordan (the Israeli National Water Carrier and Jordan East Ghor Canal). Table 3.5



Map 3.4 The Arab diversion plan

points to the gradual expansion of water usage for irrigation, the most important use of water in the Middle East. Jordan's farming economy was totally dependent on rain-fed farming in the 1930s and irrigation methods in their simplest forms remained common until the 1950s. Syria's water projects, such as

Table 3.5 Expansion of irrigation in the co-basin states, 1948–9 to 1975

Country		*Irrigation water*		
1948–9 (billion m^3)	*1964–5 (billion m^3)*	*1975 (billion m^3)*	*1959–90 (billion m^3)*	
Lebanon	–	0.196	0.647	0.669
Syria	1.2	2.3	6.0	10.0
Israel	0.300	0.568	1.33	1.2
Jordan	Less than 0.100	0.228	0.375	0.520–0.549[a]

Sources: Beaumont 1985:6–7; Nimrod 1966; Cressey 1960:483; Saliba 1968:44; Gischler 1979: 100–15; *al-Rai* 17 December 1990; Zaslavski 15 April 1991; Shahin 1989; Baasari and Ryan 1986; US Army Corps of Engineers 1991

Note:

Country		*Irrigation water*	
1948–9 (billion m^3)	*1964–5 (billion m^3)*	*1975 (billion m^3)*	*1959–90 (billion m^3)*

[a]According to Sexton (1990) water demand for irrigation amounted to 0.639 billion m^3 in 1987.

the Ghab reclamation project and the utilization of the Euphrates and Khabour, were implemented in the 1960s and early 1970s.

The Litani River in Southern Lebanon is mainly used for the production of hydro power by utilizing the water of Lake Karoun and only a small amount of water is used to irrigate lands in the Beqa'a and Nabatiah regions (Kolars, in press). According to Lebanese plans 360,000 dunums (36,000 ha) were to be irrigated from surplus water stored at Lake Karoun but, in fact, only 100 million m^3 of Litani waters were used for irrigation before the 1975–6 civil war in Lebanon.

The co-riparians to be Jordan-Yarmuk sources tripled their water usage between the end of the 1940s and mid- 1970s, but Syria and Lebanon mostly used sources other than the Jordan-Yarmuk waters. Israel and Jordan both used underground waters in addition to the Jordan-Kinneret system.

Water projects in Lebanon, Syria, Israel and Jordan

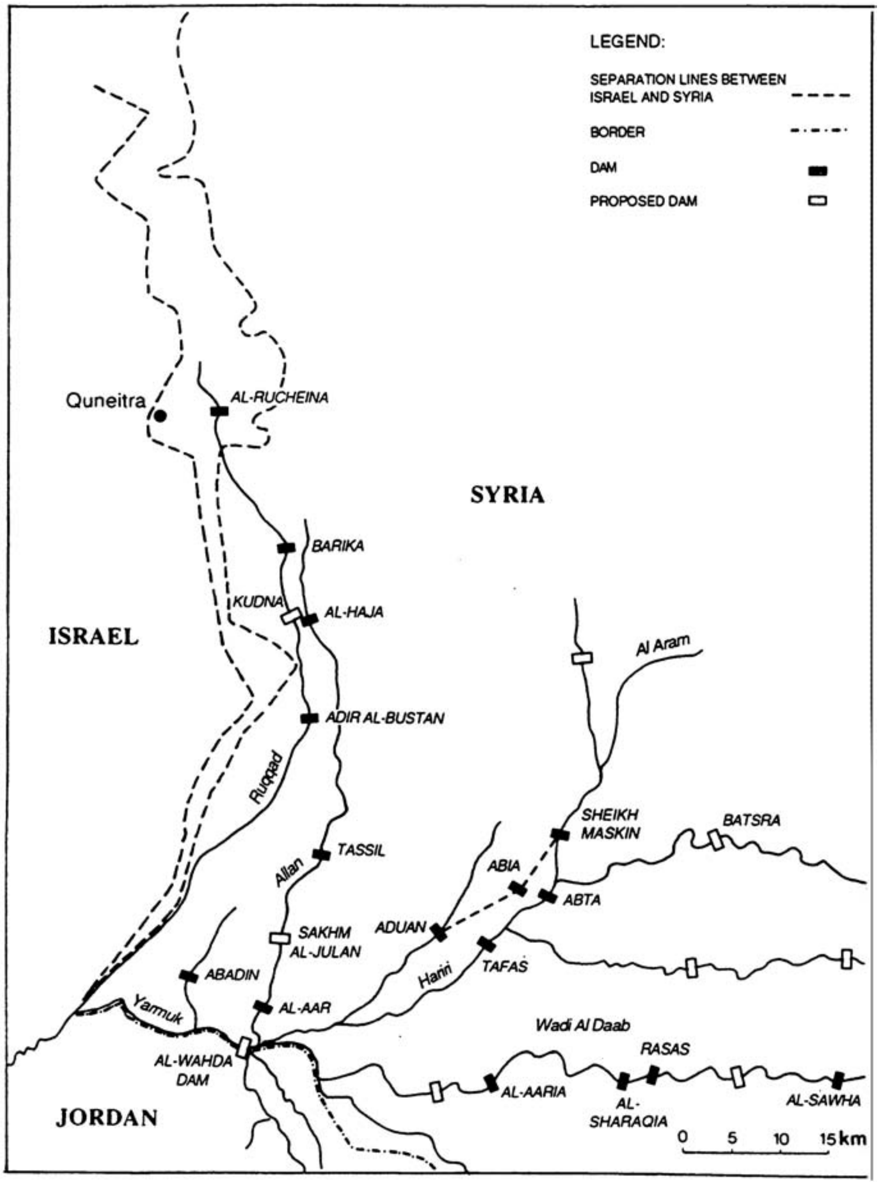
Despite the fact that all the co-riparians have many projects on other rivers and additional water sources, such as underground sources, this section deals with water projects only on the Jordan-Yarmuk system.

Lebanon

Lebanon, a country well endowed with precipitation, is a co-riparian to the Jordan through the Hasbani tributary. Apart from local use being made of the Hasbani and its source, especially the Wazzani Springs, it provides less than 25 per cent of the total water discharge of the Jordan River. Stork (1983) has charged Israel with exploiting the Hasbani for its own benefit since 1978 by setting up pumps and pipes on the Lebanese side to increase the rate of flow of water to Israel (Stork 1983:24). Stork relies solely on Arab sources and there is no other source to confirm this information, but a visit to the site of the Wazzani Springs (now under Israeli control) does reveal the existence of a small water pump serving the local Arab village of El-Ghajar (1,450 residents) alone. The upper sources of the Hasbani (the Wazzani Springs) near Hasbaya are also used by the local Lebanese Druze population. It is only the water which remains after this which flows into Israel.

Syria

According to the 1956 Johnston Agreement (with which Syria has never expressed any accord) Syria was allocated 90 million m^3 of the Yarmuk waters, 20 million m^3 from the Banias (the Jordan River tributary which was located in Syrian territory until 1967) and 22 million m^3 of water for irrigation of the Buteiha Valley on the northeastern side of Lake Kinneret—currently under Israeli control. Until the early 1970s, Syria was already using some 50–60 million m^3 of Yarmuk waters in its upper portion—the tributary Mazarib, in the District of Dara'a. Towards the end of the 1960s, however, Syria, because of both political and economic motivations, decided to expand the agricultural potential of the Syrian Golan. From a political and military point of view Syria was interested in creating a dense settlement area opposite the Israeli-occupied Golan Heights, and from an economic point of view Syria had to increase its food production in order to meet



Map 3.5 Water projects in the Upper Yarmuk, Syria

growing demands. The development of the Syrian Golan made the settlement of some 70,000 people displaced by Israel's occupation of the Golan in the 1967 War possible, and also accommodated rapid local population growth.

Data for 1990, however, point to the fact that Syria only irrigated 15,000 ha in the Dara'a district and 21, 000 ha in the Quneitra district (*Syria Statistical Abstracts* 1990). If Syria is using between 10,000 and 20, 000 m^3 of water to

Table 3.6 Water projects in the Upper Yarmuk system

Tributary	*Tributary annual discharge (million m^3)*	*Dam or barrage*	*Storage capacity (million m^3)*	*Time of completion (Five-year plan)*
Raqqad	84.6	(1) Ruchina	1.1	1975–9
	(2) Barika	1.8	1983–6	
(3) A'dir Al-Bustan	12.0	1983–6		
Allan	30.7	(4) Al-Haja	0.85	1980–2
(5) Tassil	6.60	1980–2		
(6) Al-Aar	5.50			
Al-Aram (Al-Harir)	44.4	(7) Sheikh-Maskin	15.0	1980–2
	(8) Greater Abta	3.0	1975–9	
		(9) Smaller Abta	1.5	1975–9
	(10) Aduan(Yabas)	5.68	1980–2	
	(11) Tafas	3.10	1980–2	
Wadi Al-Daab	14.5	(12) Al-Sawha	1.0	1980s
(Al-Sawha)		(13) Rasas	3.5	1980s
	(14) Al'-Aaria		1980s	
	Al'-Sharaqia	5.5	1980s	
Wadi Al-Zidi	21.3	(15) Al-Mataya (Great Butam)	1.0	1980s
	(16) Al-In	1.15	1980s	
	(17) Jeraz (Khubran)	1.95	1980s	
	(18) Sahia Al-Khadir	8.75	1980s	
	(19) East Dara'a	15.00	1975–9	
Total			92.48	

Sources: al-Ba'ath, Syria 4 December 1987, 9 December 1987; Supplement to the Jordan-Syrian Agreement for the use of the Yarmuk Waters, September 1987

irrigate 1 ha, she is only consuming 15–30 million m^3 of water in Dara'a and 21.0–42.0 million m^3 of water in the Quneitra district. This quantity of 72 million m^3 is incompatible with current estimates of Syrian water consumption from the Upper Yarmuk which are 50–70 million m^3 in the Mazarib area (Dara'a district) and 90–100 million in the middle and lower Yarmuk sections (Quneitra district) (*al-Ba'ath,* Syria 4 December 1987, 9 December 1987). According to various sources, including Jordanians, the Syrians' utilization of Yarmuk's water ranges between 90 and 250 million m^3 (Kolars 1992a).

Table 3.6 and Map 3.5 present as accurately as possible (in the light of the partial and contradictory data) the current water projects that Syria has developed up to 1991. In addition to the existing dams, Syria plans to build three dams on the Raqqad which will store 36 million m^3 and two more dams on the Allan which will store an additional 26 million m^3 (*al-Ba'ath* Syria 4 December 1987). Altogether, Syria has accumulated a storage capacity of 93 million m^3 of water without the Unity Dam and by the year 2000 when all her projects are to be completed Syria will have a total storage capacity of 150 million m^3 of water. In this book we adopt an amount of 200 million m^3 as the current Syrian water utilization from the Yarmuk, and 20 million m^3 of water returns to the Yarmuk as return irrigation flow. If and when Syria completes all its development projects for the Yarmuk, an amount of only 220–295 million m^3 (including return flows) will remain in the Yarmuk for the combined usage of Israel and Jordan. In addition, evaporation losses (of 5–10 million m^3) will reduce the Yarmuk flow to only 210–285 million m^3 without taking the construction of the Maqarin (Unity) Dam into consideration. This potential situation has alarmed Jordan and has led to an agreement being signed with Syria which restricts syrian utilization of the Yarmuk to a ceiling of no more than 170 million m^3. Jordan is hoping to persuade Syria to adhere to the agreement on this amount of water by making a trade-off, exchanging much needed electricity for Syria with much needed water for Jordan. The focus of the exchange is the Unity (Al-Wahda) Dam or, according to its old name, the Maqarin Dam.

Israeli water projects on the Jordan and Yarmuk

The most important water project in Israel is the National Water Carrier, an idea first formed by Lowdermilk in 1944 and developed by Blass, Hays and others (Kally 1965:19–26; Karmon 1971:122). Originally Israel planned to divert water to the canal directly from a spot near the Jordan's sources but, after encounters with Syria which was opposed to the Israeli plan, the diversion site was shifted to Jisr-Banat-Yaqub (Benot-Yaakov)—an area legally declared to be a demilitarized zone between Israel and Syria by the ceasefire agreements of 1949 (Nimrod 1966:28–9; Naff and Matson 1984:38). Finally, Israel shifted the entry site of the National Carrier to the northwest corner of the Kinneret after Syrian protests and a Soviet veto in the UN Security Council (on 22 January 1954). The change in the original entrance of the Water Carrier (brought on by the geopolitical settling) has had two very significant outcomes. First, the National Water Carrier uses Lake Kinneret (Tiberias) waters which have a higher content of chlorides than the sweet water of the Jordan sources at the original site (Beaumont, Blake and Wagstaff 1988:103). Second, the diversion site of the National Water Carrier at Jisr Banat-Yaqub (Benot-Yaakov) is above Lake Tiberias and it is designed so that the Jordan waters can produce electric power in the process of descent (Garbell 1965: 30). The intake and pumping of water from Eshed Kinrot −213 m below sea level consumes 8 per cent of Israel's annual electricity production (Naff and Matson 1984; Gal 1987:9; Pearce 1991: 37). This is done in order to pump 6.75 m^3/s and lift it 270 m to a penstock (from −212m below sea level to +44 m, the height of the Jordan Canal). The penstock feeds the water into an open canal (the Jordan Canal, 16 km long) which conveys the water to the operational reservoir of Zalmon. Along the route the water traverses two deep wadis through crossover pipelines known as inverted siphons which let it fall down one side of the wadi as a result of hydrostatic pressure (Garbell 1965:31). The first inverted siphon is at Amud where water is raised from −110 m to a height of +55 m. The second siphon is at Zalmon where the water is raised from +37 m above sea level to 152 m above sea level. From here the water is conveyed to the Ilabun Tunnel—the highest point in the National Water Carrier. The Ilabun Tunnel carries the water to the Beit Netofah Canal (together 17.5 km) to open lakes where the water passes through a purification process. The total length of the National Water Carrier from Lake Kinneret to Beit Netofah is 35 km, and from Beit Netofah to Rosh-Haayin the water carrier is a closed pipe 77 km long buried underground. At Rosh-Haayin, the National Water Carrier is connected to the Yarqon-Negev pipe system which was completed in 1955. The National Water Carrier is also connected to other regional water systems such as that of the lower western Galilee (the Galilee-Qishon Project) (see Map 3.6) and to the major underground water sources. The total length of the Israeli National Water Carrier including open canals, tunnels and pipes is 200 km. It was planned to have a capacity of 320 million m^3 of water—well within the water allocation provided by the Johnston Plan (Garbell 1965:31; Naff and Matson 1983:213). Water conveyance by the carrier gradually increased from 195 million m^3 in 1965 to 381 million m^3 in 1970 and averaged 350 million m^3 during the decade of 1970–80 (Karmon 1971:123; Inbar and Maos 1984:49; Naff and Matson 1984). In the 1980s the National Water

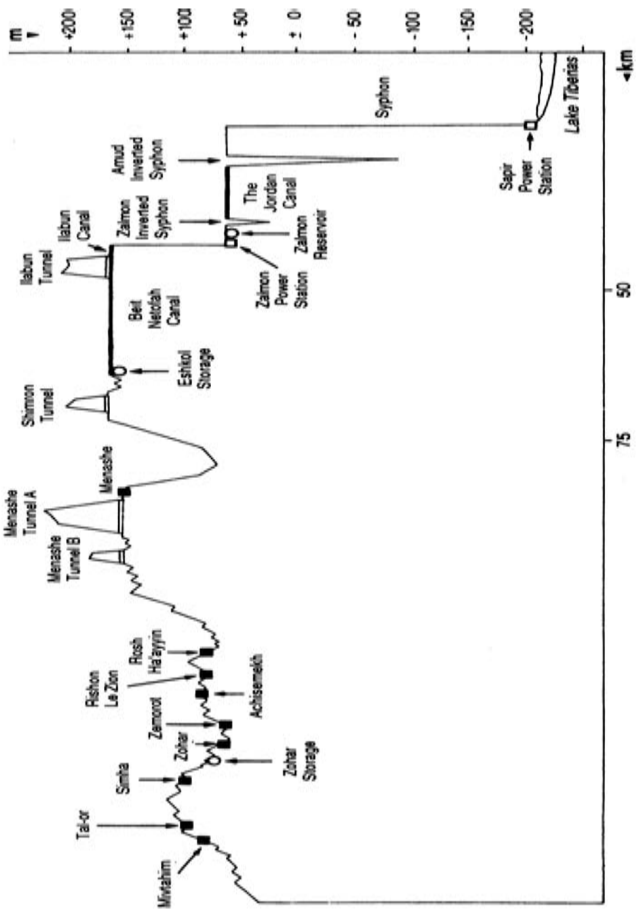


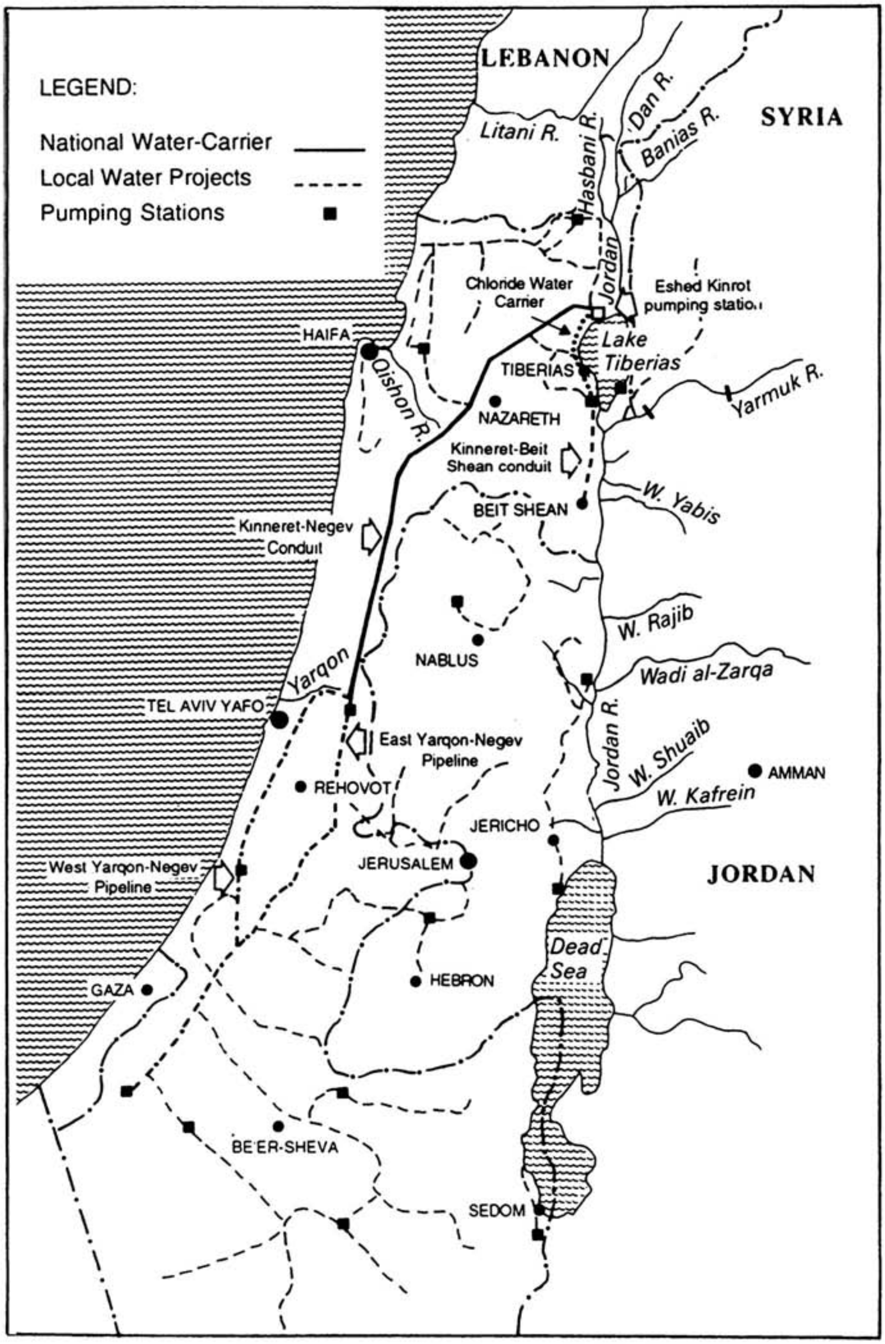
Figure 3.1 Israeli National Water Carrier

Carrier was conveying 420–450 million m^3 but in the last two years (1989–91) the water level of the Kinneret reached a low of –212 m; pumping water from the Kinneret was reduced to 200 million m^3 and subsequently ceased since the height of –213 m below sea level for Lake Kinneret has been determined as an administrative 'red line'.

The operational capacity of the Kinneret for water exploitation is very limited: within a relative height of –4 m it comprises only 650 million m^3 of water. Thus, a reduction in the water level of Lake Kinneret by 1 m is a reduction of 170 million m^3 of water. The efficiency of the National Water Carrier has been hampered by incompetent, near-sighted management of the Lake Kinneret water and this has allowed the development of an accumulated deficit of 1.0 billion m^3 water in the Kinneret and its basin (Orthenberg interview, 15 May 1991); but the severe drought is only a secondary reason for the water scarcity in the Jordan basin. Recent climatic developments have shown that 1992 was a year of abundant rainfall which filled up the Kinneret and compensated for the previous droughts.

Israel's use of the Yarmuk's water

According to the Johnston Plan, and by virtue of its actual usage of the Yarmuk's waters, Israel is recognized as a *de facto* co-riparian with rights to a share in the Yarmuk's waters, up to a quota of 25 million m^3 of 'summer waters'. During the winter time, Israel has been able to use all the flood water which



Map 3.6 Water projects in Israel

both Syria and Jordan have not been able to use. Israel has used the Yarmuk waters for both irrigation of the

Yarmuk Triangle and also to pump the water into the Kinnereth.

During the 1960s Israel demanded a quota of 40 million m^3 of the Yarmuk's summer waters—a demand unacceptable to Jordan and Syria. After 1967, and especially between 1977 and 1980 when Jordan and Syria held talks on the future construction of the Maqarin Dam, Israel insisted on an enlarged quota of 140–150 million m^3 of Yarmuk water in order to supply water to the West Bank (an area counted as part of the original territories to be irrigated by the Jordanian water quota); Jordan refused this Israeli demand, but agreed to a smaller quota of 25 million m^3. According to some sources, Israel actually pumped some 100 million m^3 of the Yarmuk's waters during the second half of the 1970s (Naff and Matson 1984; Kolars 1992a). According to Israeli sources, Israel was only pumping 70–80 million m^3 of the Yarmuk's waters during the 1980s (*Ha'aretz,* Israel 26 July 1990); and this consisted of 25 million m^3 of summer flow and 45 million m^3 of winter flow (Saliba 1968:106; *Ha'aretz,* Israel 14 September 1990). In 1989–90 some 45 million m^3 of Yarmuk water was also used in the Kinneret Basin.

Syria does not acknowledge any riparian rights for Israel. Jordan is ready to acknowledge Israeli riparian rights, perhaps even at the expense of the Jordanian quota, but only at a level much lower than the quota which Israel has demanded (*Newsweek* 12 February 1990). It seems that Israel and Jordan do have an agreement on the Israeli summer quota of 25 million m^3 of water, but Jordan does not agree to any acknowledged allocation of winter waters to Israel. In the summer of 1990 Israeli newspapers reported that Israel was willing to compromise and accept a winter water quota of only 35–50 billion m^3 (*Ha'aretz,* Israel 26 July 1990). At the end of 1990 Jordan claimed that both Syria and Israel were to blame for the deterioration of its water supply from the Yarmuk. Elias Salame, head of the Water Research Institute of the Jordanian University of Amman, has claimed that Syria is withdrawing 170 million m^3 of the Yarmuk's waters whereas Israel is pumping 100 million m^3 of water from the Yarmuk and has pessimistically estimated that neither Syria nor Israel will be willing to give up their *de facto* withdrawals from the Yarmuk (*Yediot Aharonot,* Israel 2 October 1990). Jordanian sources have specified that, in 1992, Syria was already using 39 per cent (190–195 million m^3) of the Yarmuk whereas Israel was using 26 per cent (110 million m^3) of the Yarmuk, leaving only 35 per cent of the Yarmuk flow for Jordan (Ghezawi 1992). Thus Jordanian actual water intake from the Yarmuk river is only 100 million m^3 (Al-Weshah 1992:126).

However, it should be noted that the present grave water situation which is an outcome of the continuing drought will probably not allow for a long period of negotiations.

Water projects in the Kingdom of Jordan

The most important water project in Jordan is the East Ghor Canal and its irrigation network. The East Ghor Project was part of the more ambitious plan of the Great Yarmuk Project, initiated in 1957–8, approximately at the same period when Israel began to plan its National Water Carrier. The Plan of the Great Yarmuk Project originally included two dams on the Yarmuk (Mukheiba and Maqarin) and a West Ghor Canal, 47 km long, with a siphon across the Jordan River near Wadi Faria to connect it with the East Ghor Canal. The Plan included seven dams whose purpose was to utilize the seasonal floods of the eastern tributaries, pumping stations and a network of canals to convey the water to the fields (Naff and Matson 1984:43). The component of an East Ghor Canal appeared in many of the integrated plans for the Jordan-Yarmuk River system such as the Baker-Harza, Ionides, Bunger, MacDonald and other plans.

Eventually the East Ghor Canal or, according to its current name, the King Abdullah Canal, was implemented as a pragmatic and partial solution to the dictates of the geopolitical situation in which the co-riparians could not agree on an efficient and equitable division of the Jordan-Yarmuk waters. Jordan, however, has also obtained Syria's agreement to the diversion of the Yarmuk's water into the East Ghor Canal (Dees 1959: Khouri 1981:84; Canaan 1990: 19).

The East Ghor Canal is a concrete lined gravity canal 96 km long fed by a 1 km diversion tunnel running underneath the mountain between the Yarmuk River and the village of Addassiya. The canal, when planned, aimed at irrigating a total of 117,000 dunums (11,700 ha) and at discharging 20 m^3/s or 300 million m^3 (200 million m^3 according to *South Al-Sha'ab,* Jordan 1 November 1989) per year (Kally 1965: 133; Salik 1988:105). The East Ghor Canal was originally designed to be fed by a gravity canal from Lake Tiberias (Kinneret) if international politics were ever to favour regional water sharing. By 1961 the first section of the canal was completed after being financed by the American Government. Section Two, also financed by the American Government, and Section Three began to function in April 1964 and June 1966. Between 1975 and 1978, an 18 km extension of the East Ghor Canal was built. By 1990 the Canal was extended to 100 km with service roads serving all the irrigable areas in the Jordan Valley (Canaan 1990:19) (see Map 3.6). The East Ghor Canal is similar to the Israeli National Water Carrier in that it integrates many of the local water projects into one network and serves both agricultural and domestic uses. It is different from the Israeli water carrier in that the cost of water conveyance is low —since water is carried by gravity. The water sources of the East Ghor Canal have been specified as follows: 93 million m^3 of Yarmuk summer flow, 210 million m^3 of water floods to be stored at the Maqarin and 12 million m^3 from the southern tributaries which flow within Jordanian territory; all these sources are well within its water allocation in the Yarmuk (Nimrod 1966:83). The East Ghor Canal discharge capacity could eventually reach 300 million m^3 of water (Salik 1988:105). In reality the canal supplied 76 million m^3 of water in 1974, 94 million m^3 in 1978, 101 million m^3 in 1980, 144.3 million m^3 in 1988 but only 95.5 million m^3 in 1991 (Canaan 1990; Al-Weshah 1992:127; Chezawi 1992).

It should be noted that the East Ghor Canal project was accompanied by an extensive land reform programme according to which no individual landowner could own less than 3 ha (30 dunums) or more than 20 ha (200 dunums) of land. In addition soil conservation and modern farming methods have been applied to the newly cultivated land (Khouri 1981). Irrigated land has expanded from 10,000 ha in 1974 to 13,800 ha in 1980. More important, the number of crops per year has increased from 1.06 crops a year to 1.58 crops a year (Kally 1986: 30–1). Current utilization of Yarmuk waters in Jordan is about 100 million m^3 and some 32,000 ha are being irrigated in the Jordan Valley (*South Al-Sha'ab,* Jordan 6 June 1989; Canaan 1990:19; Chezawi 1992).

As most of the land is irrigated by surface irrigation whose efficiency is only 46 per cent, water losses are high. The use of drip irrigation would save some 180 million m^3 out of the combined amount of water that is presently used in the Jordan Valley which is 340 million m^3 (Chezawi 1992). Another source estimated irrigation efficiency in Jordan as higher and ranging between 60 and 70 per cent (Al-Weshah 1992:130, quoting Bani-Hani 1992).

Some of the water conveyed by the East Ghor Canal is destined for the growing needs of the urban centres, especially Amman, and the Ghor-Amman Project will discharge an annual quantity of 45 million m^3 of the Yarmuk's waters to Amman. This quantity is not enough for the needs of the AmmanZarqa metropolitan area and Jordan plans to divert at least 50 million m^3 more of the Yarmuk waters from the Al-Wahda Dam to the capital city (*South Al-Sha'ab,* Jordan 6 June 1989).

The other important water projects use the flood waters of the Jordan River eastern tributaries where Jordan has developed a storage capacity of 115–120 million m^3 (Canaan 1990; Chezawi 1992) (Table 3.7). This is a very significant amount and Jordan is at present continuing in its efforts to store all flood waters in the eastern tributaries. The following list presents the dams and small earth dams planned for the near future (Canaan 1990:20):

Unity Dam (Maqarin)	230.0 million m^3
Karamhe Dam	55.0 million m^3
Kufrinja Dam	7.0 million m^3
Yabis Dam	7.0 million m^3
Raising Kafrein Dam	2.0 million m^3
Regulating Zarqa	3.0 million m^3

Owing to a rain shortfall over a number of years the water in the above storages was drastically reduced and the total amount stored in the King Talal Dam in February 1990 was only 34 million m^3 instead of the usual 78 million m^3; the smaller dams on Ziglab, Arab, Kafrein and Shueib stored only 5.3 million m^3 out of a storage capacity of 10 million m^3 (*al-Rai,* Jordan 11 February 1990). The total amount of water stored in all the dams in 1990 was only 65 million m^3 (Chezawi 1992). The Talal Dam also receives reclaimed sewage water from Amman which, mixed with flood waters, is used for irrigation. In sum, despite all

Table 3.7 Dams and waterworks on the eastern tributaries of the Jordan River

Rivers	*Dams*	*Features and storage capacity*	*Purpose of dams*
Zarqa River	King Talal Dam	102.5 m high; storage capacity 86 million m^3; live storage 78 million m^3	Irrigation of 48,000 dunums (4,800 ha) and production of 2.1 mW of electricity
Ziglab River	Ziglab Dam	Storage capacity 4.3 million m^3	Irrigation; drinking water
Wadi Arab	Wadi Arab Dam	63.5 m high; total storage 20 million m^3	Irrigation of 12,000 dunums (1,200 ha); in the future will irrigate 7,000 ha
Wadi Kafrein	Kafrein Dam	Storage of 3.8 million m^3	Water from Wadi Kafrein, Wadi Hisban will irrigate 4,000 ha
Wadi Shueib	Shueib Dam	Storage capacity of 2.5 million m^3	
Al-Jurum Kafr Naja Rajib	Earth-fill dams	5 million m^3 of waters	Irrigation; in the future 24,410 dunums (2,441 ha will be irrigated)

Sources: Salik 1988:105–6; *al-Ba'ath,* Syria 4 December 1987; *South Al-Sha'ab,* Jordan 4 December 1987, 27 June 1989,1 November 1989; *al-Rai,* Jordan 11 February 1990

its efforts to stretch its water sources to their maximum, Jordan has a severe shortage of water which is the outcome of both an enormous population growth and drought.

The future water balance of the Yarmuk

Figure 3.2 portrays the water situation within the Yarmuk basin for the year 2000, based on the following premises.

1 The Maqarin Dam will be constructed, and will have a total storage capacity of 250 million m^3 and available water of 150–170 million m^3.
2 Syrian water withdrawals will be 200 million m^3.
3 Israeli water withdrawal will be 25 million m^3.
4 Jordanian water withdrawal will be 135 million m^3.

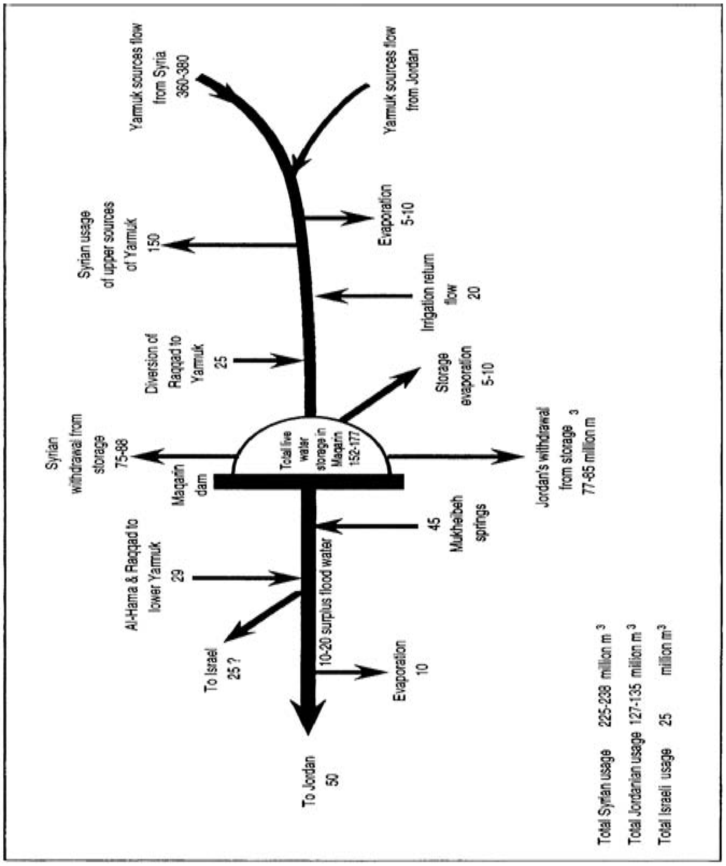


Figure 3.2 The future water budget of the Yarmuk

5 Jordan and Syria will have equal shares in the water storage of the Maqarin (between 75 and 88 million m^3 to each).

The Maqarin Dam storage water, if divided equally, will barely achieve the Jordanian water allocation. Only if Syria is satisfied with less water and/or Israel is ready to give up her water allocation will Jordan be able to expand its water withdrawal from the Yarmuk from 100–135 million m^3 to 170–180 million m^3. Any surplus water above the average flow of 400–450 million m^3 at the sources (1992, for example, was an above-average year) will also be diverted to Jordan. On the other hand, a below-average year may have a severely deteriorating effect on Jordan's water supply.

Water projects in the Jordan-Yarmuk Basin and the Helsinki and ILC Rules

The Jordan-Yarmuk drainage basin is shared by co-riparians who have been, and continue to be, involved in war and constant conflict. To begin with, the water resources to be shared are very limited and the recent droughts have exacerbated the situation, making water resources scarcer at a time when water demand has grown. The present pattern of water utilization and the various water projects which were developed separately by Syria, Jordan and Israel have aggravated the water balance of the Jordan-Yarmuk system. Syria and Israel have expanded their usage without taking the needs of Jordan into consideration at all.

Syria, which currently is utilizing some 200 million m^3 of the Yarmuk's waters, ignores both Jordan's needs and co-riparian rights, thus violating the Helsinki Rules stipulated in Chapter 2, Articles V(c), V(d), V (e) and V(f). These articles stress the importance of Jordan's climate, past and present utilization of water, the economic and social needs of Jordan and the population dependent on the water of the Yarmuk. Syria does not acknowledge any Israeli co-riparian rights to the Jordan or the Yarmuk at all and is therefore in violation of the spirit of the Helsinki and ILC Rules which call for equity as a leading principle of water sharing. Syria and Jordan took an active part in the diversion plan which aimed at stopping the natural flow of the Jordan River to Israel, and at least one source states that Syria still intends to divert the Hasbani into its territory (US Army Corps of Engineers 1991). Israel violates the Helsinki Rules by using the Yarmuk to such an extent that it negatively affects the water supply of Jordan. Moreover, Israel has demanded an enlargement of its water quota from the Yarmuk for the purpose of diverting these waters for the use of the Palestinian population of the West Bank. However, no steps have yet been taken to advance this intention. Israel also violates the Helsinki and ILC Rules which stress that the water of the Jordan-Yarmuk should be first used for the satisfaction of the needs of the population inside the basin before it is transferred outside the basin. Israel has not succeeded in obtaining an agreement from her co-riparians for the transferral of water from Lake Kinneret (Tiberias) to the Negev. Only Jordan, by accepting the Johnston Plan, has apparently agreed to Israel's water utilization of her quota outside the Jordan-Yarmuk basin. As Israel's legal status as a state has been contested by her Arab co-riparians, it is impossible to apply legal standards of behaviour to the water sector alone. In conclusion, it is probably safe to assume that the present patterns of utilization within the Jordan-Yarmuk will reinforce the possibility of conflict rather than reducing it.

WATER SUPPLY AND DEMAND FOR JORDAN-YARMUK WATERS

Water demand and supply in Syria

Water supply

Although 50–60 per cent of Syrian territory is arid and semi-arid, the country is relatively well endowed with surface and underground water sources (Karmon 1968:150; Gischler 1979:113). As stated before, the total surface water supply of Syria is 34.2 billion m^3. To this one must add underground water sources of 1.78–2.67 billion m^3 to arrive at the total water supply (Gischler 1979; *Nad'al al-Falahin,* Syria 19 August 1981; Shahin 1989). Thus, the total water supply in Syria is 35.9–36.8 billion m^3 which should be more than sufficient to provide for Syrian needs. However, an outcome of the overpumping of groundwater resources has produced a net loss of about 20 per cent in the amount of irrigated land. According to Allan (1987:31), the increased rate of use of underground waters for irrigation which took place in the 1970s and 1980s will not be sustained in the future. Currently, the recent drought years have resulted in a significant reduction in the discharge of the Barada and Awaj into the oasis of Damascus (*Ruz al-Yusuf,* Egypt 29 June 1990). Finally, Syria has a large storage capacity (for details see Chapter 2). In conclusion, Syria has enough surface water, underground water and storage capacity to provide for its needs. However, most of the water resources are shared resources with neighbouring countries (Turkey, Iraq, Israel, Lebanon and Jordan) and Syria will have to reach an agreement on water allocations.

Water demand in the agricultural sector

Syria's major demand for water is for irrigation, a land use which consumes about 90 per cent of Syria's water supply. In the 1980s, according to various sources, Syria irrigated between 531,000 ha and 670,000 ha (*al-Ba'ath,* Syria 9 May 1988; Shahin 1989; *Syria Statistical Abstracts* 1990). About half of this amount was irrigation water from the Euphrates and its tributaries (Kolars, personal communication, 5 March 1992). Only a very small amount of land (some 43,000 ha) is irrigable in the Yarmuk basin (Saliba 1968). However, the Syrian Golan Heights (the districts of Dara'a and Quneitra) have a strategic and geopolitical importance and Syria is anxious to develop this region. The data on the land currently irrigated by Syria in the Yarmuk basin offer figures ranging between 34,000 and 36,000 ha (*al-Ba'ath,* Syria 9 May 1988; *Syria Statistical Abstracts,* 1990). Syria, according to various sources, is currently using about 200 million m^3 of Yarmuk's waters for irrigation and return flow ranges between 20 and 50 million m^3 (Kolars 1992a).

Hydro power

As has already been stated, Syria has a very significant need for hydro power and its main interest in the Unity-Maqarin Dam is for its hydro power which will reach 46 million kWh per year. According to the Syrian-Jordanian Agreement, Syria will be entitled to all of the electricity which will be used to provide for the regional needs of the Upper Yarmuk area.

Water needs in the domestic and urban sector

The population of the Upper Yarmuk basin is approximately 750,000, but the Damascus metropolitan area, not too far, at present has an annual need of 600 million m^3 of water whereas its supply only reaches 500 million m^3 (Hindley 1989:5). The need for drinking water will increase Syrian demands for the Yarmuk water resources.

Total supply and demand in Syria

Currently (1990) Syria's total water demand is 3.7–5.9 billion m^3 of water whereas supply is around 30 billion m^3. Of this amount, the Yarmuk provides less than 7 per cent of the supply but about 5.0 per cent of the demand (340 million m^3) is generated by the population living in the Yarmuk basin. Thus, the Yarmuk is needed for the provision of the local needs in the Upper Yarmuk region.

A further forecast for the year 2000 points to a total Syrian demand of some 8.5 billion m^3 (Shahin 1989); at the same time total supply will be 23.0 billion m^3 (Kolars 1992a, c). The major pressure for water supplies will more probably be in the urban sector than in the agricultural sector, making water shortages in Syria local. Water transferral from areas of surplus to areas of deficit may solve this problem, if Syria can garner the necessary funds to invest in the transformation of the conveyance network.

Water supply and demand in Lebanon

Water supply in Lebanon is abundant since almost all the territory of Lebanon receives adequate precipitation and only small areas in the Beqa'a are semi-arid. It is interesting, however, to note that while Gischler estimates that at least 30 per cent of Lebanese territory is actually semi-arid, other estimates suggest that only 15–20 per cent is (Gischler 1979:100). Annual surface water potential ranges between 3.8 billion m^3 (Gischler 1979) and 4.38 billion m^3 a year (Shahin 1989:216), while groundwater reserves are 0.

60 billion m^3 (Shahin 1989). This gives a total water supply of 4.98 billion m^3. The most important contribution to surface water is made by the Litani River with a discharge of 0.6–0.7 billion m^3 (Halawani 1985:51); the Orontes (Assi) in Northern Lebanon provides another 0.7 billion m^3 a year (discharge in Ghab, Syria) but this benefits only Syria as its portion in Lebanon and Turkey is not used. There are rich tributaries in the Akkar plain in northern Syria with the Wadi al-Kabir being not only the most important but also serving as a border between Syria and Lebanon.

Water demand in Lebanon is significantly lower than supply. Irrigated farming consumed 0.245 billion m^3 to irrigate 49,000 ha in 1961–5 (Nimrod 1966:10; Beaumont 1985:6–7). In the mid-1970s Lebanon used 0. 647–0.854 billion m^3 of water for irrigation and in 1981 85,000 ha were irrigated with 0.425 billion m^3 (Beaumont 1985:6–7; Kolars 1992c). This reduction in water use can be explained by the changes caused by the 1975–6 civil war which destroyed the irrigation system and reduced demand. The irrigable land probably consumed 800–860 million m^3 in the 1980s but Lebanon could irrigate at least 2 million dunums (200,000 ha) in addition to the 85,000 ha irrigated in the mid-1980s (Kally 1986:37; Shahin 1989). In the mid-1970s demand for water in the domestic and industrial sectors was only 94 million m^3 (Gischler 1979: 104). In the mid-1980s the demand for water in the domestic sector was 145 million m^3 and in the industrial sector 9.4 million m^3 (Baasiri and Ryan 1986). The most important use for water in the non-agricultural sector was then, and still is, the production of hydro power. Three hydro-power stations with a total capacity of 281.5 MW (600–800 million kWh) take advantage of the 200 million m^3 of the stored waters of the Litani River in Lake Karoun (Kirwan). At present Lebanon is utilizing a total of 854–900 million m^3 of water and about two-thirds of it is used for both irrigation and hydro-power production (Kally 1986:37; Shahin 1989). Table 3.8 shows that the total water demand for Lebanon in the year 2000 and beyond will not surpass the total water supply of nearly 5.0 billion m^3. Thus the country in general is going to have available reserves of almost 3.0 billion m^3 and is not going to suffer any scarcity of water although local demand in specific regions such as the Beq'qa or southern Lebanon may rise.

Table 3.8 Present and future water demand in Lebanon (million m^3)

	1985	*2000*
Irrigation	669	864–700
Domestic	145	352
Industry	40	232–390
Total	854.0	1,448

Sources: Baasiri and Ryan 1986; Amer 1971; Shahin 1989; US Army Corps of Engineers 1991

Water demand and supply in Jordan

Water supply

Ninety-five per cent of Jordan's territory receives less than 200 mm of rainfall— hence, the necessity to provide agriculture with irrigation water (Canaan 1990: 18). Jordan's annual rainfall between 1986 and 1990 fell because of continuing droughts:

	Total rainfall	*Percentage change*
1986–7	6,700 million m^3	–

	Total rainfall	*Percentage change*
1987–8	12,252 million m^3	+55
1988–9	10,205 million m^3	–20
1989–90	7,609 million m^3	–34

This trend has had a direct effect on the total water supplies of Jordan over the last five years. The estimates of total water supplies ranfge from 645 million m^3 to as high as 1,311 million m^3 with an average of 850–900 million m^3 (Shahin 1989; Canaan 1990; *al-Rai,* Jordan 17 December 1990, 17 July 1990; Sexton 1990). Out of this total amount of supply, groundwater quantities range between 357 and 480 million m^3 and surface water ranges between 0.523 and 0.900 million m^3 (Gischler 1979; Shahin 1989; Canaan 1990:18; Allan 1991; Shawwa 1992:126). The surface water resources are given in Table 3.9.

In recent years the Jordan-Yarmuk system has satisfied 75 per cent of Jordan's water needs (Nasrallah 1990:16). If Jordan utilized only 100 million m^3 of Yarmuk water then the Yarmuk contributed only 14 per cent to Jordan's current water supply.

Table 3.9 presents the optimal state of surface water resources. However, in 1990 the supply of surface water was only 320 million m^3, and Jordan had to expand its utilization of groundwater from reservoirs which contained only a third to a half of their usual storage (Dougherty 1990).

Table 3.9 Surface water resources in Jordan

Source	*Permanent surface flow (million m^3)*	*Flood flow (storm runoff) (million m^3)*	*Total (million m^3)*
Yarmuk	218	182	400[a]
Eastern Jordan Valley area	139	68	207
Dead Sea basin	141	50	191
Wadi Araba basin	21.6	9.4	31
Desert basin	20.1	29.2	49.3
Total	539.7	338.6	878.3[b,c]

Sources : Cannan 1990; *South al-Sha'ab,* Jordan 17 December 1990; Shahin 1989

Notes:

[a]According to Kally (1986), the Yarmuk supplies only 430 million m^3 while Salik (1988) estimates an annual discharge of 475 million m^3.

[b]Al-Weshah (1992) estimates surface waters at 523 million m^3. An estimate for surface waters offered by the Jordanian Minister for Water and Irrigation is only 750 million m^3 of water *(al-Rai,* Jordan 17 December 1990).

[c] According to Shahin (1989) the total stream water is 900 million m^3.

Groundwaters

Long-term safe yield of renewable groundwater within Jordanian territory is estimated at a total of between 357 and 480 million m^3 (Alam 1989; Al-Weshah 1992:126; Chezawi 1992). The major groundwater basins are the Yarmuk (53 million m^3), the Jordan Valley (23 million m^3), Zarqa-Amman (94 million m^3), the Dead Sea (60 million m^3), the Red Sea (8 million m^3), Wadi Arabah (8 million m^3), Disi and Jafir (78 million m^3), Sarhan (5 million m^3), Azraq (20 million m^3) and Al Hammad (5 million m^3) (Alam 1989; Al-Weshah 1992:127). From this total of 375 million m^3, the renewable groundwater safe yield is only 275 million m^3; about 82–205 million m^3 is non-renewable (especially Wadi Sir and Disi). Groundwater usage has been at least 10 per cent above yield—about 335 million m^3 (Dougherty 1990:18; Kolars 1992c). It is thus clear that Jordan is over-stretching its underground water resources (Canaan 1990; Chezawi 1992). At the present pace of utilization, the fossil water resources are expected to last for a hundred years (Alam 1989; Chezawi 1992). Since the recent droughts reduced Jordan's total water supplies to no more than 730–800 million m^3 of water (Canaan 1990:20; *al-Rai,* Jordan 17 December 1990; Young 1991; Chezawi 1992) —it seems that the pace of utilization will increase in the future.

Measures to expand the water supply of Jordan

1 The most important step needed for expanding supply is the construction of the Maqarin Dam which would provide Jordan with an additional 100 million m^3 of water a year. According to Jordan's planned strategy for expansion of water resources by the year 1995 the Al-Wahda (Maqarin) will supply 40 million m^3 of water and, by 2005, 90 million m^3 (*al-Rai,* Jordan 19 December 1990). However, at present this strategy seems to have little chance of being implemented and the amount of incremental water from the Maqarin is so small that any investment would be uneconomical.
2 Local water projects to catch waters in the eastern tributaries is another measure with the most important projects being the Karameh Dam, the Kufrinja Dam, the Yabis Dam and raising the Kafrein Dam. The dams in the Wadi Aqaba basin such as the Al-Tanner Dam on Wadi Hasa and Al-Wala, which are aquifer recharge dams, are also important (Canaan 1990:19; *al-Rai,* Jordan 19 December 1990). These projects will add 30 million m^3 of water and, by 2005, 58 million m^3.
3 Jordan needs to take steps to reduce the waste of water in its water pipe network—especially in Amman, since it has been estimated that between 44 and 50 per cent of the water flow through Amman's pipe network is lost (*al-Rai,* Jordan 14 July l990).
4 Jordan also has to improve irrigation efficiency and to replace the system of open concrete canals which are more than twenty-five years old and have an irrigation efficiency of only 46 per cent, though other sources point to an irrigation efficiency of 60–70 per cent (Taubenblatt 1988:50; Canaan 1990: 19; Al-Weshah 1992:130). The conversion of 12,500 ha to pressure pipe instead of open canals will save about 50 million m^3 a year and efficiency will increase to 70 per cent.
5 Jordan also plans to use underground saline water sources after the water undergoes a process of desalination and purification. By 1995 some 5 million m^3 of water from this source is anticipated to be in use but this will rise to 40 million m^3 by the year 2000 (*al Rai,* Jordan 19 December 1991).
6 As stated before an important component in Jordan's plan to expand its water resources is the development of new and old underground sources. By 1995 this new source will supply 47 million m^3 of water (mostly fossil waters) and, in 2005, 35 million m^3 (*al-Rai,* Jordan 19 December 1990).
7 Sewage return flow is not used enough in Jordan for irrigation purposes. Treatment plants in Amman, Zarqa and Irbid operate below capacity and have been unable to meet their secondary aim of providing re-cycled water for restricted agricultural uses (Dougherty 1990:19). A realistic estimate has been made that by the year 1995 45 million m^3 of irrigation water will come from this source (*al-Rai,* Jordan 19 December 1990; Sexton 1990; Al-Weshah 1992). Other experts have estimated the relative contribution of this source to the total supply of irrigation water as ranging between 25 and 30 per cent (Canaan 1990:20; Dougherty 1990:19). These estimates, however, seem to be too high.

There have also been changes in the pricing policies of different Jordanian governments which have raised water prices for consumers who consume water above a ceiling of 60 m^3 per capita in one summer season

(Chezawi 1992). The current price covers only 40 per cent of the operating and maintenance costs and only 15 per cent when capital costs are added (Dougherty 1990:19). It should also be noted that Jordan is no longer considering water importation from the Euphrates in Iraq or through the Turkish Peace Pipe, because the cost of developing these sources has been found to be too high (*al-Rai,* Jordan 19 December 1990; Al-Weshah 1992:131). In addition to cost, another problem with these plans is the absence of trust between the respective countries and the political instability of the region (Al-Weshah 1992:131).

In conclusion, Jordan's development of additional water sources has been slower than planned partly because it also lacks the necessary capital needed for the development of water projects such as the Maqarin/ Al-Wahda Dam (Kally 1986:33). In the meantime, Jordan has been dealing with water shortages by imposing severe quotas on water supply and, like Israel, has been over-utilizing its underground resources.

Jordan's water demand

Demand for irrigation water in Jordan

The total land suitable for irrigation in the Jordan River valley and within Jordan ranges between 50,580 and 125,000 ha (Cressey 1960:462; Saliba 1968:43). The development of the irrigated lands and the water demand is shown in Table 3.10. Only 4.6 per cent of the cultivated land of Jordan was irrigated in 1972, compared with 41 per cent in Israel and 7.6 per cent in Syria (Naff and Matson 1984:28).

In 1986, 48,700 ha were being irrigated in Jordan and this accounted for 25

Table 3.10 Irrigated land and water demand in Jordan (various years)

Year	*Irrigated land (ha)*	*Water demand (million m^3)*	*Source*
1957	32,580	250	Cressey 1966:463
1965	33,000	258	Beaumont 1985:6–7
1975	36,000	375	Kally 1986:26
1983–5	38,000	350–400	Kally 1986:32
1986	48,000	358	Canaan 1990
1990	70,000	520	Chezawi 1992
2005	67,000–70,000	520	*al-Rai,* Jordan 1 9 December 1 990

per cent of the cultivated land, about 28,000 ha (60 per cent) of which are located in the Jordan Valley and 4,700 ha in the Dead Sea region. The remaining irrigated area is located in the upland regions of Jordan, where some 16,000 ha are irrigated by water taken from local springs and deep wells (Canaan 1990: 19). The East Ghor Canal (King Abdullah Canal) brings about 130 million m^3 of Yarmuk waters to the Jordan Valley supplying water to irrigate most of the 28,000 ha. The 4,700 ha in the Dead Sea are most probably being irrigated by stored water (Kally 1986:30; Salik 1988:105). In 1990, Jordan irrigated 70,000 ha, of which 46 per cent is mainly situated in the Jordan Valley, utilizing water from the Yarmuk and the side wadis. The sources of Jordan's irrigation waters in 1990 were specified as 130 million m^3 of Yarmuk's water, 120 million m^3 from side wadis, 240 million m^3 of groundwaters and 30 million m^3 of treated water (Chezawi 1992). All in all, the total water available for irrigation in the Jordan Valley amounts to about 225–275 million m^3 with the East Ghor Canal contributing about 50–55 per cent of this, the eastern tributaries in the Jordan Valley contributing another 40–42 per cent while the remainder is contributed by treated sewage and groundwater (*al-Rai,* Jordan 19 December 1990). In 1991 water shortage was so acute that farmers were given less than one-third of the irrigation water they normally receive (Al-Weshah 1992:128).

Water demand in Jordan in the domestic-urban sector and in industry

The greatest water shortages in Jordan are found in the urban sector, especially in Amman but also in al-Karakh and Irbid. The rise in water demand for the urban sector has been very rapid (10 per cent a year) as the data in Table 3.11 show.

Table 3.11 Water demand in the domestic sector (various years)

Year	*Demand*
1975	40 million m^3
1985	150 million m^3
1988[a]	165 million m^3
1989	172 million m^3
1990	180 million m^3
1995	225 million m^3
2000	340 million m^3
2005	400 million m^3

Sources: al-Rai, Jordan 8 January 1990; *South al-Sha'ab,* Jordan 6 June 1989; *al-Rai,* Jordan 19 December 1990; *al-Dastur,* Jordan 8 July 1990; Chezawi 1992; Al-Weshah 1992

Note: [a]It should be noted that real demand in the domestic sector was 172 million m^3 but, because of water shortages, only 165 million m^3 were allocated.

Between 1988 and 1989 the demand for water in the domestic sector grew by 4.2 per cent and between 1989 and 1990 demand grew by 1.7 per cent. The population growth rate for 1988 was 3.57 per cent and for 1989 3.69 per cent, and these high growth rates explain the expansion of demand. By 2005 the domestic sector may need 371 million m^3 of water.

Jordan was expected to have a water deficit in the domestic sector of 50 million m^3 as early as 1989–92 (*al Rai,* Jordan 8 January 1990, 16 July 1990, 19 December 1990). This deficit means that the water quotas imposed on the municipal sector during the summer months of 1990 and 1991 when many households were supplied with water for only 48 hours a week will continue (*al-Rai,* Jordan 16 July 1990; Al-Weshah 1992: 128). Amman consumed 39 million m^3 in 1989 and is expected (according to its growth) to use 50 million m^3 by the year 2000 (*al-Rai,* Jordan 8 January 1990). The same source has estimated Amman's water demand at 73 million m^3 for 1989, of which a third cannot be provided during the summer months (*al-Rai,* Jordan 16 July 1990). The artesian reservoirs around Amman are over-utilized and estimates show that Amman was already undersupplied by 50 per cent in the early 1980s (Naff and Matson 1984: 51). Water tanks storing between 7,500 and 24,000 m^3 have been constructed in Amman as a short-term solution to the water shortage (*South al-Sha'ab,* Jordan 1 January 1989). Three main water pipelines provide drinking water to the 1.5 million residents of Amman: the first pipeline from Azraq is 102 km long and it provides 14 million m^3 of water; the second from Dair-Alla is 36 km long and brings 45 million m^3; and the third is from Swaqa, 72 km long, and pumps 15 million m^3 (Al-Weshah 1992:129).

Water balance in Jordan for 1995 and 2000

The key to the explanation of the water deficit of Jordan is that, while demand was expected to rise by a factor of 5 in the 1980s, Jordan was unable to meet this high demand. By the mid-1980s it became clear that Jordan's demand for water would exceed supply during the 1990s (Naff and Matson 1984:28). in 1985 Jordanian demand was 950 million m^3—in excess of its annual supply of 840 million m^3 so that it was showing a deficit of around 110 million m^3.

Jordanian water demand in 1991 was 730 million m^3, but the waves of returnees from the Arabian Gulf increased the demand by 7–10 per cent (Al-Weshah 1992). The demand was supplied by 335 million m^3 of renewable and non-renewable groundwaters and by 394 million m^3 of surface water from the Yarmuk and the Eastern tributaries (*al-Rai,* Jordan 19 December 1990; Kolars 1992c). Jordanian authorities have estimated that the water deficit in Jordan in 2000 will range between 100 and 300 million m^3, with supply ranging between 900 million m^3 and 1.1 billion m^3 and demand being about 1,100–1,200 million m^3 (Shahin 1989; *South al-Sha'ab,* Jordan 6 June 1989) (Table 3.12). Without a significant expansion in the water supply Jordan can expect a water deficit of 172 million by the year 2025 with the construction of the Al-Wahda

Table 3.12 Water supply and demand in Jordan for the years 1990, 1995, 2000

	Supply (million m^3)			*Demand (million m^3)*		
Year	1990	1995	2000	1990	1995	2000
Agriculture	530	600[a]	630[a]	550	700	720
Domestic	165	265[b]	300[b]	180	255	340
Industry	35	55?	60	35	45	60
Total	730	920	990	765	1000	1120
Deficit				–35	–80	–130

Sources: South Al-Sha'ab, Jordan 6 June 1989; *al-Rai,* Jordan 24 July 1989; Dougherty 1990; Shahin 1989; Chezawi 1992; Al-Weshah 1992; Kolars 1992c

Notes:

[a]Supply in agriculture is based on expansion of the Dizi aquifer use to 100 million m^3 and recycling of waste and brackish water to 120 million m^3 which will be used in agriculture and industry.

[b]Supply is based on the assumption that the Maqarin Dam will provide Jordan with an additional 100 million m^3.

Dam and 272 million m^3 without it (Al-Fathftah and Abu Taleb 1992). 1991 was another drought year but 1992 was a year rich in precipitation. The best expression of the imbalance in Jordan's water economy has been the water cuts imposed on both the agricultural and domestic sectors (*al-Dastur,* Jordan 23 April 1990). In the meantime, Jordan is dealing with its water deficit by diverting some water from agriculture to municipal and industrial use and by over-utilizing its non-renewable water resources (Young 1991).

Jordan's water deficit has been shaped not only by natural causes but also by an expansion of water usage by Syria and Israel and the political stalemate which does not allow Jordan to go ahead with its plan to build the Al-Wahda Dam.

The more conservative sources estimate that by the year 2005 total demand will reach 1.13 billion m^3 and the domestic sector alone will need the enormous amount of 300 million m^3 of water. By 2000 the estimated total supply will be 1,120 billion m^3 while demand will be 1,130–1,310 billion m^3—if the Al-Wahda dam is completed by that year. If the total renewable water sources of the Jordan are no more than 1,100 billion m^3 per annum, then Jordan will be unable to utilize more than 1.1 billion m^3 of water unless it is ready to deplete future water reserves (*South al-Sha'ab,* Jordan 6 June 1989). Our estimate relies on a per capita water usage in Jordan of 250 m^3 a year in all sectors—agriculture, domestic and industry.

In the domestic sector alone per capita consumption is 53 m^3. By the year 2000, Jordan will have a population of 5.0 million, and will need 1.13 billion m^3 of water. A deficit of 100–130 million m^3 may emerge within the next decade.

Water supply and demand in Israel

Water supply in Israel

Water in Israel is a scarce resource because Israel is located in a semi-arid and arid region with 60 per cent of the national territory classified as arid (Karmon 1968:501). In an average year between 8 and 10 billion m^3 of rainfall falls on Israel but it mostly flows into the sea. Rainfall distribution in the various parts of the country is extremely inconvenient for human use with 80 per cent of the water resources being located in the area north of the Yarqon River and only 30 per cent of the cultivable land being located with this region. There is on average a deviation of 20–30 per cent in precipitation averages each year, but every two or three years a larger deviation from the average takes place (*Israel State Comptroller Report* 1987:545; *Israel State Comptroller Report* 1991).

There are differences of opinion among different sources as to the proportion of underground water sources in the Israeli water economy with their contribution variously estimated at 75 per cent, 60 per cent and 50 per cent (Gvirtzman 1990; Taubenblatt 1988:49; Naff and Matson 1984:64, respectively). Calculations made for 1990–1 suggest that the contribution of underground water sources will be 62 per cent. The contribution of the mountain aquifer ranges between 27 and 40 per cent, and the coastal aquifer contributes 27–30 per cent of the total (Naff and Matson 1984; Beaumont, Blake and Wagstaff 1988:104; Eitan 1990:8). As all the above data refer to different periods in which overpumping of all the underground sources took place, perhaps the inconsistency is smaller than it seems. Our estimate is that a well-balanced maintenance of the underground sources dictates that utilization of the aquifers should not exceed 50–55 per cent of the total supply. Table 3.13 provides the details.

Table 3.13 points to one of the major flaws in Israeli water-management policies: over-utilization of the various water sources, sometimes depleting these sources beyond repair. Simply put, the water potential of Israel (defined as 'the maximal utilization permitted without damaging that resource') ranges between 1,500 and 1,710 million m^3. This is more or less equal to the quantity of water naturally replenished (each year) in the long run (Karmon 1971:126). If the water pumping exceeds natural replenishment for a few consecutive years, water resources will be depleted. According to Israel's State Comptroller usage has exceeded the level of renewable water sources by 200–300 million m^3 with the potentially disastrous outcome being an accumulated deficit of 2.0 billion m^3 (Schwartz 1986; *Biosphera* January 1988; Gvirtzman 1990).

One main underground source is the coastal aquifer with a potential of 240– 284 million m^3 (a quantity which constitutes its natural replenishment). But in recent years water withdrawals from this aquifer have amounted to 380–420 million m^3—a process which has depleted this aquifer by 1.1–1.4 billion m^3 of water (Schwartz 1986). The second main aquifer is the mountain aquifer whose major catchment area is the mountains of the West Bank, especially the mountains of Judea and Samaria. The water caught in this area emerges in a long line of springs within Israel—from the Taninnim tributary to the Yarqon (see Map 3.7). This is the reason for statements that 'forty per cent of Israel's present water consumption derives from outside the Green Line', the Green Line being the pre-1967 boundary (Naff and Matson 1984:47) (see also pages 245–9). The water supply of the mountain aquifer is 300–330 million m^3 but this aquifer has also been over-utilized during the last decade with Israel pumping 490 million m^3 of water, although the natural recharge is no more than 330 million m^3 (*Israel State Comptroller Report* 1987:547). In November 1990 the deficit in the mountain aquifer was 330 million m^3 but it should be noted that the water crop for this aquifer was over-estimated in the past, with suggested estimates ranging between 460 million m^3 and 740 million m^3 of water (Gvirtzman 1990; Naff and Matson 1984:47).

Israel's most important water source is the Jordan-Kinneret basin. The operational storage capacity of the Kinneret lake is only 700–740 million m^3— the quantity stored between its maximum level of −208.90 m below sea level and its minimum level of −212.90 m below sea level. Between 1978 and 1986 Israeli water resources were over-utilized each year by 140–240 million m^3 (8– 14 per cent) and, as a result, the surface and underground sources were severely depleted (*Israel State Comptroller Report* 1991:9). The policy of overpumping has continued for more than twenty-five years (*Israel State Comptroller Report* 1991). Overpumping in the years 1990 and 1991 reached 200–240 million m^3 (*Israel State Comptroller Report* 1991; Zaslavsky interview, 15 April 1991). According to the last report, between 1987 and 1989, for example, water allocation to agriculture exceeded (by 8–12 per cent) the water allocations recommended by hydrologists who called for conservation. Israel's accumulated water deficit for July 1991 was estimated as ranging between 1.00 and 2.0 billion m^3 (including surface and underground sources) and an emergency plan to cut water use by as much as half was declared for agricultural and domestic use of water. Each year for the last twenty to twenty-five years, approximately 1,000 million m^3 of water were utilized, but only 515 million m^3 of water are available for use in the long run when one takes years of below-average precipitation into consideration (Kally 1986:40; *Israel State Comptroller Report* 1987:553). By August 1991 the water level reached the red line of −213 m below sea level, the lowest level in the documented history of the Kinneret.

Withdrawals from Lake Kinneret comprise two parts. The first is water pumped by the National Water Carrier, ranging between 400 and 430 million m^3 a year (Naff and Matson 1984; *Israel State Comptroller Report* 1987; Orthenberg interview, 15 May 1991). Second, some 180–200 million m^3 are pumped from this basin for local use (Schwartz 1986; Orthenberg interview, 15 May 1991). Thus, the total water supply of the Jordan-Kinneret basin is estimated at between 538 and 620 million m^3 (Avnimelech and Lecher 1978: 104; Shamir, Bear and Arad 1985:76). Estimates have been made that the

Table 3.13 Israel's water supply: major resources

Source		*Water supply*	
Water provision (million m^3)	*Overpumping or over-utilization (million m^3)*	*Notes*	
Underground sources			
(1) Coastal aquifer	240–300[a,b,c,d] (455)[d]	34[a]-80[d] (1980–90)	Accumulated deficit in this aquifer is estimated at 1.1–1.4[a] billion m^3[a,e]
(2) Local aquifers (Galilee, Carmel) (Gilboa)	23[a]–280[d]		Small deficits have been reported
(3) Mountain aquifer	300[d]–330[a,c]	49[d]–50[a] (1980–90)	Accumulated deficit in this aquifer is estimated at 300–350 million m^3 (1989)
Total	850–1,200[i]		
Surface sources			
(1) Lake Kinneret basin	575–610[a,f] (950)[g]	25 (1980–5)[c]	Deficit of 140 million m^3 in the year 1987

Source		*Water supply*	
Water provision (million m^3)	*Overpumping or over-utilization (million m^3)*	*Notes*	
(2) Floods and reclaimed sewage	200[d]–230[a]		
Total water resources	1,890[b]-2,311[b,i]		Accumulated deficit 1.57 billion m^3[a]
Total water losses	60–100		
Balance	1,790		

Sources: [a] *Israel State Comptroller Report* 1991. [b] Schwartz 1986.[c] *Biosphera* January 1988. [dEi]tan 1990:9; Zaslavsky interview, 15 April 1991. e According to Shamir 1988. f According to Kally (1986:40) the Jordan-Kinneret basin provides 650 million m^3, 350 million m^3 through the National Water Carrier and 300 million m^3 by direct pumping. [g] Orthenberg interview, 15 May 1991; Orthenberg's estimate of 950 million m^3 includes surface flow, underground springs, direct rain flows from the Yarmuk and saline springs. [h] In 1991 supply was only 1,400 billion m^3; in a normal year supply is 1.710 (Zaslavsky interview, 15 April 1991); the year 1992, though, has been a very good year and the amount of rainfall was double the average amount of rain. [i] Shamir, Bear and Arad 1985

Note: [i]There is a great variation in the estimates of water supply from underground sources. Thus, according to Shuval (1992) the mountain aquifer safe yield is 350 million m^3 in addition to 40 million m^3 of brackish water. The Schem-Gilboa aquifer has an estimated safe yield of about 130 million m^3 and the eastern aquifer which flows into the Jordan river has a safe yield of 200 million m^3, half of which is brackish; this aquifer is not included as it does not flow naturally to Israel. Total transboundary (i.e. shared) underground water resources are estimated at 545–680 million m^3 (Moore 1992a, b; Shuval 1992).

Jordan-Yarmuk-Kinneret basin provides 30 per cent of Israel's water supply (Naff and Matson 1984:47). Our estimate is that this system provides an average of 35 per cent of Israel's water supply and this is confirmed by other sources (Shamir, Bear and Arad 1985:76).

The Jordan River system has been extensively exploited by both Israel and Jordan and satisfies about one-third of Israel's water demand and 40 per cent of Jordan's water demand, while the Jordan-Yarmuk River satisfies only 5 per cent of Syrian demands (Naff and Matson 1984:27). It is thus most appropriate to conclude this discussion on the Jordan-Yarmuk-Kinneret with an old and true observation made by one of the veteran students of the region who stated: 'Much wishful thinking about the Jordan River development on both sides of the international boundary has overlooked the limited flow of the river even if water were stored, the high rates of evapotranspiration, the unfavourable terrain and the saline character of many soils' (Cressey 1960:463).

Finally, the last source of surface water resources are reclaimed sewage water, marginal water sources and flood water which total 200 million m^3 (Eitan 1990: 8). Israel does not take full advantage of this resource which currently only contributes 12 per cent (and not 5 per cent as suggested by Adams and Holt (1985:75)) of Israel's supply but which could contribute more—since more than 100 million m^3 of sewage waters are not treated at all (Zaslavsky interview, 15 April 1991). By the year 2000 this source will constitute 30–40 per cent of the water allocated to Israeli agriculture.

The water supply of Israel as presented in Table 3.13 shows that Israel has been over-utilizing all its resources. Water withdrawals have exceeded the average of 1,500 million m^3 which is the required national recharge of underground and surface water sources. Already in 1978, Galnoor stated that the total stock of sustainable water yield in Israel is only 1,500–1,600 million m^3 (Galnoor 1978). In 1991 it was estimated at about only 1.3 billion m^3 (Pearce 1991:31). This modest water crop can be expanded only in years in which precipitation is high, or just for a very short period, but Israel could stretch this yield with extended usage of treated effluents and storage of flood water. Israeli policy-makers, however, have yielded to pressure from the politically strong agricultural sector and are continuing in their policy of allotting generous water quotas to the farming sector despite the fact that nature has been less than generous (Pearce 1991:37). This policy, which has continued for more than twenty years, reduced Israel's water reserves to virtual bankruptcy in the winter of 1991 and to a water deficit beyond reclamation.

To end the survey on water supply in Israel, we should look at two final sets of factors which shape this supply: limitations on supply and measures which could be adopted to expand supply.

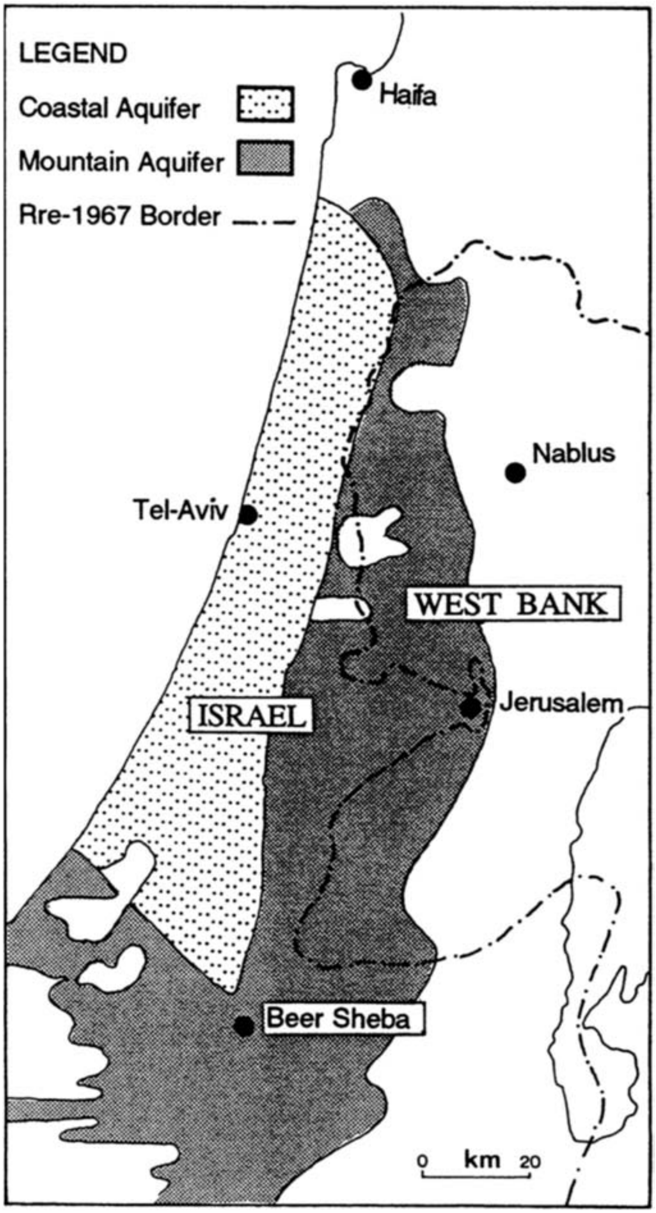
Limitations on supply

Climate Severe droughts over the last ten years, but specifically during 1987– 91, have depleted Israel's water reserves. For example the rainfall averages in the northern Jordan basin for 1989–90 were 33 per cent lower than the normal averages (*Hasadeh,* Israel September 1990). Apart from this the precipitation deficit in northern Israel has ranged between 20 and 40 per cent over the last three to four years (*Hasadeh,* Israel September 1990). The year 1992, however, was a very good year and the rainfall quantity for this year was double the long-range average rainfall. This abundant rainfall which considerably improved the water reserves of Israel (and Jordan), has not changed the basic need to adopt a more conservative water policy in the future.

Lake Kinneret basin Lake Kinneret and the Kinneret basin supply, on average, at least a quarter to one-third of Israel's annual water crop. In dry years the Kinneret receives only 100–200 million m^3 (1972, 1978, 1985, 1988–91) whereas in rainy years 1,500 million m^3 may reach it (Schwartz 1986; Orthenberg interview, 15 May 1991). The National Water Carrier can convey 420 million m^3 per year, but natural supply on this level is only fully realized in 70 per cent of the years and for the rest of the years there are water shortages. In the winter of 1991 the National Water Carrier was shut down for six months as a result of the very low level of the Kinneret which had reached the 'red line' (Pearce 1991:37). The success in maintaining the water quality of Lake Kinneret is more encouraging, however, and nitrate and pollutant content is low although there is greater salinity in the water as a result of the low water level (Geffen 1987).

Limitations to the use of underground resources The most significant limitation to Israel's water supply is the over-utilization of the two major aquifers. Overpumping of water from the coastal aquifer has caused a steep reduction in its water level and, as a result, sea water has penetrated into it causing it to become salinated over a 4 km wide belt and leading to the closing of many wells. Pollutants are accumulating within the aquifer and wells are being shut down because they contain too much salt, nitrates from fertilizers and heavy metals from sludge. About 10 per cent of the water in the coastal aquifer already exceeds the national limit for chloride salts and by 2010, if pumping continues, 20 per cent of the water will exceed the limit (Pearce 1991:37). Ultimately this will lead to 80 per cent of the wells which pump water from this aquifer being shut down by the year 2000 (*Biosphera* August 1989; Gvirtzman 1990).

Quality of drinking water According to Israel's Water Commissioner, most of the water provided to the domestic sector is below the official standard of quality for drinking water and Israel's State Comptroller has confirmed that the nitrate (NO_3) content in the drinking water is 50 mg per litre, above the international standard of 45 mg per litre (*Israel State Comptroller Report* 1991:25). In the summer of 1991 the residents of many communities had to boil water for drinking since it was found to be contaminated by bacteria and other organic materials.



Map 3.7 The groundwater aquifers of Israel and the West Bank

Measures to expand water supply and improve water usage efficiency in the Israeli water economy

Scarce water resources will compel Israel to take strict measures to cut water usage in all sectors. More specifically, the following measures are recommended for Israel's water economy to preserve and increase the available resources.

Separate water delivery systems Two separate systems for water delivery will have to be developed. The first, to supply better quality water, will distribute water to the domestic sector, while agriculture (and industry) will have to do with a system which uses reclaimed sewage and flood waters (Gvirtzman 1990).

Agriculture will have to expand its usage of saline water (classified as any water which contains more than 400 mg of chlorides per litre). Israel's agriculture will have to reduce its water consumption drastically from the 1,410 billion m^3 in 1985 to 1,180–1,260 billion m^3 in the year 2000. But the relative contribution of potable water to agriculture will be reduced from 1.2 billion m^3 (mid-1980s) to 820 million m^3 in 2000 and to only 675 million m^3 in 2010 (Schwartz 1986; *Israel State Comptroller Report* 1991; Shelef 1991:2082).

Flood water and treated sewage insertion Flood water and good quality treated effluent water will be artificially inserted into the underground sources in order to enrich these water sources. There are 250 reservoirs with a storage capacity of 200 million m^3 whose function is to store storm waters together with treated sewage. Between 1983 and 1988, Israel pumped between 54 and 122 million m^3 of water each year into the coastal aquifer and 150–200 million m^3 of water into the mountain aquifer. But this is just a small compensation for the massive over-utilization of these resources over the last twenty years which has caused the water deficit in the coastal aquifer to be more than 1.0 billion m^3. It is not going to be easy to redress this water imbalance (Schwartz 1986).

Reclaimed sewage This is one of the more important possible sources for expanding water supply in Israel; yet, up to the 1960s, unreclaimed sewage waters were flowing untreated into the sea through river channels. Moreover, untreated sewage waters were responsible for epidemics and the contamination of underground water sources. The total sewage water available in Israel is 453 million m^3 (1990) but only 160 million m^3 are fully treated for use as irrigation water—the remainder being either partially treated (60 million m^3) or not treated at all (Shelef 1991:2083). This means that some 230 million ,^{3} of water is wasted (Gvirtzman 1990; *Israel State Comptroller Report* 1991:29). Two hundred and twenty million m^3 of reclaimed sewage reservoirs is used for irrigating 19,000 ha but, in the future, at least a quarter of the water potential will originate from this source, and good quality water currently used in Israeli agriculture will be replaced by reclaimed sewage. Currently 450 settlements in the rural sector still send their sewage untreated into the wadis or underground. According to the plan some 292 million m^3 of waste waters will be fully treated by the year 2000 and will be shifted to agriculture usage (Naff and Matson 1984; Shamir, Bear and Arad 1985:160; Eitan 1990:9; Shelef 1991:2083).

Water prices The Israel State Comptroller has stated that the country-wide average cost of water is 35 cents/m^3 but only the domestic sector of Israel pays more than the real cost and surplus income from this sector is used to subsidize the farming sector which pays only 13 cents/m^3 (*Israel State Comptroller Report* 1991:37). According to the 1990 Report of the Israel State Comptroller, the low price of water is a major reason for the current crisis. Water prices for the farming sector are lower than cost, and the government annually subsidizes the water by $200–250 million (*Israel State Comptroller Report* 1991:38). According to one source there is even a subsidy paid for water consumed in the urban sector as well (Zaslavsky interview, 15 April 1991).

Water loss There is a tremendous loss of water due to leaks in the pipe network of most of the urban communities in Israel and in some cities water waste reaches 20–50 per cent (Zaslavsky interview, 15 April 1991). There is an obvious and urgent need to replace the old pipe networks in most of the urban centres of Israel.

Desalinization The cost of desalinization in Israel is estimated to range between 60 cents/m^3 and $1.00/$m^3$ of water, and at present this cost is too high for agricultural use. It is ironic to note that Israel is exporting sophisticated desalinization plants to other countries but the only two plants at work in Israel are tiny and produce water that is too expensive. The Ministry of Agriculture, however, considers this alternative feasible when combined with power stations and, perhaps, a plan involving co-operation with Jordan and the West Bank for the benefit of Palestinians, Jordanians and Israelis (Eitan 1990:10). Shuval (1991a, b) has estimated that a desalination project common to Israel, Syria, Jordan and the Palestinians will cost about $3–5 billion, but this sum is considered small compared with the direct and indirect costs of regional wars (Shuval 1991a: 39).

Flood waters The potential supply of these waters is 150–160 million m^3 but currently only 40 million m^3 are used, although Israel has constructed 250 water reservoirs which collect and store winter water together with effluents. The total capacity of these 250 storages is 150 million m^3 of water (Schwartz 1986; Shamir, Bear and Arad 1985:61; *Water Commissioner Report* 1991).

Water importation In the last few years Israeli policy-makers have been looking into the feasibility of importing water to Israel via the sea from Turkey or Yugoslavia. One major means for this envisaged water importation is the 'Peace Pipe' which was planned mainly for the Arab countries. There have been rumours, however, that a branch of this pipe fed by the water of the Ceyhan and Seyhan will also export water to Israel. The other means for exporting water to Israel is based on 'Medusa Bags', nylon bags 600 m long that will be able to transport between 1 and 2 million tons of water just beneath the surface of the sea (Pope 1990:14). The source region for the water is the Manavgat River on Turkey's Mediterranean coast. Experts believe that this imported water will be too expensive for wide usage and that it will be used only as a last resort, since it will cost 75 cents/m^3 just to convey the water from Turkey to Israel—and this is not the total cost.

As the water situation became extremely severe in 1991, emergency steps were taken to save water in the domestic sector. The irrigation of public parks and private gardens was allowed only at night, planting of new gardens was forbidden and water-saving devices were installed in many domestic households. In 1990–1, the water allocation for agriculture was cut from a quota of 1.3 billion m^3 (1988–9) to 800 million m^3, i.e. by 40 per cent (Zaslavsky interview, 15 April 1991). The price of water was also raised, but not enough.

Water demand in Israel

Israel's total water demand in 1947 was only 230 million m^3; in 1975 it amounted to 1.73 billion m^3 and in 1989 1.91 billion m^3, made up to 1.3 billion m^3 for agriculture, 495 million m^3 for the domestic sector and 107 million m^3 for industry (*Israel State Comptroller Report* 1991; Schwartz 1986). Demand has exceeded water supply by 100–200 million m^3 each year and sometimes by 300 million m^3 (Gvirtzman 1990:16; *Israel State Comptroller Report* 1991:32). On average, agriculture withdraws 70–75 per cent of Israel's water supply, while 5– 6 per cent is allocated for industry and 20–25 per cent for the domestic sector. In 1984, agriculture consumed 68.5 per cent, the domestic sector 25.9 per cent and industry 5.6 per cent, while some 100–110 million m^3 has been lost each year through water leaks from pipes (Naff and Matson 1984: 27; *Israel State Comptroller Report* 1987).

As we have seen, Israel's water supply in a normal year is only 1.5–1.7 billion m^3. With an annual consumption of 1.9–2.0 billion m^3 there is an annual deficit of 100–200 million m^3 which is a heavy burden on the Israeli water economy. In the short run, Israel took measures to cut water quotas drastically for both the

Table 3.14 Water demand in Israel, 1985 and 2000

Sectors	*1985*			*2000*		
Potable water (million m^3)	*Reclaimed water (million m^3)*	*Total*	*Potable water (million m^3)*	*Reclaimed water (million m^3)*	*Total*	
Agriculture	1,200	210	1,410	820	440	1,260
Domestic	420	–	420	685	–	685
Industry	80	30	110	100	45	145
Total	1,700	240	1,940	1,605	485	2,090

Sources: Israel State Comptroller Report 1991:46; Shelef 1991; Schwartz 1986

agricultural and domestic sectors (see Table 3.14). According to the Israel State Comptroller's 1991 report the reduction in water consumption was insufficient and the cuts often came too late (*Israel State Comptroller Report* 1991:34–6). It should be noted that some forecasts for the year 2000 differ from the above report and show estimates for the domestic sector demand as only 555 million m^3 and, for industry, 140 million m^3 instead of 135 million m^3 (Shamir 1988; *Ha'aretz,* Israel 25 November 1990). It is important to note Israel's State Comptroller's observation that despite the agricultural sector receiving reclaimed sewage water for which it had to return good quality water for general use, it was found that this exchange was never implemented (*Israel State Comptroller Report* 1987:566; 1991:48). In the year 2000 the municipal/domestic sector will have a demand of 685 million m^3 and industry will consumer 145 million m^3 (Schwartz 1986; Shelef 1991).

Demand for irrigation water in Israel

In 1988 the amount of irrigable land in Israel was 213,000 ha which comprised 43 per cent of the cultivated land of Israel (Table 3.15). Most of this irrigable land is in the coastal plain and the internal valleys, about 25 per cent is in the Negev, and only 3 per cent of the irrigable land is within the Jordan-Yarmuk system (Saliba 1968:43). At present Israel irrigates 14,000 dunums (1,400 ha) along the Jordan (Salik 1988:116). The limiting factor to expanding irrigated farming in Israel is not the lack of suitable land (for irrigation) but the quantity of available water (Saliba 1968:44). Israeli agriculture, like the agriculture of its neighbours, is a heavy consumer of water, but the average irrigation duty in Israel is 6,000 m^3 per hectare, compared with 17,000 m^3 per hectare in Egypt (Adams and Holt 1985:82) and some 11,000 m^3 per hectare in Jordan. The agricultural sector has been able to save irrigation water and reduce its water consumption from 8,570 to 5,480 m^3 per hectare. Between 1955 and 1975 water demand for

Table 3.15 The development of irrigated land in Israel, 1948–89

Years	*Irrigated land (ha)*	*Water use (million m^3)*	*Per capita (m^3 per hectare)*
1948–9	30,000	257	8,570
1954–5	89,000	760	8,430
1964–5	151,000	1,087	7,190
1978–9	189,000	1,327	7,020
1985–6	219,000	1,389	6,280
1987	207, 200	1,025	4,980
1988	213,500	1,179	5,480

Years	*Irrigated land (ha)*	*Water use (million m^3)*	*Per capita (m^3 per hectare)*
1989	214,210	1,238	5,730

Source: Israel Statistical Abstracts selected years

agriculture decreased from 0.85 to 0.71 billion m^3 of water (Galnoor 1978). These savings have not changed the basic trend of agriculture which was to consume large amounts of water even when they are not available.

As the 'favourite' of all the Israeli governments, agriculture has always been considered an important vehicle for settling the land and, consequently, has been allotted very generous water quotas. By the end of the 1980s, Israeli agriculture was consuming 1.2–1.3 billion m^3 and policy-makers continued in their generous water allocation to the farming sector, despite the meagre water supply. The powerful agricultural lobby in the Israeli parliament and government has been able to block most efforts to curtail these water quotas or even to place a more realistic price-tag on water.

The greatest criticism of Israeli agriculture has concerned crops which consume enormous quantities of water such as cotton (consumed 141 million m^3 in 1989–90), corn and various orchards which, in addition to consuming huge amounts of water, have proven to be unprofitable without heavy governmental subsidies. It is anticipated that cotton and unprofitable orange and avocado groves, great consumers of water, will be the first branches to disappear from the agricultural landscape and this sector will concentrate on crops and computerized drip irrigation which consume small amounts of water.

Water demand in the domestic sector

On average, per capita consumption in Israel is 100 m^3 per year (Schwartz 1986). Another source (Naff and Matson 1984:27) puts the demand in this sector at 86 m^3 per year, but we regard this as too low. In 1986 the per capita water consumption in the domestic sector was 97.6 m^3 and in 1989 110.0 m^3. This contrasts with the per capita water allocation to the domestic section which is only 75 m^3. This means that this sector over-utilized its water quota by 150 million m^3. In 1980 the total consumption of this sector was 350 million m^3 and in 1985 430 million m^3. At present, the domestic sector uses some 495 million m^3 of water per year and by the year 2000 Israel will need at least 685 million m^3 of water depending, of course, on population growth. The recent immigration to Israel means that Israel's population will probably grow at a more rapid rate over the next decade and water demand will consequently increase.

Water demand for industry

Israeli industries at present consume 110 million m^3 of water—some of it reclaimed sewage waters—but, by the year 2000, this sector will consume 145 million m^3 (Schwartz 1986; *Israel State Comptroller Report* 1987).

The water balance of Israel—some concluding remarks

A political-ideological setting which has always favoured the agricultural sector is partially responsible for the negative water balance of Israel (Lowi 1991). Another major factor which has brought the water resources of Israel to their grave state is the multiplicity of authorities which manage water resources and pursue policies which are usually uncoordinated and often contradictory. The water planning authority, Tahal, planned a water economy based on an over-estimated water supply of 2.0 billion m^3. The two other offices responsible for the management of water and provision to the consumers, Mekorot and the Water Commissioner's Office, did not respond to a continuing process of depletion in water resources which ultimately created severe water shortages, so that in 1990–1, Israel's accumulated water deficit reached 2.0 billion m^3. In an average year, water supply is 1.5–1.7 billion m^3 and demand exceeds this supply by 100–200 million m^3. The above supply has not been available in recent years because of low rates of precipitation, and the deficit between 1987 and 1989 was 8–14 per cent for each year.

Among the measures recommended to offset the danger of this confusion are the following: establishing an independent body to deal with all aspects of water provision; introducing reforms in water allocation and water pricing. But the most important reform needed is the de-politicization of the water economy by removing the responsibility for water allocation from the farmers. Israel (and its neighbours) should acknowledge that water is a finite resource and recognize that, in Israel, all its renewable resources are, at best, 1.70–1.80 billion m^3. As we have stressed, Israel should limit its water consumption to this level.

Water demand and supply in Gaza and the West Bank

Water and land are the most important resources of the West Bank and Gaza Strip and will play a crucial role in any plan for the future of the Occupied Territories. The water resource, being a scarce resource in the West Bank and Gaza—as it is in Israel—is going to be the most difficult resource to divide (or share). In this section we shall discuss the complex, intertwined and inter-tangled state of water resources.

Water demand and supply in the Gaza Strip

The total population of the Gaza Strip was 390,000 in 1967, 633,000 in 1987 and more than 680,000 in 1990 (*Israel Statistical Abstracts* 1990). The Gaza Strip, with a very high population density rate—1,730 people per km^2 compared with 198 in Israel and 193 in the West Bank—is an extremely poor area which lacks any resources except for water and land, all of which are over-utilized.

The Gaza Strip is an area of 360 km^2 with a rainfall averaging between 200 and 300 mm in its southern part and 300–400 mm in its northern part. As a result of the combination of the semi-arid climate and a rapid population growth, the water resources have been virtually exhausted and groundwater from the sandstone aquifer located 10–15 m below the surface remains the only source of water in the Gaza Strip.

The arithmetic of Gaza's water resources is simple: the natural replenishment of the aquifer is 60 million m^3 whereas demand is 100–120 million m^3 per year (Kally 1986:75), leaving a deficit of 40 million m^3 (Shawwa 1992:16). The gap between supply and demand is met by overpumping which has led to a drop in the water table by an average of 15–20 cm per annum and an increasing salinization of wells. According to Palestinian sources, the overpumping has been exacerbated by new wells dug for Israeli settlements set up along the Strip, and projects to replenish the aquifer with rainwater have been stalled because sewage from the city's drains is leaking into the water canals (Pearce 1991:39). Approximately 60 per cent of the water sources in Gaza have over 400 mg of chlorides per litre. Over-utilization of the underground sources has continued for more than 30 years and the process of seepage of saline water from the sea into the coastal aquifer has been going on for a long time (Kahan 1987:3). Of a total consumption of 100–120 million m^3, 40 million m^3 is used by the domestic sector (1991) and 60–80 million m^3 is used for irrigation (Shawwa 1992:19). The method of irrigation is simple, consisting of more than 2,195 boreholes which farmers have drilled in the local aquifer, generally without any control. Restrictions against digging new boreholes for farming purposes were imposed in the mid-1970s but permits continue to be granted for the extraction of drinking water (Benvenisti and Khayat 1988:113). The total irrigated area of the Gaza Strip increased from 18,700 ha in 1966 to 20,000 ha in 1985–6.

The area of cultivated land increased from 18,700 ha in 1966 to 20,000 ha in 1985–6, but only 16,800 ha in 1990 (Kahan 1987:19; Shawwa 1992:16). About 50 per cent of the total cultivated area is irrigated at present, compared with 40 per cent in 1966 (Kahan 1987:19). The irrigated area is reduced because of the high salinity of wells and the great water deficit.

What are the measures to expand Gaza water supply?

The first option which was examined carefully and is under implementation is Gaza Storm Water Project which collects storm water in order to recharge the water table with some 2.0 million m^3 a year. The second option which was examined is the construction of sea water desalination plants which will provide fresh water at a cost ranging between 48 and 100 cents/m^3 (Shawwa 1992).

The other options suggested are options which are disputed between Israel and the Palestinians. The Palestinian sources complain that the flow of water in Wadi Gaza that used to reach the Gaza Strip is stopped by Israel (Shawwa 1992). They estimate that some 20–30 million m^3 of water from this source could be used by the Palestinians (Elmusa 1992). Elmusa also claimed that Israel intercepts groundwater from the coastal aquifer that would otherwise flow to Gaza— his estimate is that 50–60 million m^3 of water is intercepted this way. Israeli hydrologists claim that there is no significant connection between the Gaza aquifer and the Israeli aquifer (Elmusa 1992:11).

The eighteen Jewish settlements in the Gaza Strip consume 3.3 million m^3 of water with 92 per cent of the water going to the agricultural sector (Kahan 1987: 106). A resource conflict has developed between the Jewish settlements located on the fertile land with its nearby water aquifer which they can utilize and the Palestinian residents of the Gaza Strip.

Water demand in the Gaza Strip will reach 200–250 million m^3 by the year 2000 (Kally 1986:75). According to Moore (1992a, b) total demand in Gaza for that year will be only 109.0 million m^3 without an established Palestinian state and 123.0 million m^3 with it. As for the domestic sector, its total real usage of potable water was 19.8 million m^3 whereas demand amounted to 22.2 million m^3, the deficit of 2.4 million m^3 being met by pumping brackish water (Benvenisti and Khayat 1988:114). As has been pointed out, Palestinian sources estimated the domestic sector water demand in Gaza as 40 million m^3; therefore by the year 2000 this sector will need at least 45 million m^3 of water. By the year 2000 the Gaza Strip will have a total water deficit of about 140–190 million m^3 and that enormous amount will have to be met by importing water from outside the region and by desalinating sea water. Gaza, therefore, should have first priority for any project which will increase its water supply. A desalination project which would share water between the Israeli Negev (particularly Beer Sheba) and Gaza was suggested in 1992 (Zaslavsky interview, 13 March 1992).

Water demand and supply in the West Bank

The water and land resources of the West Bank present the most important obstacle to any possible political solution for the conflict situation in this region. Israeli settlers have taken hold of some 31 per cent of the cultivated land since the occupation of this area by Israel in 1967 (Kahan 1987:111). The situation is especially complex in the case of water resources since nature has made the West Bank and Israel unwilling partners to the same underground water source: the mountain aquifer, and the Schem-Gilboa aquifer. Before the Six Day War of 1967, when Israel took control of the West Bank and the Gaza Strip, Israel was already abstracting 480–500 million m^3 of water a year from these two aquifers whereas the Arabs of the West Bank pumped just 40 million m^3 water a year from them (Shuval 1991a; Baskin 1992:3). The mountain aquifer still provides about 20–40 per cent of Israel's water depending on the amount of rainfall (Pearce 1991:36). Any future political solution for the region will have to take the water needs of these two unwilling partners into consideration. The Jewish settlements on the West Bank also use the eastern aquifer.

The West Bank had a population of 900,000 in 1990 and, by the year 2000, is expected to have a population of 1–1.3 million people (*Israel Statistical Abstract* 1989:721). Some 32 per cent of the population of the West Bank is employed in agriculture and its contribution to the GDP of the West Bank was 34.5 per cent for the period 1979–81 and 25.4 per cent for 1983–5 (Kahan 1987:14). The total area of the West Bank is 5.8 million dunums (580,000 ha) and some 2.0 million dunums (200,000 ha), or 36 per cent of the total area, is cultivable.

West Bank rainfall is 600–800 mm on the mountain ranges of Judea and Samaria, 500–600 mm on the western slopes of the mountain, 250–400 mm on the semi-arid southern zone, and less than 200 mm in the southern Jordan Valley. Much of the precipitation is lost through evapotranspiration and the usable reserves (naturally replenished) have been estimated at close to 400 million m^3 of water (Kahan 1987:1).

The overall consumption of water in 1967 in the West Bank amounted to 80– 100 million m^3 per year, 4–6.5 per cent of which was used in the domestic sector and 93.5–96 per cent was allocated to the farming sector (Kahan 1987:2). This total demand represented no more than 22 per cent of the water potential of the West Bank. Based on the Helsinki Rules which stress that patterns of utilization may be used as a basis for water allocation, these low rates of utilization could prevent the West Bank Palestinians from expanding their water utilization patterns.

It is also of consequence that whereas the Helsinki Rules do consider prior use as an important criterion for future water allocation, the ILC Rules do not recognize prior use as a valid criterion for equitable water division. In this case, the prior usage of Israel (or Jordan and Syria) is not going to affect the future utilization of the Jordan-Yarmuk waters by all the co-riparians including the Palestinians. Until now, according to various sources, Israel has restricted Palestinian water consumption to 20 per cent of the shared aquifers and the Palestinians have been prevented by the Israeli authorities from increasing their abstractions or digging new wells (Pearce 1991:36; Young 1991:23).

Arab sources state that Arab villages on the West Bank have lost their water supplies allegedly as a result of abstractions by Jewish settlements. Pearce has observed that in the politically charged atmosphere on the West Bank it is impossible to be sure about such accusations; but, even if the springs and wells are naturally drying up, the Palestinians have been prevented by Israeli restrictions from finding alternative sources of water for their fields. They are only allowed to dig wells for tap water (Pearce 1991:39). The disparity between the water allocations to Jewish and Arab settlements on the West Bank is enormous: the 100,000 Jewish settlers are allocated 160 million m^3, whereas the Palestinians were allocated, according to various sources, between 120 and 160 million m^3 of water. (Some of the differences are explained by the inclusion of East Jerusalem within the West Bank by Palestinian sources whereas Israeli sources include East Jerusalem with Israel.) (See Al-Khatib 1992; Baskin 1992: 3–7.) The Palestinian quota of 130 million m^3 represents only 20 per cent of the rechargeable groundwater reserves of the West Bank estimated as ranging from 580 million m^3 to a maximum of 710 million m^3 (Elmusa 1992:9). The average aggregate per capita consumption for the Jewish settlements ranges between 90 and 120 million m^3, whereas for Arab settlements the consumption is only 25– 35 m^3 per capita (Elmusa 1992:12). Another source estimates water consumption per capita in Palestinian villages at 15 m^3, and at 35 m^3 in Arab towns (Benvenisti and Khayat 1988:26).

In the mid-1980s only 104,000 dunums (10,400 ha) (out of 1,640,000 million dunums which were cultivated) were irrigated and this constituted 6.5 per cent of the cultivated land. During 1981–5 the cultivated land was reduced by approximately 20 per cent because of the drought conditions and the poor distribution of rain but, in the same period, irrigated land increased from 92,000 dunums (9,200 ha) to 104, 000 dunums (10,400 ha). Irrigable land in the West Bank as a whole is estimated at 535,000 dunums or 50, 000 ha (Kally 1986:110; Benvenisti and Khayat 1988:25). Thus, only one-fifth of the irrigable land is, in fact, irrigated in practice. It is estimated that a water allocation of 300 million m^3 will be needed for full realization of all the Palestinian irrigable land of the West Bank (Kally 1986:45) but only 90–100 million m^3 annually have been set aside by the Israeli authorities for the use of Palestinian agriculture (Jacobson 1990: 31; Baskin 1992). It has also been estimated that about 40 per cent of the irrigation water used in the West Bank is wasted because of inefficient irrigation (Lipschitz 1976).

In conclusion, there is no doubt that the shared groundwater resources of the West Bank are over-utilized by Israel (with an accumulated deficit of 100–200 million m^3). One-quarter to one-third of Israel's annual water supplies—some 475–500 million m^3—originates from the West Bank aquifers. The Palestinians who are restricted by Israel to only 20 per cent of the renewable groundwaters of the West Bank demand a more equitable share in the water resources of that area. Elmusa (1992), for example, estimated that the amount of the shared Palestinian-Israeli water resources comprised 480–535 million m^3 of groundwaters and 100 million m^3 of water from the Jordan and that that amount should be demanded (Elmusa 1992). Both Palestinian and Israeli specialists agree that water allotment to the Palestinians in Gaza and the West Bank should expand, as soon as possible. Two proposals for equitable water allocations which were

Table 3.16 Baseline minimum allocations for Israel, the Palestinians and Jordan (year 2022)

	Population (millions)	*Baseline fresh water (millions m^3/year)*	*Recycled water (millions m^3/year)*	*Total fresh and recycled (millions m^3/year)*
Palestinians	5	625	325	950
Jordan	7	875	455	1,330
Israel	10	1,250	650	1,900

Source: Shuval 1992

submitted in 1992 will be presented. The first includes Jordan as a co-riparian whereas the second proposal relates only to Israel and the Palestinians.

Shuval based his proposal on the assumptions that all the parties are entitled to an equal allocation of per-capita water divided into three categories according to its quality (Table 3.16). Prime quality water will be allocated at an equal quota of 100 m^3 per person per year, which will be used in the domestic and industrial sectors, and 25 m^3 per year will be allotted for agriculture.

The Palestinian water quota will come from the eastern aquifer (200 million m^3) and from the Jordan river (100 million m^3)—depending on the completion of the Al-Wahda Dam. The West Bank might also obtain additional water directly from the Litani or from the Turkish Peace Pipe (Shuval 1991b, 1992).

Another proposal for equitable water allocation was suggested by Moore (1992b). Moore suggests two scenarios: the first in which there is no final settlement between Israel and the Palestinians and the second in which an independent Palestinian state is established. Water resources are divided to exclusive resources and shared or transboundary resources. In both cases Israel will have for its exclusive use 573 million m^3 of groundwater, 650 million m^3 of surface water and 235 million m^3 of flood and recycled water. From the shared transboundary water resources Israel will utilize 450 million m^3 without final settlement, but only

364 million m^3 with an independent Palestinian state. The West Bank Palestinians will have exclusive groundwater of 100 million m^3 and their quota of transboundary groundwater will expand from 95 to 181 million m^3 if a Palestinian state is established (Moore 1992a, b).

The above scenarios assume that both Israel and the Palestinians will have water deficits of 136.4–222.4 and 45.5–58.0 respectively—the lower values represent the scenario of an established Palestinian state by the year 2000.

There is little doubt that the two proposals offer a more equitable water division between Israel and the Palestinians. However, they do not take into consideration all the relevant Helsinki and ILC Rules and their scope is narrow. Also, the proposals do not provide any mechanism for supervising the utilization of the common water resources and enforcing the agreed quotas. Without such arrangements any agreement will be founded on shaky grounds and may eventually collapse.

The Helsinki and ILC Rules and the patterns of water supply and demand in the Jordan-Yarmuk basin

The supply and demand patterns in the drainage basin of the Jordan-Yarmuk reveals five features, as follows: First, all the surface water and groundwater resources are over-stretched and over-utilized. Second, only in the case of two of the co-riparians, Syria and Lebanon, does water supply surpass water demand; in Israel and Jordan demand is higher than supply and this creates a constant deficit in the water balance. Third, for three countries, Syria, Jordan and Israel, the proportion of their international water resources is very high. Syria has more than 90 per cent of the water resources shared with her neighbours Turkey, Iraq, Israel, Lebanon and Jordan. Jordan gets more than 36 per cent of its water from sources shared with Syria, Palestine and Israel. About 50–60 per cent of Israel water resources are shared with Syria, Lebanon, Jordan and the Palestinians. This special feature of the region adds extra difficulties to any agreement on water division. Fourth, technological solutions to the supply problem have a special appeal in this basin, especially large-scale desalinization projects for Israel, Jordan and the Palestinians and perhaps sophisticated measures to increase the efficiency of irrigation technologies and irrigation methods. Methods to re-use water resources and brackish water resources are also important in this region. Fifth, the regional dimension of available water resources is very significant in this area. The Yarmuk waters are necessary for the development of the Syrian Golan Heights and the fact that Syria has a water surplus in other parts of the country (such as in the Euphrates basin) does not bear any significance on Syria's readiness to give up her right to utilize the Yarmuk. On the other hand, Israel needs the water outside the Jordan-Yarmuk basin whereas Jordan needs to utilize the water mainly within the Jordan Valley. Many of these issues, however, are not dealt with at all by either the Helsinki Rules or the ILC Rules.

The Helsinki Rules which need to be discussed in connection with supply and demand patterns are in Chapter 2, Articles V(g)-V(k). Article V(i) stresses the need to avoid unnecessary waste in the utilization of the basin water and can be taken as a very useful rule for the saving of precious water which might otherwise be lost in the poorly maintained urban water delivery systems of both Jordan and Israel. This is also true of the large water losses in the irrigation systems of Syria and Jordan. Saving water in these sectors could increase the water supply for all the co-riparians. Article V(k), which calls for the satisfaction of the needs of one basin state without causing damage to the other co-riparians, is of extreme importance in this basin. Syria (and Israel), by expanding their utilization of the Yarmuk, have limited the quantities of Yarmuk water available to Jordan. Israel limits the quantity of water the Palestinians can use in both Gaza and the West Bank and all the co-riparians are to blame for the deterioration in water quality which they cause by over-utilization of both surface water and groundwater resources.

Article VII of the Helsinki Rules states that: ‘A basin-state may not be denied the present reasonable use of the waters of an international drainage basin to reserve for a co-basin state a future use of such water’. This may jeopardize the water resources of a future Palestinian state since Israel and the other co-riparians do not feel themselves obligated to ‘free’ waters which they are using for the future Palestinian entity. However, the present restricted water allocations for the Palestinians violate the spirit of the Helsinki Rules on equity and the Palestinians’ rights to an equal share in the common water resources. Article VIII of Chapter 2 also mentions that existing water use may be modified or terminated so as to accommodate a competing incompatible use. This is a very important rule and two sets of changes may take place because of it. First, within a country, priority may be given to the water needs of the urban/domestic sector or the hydro-power sector over the agricultural sector. Such a change needs to be made, especially in Syria and Israel, if the total supply available to the co-riparians is to grow. Second, priorities for water allocation may also change for states or entities, according to their changing needs.

Finally, at least one rule evolved by the ILC Rules has special value in the Jordan-Yarmuk Basin. This is Article 6(e) which stresses the need for conservation, protection and development of the economical use of water resources. The Jordan-Yarmuk basin, more than the Nile or Tigris-Euphrates, needs measures of conservation and protection of both surface water and groundwater resources. The co-riparians have to economize on their water resources by putting the right price-tag on them—a process which will eventually eliminate wastage and encourage more efficient water use. Technological knowledge accumulated in Israel in relation to drip irrigation, de-salinization and utilization of brackish water resources as irrigation water is an important asset which Israel can transfer to its Arab neighbours when co-operation in the utilization of common water resources is instituted. The lack of regional co-operation is certainly more harmful in the Jordan-Yarmuk basin than in either the Nile or Tigris-Euphrates.

SOCIAL AND ECONOMIC FEATURES OF THE JORDAN-YARMUK STATES AND THEIR IMPLICATIONS FOR JORDAN-YARMUK WATER UTILIZATION

Social and economic facets of development

Tables 3.17 and 3.18 show the discrepancy between the state of development of Lebanon, Syria and Jordan, on the one hand, and Israel on the other. The indicators of life expectancy, infant mortality and adult literacy in Jordan, Syria and Lebanon place them amongst the least developing countries, whereas Israel

Table 3.17 Selected social indicators of the Jordan basin countries

Country	*Life expectancy at birth (years) (1990)*	*Infant mortality per 1, 000 live births (1990)*	*Adult illiteracy (1990) (%)*	*Average annual population growth 1990–2000 (%)*
Syria	66.1	43	36	3.6
Jordan	66.9	51	20	3.3
Israel	75.9	10	95	1.5
Lebanon	65.0	45	20	2.1

Sources: World Bank 1992; World Resources Institute 1992–3; *Human Development Report* 1992

shows more similarity to the more advanced ones. In this respect, the saddest situation is that of Lebanon which, until the mid-1970s, was one of the more progressive states in the Middle East. The incessant communal conflicts have reduced this country to a sorry state and reconstruction will most probably be very difficult. The economic indicators are only partial or are unavailable for Lebanon, and partial or old for Jordan and Israel. The per capita GNP of Israel is generally four times higher than the GNP of its neighbours but Israel, like Jordan, is burdened by long- and short-term debts. None of the riparians is hampered by populations too large to support but Jordan and Syria have a very high average annual population growth rate (see Tables 3.17 and 3.18).

Based only on social and economic indicators, Jordan, Syria and Lebanon are clearly entitled to receive priority in water allocation from the Jordan-Yarmuk as their need is great. Israel, although plagued with a very high foreign debt, has an

Table 3.18 Selected economic indicators of Jordan basin countries

Country	*GNP in $ 1990 (per capita) ($)*	*Average GNP annual growth 1980–8 (%)*	*Population size 1990 (millions)*	*Average annual population growth 1995–2000 (%)*	*Total long-term debt as percentage of GNP 1989 (%)*
Syria	1,100	3.1	12.6	3.45	25.0
Jordan	1,730	−1.4	4.0	3.19	148.0
Israel	9,750	1.4	4.6	1.42	67.2 (1988)
Lebanon	880	n.d.	2.7	1.98	n.d.

Sources: World Bank 1992; World Resources Institute 1992–3; Allan and Lantz 1990–1; *Human Development Report* 1992

Note: n.d., no data available.

advanced economy based on manufacturing and services and its dependence on agriculture is smaller than that of Jordan and Syria.

The battle between population growth and food production

As in the case of the Nile and the Tigris-Euphrates, there is a certain degree of dependence on agriculture as Tables 3.19 and 3.20 show. Dependence on employment in the agricultural sector is much higher in Syria than among her co-riparians, although Jordan and Lebanon have a relatively high proportion of their labour employed in agriculture—especially compared with European countries. Syrian dependence on the agricultural sector is also revealed in the very high contribution of agriculture to the GDP. Agriculture contributes only 8–10 per cent of the GDP among the other co-riparians while its contribution to the Syrian and Jordanian export national account is very significant. All the co-riparians of the Jordan-Yarmuk basin are dependent on food imports and food aid as Table 3.20 demonstrates.

Food import and food aid have become a crucial element in the fragile economies of all four partners to the basin. One measurement of dependence on food importation is the food import dependency ratio which is calculated as the sum of food production plus food imports minus food exports, and is presented as percentage. This ratio for Syria is 29.1 per cent and for Jordan 85.2 per cent— a very high level of dependence. Syria did not perform very well on the food production index in the 1980s whereas Jordan performed well. There are no data for Israel and Lebanon in this matter. What is common to all is that the co-riparians had to expand their food imports and the USA has become a major source of food aid and food exports to the Middle East. It is possible to describe the food situation in the region as subject to 'food politics' where food has become an important weapon or leverage mechanism to advance pro-American policies among the countries of the region.

Table 3.19 Agriculture and population growth in the countries of the Jordan basin

Countries	*Agricultural employment (1985–8) (%)*[a]	*Agricultural contribution to GDP (1990) (%)*[a]	*Percentage contribution to exports (1988) (%)*[b]	*Average annual growth rate in agriculture (1980–90) (%)*[c]	*Index of food production per capita (1979–81=100) (1988–90)*[c]
Syria	24.9	28	25	–0.6	83
Jordan	10.2	8	10	4.1	113
Israel	4.9	10	13	n.d.	100
Lebanon	14.3	8	16.2 (1977)	n.d.	145

Sources: [a]Allan and Lantz 1990–1; [b]World Bank 1992; [c]*Human Development Report* 1992

Table 3.20 Food importation in the Jordan basin

Countries	*Cereal imports (thousands of metric tons) 1990*	*Food aid in cereals (thousands of metric tons)*		*Food imports as percentage of merchandise import 1990*	*Food import dependency ratio 1986–8*
1974–5	*1989*				
Syria	2091	47	31	17	29.1
Jordan	1491	79	25	19	85.2
Israel	1802	53	2	7	n.d.
Lebanon	356	26	32	n.d.	n.d.

Sources: World Bank 1992; World Resources Institute 1992–3

Branches of the economy other than agriculture are no more promising. Lebanon does not have any minerals or cheap energy, and in the past its economy was based on human resources and the country's evolution as a trade and financial centre of the Middle East. But the sixteen years of civil war and the 1990–1 Gulf crisis have significantly reduced the remittances that Lebanon receives from Lebanese who work in the Gulf. The average per capita income of Lebanon has fallen from $1,150 in 1987 to $900 in 1990. Approximately one-quarter of the labour force is unemployed, the country suffers from hyperinflation, and the water, roads and electricity infrastructures hardly function (*Reuters* 8 September 1990). There is no doubt, however, that Jordan is in the worst economic situation for Jordan is not well endowed with mineral wealth and needs to import oil and other necessary commodities (Kanovsky 1989). It is rich in phosphate deposits and large amounts of potash which are mined at the Dead Sea and exported. Even before the Gulf crisis the Jordanian economy was unable to cope with its fast-growing population and food shortages. The Jordanian newspapers frequently report bread and food shortages as well as electricity and water shortages. Since 1990, Jordan has been paying higher bills for its oil imports and remittances from Jordanian workers in the Gulf, which had steadily decreased during the 1980s, have finally come to a halt (*MEED* 21 November 1987; *Economist* 28 July 1990).

In the summer of 1990 the United Nations acknowledged Jordan's severe economic crisis and was in the process of preparing an aid package for that country. An estimate has been made that Jordan's direct losses from Iraq's invasion of Kuwait and the Gulf War are $2.0 billion a year (*Reuters* 23 August 1990). The World Bank has estimated that by the end of 1991 the Gulf War losses of both Jordan and Egypt will reach

$2–4 billion (*Associated Press* 27 September 1990). Approximately one-quarter of Jordan's production capacity has been directly affected by the Gulf crisis and the ensuing war. Because of an annual inflation of 35 per cent, annual unemployment at 20 per cent, a negative balance of payments, an external debt of $7.3 billion and foreign currency reserves of less than $100 million, Jordan proclaimed a severe austerity regime in the fall of 1990. This means that Jordan is hard pressed over the water issue and needs to find a quick solution to its problems.

As for Syria, the economic crisis in this country started in the 1980s. Syria's trade balance and balance of payments are negative though it has succeeded in narrowing both during the last two years. It has very small foreign currency reserves and a per capita GNP estimated at $1,100 (1990).

Syria's stand in the recent Gulf War has brought it considerable dividends: Saudi Arabia and Kuwait have been generous in their aid and some of Syria's foreign debt has been erased from the books. Syria is able to export oil, cotton and phosphates (mainly to the former USSR) and new gas fields will enable Syria to produce much needed energy for electricity production.

Israel, a passive participant in the Gulf War has estimated its direct and indirect damages from the war at $2.0 billion. Israel's economy is highly developed but it is impaired by a lack of cheap sources of energy and raw materials. Inflation of 20 per cent and a relatively high portion of GNP dedicated to defence (20 per cent) weakens Israel's ability to compete in foreign markets. The current severe water shortage will cut water consumption for agriculture and will lead to a reduction in Israeli exports of agricultural produce—mainly citrus fruit, fresh vegetables and cut flowers.

To sum up, the economies and societies of the partners to the basin of the Jordan-Yarmuk are highly vulnerable to any restrictions in their water supplies; hence, the situation is highly volatile and may well explode. War over water resources in this region is not anything new as the next part of this chapter will show.

Conclusions—the Helsinki and ILC Rules and economic and social features of development in the Jordan—Yarmuk basin

The relevant Helsinki Rules are those which refer to the economic and social needs of each basin state, the population dependent on the basin water in each basin state, and the availability of other resources (Chapter 2, Articles V(e), V(f), V(h)). The relevant ILC Rules are in Article 6(e). It is interesting to note that the ILC Rules do not consider a population's dependence on water as a factor for equitable water allocation.

According to these rules, Jordan and Syria will be preferred in any process of water allocation and Lebanon and Israel will follow. Again, the fact that the Helsinki and ILC Rules give equal weight to all the factors is found to be quite limiting. For example, applying the Helsinki Rules equally to developing and developed societies might be discriminatory since developed societies (in this case Israel) could (for a price) develop alternative sources of income which could cover the cost of food importation. Again, it was found that as data on social and economic conditions, and on agriculture and food production, are collected for whole countries, and do not refer to their particular portions in the respective international river basin, it is impossible to apply principles of equity to the population which lives *within* the basin and which may (or may not) be dependent on its water resources.

It seems that a deliberate and compensatory discriminatory policy in the application of the Helsinki Rules to developed societies versus developing societies may be helpful. Accordingly, Israel would be judged according to the general strength of its society and economy whereas Jordan, Syria and Lebanon would be evaluated according to their direct dependence on irrigation water for agriculture and on their success in bridging the gap between population growth and food production. In this manner equity will be gained by enabling the developing societies to take advantage of a potential for future development which is found in the water resources of international rivers—in this case, the Jordan-Yarmuk system. But as is the case in the Nile and the Tigris-Euphrates basins, political variables such as those which shape a policy of 'food security' and the wish of countries to be self-sufficient in the production of basic foods prevail in the Jordan basin, too. These policies are still influential in Israeli agrarian policy. And the agricultural policies of Jordan and Syria are also still affected by political considerations of food security which have nothing to do with the Helsinki Rules for equitable water allocation (Allan 1983). Politics and legal issues will be the focus of the discussion in the next section. In the Jordan-Yarmuk basin geopolitical and legal issues are perhaps more decisive in the formation of co-riparian water policies than they are in the Nile and Tigris-Euphrates basins.

THE LEGAL AND GEOPOLITICAL SETTING OF THE JORDAN BASIN

There is no one single legal agreement which binds all the partners to the Jordan-Yarmuk basin, but there are several agreements between Jordan and Syria and a quasi-agreement (the Johnston Plan) which was more or less considered as binding by Israel and Jordan.

The first legal document relating to the Jordan-Yarmuk was the Franco-British convention signed on 23 December 1920. This agreement stipulated that the two parties would agree to nominate a commission to examine the employment of water for the purposes of irrigation and the production of hydro power with water from the Upper Jordan and Yarmuk and their tributaries after satisfaction of the needs of the territory under the French Mandate (Saliba 1968: 60).

The treaty of 3 February 1922 went even further in protecting the vested rights of the riparian states. It declared that any existing rights over the waters of the Jordan by the inhabitants of Syria should be maintained unimpaired. The treaty further stated that the inhabitants of Syria and Lebanon should have the same fishing and navigation rights as the inhabitants of Palestine on Lakes Huleh and Tiberias and on the River Jordan between these lakes (Saliba 1968:60).

In June 1953, Syria and Jordan signed an agreement concerning the joint development of the Yarmuk's waters. The agreement, or treaty, stipulated that Syria would receive 75 per cent of the electric power produced by the development of the Yarmuk waters whereas Jordan would be allowed to use most of the excess flow of the Yarmuk's water (Stevens 1965:37; Nimrod 1966:36; Saliba 1968:37). The treaty also called for a joint Syrian-Jordanian committee to supervise the execution of the plan. Since Syrian-Jordanian plans to build the dam(s) at Mukheiba (as part of the diversion plan) and/or Maqarin have not been implemented, the above treaty has become meaningless and the two countries have proceeded with their separate plans to develop the Yarmuk's waters. Syria has built water storages and developed agricultural projects based on irrigation in the upper parts of the Yarmuk basin and Jordan has constructed the East Ghor Canal which uses the Yarmuk's waters.

In September 1987 Syria and Jordan signed an agreement to build a dam in Maqarin with a live storage capacity of 150 million m^3. Jordan is entitled to at least half of the water impounded in the new dam whereas Syria will benefit from 75 per cent of the electricity to be produced by the dam. Israel is not a side to any agreement concerning water allocations from the Yarmuk since Syria does not acknowledge any Israeli rights to the Yarmuk's waters. Jordan, on the other hand, has acknowledged Israel's right to 25 million m^3 of the Yarmuk's water according to the Johnston Plan. At present, with the accelerated pace of Syrian development of the Yarmuk's water sources, it does not look as if the Maqarin Dam will have any practical value: its benefits are going to be very marginal, if there are any at all.

The only quasi-agreement which applies to Israel and Jordan is the Johnston Plan which is based on an exchange of agreements between the USA and Israel, on the one hand, and Jordan and the USA, on the other. But even for this agreement the two sides differ in their interpretations. According to the Israeli version of the agreement, Israel is entitled to the residue water remaining after Jordan uses 720 million m^3, Syria 132 million m^3 and Lebanon 35 million m^3, which represent their quotas from the Jordan-Yarmuk system, from a total of 1,287 million m^3. The Israeli quota has been variously estimated as 400–466 million m^3 (Stevens 1965; Nimrod 1966). According to the American and Arab versions of the Johnston Plan, Jordan is entitled to 377 million m^3 (Jordan and Yarmuk) and Israel 25 million m^3 (of the Yarmuk's water summer flow) while the Israeli version stipulates a quantity of 40 million m^3, including winter flow. This could be identified as a cognitive conflict between Israel and the Arab states.

The Jordanians refuse to recognize any legitimate status to the Israeli demand for water allocation from the Yarmuk for usage in the West Bank. It is important to note that, through American mediation, the two sides have had frequent discussions over the division of the Yarmuk's waters and do co-operate in technical matters concerning maintenance of the water flow in the river channel. Syria does not take part in these discussions. It is also important to note that Lebanon's right to a share of the Jordan's water according to the Johnston Plan has been almost totally ignored, except for the local usage by Lebanese citizens of the Hasbani waters.

The overt and covert conflict over the sharing or, more accurately, over the partition of the Jordan-Yarmuk waters is aggravated by the all-embracing Israeli-Arab conflict which is charged with high levels of hostility (Nijim 1971; Naff and Matson 1984:53). This conflict affects almost all areas of contact between the Arab states and Israel. First, and most importantly, the conflict is ideological and political and the Arab stand has been well expressed by Hadawi (1967) who claimed that the Arab Yarmuk project was designed not to divert water from anybody (Israel) but to put it to better use entirely within the river bed of the Jordan Valley (Hadawi 1967:285). Hadawi, however, does also refer to the political implications of the Israeli National Carrier. According to him, the purpose of Israel's National Water Carrier is (1) to utilize every tract of land and thus make it impossible for the Palestine Arabs to return to their homes and lands; (2) to make room for a greater influx of Jewish immigrants in order to expand further into Arab territory and realize the Zionist dream of an 'empire' from the Nile to the Euphrates; (3) to render ineffective all United Nations resolutions and directives on Palestine (Hadawi 1967:286).

Ideological facets of the Arab-Israeli conflict are also reflected in the Arab opposition to Israel's plans to expand its agriculture (with the Jordan's water) in the Negev and thus settle southern Israel—a process which might foil any Arab plan both to restrict Israel's growth and to boycott it economically and politically (Nimrod 1966; Saliba 1968:74).

Israel has also increased the volatility of the situation by shifting the site of its National Water Carrier to the demilitarized zone, thus provoking Syrian military action which threatened to shatter the armistice agreements (Nimrod 1966:28; Naff and Matson 1984:33). Nimrod (1966) speculated about the real Israeli political motive in this matter which, he suggests, was to claim sovereignty over the area. United Nations intervention and American economic pressure on Israel were needed before Israel withdrew from its plans to start the National Water Carrier in the demilitarized zone area near Jisr-Banat-Ya'aqub (Nimrod 1966: 29–30). On the Arab side, the diversion plan is obviously a clear manifestation of the ideological and political face of the conflict as its purpose is to prevent Jordan water from flowing into Israel, this being part of the Arab effort to harm Israel by affecting its ability to sustain a viable existence (Starr and Caelleigh 1983:129). It should be stressed that the Arab diversion plan, which aimed at diverting 125 million m^3 of water from the Jordan to Lebanon, Syria and Jordan, was neither economically viable nor profitable, apart from being very difficult to implement practically. Its only aim was political (Kally 1965:139–40; Inbar and Maos 1984:50).

In addition to the ideological facets of the Arab-Israeli conflict, the two sides also disagree over facts and thus are also involved in cognitive conflicts. These conflicts mainly revolve around the size of the water allocation that Israel is allowed to withdraw from the Yarmuk, or whether Israel may use water which originates in the rainfall over the West Bank and flows naturally into the Israeli aquifer. It is interesting to note that in matters concerning water resources Syria and Jordan differ in their attitudes towards Israel's needs: Syria tends to adopt an ideological and legal posture (ideological political conflict) whereas Jordan has abandoned its original position which was an attempt to deligitimize Israel and has adopted a position which is ready to accept Israel's rights for an increased water quota. As cognitive conflicts are more likely to be solved than ideological conflicts, this shift should be interpreted as progress in Israeli-Arab relations.

Finally, it should be emphasized that, unlike conflicts in the Nile or Tigris-Euphrates basins, the conflict in the Jordan drainage basin has been overtly expressed in a series of incidents which took place in the 1960s. The first major incident between Syria and Israel took place in 1951 at the site of the planned Israeli Water Carrier near Jisr Banat Ya'aqub (Golan 1983:855). The next five or six incidents took place near the sources of the Dan between Syria and Israel, and between 1964 and 1966 some fifty to sixty skirmishes took place in various locations along the Jordan River. In 1965 Israel bombed Syrian heavy equipment which was working on the Banias diversion canal and Israeli and Syrian forces have exchanged heavy fire over the Arab diversion plan at least twice. In 1965 Palestinian terrorist actions against the Israeli Water Carrier led to Israeli military retaliation and, in 1966, Israel's air force attacked Syrian works on the diversion canal (Golan 1983:856–8). All in all, according to Naff and Matson, eleven major incidents took place in the Jordan River system from 1951 to 1967 (Naff and Matson 1984:33). In fact there were periods in which fire exchanges took place every day and it was only the 1967 Arab-Israeli war and the resultant Israeli occupation of the Golan Heights which ultimately put an end to this 'water war'.

The above description, however, does not reveal a number of other facets of the Syrian-Israeli conflict such as Syria's objection to Israeli drainage of the Huleh swamps and the shooting incidents over fishing and navigation in Lake Tiberias (Lowi 1984:16–17). The multiplicity of conflicts has impaired all efforts to find a peaceful solution to the conflict over water. A question which arises in connection with these skirmishes is whether they also reflected a stakeholder conflict—namely, a conflict over regional dominance. Even if there were elements of regional struggle in this conflict, it does not seem to have been a major or important component of the Arab-Israeli conflict.

Another front opened was with Jordan. In 1969–71, as a reaction to PLO activity from Jordanian territory, Israel bombed the Ghor Canal as a means of putting pressure on Jordan to terminate the attacks. Israel initially refrained from damaging the East Ghor Canal, but when the PLO actions did not stop, it did cause damage. After secret negotiations, and with the mediation of the USA, Jordan was allowed to repair the canal in exchange for Jordanian reaffirmation of the Johnston Plan quotas and its pledge to terminate PLO activity from its territory (Naff and Matson 1984:46). Since then Israel and Jordan have solved their differences through negotiations.

Towards the end of the 1980s and the beginning of the 1990s, however, and as a result of the continuing drought and the growing need for water for the expanding population of the Jordan basin, the winds of war again returned to the region. The Jordanian Minister for Water and Irrigation blames Israel for 'stealing' 1.3 billion m^3 of water from the Jordan (*Ha'aretz,* Israel 18 July 1990). Jordan's King Hussein stated that the next war in the Middle East would focus on the scarce water resources (*Independent on Sunday* 15 May 1990). These gloomy forecasts have frequently appeared in the foreign and Israeli press, but both Arabs and Israelis have failed to negotiate a compromise which would satisfy some of their needs.

1992 was a year rich in rainfall and the above gloomy forecasts have not been fulfilled, but the sequence of events reinforces the need for a stable agreement between Israel and its neighbours over the equitable water allocation of the Jordan-Yarmuk waters.

Our final note will focus on the influence of outside water specialists on the inflammable Israeli-Arab conflict. Political analysts have a tendency to search for hidden political motives for Israeli actions and sometimes refer to Israeli actions and projects which have not been carried out. According to one analyst Israel, motivated by its 'hydraulic imperative', invaded Lebanon to capture the Litani in order to divert it later to Israel (Cooley 1983, 1984). In his testimony before the House Committee on Foreign Affairs on 26 June 1990, Naff stated that Israel was conducting a large-scale operation of trucking water to Israel from the Litani River (Naff 1990:7). There is evidence to refute these accusations, but they demonstrate the politicization of the conflict rather well. It is difficult to estimate how harmful this type of statement is but it is obviously not very constructive to Israeli-Arab negotiations over substantial issues.

In the spring of 1992, Israel, the Palestinians and the Arab states began their first series of negotiations which may eventually lead to an agreement over the establishment of a Palestinian political entity of one kind or another. Sharing water resources and the problem of Jerusalem are likely to be the most difficult problems to solve and specialists in 'water politics' could prove to be very useful in these negotiations.

CONCLUSIONS: PRINCIPLES FOR WATER ALLOCATION IN THE JORDAN-YARMUK BASIN

The major problem which confronts anyone who proposes the application of the Helsinki or ILC Rules to the Jordan-Yarmuk basin is that such rules (or suggested norms) are not suitable to a region which is in such a state of deep conflict over every issue. One has to assume that any process of equitable water allocation in this area must rely on a division of both surface water and groundwater sources and not on the possibility of co-operative sharing of the resources—

Table 3.21 Principles of water allocation in the Jordan-Yarmuk basin

Country	*Country share in area of Jordan-Yarmuk system %*	*Country water contribution to the Jordan-Yarmuk % %*	*Climate*	*Past and present utilization*	*Social and economic needs (1990)*	*Level of dependence on agriculture (1990)*	*Availability of other resources*	*Treaties and legal agreements concerning the basin*	*Notes and evaluation*
Lebanon			Mediterranean climate with large amounts of Precipitation	0.647 billion m^3 in 1975 (1.0 billion 1990) (only local use of the Hasbani); present use, 0.7–0.8 billion	Income 880 Pop. growth 1.98 Agric. growth n.d. L. exp. 65.0 Inf. mor. 45[a]	Food importation n.d.	Economy devastated by civil war	None	Middle-income economy

Country	*Country share in area of Jordan-Yarmuk system %*	*Country water contribution to the Jordan-Yarmuk % %*	*Climate*	*Past and present utilization*	*Social and economic needs (1990)*	*Level of dependence on agriculture (1990)*	*Availability of other resources*	*Treaties and legal agreements concerning the basin*	*Notes and evaluation*
				m^3 without Jordan tributaries					
Northern basin	24%	25%							
Southern basin	–	–	Agric. in GDP 8%	Lower-middle-income economy					
Syria			Mediterranean to semi-arid climate in the Syrian Golan	6.0 billion m^3 (1975); 6.0–6.4 billion m^3 (1990); 150–160 million m^3 of water from the Yarmuk	Income 1,100 Pop. growth 3.45 Agric. growth −66.1 L. exp. 66.1 Inf. mor. 43	Food importation 17%	Oil, phosphates	Franco-British Convention (MA); 1953 Treaty (for utilization of the Yarmuk); 1987 Agreement for utilization of the Yarmuk	Middle-income economy [b]
Northern basin	38.0%	27%							
Southern basin	41.0%	50%	Agric. in GDP 28%	Upper-middle income[b]					
Israel			Israeli portion in the Jordan basin has Mediterranean climate	Israel's total use is 1.7–1.8 billion m^3; 500 million m^3 from the Jordan, 100	Income (1987) 9,750 Pop. growth 142 Agric. growth n.d.	Food importation 7%	Potash, phosphates, manufactured goods	Johnston Plan	Upper-income economy

				million m^3 from the Yarmuk	L. exp. 75.9 Inf. mor. 10				
Northern basin	38%	47.3%							
Southern basin	13.6%	7.2%	Agric. in GDP 10%	Upper-middle income[b]					
Jordan			Jordan part in Jordan-Yarmuk is arid to Mediterranean climate	0.375 billion m^3 (1975); 0.780 billion m^3 (1990); Jordan withdrawn 100–125 million m^3 from Yarmuk and 280 million m^3 from Lower Jordan tributaries	Income 1,730 Pop. growth 3.19 Agric. growth 4.1 L. exp. 66.9 Inf. mor. 51	Food importation 19%	Potash, phosphates	Johnston Plan; Franco-British Convention 1920 (MA); 1922 Treaty (MA); 1953 Treaty (for utilization of the Yarmuk); 1987 Agreement	Middle-income economy[b]
Northern basin									
Southern basin	45.4%	42.8%	Agric in GDP 8%	Lower-middle income[b]					

Sources: World Bank 1992; World Resources Institute 1992–3; Allan and Lantz 1990–1; Beaumont, Blake and Wagstaff 1988; Ben-Aryeh 1965; Nimrod 1966; Karmon 1971; Naff and Matson 1984; Gilead 1988; Salik 1988

Notes: MA, Mandatory Agreement. Units of measurement as in Table 2.19 pp. 172–7.

[a] Estimate for 1985–90.

[b]Lower-middle-income economy, developing country with 1985 GNP per person of $400 or less; middle-income economy, developing country with 1985 GNP per person of $401 or more; lower-middle income, countries with per capita income ranging between $401 and $1,600 (1985); upper-middle income, countries with per capita income ranging between $1,600 and $7,500.

Definitions are based on World Bank (1987).

at least not yet. It is also important to achieve a state of equity in this division, not only between Israel and its co-riparians (including the Palestinians) but also among the Arab co-riparians themselves. Based on these assumptions, the proposal for water allocation in Table 3.21 divides the units of water allocation into two: the northern and southern basins of the Jordan-Yarmuk. This is done in order to separate the utilization patterns of the co-riparians as much as possible. It is important to note that the Palestinians are not included in Table 3.21 as it is not clear what their definite territory (which includes water resources) will be. However, we shall try to suggest a water allocation and sources for such a quota in the final analysis.

According to the climate, hydrology and geomorphology of the northern basin of the Jordan-Yarmuk, Lebanon is entitled to about 20–25 per cent of the surface water, Syria to 30–35 per cent and Israel to 40–50 per cent. In the southern basin of the Jordan-Yarmuk system, Jordan and Syria deserve to receive most of the water—about 90–95 per cent—and Israel is entitled to the remainder. Perhaps Israel's current use of Yarmuk water (about 50–70 million m^3) will be diverted to Palestinian use, together with groundwater from both the mountain aquifer and the eastern basin aquifer. Here the weaknesses of the Helsinki Rules are again exposed in that, if the rule which stresses water contribution were fully applied, both Israel and Jordan would receive smaller amounts of water. For these two countries it is important to apply the Helsinki and ILC Rules which emphasize the degree of dependence on the Jordan-Yarmuk waters. Nearly one-third to 40 per cent of the water supply of these two countries is tied to the Jordan-Yarmuk system; hence, their level of dependence is extremely high. Both Lebanon and Syria are clearly less dependent on the Jordan-Yarmuk waters and could develop their farming and domestic water demands without affecting Israel and Jordan. The existing patterns of water utilization clearly show that Syria and Israel have extended their utilization of the Jordan-Yarmuk water to such a degree that it has upset the water supply of Jordan and the Palestinians and the two countries will have to limit their usage, particularly in agriculture. Looking at the social and economic indicators which characterize the co-riparians we again see a rapid pace of population growth in Syria and Jordan (and the Palestinians); Israel's population has also expanded at a rapid pace owing to immigration from the former Soviet Union and from Ethiopia. Syria, and to a lesser degree Jordan, are dependent on agriculture for supplying the basic requirements of life; Israel is not dependent on farming to this degree but farming is a way of life and the farming sector is supported by strong political allies. Thus, any restriction on water allocation allotted to this sector is going to face major difficulties.

The availability of other resources, and particularly the viability of its economy, puts Israel in a better position than its Arab neighbours or the Palestinians. It is also important to note that Israel has the technological expertise to extend its utilization of second grade water, flood water and de-salinated water. All the co-riparians to the Jordan basin are remiss because of

Table 3.22 The relative ranking of the Jordan-Yarmuk co-riparians according to the Helsinki and ILC Rules

Features	*Lebanon*	*Syria*	*Jordan*	*Israel*
Country share in area of drainage basin	4	1	2	3
Country's water contribution	4	1	3	2
Climate	4	2	1	3
Patterns of utilization				
Past	4	2	1	3
Present	3	2	1	1
Social indicators				
Life expectancy	1	1	2	3
Infant mortality	3	2	1	4
Economic indicators				
Per capita GNP ($)		3	2	4
Total debt		2	1	2
Total population (1990)	4	1	3	2

Features	*Lebanon*	*Syria*	*Jordan*	*Israel*
Average annual population growth	4	1	2	3
Cereal import	4	2	3	1

Sources: As for Tables 3.1, 3.2, 3.5, 3.17, 3.18

wasteful and non-economical patterns of water utilization and all need to adopt immediate and urgent measures to conserve their water resources.

The relative ranking of the co-riparians of the Jordan-Yarmuk river basin reveals Lebanon's marginal place in this basin and her needs will certainly not receive any priority in the future (Table 3.22). Jordan ranks high on many of the indicators and, relatively speaking, should receive large amounts of water from the Jordan-Yarmuk systems, according to the principle of equity. Syria is second to Jordan in its relative ranking in the basin, a fact which should entitle it to large amounts of water. Israel, according to its ranking on most of the above features, is placed third for equitable water allocation from the Jordan-Yarmuk.

Since all the water resources are over-stretched, any future equitable water allocation should be founded on two principles. First, not only surface water should be included in the total water resources available but also groundwater, and urgent measures must be taken in order to repair the grave situation of groundwater resources in both Israel and Jordan. This can only be done if the two countries divert surface water to replenish underground water resources.

Second, an equitable water allocation will primarily assign quotas of first grade water for the consumption of the urban domestic sector for *all* the co- riparians. This means that about 450–500 million m^3 will be allocated to Israel, 400–450 million m^3 to Jordan, 160 million to the Palestinians in Gaza and the West Bank and 50 million m^3 to Syria, for its population within the Syrian parts of the Yarmuk drainage basin. Beyond these quotas which will utilize the best groundwater resources available (for example, the mountain aquifer in Israel and the Disi aquifer in Jordan) water will be grouped according to its quality.

About 50–60 per cent of the water assigned for agriculture to each co-riparian *must comprise* low grade waste water and any expansion of agriculture will be related only to an expansion of these sources. Such a policy, if adopted, would become an important incentive for the re-use of water resources wasted at present and brackish waters. The benefit which would arise out of even a partial accommodation to the Arab/Palestinian-Israeli conflict would be felt first in this sector. Israel, which is an unwilling partner in the Jordan-Yarmuk basin, has in the past not only experienced Arab hostility but also suffered from Arab policies which are intended to prevent the natural flow of the Jordan into Israel (against the clear intentions of the Helsinki and ILC Rules). Today suggestions have been made that Israel 'is stealing' Palestinian water. No differentiation was made between the natural flow of the mountain aquifer into Israel (to which she is fully entitled according to the Helsinki or ILC Rules) and water that the State of Israel pumps within the West Bank for Jewish settlements which deprives the Palestinians of their water resources (which is certainly against the Helsinki and ILC Rules). Israel, in the absence of any agreement with the Palestinians or the Arab states, has expanded its utilization of the mountain aquifer and the Yarmuk beyond what can be considered equitable water use. A political accommodation might allow for limited co-operation—for example, in the construction of two major de-salination plants able to serve the Palestinians, Jordan and Israel. A water supplement of 200 million m^3 to each of the co-riparians over the next decade would alleviate any short-term water scarcity and might make a contribution to reducing the hostile images of enmity so entrenched in the nationalism of the co-riparians. An expanded water supply and the mutual exchange of technological benefits in the water sector might eventually lead to linkage with other sectors of polity and society. Such ventures could also gain international support (for example from the World Bank).

As of the spring of 1992 such a scenario looked as distant as ever and there were no signs of the two sides making any progress towards such a goal of conflict accommodation; it seems that water is going to remain a major source of conflict and instability in the region.

4

THE HELSINKI AND ILC RULES: PRINCIPLES AND PRACTICE FOR WATER DIVISION IN THE NILE, THE TIGRIS-EUPHRATES AND THE JORDAN-YARMUK—CONCLUDING REMARKS

This book has tried to examine the practicability of applying the Helsinki and ILC Rules to the process of water allocation of international rivers—in particular to the Nile, the Euphrates and the Jordan-Yarmuk river systems. Before we carefully examine the possible outcomes of such an application, some general features of these rivers and the populations whose livelihoods depend on the water of the rivers should be taken into account.

First, as a result of the combined forces of nature (in the form of consecutive droughts) and society (in the form of accelerated population growth rates), the water resources of the three rivers are becoming scarcer and thus more precious. As a result, the Jordan-Yarmuk, the Nile and the Tigris-Euphrates (in that order) have reached a state of over-utilization and the quality of their water resources has deteriorated significantly.

Second, although scarcity of water has been strongly felt among all the coriparians of the three rivers, there is still a peculiarly large water wastage in all three—mainly as a result of wasteful irrigation methods, under-maintained water delivery systems and poor management. The human response to the required changes has been painfully slow in its accommodation to the new situation of reduced water supplies.

Third, in none of the three international river basins discussed in this book have the fluctuations in water supply over the last decade led to political and legal co-operation or to the adoption of more equitable water allocation. The few existing agreements for water allocation such as that for the Nile have not been based on equity for all the co-riparians and, in the Tigris-Euphrates and JordanYarmuk river basins, some co-riparians have over-extended their water usage at the expense of the other co-riparians. Finally, as a result of all the above processes, the chances for a 'water war' erupting in the Middle East are increasing, especially in the Jordan-Yarmuk basin where the great dependence of the partners on the modest water resources of the river combined together with the old Arab-Israeli conflict can very easily ignite the situation into war. A similar situation exists in the Euphrates where long-standing Iraqi-Syrian animosity could focus on the Euphrates water. In the light of this, one must ask whether the Helsinki and ILC Rules can be applied to the Nile, Tigris-Euphrates and the Jordan-Yarmuk river systems. Even more importantly, can the application of the Helsinki Rules secure equity among the partners of international rivers and thus prevent the danger of war? The three river basins will be examined separately.

THE HELSINKI AND ILC RULES IN THE NILE BASIN

The Nile is shared by nine African co-riparians of which only two, Egypt and the Sudan, not only take full advantage of its waters but also are bound by an agreement to divide the Nile's waters between themselves, thus excluding the other co-riparians from the benefits of the river.

No measures of integrated planning have been applied to the Nile basin. Moreover, since the only multipurpose (and highly consumptive) project, the Aswan High Dam, is located in Egypt (for the sole benefit of that country and the Sudan), any plans for future utilization of the Upper Nile waters, either in Ethiopia or the Equatorial states, is interpreted in Egypt as a threat to its very existence.

The first Helsinki and ILC rules which were applied to the Nile's basin concerned the geography, climate and hydrology of that basin. It was found that, whilst the Sudan had the largest share in the area of the Nile's basin and in both its main channel and tributaries, its water contribution to the Nile was nearly nil. Ethiopia, the upper riparian second to the Sudan in its share in drainage basin area, with significant portions in the channels and water resources of the Nile and which is the most important contributor to the Nile's discharge, has been using almost none of these waters. Egypt, on the other hand, with significant shares in the area of the drainage basin and the main river channel—but with no water contribution—has been using most of its waters.

The disparity between the Nile users and the Nile water feeders (or contributors) also manifests itself in the case of the other upper riparians: the Equatorial states of Kenya, Tanzania, Uganda, Zaire, Rwanda and Burundi, all of whom contribute large amounts of water to the Nile, have shares in the area of its sources but use very small amounts of its waters.

Some problems appeared when the Helsinki Rules were indiscriminately applied to the co-riparians by giving all the rules the same weight. First, for *climate* and *water contribution* to receive the same weight when drought conditions prevail in large parts of the Nile basin does not seem to be completely fair. The benefits arising out of water contribution by co-riparians should be appreciated more in times of water scarcity. There was a problem with equal weight being given to factors such as area controlled in the drainage basin and portions of the river channel with water contribution to the discharge of the Nile. One factor of the Helsinki and ILC Rules, climate, is interesting in that it relates to need and not some 'objective' element such as a country's share in the drainage basin. If the factor of climate (which represents the need for and dependence on the Nile water of countries such as Egypt and the Sudan) is counterbalanced against their water contribution and other hydrological elements, we may reach a conclusion that putting differential weight to each of the geographic, hydrological variables will serve the principle of equitable water allocation more properly.

Another feature emerged from a careful examination of the suitability of the Helsinki and ILC Rules to the Nile basin: the importance of both data collection and the levels of accuracy of those data. If equitable water allocation relies on geographic and hydrological features of the basin state, then we need to be in possession of very accurate information about those features. Unfortunately in the Nile basin (as well as in the Tigris-Euphrates and Jordan-Yarmuk basins) there are unsatisfactory data on some of the hydrological features and contradictory data on other features. This makes any decision-making on equitable water allocation at least partially arbitrary since it is dependent on the set of data upon which decisions are made. In addition, if climate changes take place in the Nile basin (as is the case in the other basins) then the accuracy of the data on which water allocation is based becomes extremely important.

Neither the the Helsinki Rules nor the ILC Rules refer to the possible negative contribution of a co-riparian to the total water budget of a river. In the Nile basin the water losses in the Sudd could be such a case and, as the Nile's water becomes scarcer, such an enormous water loss should be measured against Sudan's water allocation from the Nile. In a similar way, if the Equatorial co-riparians are able to increase their contribution to the Nile's water discharge (either by measures of economy or by the sheer fact that climate changes are responsible for their larger contribution) they should be entitled to a greater water allocation.

A final note in relation to hydrology and geography is that groundwater sources, which are included among the water sources of a certain basin to be shared by the co-riparians, pose problems of measurement and division. Sometimes, in order to provide equity and justice for all water resources, groundwater and surface water should be included in the process of water allocation. Both the Helsinki and the ILC Rules contain clauses which refer to 'the availability of alternatives, of corresponding value, to a particular planned or existing use' (ILC Article 6(f)) or 'the availability of other resources' (Helsinki Article V(h)). Both these clauses could be interpreted as relating to other sources in general, including water resources.

The Helsinki and ILC Rules were also examined for the patterns of past and present water utilization in the Nile basin. Past utilization patterns reveal that Egypt has established prior right for herself for most of the Nile's waters. Egypt has been able to use the Nile solely for its own purposes because for many centuries the old Egyptian Empire was the most powerful state within the Nile basin. In the modern era Britain, as a colonial power, supported the Egyptian claim to the Nile—often preferring Egypt to their other colonies such as the Sudan or the Equatorial states. The 1929 Anglo-Egyptian Agreement represented the epitome of Egyptian advocation of the doctrine of absolute territorial integrity. It allotted Egypt 48 billion m^3 of the Nile's waters as against a Sudanese allocation of only 4.0 billion m^3. Although Egypt later abandoned this doctrine and replaced it with a more agreeable and equitable position (exemplified by its 1959 agreement for the division of the High Aswan Dam waters), many of the water projects which were constructed within the Nile drainage were designed for the benefit of Egypt alone. Extreme examples of Egypt's virtual monopoly of the Nile's water are the Jebel Aulia Dam which was built in the Sudan but was intended to store water for Egypt, the Owen Falls Dam which was built to store water for both Egypt and the Sudan, and the Aswan Dam which also served only Egypt and the Sudan. How are Egyptian prior rights treated by the Helsinki or ILC Rules? The Helsinki Rules (Article V(d)) acknowledge past utilization of water as one of many (equally weighted) factors to consider when water is allocated, whereas the ILC Rules certainly reflect the newer legal spirit which ignores prior rights of utilization.

Article 6(d) of the ILC Rules calls for the consideration of 'existing and potential uses of the international watercourse'. This could be interpreted as pointing to the rights of upper riparians such as Ethiopia, Uganda, Tanzania and others to an equitable water allotment of the Nile. Egyptian prior rights have no relevance in this process of equitable water allocation—only her present water usage and the potential for future development do.

Some of the water projects which have been developed in the Nile basin raise other points of interest in relation to the Helsinki Rules and ILC Rules. For example, the Owen Falls Dam on Lake Victoria is certainly an example of a water project carried out in the spirit of Article V(i) of the Helsinki Rules which calls for the avoidance of unnecessary waste in the utilization of waters in the basin or of Article 6(e) of the ILC Rules which advocates the economic use of water resources. However, Uganda only benefits from the hydro power produced by the dam and from periodic compensation paid by Egypt and the Sudan when the coastal population of Lake Victoria is hurt by floods. The Helsinki and ILC Rules do not provide for a set payment which the lower riparians should pay Uganda for the benefits derived from additional water that Uganda sends downstream for the use of Egypt and the Sudan.

Some of the planned projects for the Nile such as the Jonglei Canal may damage the way of life of the Sudanese Nilotic population thus contradicting Article V(k) of the Helsinki Rules and Article 7 of the ILC Rules, which both call for the utilization of international rivers in such a way as not to cause appreciable harm to other water course states. The most important project in the Nile basin, the Aswan High Dam, was built in Egyptian territory and so evaporation rates waste almost all its incremental waters. The dam has affected the lives of both Egyptian and Sudanese peasants who have had to be relocated—which is against the spirit of the Helsinki Rules. As stated before, the Aswan High Dam serves only Egypt and the Sudan—unlike the Century Storage plan which could benefit all the co-riparians of the Nile.

The application of the Helsinki and ILC Rules to the patterns of supply and demand for the water of the Nile clearly strengthens the former trends of expanded water usage by Egypt and the Sudan (often accompanied by vast water wastage). The upper riparians hardly use the water and the Nile's water is not shared equally among these co-riparians. Also conspicuous in this pattern of usage is that the Helsinki Rules postulated in Articles V(i), V(j), V(k) and article 6(e) of the ILC Rules are observed only occasionally. Water waste is not prevented and there is no conservation, protection, development and economy of use of the water resources of the Nile. Both the Helsinki and the ILC Rules dedicate almost half of their clauses to the social and economic implications of water utilization. They concern themselves with how equity can be best served by giving consideration to factors such as the economic and social needs of each basin state, the population dependent on the waters of the basin in each basin state, the availability of other resources and even the comparative costs of alternative means of satisfying the economic and social needs of each basin state. Applying these principles to the Nile basin raises several major problems. First, it was found that when all the co-riparians are poor and underdeveloped it is extremely difficult to decide whose needs are greater. Second, the Helsinki and ILC Rules are inherently based on the premise that there is a direct connection between the Nile's waters and the prosperity of the co-riparians to the basin. This may be true only for Egypt (and perhaps the Sudan) which really can show a direct correlation between their economic and social affluence and the Nile; but this connection does not exist (or is not easily discovered) in the economic and social features of Ethiopia and the other co-riparians, since these countries do not show direct dependence on the Nile's sources. Again, the relevance of water resources other than the Nile becomes apparent when the agricultural economies of the Equatorial states is examined. As all these countries are predominantly located in areas of relatively rich precipitation, the benefit which they can directly derive from the withdrawal of Nile water is not clear at all.

Applying the Helsinki or ILC Rules which emphasize the availability of other resources as a relevant guideline for equitable water allotment was also found to be unsuitable for the nine co-riparians of the Nile who are too poor or too underdeveloped to take advantage of their other resources. The same goes for articles in the Helsinki Rules which consider 'the practicability of compensation to one or more of the co-basin states as a means of adjusting conflicts' and 'the comparative costs of alternative means of satisfying the economic and social needs of each basin state'. These clauses are more suitable for well-developed economies. Interestingly enough, the ILC Rules which reflect the 'newer' legal spirit do not include any similar clauses; perhaps they were not found to be applicable.

Finally, the Nile basin no doubt represents a good (and negative) example of what can happen in an international river basin where the co-riparians are engaged in separate development, do not consult with each other, prefer to exchange threats rather than information and refuse to co-operate. The ILC Rules which enforce co-operation on the co-riparians represent an advancement over the Helsinki Rules which do not classify these functions as mandatory.

The present situation, in which the existing legal agreements were developed for the benefit of Egypt and the Sudan, and for the partial benefit of Uganda, guarantee that equitable water allocation will continue to be absent from the Nile basin. As a result conflict over Nile water may arise in the next decade when the other co-riparians, especially Ethiopia, might decide to develop Upper Nile resources for the benefit of their populations.

THE HELSINKI AND ILC RULES IN THE TIGRIS-EUPHRATES BASIN

Many of the shortfalls of the Helsinki Rules identified when applied to the Nile basin also exist for the Tigris-Euphrates, despite the fact that this basin has only three main riparians in competition over its water.

The hydrology and geography of this basin also make the lower co-riparian, Iraq, the most important water user of the combined river discharge but, in contrast with the case of the Nile, the upper riparians

Turkey and Syria have been expanding their water usage of the Tigris-Euphrates in a manner which may reduce the water supply to Iraq.

According to both the Helsinki and the ILC Rules which relate to the climate, geography and hydrology of the Tigris-Euphrates, Turkey is entitled to a large amount of the Tigris-Euphrates water. Turkey not only contributes almost all the water to the Euphrates and much of water to the Tigris but also has a large share in the area of their drainage basins and portions in the river channel. Turkey, however, has a favourable climate compared with its co-riparians who have large arid areas and are therefore more in need of the Tigris-Euphrates water. Syria, a co-riparian to the Euphrates, is in control of large parts of the Euphrates basin and channels but mainly through its tributaries—the Khabour and the Balikh. Syria contributes very little to the actual discharge of the Euphrates itself. Syria could find itself in a position where it is pressed by downstream Iraq whenever that country feels that Syria is not sending enough water for its use. Iraq has control over some 40 per cent of the Euphrates basin but contributes nothing to its water budget. Iraq is in a better position with regard to the Tigris basin, though even here it contributes very little to the river's water budget. The role of Iran, the remaining co-riparian, is very small. If all the relevant Helsinki and ILC Rules were applied equally for all the co-riparians, Turkey would most probably gain the largest portion of the Tigris-Euphrates water. Iraq's claim to prior rights would probably be ignored in line with the current specialists' opinion that prior rights have no relevance to equitable water allocation. The strongest asset to the Iraqi position will be its arid climate, its total dependence on the Tigris-Euphrates water and the scarcity of other water resources. The Helsinki Rules and ILC Rules do not stipulate clearly enough that a country such as Turkey, which is rich in both surface water and groundwater resources, should receive a lower priority. Reduced weight should also be assigned to the geographical and hydrological data and more weight to the Syrian and Iraqi dependence on the Tigris-Euphrates as the major source of water (in the case of Syria) or as the only source of water (in the case of Iraq). It is also important to note that the hydrological configuration of the Tigris-Euphrates enables a trade-off to be made of Tigris water for Euphrates water. The Helsinki or ILC Rules do not refer directly to any such option but articles in both sets of rules stress the need to avoid waste in the utilization of waters of the basin and the requirement to satisfy the needs of a basin state without causing substantial injury to a co-basin state. Assigning most of the Euphrates water for the sole use of Turkey and Syria and leaving the Tigris for Iraqi utilization and perhaps for the future use of Iran seems to be a solution which suits the spirit of the Helsinki and ILC Rules.

Another aspect of using the water of international rivers which is not referred to by either the Helsinki or the ILC Rules is a hydrological situation in which co-riparians to one river basin are partners to other basins as well. Turkey and Syria share not only the Euphrates but also the Orontes and other secondary tributaries. In working out a solution for water sharing in one basin, it might be useful to look at the hydrological and geographical situation in the other international river basins as well, using arrangements in one basin as trade-offs for arrangements in another basin.

The application of the Helsinki and ILC Rules to the water projects developed in the Tigris-Euphrates basin has shown that the co-riparians have encouraged water wastage in the various water projects. The Turkish water projects, which are particularly large, revealed that during the impoundment periods the co-riparians suffered harmful effects. In the long run, Turkey is going to affect both the quantity and quality of water which will be available to its co-riparian and will thus violate the rules which demand that co-riparians 'do not cause appreciable harm to other watercourse states' (ILC Article 7).

The separate development of water projects in the past has been carried out without mutual consultation, exchange of information and data, or any other form of co-operation as required by ILC Rules. The GAP schemes will eventually affect the existing and potential uses of the Tigris-Euphrates yet Turkey operates according to the Harmon Doctrine while Syria advocates the doctrine of limited sovereignty and Iraq that of absolute territorial integrity. The adoption of such opposing doctrines will clearly prevent a more equitable division of water in the Tigris-Euphrates. The application of the Helsinki Rules to the patterns of water supply and demand in the Tigris-Euphrates once again reveals the impossibility of adopting them if the quality of data available on this basin remains the way it is. Another important issue which emerges from the patterns of water supply and demand within the Tigris-Euphrates is the conflict between consumptive and non-consumptive water use. For example one way to accommodate the needs of the co-riparians in a minimally harmful way is to use criteria of equity in allotting water to the partners according to their consumptive or non-consumptive uses. This means ranking the various water uses according to the following hierarchy. First, water should be allotted in predetermined quotas for hydro-power production, then for domestic use and only last for irrigation. The Helsinki Rule which calls for compensation could be applied in order to compensate Iraq and Syria for the deterioration in the quality of water which will flow in the Euphrates once Turkey completes its development projects.

An examination of the population's economic and social needs and the availability of other resources as information which can help form guidelines for water allocation indicate that, as in the case of the Nile, when the needs of developing societies are surveyed all rank equally and deserve equal amounts of water.

We also find it difficult to weigh the degree of dependence in agriculture in the basin states in an adequate way, which raises the question of whether agrarian economies should receive precedence in water allocation. Countries in need of food and other agricultural products can always purchase them with income deriving from other sectors of the economy such as the oil sector. Again, there is a difficulty in drawing a direct link between the Tigris-Euphrates water and the general well-being of the Turkish, Syrian and Iraqi societies. As in the case of the Nile, a measure of the level of dependence on water could be useful for the Tigris-Euphrates but neither the Helsinki Rules nor the ILC Rules supply any such measure.

Levels of co-operation in the Tigris-Euphrates basin are low and, in the past, conflicts have evolved round several issues. The lack of any legal agreement on equitable water division adds another dimension to the present conflicts. The only binding agreement is Turkey's oral commitment to release a certain amount of water to its co-riparians which is far below what its co-riparians would like to receive. As long as Syria and Iraq are dependent on Turkey's goodwill and their water allotment is not anchored in a formal legally binding agreement, the tension among the co-riparians may be expected to rise again and again and may lead to acts of hostility.

THE HELSINKI AND ILC RULES IN THE JORDAN-YARMUK BASIN

The Jordan-Yarmuk river system represents an extreme case of an international river with a very small amount of water bitterly fought over by Israel and its Arab neighbours. This is the only international basin in which gunfire has been exchanged in order to stop or prevent the implementation of water projects. Typical of this drainage basin is also the fact that all its water resources (surface and ground) are over-exploited, causing a significant reduction in quantity and quality over the last decade. The key to success in the application of the Helsinki Rules and ILC Rules to the Jordan-Yarmuk basin is the minimization of contact between the hostile co-riparians. The geomorphology and hydrology of the basin make it possible to separate the northern and southern sub-basins of the Jordan-Yarmuk basin, establishing only three co-riparians in each of the sub-basins. Thus, according to its climate, Lebanon would not need to receive any water allotment from the Jordan-Yarmuk but, since it controls part of the drainage basin and since one of the Jordan's sources is wholly in Lebanese territory (making Lebanon the source of its water), it is entitled to be included in any equitable water allocation of the Jordan-Yarmuk waters. Syria and Israel, according to their relative portions in the drainage basin, river channel and water contribution, are entitled to most of the waters of the northern basin. In the southern basin Syria and Jordan are the major co-riparians and Israel a minor one according to climate, hydrography and geography in their respective parts of the basin.

This raises two major problems in connection with the Helsinki and ILC Rules. First, the Jordan-Yarmuk drainage basin is a good example which supports the inclusion of surface water and groundwater in any equitable water allocation. Moreover, because of water scarcity in the region, the Jordan-Yarmuk river basin demonstrates the great sense of including all water resources (surface and ground) in the process of allotting precious water with equity. As Jordan, Israel and the Palestinians share both surface water and groundwater resources, any process which intends to share the limited amount of water must include all water resources.

Water allocation for the Palestinians in Gaza and the West Bank raises another question—their status as co-riparians. The Helsinki or ILC Rules do not specifically refer to the status of non-state entities in the process of dividing the water of international rivers. This ties in with another problem. Article VII of the Helsinki Rules states that ‘a basin state may not be denied the present reasonable use of the waters of an international drainage basin [so as] to reserve for a co-basin state a future use of such waters’ (United Nations 1970:78). The relevant Article 7(d) of the ILC Rules, on the other hand, calls for the consideration of both ‘existing and potential uses of the international water course’ when equitable water allocation is determined. This could be interpreted as the need to take into consideration an equitable water allocation for a possible future Palestinian entity now (according to the Helsinki Rules); or to evaluate, in depth, the potential for the development of a future Palestinian entity and the need to allot it water for future development.

Finally, problems may be anticipated with regard to ownership rights to the Jordan-Yarmuk water. We have already discussed the legal problems concerning the lower resources of the Hasbani, but there are also legal problems concerning the Banias—one of the sources of the Jordan which was located in Syria only as a temporary arrangement between Britain and France, the former mandate powers. There is a serious problem concerning the ownership of the mountain aquifer which is not part of the Jordan-Yarmuk system but may affect any future arrangements made between Israel and the Palestinians.

The water projects which have been planned for the Jordan-Yarmuk drainage basin (and those which have already been implemented) have exacerbated the Arab-Israeli conflict and virtually none of them has entailed any Israeli-Arab co-operation. Almost all the past plans, except for the Johnston Plan, have ignored the principles of equity as a result of which Syria, Lebanon and Israel often receive less water than they are entitled to according to their geographical features and needs. Many of the past water projects and certainly the present water projects have aimed at consumptive use of the drainage basin—particularly for irrigation. As water usage is expanding very rapidly among all the co-basin states, the competition over the scarce water is increasing. As with the Tigris-Euphrates basin, equity might be achieved by assigning specific amounts of water for each type of usage, thus ranking the various needs of the co-riparians. Both the Helsinki and the ILC Rules clearly stipulate that all water uses should be treated equally and we suggest that this attitude should be re-examined.

The Helsinki and ILC Rule which is being violated in the Jordan-Yarmuk basin is the regulation which states that only after the water needs within a certain drainage basin are satisfied may the water be transmitted outside the basin. Israel, in particular, has been criticized for using the Jordan-Yarmuk waters outside the basin itself. Again, we may ask whether this principle does not contradict other Helsinki and ILC Rules which stress the economic and social needs as important criteria for water allocation. A careful examination of the Helsinki and ILC Rules might reveal that some of these rules, in fact, do allow transference of the benefits of a certain river basin outside that basin while other regulations do not.

The Jordan-Yarmuk utilization patterns also raise another issue concerning the Helsinki Rules. Article VIII of these rules states that ‘an existing reasonable use may continue in operation unless the factors justifying its continuance are outweighed by other factors leading to the conclusion that it be modified or terminated so as to accommodate a competing incompatible use' (United Nations 1970:78). This exceptional clause (the ILC Rules do not contain any similar clause) enables the co-riparians of a drainage basin to shift water uses if a new use justifies its necessity. In the Jordan-Yarmuk basin a good example of this would be a shift of water from agriculture to the domestic sector. Again, the weakness of such clauses lies in the fact that in a basin such as the Jordan-Yarmuk, where there is no co-operation, the chance of such a regulation being put into practice is almost nil.

The patterns of water supply and demand for the Jordan-Yarmuk drainage basin also demonstrate some of the shortcomings of the Helsinki and ILC Rules when applied to a basin characterized by lack of co-operation and even conflict. First, it is difficult to implement an equitable water allocation arrangement to a drainage basin in which two co-riparians (Israel and Jordan) are in a position where demand is greater than the water supply and the water sector is in a constant state of deficit.

Other important issues which arise in applying the Helsinki and ILC Rules to water supply and demand in the Jordan-Yarmuk basin concern the equal weight that various water uses receive according to the above set of regulations. Again, there is an urgent need to divert good quality water presently used for irrigation to the rapidly growing domestic sector. The over-utilization and resulting deterioration of water resources in the Jordan basin again put into question the Helsinki and ILC Rule which does not allow one co-riparian to harm the quantity and quality of water available to the other co-riparians. The Helsinki and ILC Rules do not refer to the possibility of rewarding co-riparians who assist in the expansion of water supply through technological innovations such as sophisticated irrigation equipment or desalination plants. Since measures to increase water supply in the Jordan-Yarmuk and other basins are going to be extremely important in the future, the Helsinki and ILC Rules should introduce such possibilities (including water importation) into their detailed clauses. Any expansion of water supply in a basin which is the result of a co-operative endeavour should receive special attention by the Helsinki and ILC Rules.

Finally, applying the Helsinki and ILC Rules to the social and economic conditions which characterize the co-riparian societies adds a new problem to the former problems mentioned in the discussion of the Nile and the Tigris-Euphrates river basins. How does one apply these rules when there is a development gap between Israel and its neighbours? The rules, it was found, once again clearly classify the level of the co-riparians' dependence on the water resources of the Jordan-Yarmuk on the basis of their socio-economic characteristics. Again, however, we found that it is difficult to link the benefits of the Jordan-Yarmuk waters to the general well-being of the co-riparians. This connection is more or less obvious for Jordan, but not for the other co-riparians. One thing is clear, however. Any effort to implement the Helsinki or ILC Rules in the Jordan-Yarmuk Basin will be impaired by the fact that Israel has never been accepted as a legitimate co-riparian with a legal status equal to the other co-riparians. The Arab countries in the past have tried to prevent water from flowing into Israel by planning diversion schemes and through war. Eventually each country in the basin has gone its separate way and developed its own water projects—only partially paying heed to the needs of the other co-riparians. There is a general agreement among Middle East specialists that dividing the Jordan-Yarmuk water among all the co-riparians in an acceptable and equitable manner will, most probably, be the most difficult task in any peace negotiations.

THE HELSINKI AND ILC RULES: CONCLUDING NOTES

The analysis of the three international Middle Eastern river basins has identified seven characteristics in relation to the Helsinki and ILC Rules.

1 For any equitable water allocation to be made the rules have to include clearcut clauses which encompass all surface water and groundwater *within* a certain basin and *outside.*

2 These rules should pay special attention to the regional and locational aspects of water allotment. This means that data on the needs and usage in a certain drainage basin should be gathered for this particular basin or parts of basin before an equitable water allocation is suggested. Only after regional and locational patterns of water needs and usage are established should an examination of the needs of the society at large be weighed.

3 It is extremely important to include the involvement of co-riparians in all their river basins when any decisions about water allotment from a specific river basin are made. Sometimes arrangements in one river basin can assist in setting the appropriate water allocation in another river basin. Equity can best be served when all the river basins concerned are taken into consideration.

4 The notion of the ‘carrying capacity of water resources’ should be clearly defined and included in the Helsinki and ILC Rules in order to secure the long-term safe utilization of water resources according to their water yield.

5 Better criteria for dependence on water resources should be developed, perhaps even by proposing different sets of dependence criteria for developed and developing societies. A more difficult, and perhaps impossible, task will be to provide a possible ranking for various water uses (irrigation, hydropower, domestic). As needs and patterns of utilization differ in various countries, it seems that giving all the Helsinki and ILC Rules equal weight does not always serve the principles of equity.

6 It was found that the Helsinki and ILC Rules should more clearly relate to technological and scientific measures which increase the water supply and reduce water wastage. The existing set of regulations does not provide enough incentive for water preservation and conservation, especially when they might be achieved through co-operation between co-riparians.

7 Finally, the Helsinki and ILC Rules lack mechanisms to solve conflicts over water resources. Since such conflicts may become more frequent over the coming decades, the need for such mechanisms is going to become urgent. The use and adoption of legal norms such as the Helsinki and ILC Rules are founded on the goodwill and rational behaviour of nation states. Therefore one might be excused for expressing serious scepticism that such regulations will soon govern their customary behaviour in the search for solutions to problems of legality.

APPENDIX A:
HELSINKI RULES ON THE USES OF THE WATERS OF INTERNATIONAL RIVERS

Adopted by the International Law Association at its Fifty-second Conference held at Helsinki in 1966

CHAPTER 1
GENERAL

Article I

The general rules of international law as set forth in these chapters are applicable to the use of the waters of an international drainage basin except as may be provided otherwise by convention, agreement or binding custom among the basin States.

Article II

An international drainage basin is a geographical area extending over two or more States determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus.

Article III

A"basin State" is a state the territory of which includes a portion of an international drainage basin.

CHAPTER 2
EQUITABLE UTILIZATION OF THE WATERS OF AN INTERNATIONAL DRAINAGE BASIN

Article IV

Each basin State is entitled to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin.

Article V

(1) What is a reasonable and equitable share within the meaning of Article I is to be determined in the light of all the relevant factors in each particular case.

(2) Relevant factors which are to be considered include, but are not limited to:

(a) The geography of the basin including in particular the extent of the drainage area in the territory of each basin State;
(b) The hydrology of the basin, including in particular the contribution of water by each basin State;
(c) The climate affecting the basin;
(d) The past utilization of the waters of the basin, including in particular existing utilization;
(e) The economic and social needs of each basin State;
(f) The population dependent on the waters of the basin in each basin State;
(g) The comparative costs of alternative means of satisfying the economic and social needs of each basin State;
(h) The availability of other resources;
(i) The avoidance of unnecessary waste in the utilization of waters of the basin;
(j) The practicability of compensation to one of more of the co-basin States as a means of adjusting conflicts among uses; and
(k) The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.

(3) The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable share, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.

Article VI

A use or category of uses is not entitled to any inherent preference over any other use or category of uses.

Article VII

A basin State may not be denied the present reasonable use of the waters of an international drainage basin to reserve for a co-basin State a future use of such waters.

Article VIII

1. An existing reasonable use may continue in operation unless the factors justifying its continuance are outweighed by other factors leading to the con clusion that it be modified or terminated so as to accommodate a competing incompatible use.

2. (a) A use that is in fact operational is deemed to have been an existing use from the time of the initiation of construction directly related to the use or, where such construction is not required, the undertaking of comparable acts of actual implementation.

(b) Such a use continues to be an existing use until such time as it is discontinued with the intention that it be abandoned.

3. A use will not be deemed an existing use if at the time of becoming operational it is incompatible with an already existing reasonable use.

CHAPTER 3
POLLUTION

Article IX

As used in this Chapter, the term water pollution refers to any detrimental change resulting from human conduct in the natural composition, content, or quality of the waters of an international drainage basin.

Article X

1. Consistent with the principle of equitable utilization of the waters of an international drainage basin, a State

(a) Must prevent any new form of water pollution or any increase in the degree of existing water pollution in an international drainage basin which would cause substantial injury in the territory of a co-basin State, and

(b) Should take all reasonable measure to abate existing water pollution in an international drainage basin to such an extent that no substantial damage is caused in the territory of a co-basin State.

2. The rule stated in paragraph 1 of this Article applies to water pollution originating

(a) Within the territory of the State, or

(b) Outside the territory of the State, if it is caused by the State's conduct.

Article XI

1. In the case of a violation of the rule stated in paragraph 1(a) of Article X of this chapter, the State responsible shall be required to cease the wrongful conduct and compensate the injured co-basin State for the injury that has been caused to it;

2. In a case falling under the rule stated in paragraph 1 (b) of Article X, if a State fails to take reasonable measures, it shall be required promptly to enter into negotiations with the injured State with a view toward reaching a settlement equitable under the circumstances.

CHAPTER 4
NAVIGATION

Article XII

1. This Chapter refers to those rivers and lakes portions of which are both navigable and separate or traverse the territories of two or more States.

2. Rivers or lakes are "navigable" if in their natural or canalized state they are currently used for commercial navigation or are capable by reason of their natural condition of being so used.

3. In this Chapter the term "riparian State" refers to a State through or along which the navigable portion of a river flows or a lake lies.

Article XIII

Subject to any limitations or qualifications referred to in these Chapters, each riparian State is entitled to enjoy rights of free navigation on the entire course of a river or lake.

Article IX

"Free navigation", as the term is used in this Chapter, includes the following freedom for vessels of a riparian State on a basis of equality:

(a) Freedom of movement on the entire navigable course of the river or lake;

(b) Freedom to enter ports and to make use of plants and docks; and

(c) Freedom to transport goods and passengers, either directly or through trans-shipment, between the territory of one riparian State and the territory of another riparian State and between the territory of a riparian State and the open sea.

Article XV

A riparian State may exercise rights of police, including but not limited to the protection of public safety and health, over that portion of a river or lake subject to its jurisdiction, provided the exercise of such rights does not unreasonably interfere with the enjoyment of the rights of free navigation defined in Articles XIII and XIV.

Article XVI

Each riparian State may restrict or prohibit the loading by vessels of a foreign State of goods and passengers in its territory for discharge in such territory.

Article XVII

A riparian state may grant rights of navigation to non-riparian States on rivers or lakes within its territory.

Article XVIII

Each riparian State is, to the extent of the means available or made available to it, required to maintain in good order that portion of the navigable course of a river or lake within its jurisdiction.

Article XIX

The rules stated in this Chapter are not applicable to the navigation of vessels of war or of vessels performing police or administrative functions, or, in general, exercising any other form of public authority.

Article XX

In time of war, other armed conflict, or public emergency constituting a threat to the life of the State, a riparian State may take measures derogating from its obligations under this Chapter to the extent strictly required by the exigencies of the situation, provided that such measures are not inconsistent with its other obligations under international law. The riparian States shall in any case facilitate navigation for humanitarian purposes.

CHAPTER 5
TIMBER FLOATING

Article XXI

The floating of timber on a watercourse which flows through or between the territories of two or more States is governed by the following Articles except in cases in which floating is governed by rules of navigation according to applicable law or custom binding upon the riparians.

Article XXII

The States riparian to an international watercourse utilized for navigation may determine by common consent whether and under what conditions timber floating may be permitted upon the watercourse.

Article XIII

1. It is recommended that each State riparian to an international watercourse not used for navigation should, with due regard to other uses of the watercourse, authorize the co-riparian States to use the watercourse and its banks within the territory of each riparian State for the floating of timber.

2. This authorization should extend to all necessary work along the banks by the floating crew and to the installation of such facilities as may be required for the timber floating.

Article XXIV

If a riparian State requires permanent installations for floating inside a territory of a co-riparian State or if it is necessary to regulate the flow of the watercourse, all questions connected with these installations and measures should be determined by agreement between the States concerned.

Article XXV

Co-riparian states of a watercourse which is or is to be used for floating timber should negotiate in order to come to an agreement governing the administrative regime of floating, and if necessary to establish a joint agency or commission in order to facilitate the regulation of floating in all aspects.

CHAPTER 6
PROCEDURES FOR THE PREVENTION AND SETTLEMENT OF DISPUTES

Article XXVI

This chapter relates to procedures for the prevention and settlement of international disputes as to the legal rights or other interests of basin States and of other States in the waters of an international drainage basin.

Article XXVI

1. Consistently with the Charter of the United Nations, States are under an obligation to settle international disputes as to their legal rights or other interests by peaceful means in such a manner that international peace and security, and justice are not endangered.

2. It is recommended that States resort progressively to the means of prevention and settlement of disputes stipulated in Articles XXIX to XXXIV of this Chapter.

Article XXVIII

1. States are under a primary obligation to resort to means of prevention and settlement of disputes stipulated in the applicable treaties binding upon them.

2. States are limited to the means of prevention and settlement of disputes stipulated in treaties binding upon them only to the extent provided by the applicable treaties.

Article XXIX

1. With a view to preventing disputes from arising between basin States as to their legal rights or other interests, it is recommended that each basin State furnish relevant and reasonably available information to the other basin States concerning the waters of a drainage basin within its territory and its use of, and activities with respect to, such waters.

2. A State, regardless of its location in a drainage basin, should in particular furnish to any other basin State, the interests of which may be substantially affected, notice of any proposed construction or installation which would alter the regime of the basin in a way which might give rise to a dispute as defined in Article XXVI of this Chapter. The notice should include such essential facts as will permit the recipient to make an assessment of the probable effect of the proposed alteration.

3. A State providing the notice referred to in paragraph 2 of this Article should afford to the recipient a reasonable period of time to make an assessment of the probable effect of the proposed construction or installation and to submit its views thereon to the State furnishing the notice.

4. If a State has failed to give the notice referred to in paragraph 2 of this Article, the alteration by the State in the regime of the drainage basin shall not be given the weight normally accorded to temporal priority to use in the event of a determination of what is a reasonable and equitable share of the waters of the basin.

Article XXX

In case of a dispute between States as to their legal rights or other interests, as defined in Article XXVI, they should seek a solution by negotiation.

Article XXXI

1. If a question or dispute arises which relates to the present or future utilization of the waters of an international drainage basin, it is recommended that the basin States refer the question or dispute to a joint agency and that they request the agency to survey the international drainage basin and to formulate plans or recommendations for the fullest and most efficient use thereof in the interests of all such states.

2. It is recommended that the joint agency be instructed to submit reports on all matters within its competence to the appropriate authorities of the member States concerned.

3. It is recommended that the member States of the joint agency in appropriate cases invite non-basin States which by treaty enjoy a right in the use of the waters of an international drainage basin to associate themselves with the work of the joint agency or that they be permitted to appear before the agency.

Article XXXII

If a question or a dispute is one which is considered by the States concerned to be incapable of resolution in the manner set forth in Article VI, it is recommended that they seek the good offices, or jointly request the mediation of a third State, of a qualified international organization or of a qualified person.

Article XXXIII

1. If the States concerned have not been able to resolve their dispute through negotiation or have been unable to agree on the measures described in Articles XXXI and XXXII, it is recommended that they form a commission of inquiry or an ad hoc conciliation commission, which shall endeavour to find a solution, likely to be accepted by the States concerned, of any dispute as to their legal rights.

2. It is recommended that the conciliation commission be constituted in the manner set forth in the Annex.

Article XXXIV

It is recommended that the States concerned agree to submit their legal disputes to an ad hoc arbitral tribunal, to a permanent arbitral tribunal or to the International Court of Justice if

(a) A commission has not been formed as provided in Article XXXIII, or

(b) The commission has not been able to find a solution to be recommended, or

(c) A solution recommended has not been accepted by the States concerned, and
(d) An agreement has not been otherwise arrived at.

Article XXXV

It is recommended that in the event of arbitration the States concerned have recourse to the Model Rules on Arbitral Procedure prepared by the International Law Commission of the United Nations at its tenth session in 1958.

Article XXXVI

Recourse to arbitration implies the undertaking by the States concerned to consider the award to be given as final and to submit in good faith to its execution.

Article XXXVII

The means of settlement referred to in the preceding Articles of this Chapter are without prejudice to the utilization of means of settlement recommended to, or required of, members of regional arrangements or agencies and of other international organizations.

APPENDIX 2

Complementary Rules Applicable to International Resources, 1986

(Adopted by the International Law Association at the Sixty-Second Conference held at Seoul in 1986)

Article 1: Substantial injury

A basin state shall refrain from and prevent acts or omissions within its territory that will cause substantial injury to any co-basin State, provided that the application of the principle of equitable utilization as set forth in Article IV of the Helsinki Rules does not justify an exception in a particular case. Such an exception shall be determined in accordance with Article V of the Helsinki Rules.

Article 2: Measures within the territory of other basin states

If an undertaking, to be executed by a basin State, requires works or installations within the territory of a co-basin State, or the utilization of water resources in that territory, all questions connected with these measures are to be determined by agreement. The States concerned shall use their best endeavors to reach a just and reasonable agreement in accordance with the principle of equitable utilization.

Article 3: Notification and objection

1. When a basin State proposes to undertake, or to permit the undertaking of, a project that may substantially affect the interests of any co-basin State, it shall give such State or States notice of the project. The notice shall include information, data and specifications adequate for assessment of the project.
2. After having received the notice required by paragraph 1, a basin State shall have a reasonable period of time, which shall not be less than six months, to evaluate the project and to communicate its reasoned objection to the proposing State. During that period the proposing State shall not proceed with the project.
3. If a basin State does not object to the project within the time permitted under paragraph 2, the proposing State may proceed with the project in accordance with the notice. If a basin State objects to the project, the States concerned shall make every effort expeditiously to settle the matter consistent with the

procedures set forth in Chapter 6 of the Helsinki Rules. The proposing State shall not proceed with the project while these efforts are continuing provided that they are not unduly protracted. If these efforts become unduly protracted, or an objecting State has refused to have resort to third party procedures for settlement of the remaining differences, the proposing State may, on its own responsibility, proceed with the project in accordance with the notice.

4. The notice and other communications referred to in this Article shall be transmitted through appropriate official channels unless otherwise agreed.

APPENDIX 3

The Seoul Rules on International Groundwater, 1986

(Adopted by the International Law Association at the Sixty-Second Conference held at Seoul in 1986)

Article 1: The waters of international aquifers

The waters of an aquifer that is intersected by the boundary between two or more States are international groundwaters if such an aquifer with its waters forms an international basin or part thereof. Those states are basin States within the meaning of the Helsinki Rules whether or not the aquifer and its waters form surface waters part of a hydraulic system flowing into a common terminus.

Article 2: Hydraulic interdependence

1. An aquifer that contributes water to, or receives water from, surface waters of an international basin constitutes part of an international basin for the purposes of the Helsinki Rules.

2. An aquifer intersected by the boundary between two or more States that does not contribute water to, or receive water from, surface waters of an international drainage basin constitutes an international drainage basin for the purposes of the Helsinki Rules.

3. Basin states, in exercising their rights and performing their duties under international law, shall take into account any interdependence of the groundwater and other waters including any interconnections between aquifers, and any leaching into aquifers caused by activities and areas under their jurisdiction.

Article 3: Protection of groundwater

1. Basin states shall prevent or abate the pollution of international groundwaters in accordance with international law applicable to existing, new, increased and highly dangerous pollution. Special considerations shall be given to the long-term effects of the pollution of groundwater.

2. Basin states shall consult and exchange relevant available information and data at the request of any one of them—

(a) for the purpose of preserving the groundwaters of the basin from degradation and protecting from impairment the geological structure of the aquifers, including recharge areas;

(b) for the purpose of considering joint or parallel quality standards and environmental protection measures applicable to international groundwaters and their aquifers.

3. Basin states shall cooperate, at the request of any one of them, for the purpose of collecting and analyzing additional needed information and data pertinent to the international groundwaters or their aquifers.

Article 4: Groundwater management and surface waters

Basin states should consider the integrated management, including conjunctive use with surface waters, of their international groundwaters at the request of any one of them.

APPENDIX B: UN/ILC THE LAW OF THE NON-NAVIGATIONAL USES OF INTERNATIONAL WATERCOURSES*

PART I
INTRODUCTION

Article 1[(1)]

Scope of the present articles

1. The present articles apply to uses of international watercourses and of their waters for purposes other than navigation and to measures of conservation related to the uses of those watercourses and their waters.
2. The use of international watercourses for navigation is not within the scope of the present articles except in so far as other uses affect navigation or are affected by navigation.

Article 2[(2)]

Use of terms

For the purpose of the present articles:

a) 'International Watercourse' means a watercourse, parts of which are situated in different states.
b) 'Watercourse' means a system of surface and underground waters constituting, by virtue of their physical relationship, a unitary whole and flowing into a common terminus.
c) 'Watercourse State' means a state in whose territory part of an international watercourse is situated.

Article 3[(3)]

Watercourse agreements

* International Law Commission, Forty Third Session, 29 April-19 July 1991.

(1) Initially adopted as article 3.

(2) Subparagraph (c) was initially adopted as article 3.

1. Watercourse States may enter into one or more agreements hereinafter referred to as ‘watercourse’ agreements, which apply and adjust the provisions of the present articles to the characteristics and uses of a particular international watercourse or part thereof.

2. Where a watercourse agreement is concluded between two or more watercourse States, it shall define the waters to which it applies. Such an agreement may be entered into with respect to an entire international watercourse or with respect to any part thereof or a particular project, programme or use, provided that the agreement does not adversely affect, to an appreciable extent, the use by one or more other watercourse States of the waters of the watercourse.

3. Where a watercourse State considers that adjustment or application of the provisions of the present articles is required because of the characteristics and uses of a particular international watercourse, watercourse States shall consult with a view to negotiating in good faith for the purpose of concluding a watercourse agreement or agreements.

Article 4(4)

Parties to watercourse agreements

1. Every watercourse State is entitled to participate in the negotiation of and to become a party to any watercourse agreement that applies to the entire international watercourse [system], as well as to participate in any relevant consultations.

2. A watercourse State whose use of an international watercourse may be affected to an appreciable extent by the implementation of a proposed watercourse agreement that applies only to a part of the watercourse or to a particular project, programme or use is entitled to participate in consultations on, and in the negotiation of, such an agreement, to the extent that its use is thereby affected, and to become a party thereto.

PART II
General principles

Article 5(5)

Equitable and reasonable utilization and participation

1. Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal utilization thereof and benefits there from consistent with adequate protection of the watercourse.

2. Watercourse States shall participate in the use, development and protection of an international watercourse in an equitable and reasonable manner. Such participation includes both the right to utilize the watercourse and the duty to co-operate in the protection and development thereof, as provided in the present articles.

Article 6(6)

(3) Initially adopted as article 4.

(4) Initially adopted as article 5.

Factors relevant to equitable and reasonable utilization

1. Utilization of an international watercourse in an equitable and reasonable manner within the meaning of article 5 requires taking into account all relevant factors and circumstances, including:

(a) geographic, hydrographic, hydrological, climatic, biological and other factors of a natural character;
(b) the social and economic needs of the watercourse States concerned;
(c) the effects of the use or uses of the watercourse in one watercourse State on other watercourse States;
(d) existing and potential uses of the watercourse;
(e) conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
(f) the availability of alternatives, of corresponding value, to a particular planned or existing use.

2. In the application of article 5 or paragraph 1 of this article, watercourse States concerned shall, when the need arises, enter into consultations in a spirit of cooperation.

Article 7[(7)]

Obligation not to cause appreciable harm

Watercourse States shall utilize an international watercourse [system] in such a way as not to cause appreciable harm to other watercourse States.

Article 8[(8)]

General obligation to co-operate

Watercourse States shall co-operate on the basis of sovereign equality, territorial integrity and mutual benefit in order to attain optimum utilization and adequate protection of an international watercourse.

Article 9[(9)]

Regular exchange of data and information

1. Pursuant to article 8, watercourse States shall on a regular basis exchange reasonable available data and information on the condition of the watercourse, in particular that of a hydrological, meteorological, hydrogeological and ecological nature, as well as related forecasts.

2. If a watercourse State is requested by another watercourse State to provide data or information that is not reasonably available, it shall employ its best efforts to comply with the request but may condition its compliance upon payment by the requesting State of the reasonable costs of collecting and, where appropriate, processing such data or information.

3. Watercourse States shall employ their best efforts to collect and, where appropriate, to process data and information in a manner which facilitates its utilization by the other watercourse States to which it is communicated.

Article 10

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(5) Initially adopted as article 6.

(6) Initially adopted as article 7.

Relationship between uses

1. In the absence of agreement or custom to the contrary no use of an international watercourse enjoys inherent priority over other uses.

2. In the event of a conflict between uses of an international watercourse, it shall be resolved with reference to the principles and factors set out in articles 5 to 7 with special regard being given to the requirements of vital human needs.

(7) Initially adopted as article 8.

(8) Initially adopted as article 9.

(9) Initially adopted as article 10.

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