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The Impact of Arid Land Development
on River and Marine Environments in the Middle East
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John Kolars
Professor Emeritus, University of Michigan
25 Tano Road, Santa Fe, NM 87501-7084

"The Environmental Web of Development"

Irrigated fields and urban high rises are the obvious artifacts of arid land development, but the impact of such development only begins with the implemented projects. The environment in which development takes place is a complex skein of physical linkages and human perceptions, values, and communication, and like a spider,s web, activity in one spot can result in unexpected reverberations elsewhere. The continuing effects of arid land development, that is the depletion of resources and the pollution of water, soils, and the atmosphere, have far reaching, often delayed, consequences. The Middle East with its scarce and unequally distributed water supply is a paramount example of such interconnectedness.

This discussion illustrates the above premise by examining the wide spread environmental impact of arid land development in the basin(s) of the Euphrates and Tigris Rivers. The word "impact" often implies either pollution or depletion of resources (Table 1). In terms of the economies involved and the well being of their populations the developments, which may be positive in the short run, nevertheless can have long range, negative consequences. It is the nature of such consequences which concern us here.

The Situation: Physical, Cultural, Political

A brief survey of the region, its participants and resources is necessary in order to understand the environmental fall out possible in the Middle East. There are three major and two minor river basins in northeast Africa and southwest Asia, the Nile, the Euphrates/Tigris, the Jordan, the Litani, and the Orontes (Asi). (See: Kolars, 1992, for a detailed review of water availability in the Middle East.)

The Euphrates (estimated natural annual flow [enaf], 33,460 Mcm) and Tigris Rivers (enaf 49,200 Mcm) shared by Turkey, Syria, and
Table 1

A Geographic Spectrum of Existing and Possible Water Related Environmental Impacts in the Middle East

Type of Pollution	Gulf & Open Sea	Tidal Zone/ Inshore Littoral	Underground Waters Aquifers/ground water
Removals	/ /		

Finally, those participating in this workshop unanimously approved the content of the Charter "Water and Health for the General Public" prepared by the Water Academy at the request of the European Union in order to raise the consciousness of the public in Europe.

/ / / / / / / /

Water XX XX XX Depletions: Jordanian Saq,
Syrian Jezirah,
West Bank. Jordan

Soil
XX XX XX XX

Biota
over fishing over fishing XX

Additions
(Pollution) /
/ / / / / / / / / / / / / / / / / / / /

Silt
northern deltas possible XX
Gulf

Salts Aqaba & Desalination Salt water
northern Return Flow intrusions
Gulf Dead zones

Heavy Metals tanker general: e.g. Gaza water supply
& Sewage, etc. spills & nesting/
bilges feeding grounds

Inundations
XX XX XX water logging in
Saudi Arabian cities

Biota
XX XX bacteria bacteria

Visual &
Acoustical XX oil spills XX
off shore flotsam & jetsam.
oil rigs desal. plants

Type of Pollution | Springs & Oases | Rivers & Streams | Lakes & Reservoirs | Playas & Salt Lakes

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Removals /
/ / / / / / /

Water Israel: Euphrates Lake Assad Dead Sea
coastal Asi
springs;
Jordan:
Azraq Oasis

Soil
XX Erosion XX XX

Biota
Azraq Oasis possible loss XX XX
bird life of spawning fish

Additions
(Pollution) /
/ /

Silt & Algerian Euphrates Lake Ataturk
??
sand Oases Lake Asad, etc.
overwhelmed

Salts Euphrates possible possible
possible Shatt Al-Arab
Lower Jordan

Heavy Metals
& Sewage, etc. possible as with above salts
possible possible

Inundations
XX run off into Sea of Galilee
possible Dead
Syrian Jezirah wtr capacity
Sea flooded
shorelines

Biota
new macro species bacteria schistosomes schistosomes XX
bacteria bacteria

Visual &
Acoustical
desiccation Low water mud banks shifting shore
factories
lines chemical plants

Source: Biswas, Kolars, et al.

Iraq, is the second largest river system in the Middle East. Turkey provides 98% of the water in the Euphrates (see below) and 43% of that in the Tigris. Syria is the source of the additional 2% in the Euphrates, but none of that in the Tigris, the remainder of which comes from the Zagros Mountains in Iraq. The two rivers join at Qurna, Iraq, and form the Shatt Al-Arab which empties into the upper end of the Arabian/Persian Gulf.

Turkey is well on the road to completing its Southeast Anatolia Development Project, acronym GAP, on the Euphrates and Tigris Rivers. This consists of 15 dams, 14 hydroelectric power stations, and 19 irrigation projects on the Euphrates (Table 2), and an additional giant dam, the Keban, on the same river but upstream from GAP borders. Similar, though fewer, projects are envisioned on the Tigris at a later date. Syria has built three dams on the Euphrates, the Tishreen, the Tabqa or Ath Thawrah, and the Ba,ath (Table 2). Syria and Iraq, usually enemies, have collaborated in their opposition to Turkey,s control of the Euphrates, flow, and in sharing what water does cross the border into Syria. Iraq is to receive 58% and Syria the remainder. Iraq has elaborate irrigation and diversion works on the two rivers and two large dams with shallow reservoirs on the Euphrates (Table 2).

By far the smallest of the three basins is that of the Jordan River (enaf, 1,477 Mcm). Nevertheless, need is so great that its waters have become a major element in the ongoing Peace Process. The headwaters of Jordan derive from the Hasbani River (125 Mcm) rising in extreme southeast Lebanon, the Dan spring within eratz Israel (250 Mcm), and the Hermon Spring and Banias River (125 Mcm) at the foot of the Golan Heights. These waters enter the Sea of Galilee (Lake Kinneret or Lake Tiberius) which is the point of origin of the Israeli National Water Carrier. A major tributary, the Yarmouk River (400 Mcm), rises essentially in Syria and forms the border first between Syria and Jordan and then between the Golan and Jordan before entering the main stream just below the Sea of Galilee. (Additional flow to the Jordan from springs and wadis equals approximately 577 Mcm.) Thus, Israel, Jordan, Lebanon, the Palestinian entity, and Syria (alphabetical order) all have stakes in these waters. However, the actions, reactions, and machinations regarding the history of this river are far too complicated and lengthy to recount here. (See Lowi, 1995, and/or Wolf, 1995, for excellent accounts and analyses of all this.)

TABLE 2

TABLE 1: Surface Areas and Vols. Of Some Middle Eastern Reservoirs
Country Dam/Reservoir Vol. Area Ratio:V/A
(1x106 m3) km2 (1x106m2)

Turkey Keban 30,600 675 44 .4
Karakaya 9,580 298 32.1
Ataturk 48,700 817 59.6
Birecik* 1,220 56.25 21.7
Karkamis** 200 28.4 7.0
Syria Tishreen 1,300 70 18.6
Tabqa (Ath Thawrah) 11,700 628 18.6
Ba'ath 90 2.7 33.3
Martyr Basel al-Assad 605 92,5 6.5
(Khabour River)***

Iraq Haditha (Qadasiyah) 10,000 550 18.2
Habbaniyah 3,100 400 7.8
Egypt Lake Nasser 78,500 3,500 22.4
Sources: Kolars and Mitchell, Army Corps of Engineers, Özal and Altinbilek, ***G.W.R., p. 10. (Computations by author.)
* under construction. **Proposed

The above ratios indicate the average number of cubic meters of water beneath each square meter of reservoir area. The larger the number, the more efficient the storage vis a vis evaporation losses. Mountain (i.e. headwater) locations provide the best and deepest reservoir sites. In the case of the Euphrates reservoirs, it should be noted that the farther downstream the reservoir in question is located, the higher will be the average annual ambient air temperature, resulting in greater evaporation losses per square meter of surface. This constitutes a multiplier effect when considering the best (or worst) places to store water. These comments, however, do not take into account the political ramifications of the situation, for downstream users may have serious reservations as to the availability of water stored in upstream locations.

The two minor river basins are those of the Litani River (920 Mcm), which rises and flows entirely within Lebanon, and the Orontes or Asi River (1,100 Mcm) rising in the Bekaa Valley of Lebanon and flowing north through Syria until it reaches the sea in Hatay province in Turkey.

Let me state at this point that I find no convincing evidence to the claim that Israel is removing water from the Litani River for its own use. On the other hand, the waters of the Litani have long been considered an important pawn in ongoing negotiations, whether or not they will ever be consumed by non-Lebanese. The waters of the Orontes are already under contention. Syria is diverting significant quantities for use, a removal to which Turkey strongly objects.

The largest river system within the region is that of the Nile (1990 Enaf, 92,600 million cubic meters, mcm), (Howell and Allen, Table 7, p. 17). It receives little discussion herein because of its complexity and the enormous amount of research already devoted to it, as well as the fact that although Egyptian President Anwar Sadat proposed sending Nile water to Gaza and perhaps Israel, his suggestion was an empty one. Nine riparians share the Nile (or ten if one counts a tiny bit of Eritrea with some dry wadis). At the present time only Egypt and the Sudan have formal agreements regarding use of its waters. Even so, Egypt receives the lion,s share of the water with Sudan a poor second -- 62 billion cubic meters for Egypt, 8 billion for Sudan (Waterbury, p. 68). No other nation is involved although neither of the latter countries contribute to the waters of the Nile. The base flow of the river derives from sub-Saharan Lakes, particularly Victoria, and the seasonal floods -- upon which Egypt depends -- from monsoon rains which fall on Ethiopia. In time, there will be an inevitable renegotiating of these waters, first between Sudan and Egypt and later among these two and Ethiopia and the sub-Saharan source nations. Thus, any offers by Egypt to share water must first be approved by eight or nine other riparian partners, an unlikely event.

The Problem

Conventional explanations of Middle Eastern resource and environmental evaluation follow a cycle in which nationalism is seen encouraging large and growing populations, larger populations in turn require additional water and food, which leads to water shortages. Water shortages demand new sources of water. At the same time, increased food production requires additional irrigation systems, fertilizers, pesticides, and herbicides. Thus, run off from fields and cities leads to pollution, which along with depletions results in environmental degradation. Environmental issues are either overlooked, or at best considered ancillary to economic and social problems.

First, last, and always the problem is population. An estimate made by the World Bank in 1983 found that the 217 million people living in northeast Africa and southwest Asia including Turkey, Iran, and the Arab states would increase in number to 337 million by the year 2000, an increase of 55 percent in seventeen years. Unlikely? No, conservative. Egypt adds one million new people to its population, births over deaths, every eight to nine months. Jordan is doubling its population every eighteen years. A more recent study of population growth for Israel, Jordan and the West Bank and Gaza (Palestine) using high and low estimates has found that in terms of domestic water consumption of 100 cubic meters per capita per year by the year 2020 Israel can expect an absolute water deficit of 800 million cubic meters (mcm), Jordan 750 mcm, and the West Bank and Gaza Arab population between 455 and 705 mcm (Biswas, Kolars, et al, chap. 3).

Farther south, in Saudi Arabia, there are no perennial surface waters. Its population depends upon limited spring flow, water pumped from aquifers (water storing, porous rock strata deep beneath the surface), and desalinized sea water. It is estimated by Saudi Hydrologists that proven supplies of ground water in the country will be exhausted by the year 2005; probable supplies may last until 2035, and possible supplies until 2060 (Abu Rizaiza, 1989). This will also mean the end of surface springs.

Desalination of sea water can meet part of the pending shortages, but the extravagant use of water by agriculture will eventually prohibit the Saudis from continuing their massive irrigation of wheat and other grain crops. As for desalination in general, it should be remembered that the costs of desalinized water must also include maintenance and replacement of equipment as well as the cost of pumping water from sea level to higher elevations. An example of the latter cost is that approximately 18% of all the energy used in Israel goes to pumping water from the Sea of Galilee (Lake Kinneret) to and through the National Water Carrier.

Put in still another way, the Nile and Euphrates Rivers are exotic streams. That is, they receive their waters in mountainous areas far from where their major use occurs. Streams such as these actually grow smaller as they flow to their final destinations. Even the Jordan River can be thought of in these terms. Furthermore, the source areas of the above rivers are in countries different from their downstream users. Egypt receives 95% of the Nile waters it uses from Ethiopia: the Blue Nile, Atbara, Sobat Rivers, and 5% from equatorial lakes (Waterbury, p. 23).

Consider, too, that Turkey is non-Arab in both language and culture, as is Ethiopia. Almost two-thirds of the Arabic speaking population of this part of the world depends on river water that crosses an international border from a non-Arab country. Combine this with another 24% who depend upon water from deep wells and/or desalination plants, and the seriousness of their situation can be seen: over 90% of Arabic speaking Middle Easterners are at some risk where water is concerned.

Water: Conflicting Claims and Over-subscription

Turkey, the source of 98 per cent of the Euphrates, water, may someday annually claim 18 billion cubic meters of the river. Syria may claim 11 billion cm/a, and Iraq another 23 billion cm/a, a total of 52 billion cm/a (Volkan, p. 55). I have estimated the average flow of the river to be perhaps 33.46 billion cubic meters.. A less draconian interpretation of the situation still leaves Iraq with only 5 billion cubic meters, an impossibly small amount of Euphrates water. This is illustrated in Figure 1. The increased pollution of agricultural and domestic waters and the pollution of downstream fields is frequently mentioned accompanying such depletions. An unappreciated and seldom mentioned consequence of such profligate development Is the impact on the ecosystem(s) of the rivers, marshes, and marine destinations of these waters. Table 3 shows estimated past, present, and future use of irrigated lands in Euphrates/Tigris basin(s). Obviously, someone or something has to give.

As eluded to above, a similar situation exists in the Jordan basin. A recent analysis shows 4.4 million people in Israel consuming 2,100/2,200 mcm per year in 1991, with a renewable fresh water supply of 1,950 mcm, contrasted with an estimated 6.3 million people consuming 2,800/2,900 mcm annually in the year 2020 and a foreseeable fresh water supply at that time of 2,060 mcm (Lowi, p. 153).

TABLE 3

Estimated Land Irrigated from the Euphrates-Tigris Rivers and the Percent of Shared Impact by the Three Riparians on the Gulf

1 x 106 hectares -- % shown in ()

Country	Iraq	Syria	Turkey	Total
Time Period				

Pre-1917 .58 --- --- .58
(100) (100)

Pre-1950 1.44 --- --- 1.44
(100) (100)

1950 - 1968 1.15 .1865 --- 1.3365
(86.0) (14.0) (100)

1969 - 1985 2.875 .2400 ? 3.115
(92.3) (7.7) (100)

1986 - 1992 2.6 .2793 est. .06486 2.9941
(88.3) (9.5) (2.2) (100)

2010 4.0 .3186 est. .290166 4.6088
(86.8) (6.9) (6.3) (100)
E: 1.31
T: 2.75

2020 4.0 . 3579 est. .845986 5.20389
(76.9) (6.9) sic (16.2) (100)

2040 4.0 .3972 est. 1.662189 6.05939
(66.0) (6.6) (27.4) (100)
E: 1.134
T: .573

Source: Kolars, 1994

Table 4

Land Use Potential of the Shatt Al-Arab Basin
(Source: Özal and Altinbilek)
(These figures show the Turkish Interpretation. Note the use of the term "Shatt Al-Arab Basin," i.e. the one basin approach.)

Period Countries

Turkey Syria Iraq Total
Irrigation Irrigation Irrigation Irrigation
1000 ha 1000 ha 1000 ha 1000 ha

<1920 30 --- 600 630
E 25
T 5

1950 70 30 1,400 1,500
E 60 E 30 E 450 E 540
T 10 T 950 T 960

1970 160 200 1,200 1,560
E 30 E 200 E 400 E 730
T 30 T 800 T 830

1985 200 240 2,000 2,440

	E 150	E 240	E 800	E 1,190
	T 50		T 1,200	T 1,250
1995	250	280	2,600	3,130
	E 190	E 280	E 1,000	E 1,470
	T 60		T 1,600	T 1,660
2010	680	320	4,000	5,000
	E 520	E 320	E 1,300	E 2,140
	T 160		T 2,700	
2020	1,140	360	4,000	5,500
	E 820	E 360	E 1,300	E 2,480
	T 320		T 2,700	T 3,020
2040	1,800	400	4,000	6,200
	E 1,150	E 400	E 1,300	E 2,850
	T 650		T 2,700	T 3,350

Figure 1

The Two Rivers and the Gulf In Historical Perspective

From an historical point of view, Iraq was the first to impact the natural environment of the Shatt al-Arab, the marshes of its delta, and the Gulf itself. Estimates suggest little or no use of the rivers by Syria and none by Turkey in Ottoman times. The area which is now Iraq had somewhat more then half a million hectares (580,000) irrigated by gravity flow and simple lifts at that time (Figure 2).

Study and development of the Euphrates followed during the British Mandate (1917-1932). The Hindiya Barrage built 1908-1913 and reconstructed 1921-1922 was the first on the river. The Kut Barrage on the Tigris (1934-1943) and the Diyala Weir (1927-1928) allowed further expansion of irrigated agriculture (U.K. Naval Int. Div., pp. 438-439). In the years that followed, the Kingdom of Iraq established a Board of Development, the Ministry of Development, and the Ministry of Agrarian Reform. By 1954 irrigation along both rivers had nearly tripled to approximately 1,440,000 hectares. From an Iraqi point of view, this early use of the rivers establishes a claim, through prior usage, on the water in question.

Important new features are being added to the irrigation scene in Iraq. The Main Outfall drain (The Saddam River or the Third River) which is intended to collect drainage from farmland between the two rivers, thus eliminating severe problems of water logging and salination, has been completed. Five hundred kilometers in length, with an average depth of 4 meters and width of 180 meters, its most southerly section, which discharges into the Shatt al-Basrah Canal and subsequently into the Khor al-Zubair Estuary, is 220 km in length and has a discharge capacity of 300 m3/sec (9.46 bcm/yr)(Map 1). This and other measures will facilitate the expansion of irrigated agriculture. A recent estimate anticipates a total of 4 million hectares of irrigated land on the twin rivers circa 2010.

The completion of the Main Outfall Drain (MOD), referred to above, is an event of ecological and commercial significance. This canal will collect runoff from irrigated fields between the Euphrates and Tigris Rivers and lead the flow south, crossing the Euphrates by siphon and emptying it into the Shatt al-Basra Canal (opened March 1983) which thereafter empties into the Khor al-Zubair (estuary) and subsequently into the Gulf on the inland side of Bubiyan Island in Kuwaiti waters (Al-Dahan and Yousif, p. 412). A possible discharge of
Figure 2

Map 1

9 billion m3 could significantly change the quality of the waters involved. Salinity would increase sharply in the canal. Research must also be carried out to determine the increase, if any, of pesticides and herbicides and to take action to control such inputs.

Flood waters of the Euphrates formerly reached the al-Basrah canal in late spring and early summer with an abundance of freshwater species of fish appearing in April (Al-Dahan and Yousif, p. 419). On the Euphrates itself the predicted sharp decrease in flooding -- to be replaced by a sustained flow in order to even out seasonal variance -- will change the nature of the marshes and Lake Hammar. Increased salinity would destroy the habitat of these fish. More freshwater species may possibly appear with the diversion of saline waters, but as stated, those same diverted waters may in turn inhibit freshwater species in the estuary. Conversely, the habitat of salt water species may not be affected, or perhaps increased in area. In counterpoint to these events may be the absolute reduction in flow of the rivers (particularly that of the Euphrates) resulting from upstream activities. Nevertheless, a bare minimum of at least 5 billion m3 must be retained in the latter river in order to provide surge flow for gravity fed irrigation systems.

The question of political versus economic motivation arises at this point. It has been suggested that the main purpose of the drainage canals being dug in the southern Iraqi marshes is to punish local dissidents who live there and to deny them hiding places. An alternative view is that more land is needed for agricultural production. This author believes that sufficient land exists elsewhere for such production, either through reclamation of salinized fields upstream or perhaps through new lands on the valley margins. It is undeniable that many developers feel the challenge of marsh land reclamation, so this question remains unanswered.

Syria, and thereafter Turkey, also have contributed to this environmental impact (Figure 2). Syrian utilization of Euphrates' waters prior to the 1950s was slight, if not negligible, until the introduction of gasoline pumps for cotton production. Irrigated lands on the Euphrates, Orontes (Asi), and Khabur leaped from 284,000 ha in 1956 to 583,000 ha in 1957. Unlikely as such an increase may seem, this "miracle in the desert" is reported to have taken place (Sanlaville, 1979, p. 321). Such irrigation was largely in the hands of private entrepreneurs and by 1970 reached 160,000 ha in the Euphrates valley (Treakle, 1970).

The construction of the Tabqa (Ath-Thawrah) Dam and the filling of Lake Assad in 1974 ushered in a new era of river management. The story of the estimates, ambitions, and re-estimates of land to be irrigated with waters from the reservoir is too complex to be told here (see: Kolars and Mitchell, 1991, Chap. 8). Estimates show that about 240,000 ha of land were being irrigated through government and private means at the beginning of the 1990s.

Careful evaluation of available soils and alternative locations for irrigation indicate that Syria may show a slow but steady increase of irrigated lands dependent upon Euphrates waters, which should reach a maximum of almost 400,000 ha in 2015. Use of the
the Tigris itself is conjectural given the short distance that the river touches Syria where it forms a mutual boundary in part with Turkey and in part with Iraq. It is reported, however, that upwards of 50,000 hectares out of an eventual 125,000 hectares are currently being irrigated in the northeast from tributaries of the Tigris. Because of the uncertainty surrounding these figures, the downstream impact that Syria shares with Iran and Turkey is shown in Figure 2 and Tables 3 and 4 to level off shortly after the turn of the millennium.

Turkey is the late comer to this history of river use (see Bagis, 1989, for a complete account of GAP). As of 1992, a total of about 65,000 ha were being irrigated in Turkey with water from the Euphrates River (45,830 ha) and from the Devegecedi, Silvan I & II, and Nardus projects on the Tigris River (19030) (EKA, "Heavy Construction . . ., n.p. #). The goals and achievements of the Southeast Anatolia Development Project are too well known to recount here, although most of the results, beginning with the development of the Harran Plain south of SanliUrfa, are only now beginning to be realized. Turkey, like its neighbors faces a host of challenges and difficulties in order to realize its plans in their totality. Nevertheless, predictions indicate steady growth of irrigated areas dependent upon the twin rivers. What is overlooked is that Turkey, as yet, has had little lasting impact upon the Euphrates and Tigris rivers. Estimated increases in irrigated land development are shown in Table 4.

The Impact of Arid Land Development on the Ecology of the Gulf

The Gulf is a marginal sea with one narrow opening at its southern end (Map 2). It is shallow, with an average depth of 35 meters. It reaches its greatest depth (100 meters) near the Straits of

Map 2

Hormuz, and ends in an estuarine slope, the Mesopotamian shelf, in the north were its major tributary, the Shatt al-Arab enters. Evaporation is great and because of the gulf's land locked nature a slow surface current enters from the gulf of Oman and moves along the east (Iranian) shore (Purser and Seibold, p. 1-9).

The bottom of the gulf is shallow and shelving on the western, Arabian side, while its deeper parts parallel the Iranian shore (Map 1). Small streams which enter the Gulf on the Iranian side in the form of flash floods emanate from the Zagros Mountains and carry quantities of terrigeneous material into the marine basin. It should be noted that the much greater flow of the Shatt Al-Arab contributes very little solid material the Mesopotamian shelf (Purser and Seibold, p. 5) although the accumulation and scouring of millennia does give a distinctive "comb like" appearance to the submarine topography of the northern shallows. It is possible that more alluvium reached the Gulf before deposits from the Karun River blocked the twin rivers direct access to the Gulf, but that event would predate historic times. As a consequence, alluvial materials carried by the Euphrates and Tigris were deposited in the swamps near Lake Hammar and very little silt or sand reached the Gulf from those sources. At the present time, reservoirs in Syria and Turkey remove much of the suspended load of the Euphrates before it reaches Iraq. In fact, the waters of the Euphrates west of Baghdad are reported at this time to be running clear, and green algae now covers the river bottom as the result of sunlight's reaching new depths (interview with Iraqi hydrologist). Whether or not this will create problems of eutrophication remains to be seen.

The load of dissolved substances carried by the rivers can also be significant. Nutrients in the form of nitrogen and phosphorous contribute to the growth of phytoplankton which are the basis for larger marine life. Total Organic Carbon (TOC), while a solid, is often included in discussions of aquatic nutrients and will also be considered at this point.

There can be little doubt that the Shatt al-Arab is a source of nutrients for the Gulf (Abaychi, et al), although the Gulf, in general, is poorly supplied. This can be seen in Map 3 which shows the extension of nutrient concentrations in samples taken progressively farther from the mouth of the Shatt al-Arab. The map shows combined nitrogen and phosphorus as mg/g-1. (The reader is referred to Abaychi, et al for details.) Talling (pp. 76-79) confirms the presence of nitrate-nitrogen, phosphate-phosphorous, and silicate-silicon in the marshes
and the Shatt al-Arab, though silicon and nitrogen appear diluted as marine waters are approached (Map 3). In general, the effect of the Shatt al-Arab appears to be limited to an area north of 29o N lat. this places the impact of the river, whether natural or modified by humans, in Kuwaiti, Iranian, and Iraqi waters (U.S. Department of State, #94).

The ability of the Gulf to provide a sustainable catch of food fish, shrimp and other crustaceans, and mollusks is the focus of these considerations. A secondary but no less important goal is the maintenance of as much of the natural ecology of the area as possible in line with similar aims and directives throughout the world. the importance of the northern fishing grounds in the Gulf is demonstrated by research carried out by Kuronuma (p. 92) who shows a total catch of all types of fish and prawns of 9.44 kg/km through trawling in Kuwaiti waters 80 percent as much as the 11. 85 kg/km taken in Qatar-Trucial waters. Catches along the Gulf coast of Saudi Arabia in 1977 amounted to 6,000 metric tons as compared to 10,000 MT off Saudi Arabia in the Red Sea (Morgan, Table 15). The total catch of all types landed in Bahrain in 1979 amounted to 3,800 MT (Morgan, Table 1). Thus, sustaining Gulf ecology and the marine catch will remain important to all the members of the GCC as well as to Iraq and Iran.

The importance of such considerations is emphasized by examples in other parts of the world. Attention has been called to the negative results caused by the High Dam on the Nile River at Aswan. Beginning in 1965, the sardine catch of the Egyptian fleet in the eastern Mediterranean Sea declined by 59 percent (18,000 MT from 30,600 MT) (George, p. 159). This was directly attributable to the impounding of the annual flood waters and the loss of silt and other nutrients, as has been the subsequent deterioration of the Nile delta forelands. Although it is unlikely that an exact parallel exists between the situation on the Nile and the new conditions on the Euphrates/Tigris,a word to the wise is sufficient.

The Problem Redefined: Determining the Political/Environmental Threshold of Development

Downstream ecological and economic impacts of dams, reservoirs, and irrigation, as shown by existing examples elsewhere in the world, can be severe. The Nile, Danube, and Colorado Rivers have all experienced upstream manipulations with subsequent negative repercussions involving downstream nations and ecologies including marine destinations. In the words of an expert on the biology of the Nile River:

I am led to question the validity of the unilateral acts of any country which may influence on the ecology of a region shared by a group of countries. The High Dam (i.e. in Egypt) is not unique. Dams of nearly comparable influence are planned for the Mesopotamian Valley and Iran . . . The influence of such acts is invariably more accentuated when the marine waters involved are partially land-locked such as the Mediterranean, Persian Gulf and the Caribbean. . . . International regional ecological studies and planning seem an essential feature if there is to be any hope of avoiding an enduring misuse of natural resources (George, 1972).

While the political impact of the developments referred to above, extant and proposed, have been and will be dramatic (Starr and Stoll), their ecological consequences promise to overshadow the hydropolitical relations of all involved. In order to untangle the resulting confusion of claims and counter claims, three elements relating to the situation must be recognized. These are: Facts, Acts, and Interpretations (i.e. nationally influenced perceptions.) The utility of facts and the consequences (good or bad) of the acts (developmental activities) based on such facts depends upon their interpretation. Interpretation inevitably reflects the political and cultural biases of the interpreters.

To illustrate this point: facts may vary with the methods of observation employed as well as the times and sites involved. For example, the wide seasonal and multi-annual variation in the flow of the Euphrates is a fact. Our perception of the magnitude of such variance depends upon how the observations were made (and our ability to agree upon their accuracy) (See Kolars and Mitchell, Chap. 5). Some other facts depend upon how they are worded. That "88 per cent of the flow of the (Euphrates) river is generated in Turkey," a commonly cited figure, hinges upon the definition of the word "generated." The aquifers feeding the Balikh and Khabur Syrian tributaries of the

Euphrates depend on springs rising in Syria but dependent upon aquifers charged by rainfall in Turkey. In view of this, 96 to 98 per cent of the flow of the Euphrates is generated in Turkey.

Again, recent statements indicate that Turkey has guaranteed 500 cubic meters per second (cms) of downstream flow of the Euphrates to Syria and Iraq. At least one observer goes on to comment that Turkey has "only been willing to" do so. The spin thus put on the initial guarantee can be interpreted as selfish ("only about 50 per cent of the natural flow of the river"), or on the other hand, the 500 cms can be taken as carefully realistic since there have been runs of dry years where less than 500 cms has been available (Table 5). The concept of average annual flow is a statistical abstraction rarely found in nature. This is shown in Table 5 where it is assumed that Turkey retains an average of 450 cms, instead of 500 cms, and allows all other flow downstream, and yet the system sometimes still comes up short.

A further example involves the interpretation of storage reservoirs on major rivers in the region. Middle Eastern rivers reflect existing wide swings in climate and precipitation by extreme variance in flow volumes, both seasonal and multi-annual. The Euphrates and the Jordan Rivers experience flood conditions in late winter or spring (summer for the Nile), and yet by September their beds may be all but dry. There may also be runs of dry years followed by multi-year sequences of ample flow. The rational way to even out such variance is to provide storage reservoirs near upstream sources where mountain canyons provide good dam sites. Regardless of any other use or motivation, the upstream dams Turkey has built for its GAP project allow the smoothing of variable flow and guarantee a steady amount of water,s being delivered down stream. However, this interpretation of the role of Turkish dams does not suit the Syrians or the Iraqis. Their claim is that Turkey is withholding their water resources and that such water should be stored within their own borders. On the other hand, the fact that the Syrians have already built 24 retaining dams on the upstream tributaries of the Yarmouk River in order to hold back winter floods that otherwise would flow unchecked into the Dead Sea, to be forever lost, is accepted by at least the Syrians as good planning.

In the October 1996 issue of Middle East Policy Fred Lawson evaluates the situation existing between Israel and Syria and suggests how United States, financial aid might improve it. He devotes a quarter of his article to "Guaranteeing the Flow of Water," by which he means making certain that Syria and Iraq receive fair shares of the Euphrates River. This would be a commendable undertaking. However

Table 5

Average Yearly Flows (cms) of the Euphrates River -- 1937-1963 (a period of generally low flows)
(27 year average flow = 854.6 cms = 27.0 X 109m3/yr)
(Assumed storage 46.8 bcm = 1484 cms) (Turkey uses 450 cms/yr)
(Short & Long refer to values above and below 500 cms downstream)

Year	cms	Downstream	Short	Long	Cumulative stored
				Assuming 46,8 bcm (Turkey keeps 450/yr) to begin	
assumed full storage at beginning of series in cms					+1484
37	894	444	- 56	- 56	1428
38	997	547	+47	- 9	1475
39	831	381	-119	- 128	1356
40	1165	715	+215	+ 87	1484*
41	1120	670	+170	+ 257	1484*
42	1032	582	+82	+ 339	1484*
43	856	406	-94	+ 245	1390
44	1056	606	+106	+ 351	1484*
45	691	241	-259	+ 92	1225
46	920	470	-30	+ 62	1195
47	703	253	-247	- 185	948
48	1007	557	+ 57	- 128	1005
49	662	212	-288	- 416	717
50	753	303	-197	- 613	520
51	716	266	-234	- 847	286
52	932	482	- 18	- 865	268
53	906	456	-44	- 909	224
54	1012	562	+ 62	- 847	286

....reservoirs empty beyond this point.......................

55	588	138	-362	-1209	0	- 76
56	827	377	-123	-1332	0	-199
57	818	368	-132	-1464	0	-331
58	655	205	-295	-1759	0	-626
59	574	124	-376	-2135	0	-1002
60	826	376	-124	-2259	0	-1126
61	484	34	-466	-2725	0	-1592
62	692	242	-258	-2983	0	-1850
63	1356	906	+406	-2577	0	-1444

*Additional surplus lost - assuming no additional storage.
This assumes a Turkish minimum use of 450 cms, and therefore, no Turkish losses. Cumulative downstream losses = 1444 cms = approximately 45.8 x 109m3.
Lawson in his provisions for such action lists among other points, "Second, Washington would take steps to ensure that storage facilities inside Syria matched those under Turkish control" (p. 108).

This simply is not possible. The Euphrates River in Turkey flows through mountainous terrain with a number of sites ideally suited for deep storage reservoirs. There are no mountain gorges on the Euphrates in Syria and the few places suitable for even the shallow impounding of water have already been utilized (the Tishreen Dam, Ath-Thawrah Dam, Al- Ba,ath Dam). Moreover, existing reservoirs are shallow, and compared with reservoirs upstream in Turkey, lose disproportionately large amounts of water through evaporation (Table 2). Much valuable time and effort might be lost negotiating this moot suggestion regarding a circumstance due entirely to the asymmetry of natural conditions.

And again, that two rivers are involved is a fact, but whether or not the Euphrates and Tigris share one basin (the Turkish view) or are in two independent basins (the Iraqi view) depends upon the human/political interpretations involved (Government of Turkey, June 1996).

Environmental impact is marked by the intersection of human interpretations with dispassionate facts. It is this meeting ground that needs be identified. But when people with different views and agendas meet, confusion results. How can this dilemma be resolved? What I propose is that problems of development and environmental impact in the case of the Euphrates and Tigris Rivers can best be examined and resolved through the introduction of a River Ethic, supported by an impartial group representing River Advocacy. The introduction of a dispassionate third party advocating the good of the river would put opposing political points of view in perspective, and in the long run benefit human users as well.

The Importance of Communication

Open communication between users underlies the success of any environmentally sound undertaking (Kaufman, et al; Stein and Lewis). One example will suffice. In February 1997 a "second track" meeting between water managers in the Middle East was held in France. One session was reserved for discussion of the Euphrates waters and their use. The question was raised concerning Syria,s charge, made the year before, that Turkish projects on the Euphrates were polluting the river. This, to non-aligned observers, seemed unlikely for few factories, if any, or irrigated fields were on-line at that time which would directly pollute the main stream of the river.

Discussion between the participants revealed that the pollution was of the Balik River, a tributary of the Euphrates that rises in Turkey and thereafter flows through Syria. Further talk revealed that the pollution was originating from the Turkish border town of Akçakale, the sewer system of which had been unable to meet the demands of boom town growth, based in turn on anticipation of the arrival of irrigation water from Lake Ataturk via the Urfa Tunnels. The Director of the Turkish State Hydraulic works expressed true concern over the situation, and also stated that he had been unaware of the problem until that time. (He had previously objected to the idea of Turkish pollution in the river, having thought that the main stream had been meant by the accusation.)

The Director stated emphatically that the matter would be attended to immediately upon his return to Turkey. The Syrian delegation was mollified, and another crisis averted. Only open discussion in a less-than-public atmosphere led to this positive move.

It is imperative that off the record, privately hosted discussions such as these continue to be encouraged and facilitated.

In conclusion, the above comments on these complex relationships are not intended to be either comprehensive or definitive, but rather are presented in order to suggest future possibilities for the twin rivers, the Shatt al-Arab, and the Gulf. It should be kept in mind that activities in Iraq are being paralleled by those in Syria and Turkey, and it is necessary to recognize their combined potential impact and that multi-national plans be made for studying and responding to possible ecological and economic consequences before they occur.

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