Sustainable Development for Peace: Promoting Access to Natural Resources to Alleviate Rural Poverty | NAKASHIMA Masahiro

INTERNATIONAL ENVIRONMENTAL CONFLICT RESOLUTION

THE ROLE OF THE UNITED NATIONS

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5 *Chapter Five* International River Systems

Chapter Five

CASE STUDIES

International river systems 5

5.1 Introduction

This chapter assesses the driving forces behind IECs related to international rivers, and illustrates some of their main components through brief case studies. A more in-depth case study examines how IECs have been managed in relation to the Zambezi River System in Southern Africa.

Demand for water, and the services it can provide, is increasing worldwide, particularly in arid and semi-arid lands. Under pressure from rising demand, national water resources will become increasingly exploited. Some may even face depletion. Population growth, agricultural expansion, and the ever-rising expectations for improved standard of living worldwide, have all contributed to the realization that water is not an unlimited resource.

Competition for both quality and quantity of shared water at a local level often leads to international water conflicts. Many IECs have been triggered because of the numerous shared water resources worldwide. Today, there are approximately 200 large river systems which are each shared by two or more nations. The need for basin-wide management is becoming more acute as the number of IECs increases.[1]

A river basin (also known as a catchment area, or a drainage basin) is an area which receives rain and which supplies water to a stream. River basins, drainage basins and catchment areas have both overland flow and groundwater. An international river system is a main river and all its tributaries, which run through, or separate, two or more states. As a result, co-operation at an international level is essential in order to manage the resource properly and avoid IECs.

While the potential for using river water in development plans is enormous, it cannot satisfy all possible uses. What happens upstream will inevitably have consequences

*IEC = International Env. Conflict

Chapter Five in overview

for downstream uses. If countries continue to consider only national priorities while developing and using international river systems, conflicts will undoubtedly arise. Some are shown in Table 1.

5.2 The water resource system

Most international river systems, while large in terms of their physical proportions, are in fact sensitive natural resources. The watershed from which a river originates determines the quality and quantity of its water. Rivers can be seen not only as natural drains through which surplus water reaches the sea, but also as a means of redistributing water from areas with high precipitation to other, possibly drier, regions. Water as a natural resource is not only used for drinking, but also for household, industrial, agricultural and transportation purposes. Forests, vegetation, fish and wildlife also depend on water. However, the volume of fresh water which is readily accessible for users is only a tiny fraction of the total amount which is transported globally by the hydrological cycle. This accessible water is mainly found in rivers, reservoirs and lakes, or a short distance below the ground. It typically has a brief residence time, and because of the spatial and temporal vagaries of the hydrological cycle, its distribution varies greatly from one part of the world to another. These variations cause serious problems for the assessment of water resources both globally and nationally, and even for a single river basin. Yet without such assessments there is no rational basis for planning how water resources should best be utilized and managed in order to reach prescribed goals.[2] Any particular use of water has consequences for other uses. Water extraction, water discharge and flow-regulation can all have basin-wide consequences, seriously affecting the nature and extent of benefits realizable throughout the basin.

Table 1. IECs over River Systems

River System	Countries involved with incompatible goals	Main subject of conflict
Nile	Egypt, Ethiopia, Sudan	Water flow
Euphrates, Tigris	Iraq, Syria, Turkey	Dams, water flow
Jordan, Litany	Israel, Lebanon	Water flow
Yarmouk	Jordan, Syria	Water flow
Indus, Sutlei	India, Pakistan	Irrigation
Ganges	Bangladesh, India	Siltation, flooding
Mekong	Kampuchea, Laos, Thailand, Vietnam	Water flow
Parana	Argentina, Brazil	Dam, flooding
Lauca	Bolivia, Chile	Dam, salination
Rio Grande, Colorado	Mexico, United States	Salination,water flow, agro-chemical pollution
Great Lakes	Canada, United States	Water diversion
Rhine	France, Germany, Netherlands, Switzerland	Industrial pollution
Elbe	Czechoslovakia, Germany	Industrial pollution
Szamos	Hungary, Romania	Industrial pollution
Danube	Czechoslovakia, Germany, Hungary	Dam / Water flow

5.3 Conflicting demands

Every international river system is unique, and the demands, priorities and suitability of a river system to different types of use will vary from place to place and from time to time. The location of a river system, together with such factors as climate, population, agriculture and degree of industrialization, determine which types of use are given priority and which create problems and conflicts.

Unless such conflicts are resolved and agreements reached on a co-operative basis, users decide individually how, and to what extent, they may utilize shared resources. The users' objectives are usually centred on claims and goals aimed at maximizing their own needs and values.

In order to analyse IECs related to international river systems, reference must first be made to the participants involved in different levels of conflicts. First, on a local level, competing groups may be national governments versus non-governmental claimants (e.g., individuals such as farmers and pastoralists, or private groups, organizations and associations). Water resource conflicts may also arise between such sectors as agriculture and industry (e.g., hydroelectric power generation).

Second, IECs may arise at, or escalate to, a regional level where two or more countries perceive that they possess mutually incompatible goals in utilizing the shared river system. Local conflicts, escalating from claims made by private individuals or groups, usually form the underlying element in claims advanced by national governments and presented at regional or international arenas.

Third, reference can be made to the independent sector level, a cross-level involving IECs between transnational corporations and local or regional user groups like farmers or environmental NGOs, where the contentious issues are the consumptive use and/or industrial pollution of the river system. (See Chapter Four). The global level is not relevant in this context, except where debt repayment issues or global climatic changes are linked to international river systems.

5.4 Driving forces behind IECs

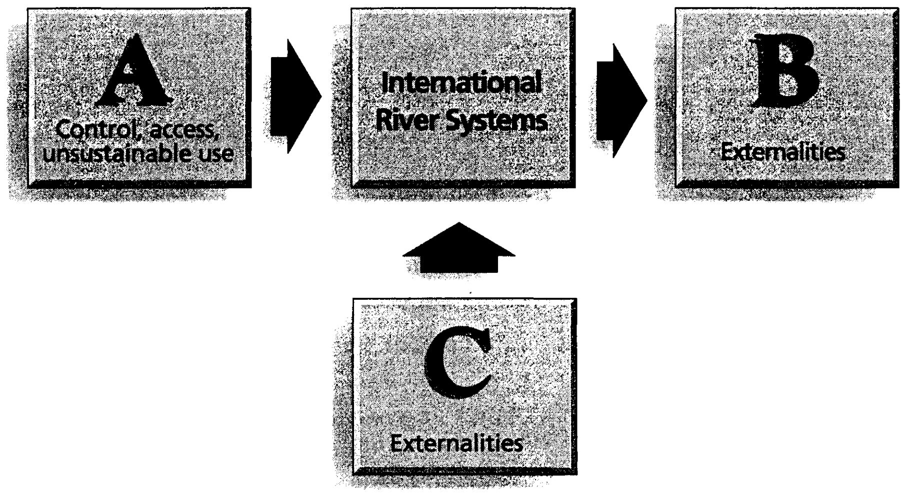
The analysis of driving forces behind IECs often has to be based on conflicts arising at a local level. Conflict issues and their motivation are still the same at an international level, but man-made national borders, and additional difficulties, such as national sovereignty claiming power over its 'own' river resources complicate the conflict management process at this level. The three-part model described in Figure 1 illustrates the basic types of conflict that may arise:

A—incompatible goals related to access to, control over, and unsustainable use of international river systems (for example, through water diversion, dams and reservoirs);

B—externalities created by utilizing the international river systems (for example, salination as a result of irrigation; changed water flow as a result of regulation; pollution from industry using water in the production process; sewage from cities and communities); and

C—IECs arising as a result of externalities from other activities affecting the river systems (for example, eutrophication, pollution from industries which do not use the water resource in the production process, soil erosion and siltation of water courses following deforestation or over-grazing).

Figure 6. The ABC model and international river systems



5.5 (A) Access to, control over, and unsustainable use of international river systems

Access to water resources is determined by the location of a country in relation to a river system. Climate has considerable influence on a country's access to water resources. The amount of inflow from upstream countries depends on the nature of water-consuming activities in these countries; and downstream countries depend on their upstream neighbours for their own water-consuming activities.

Control of water in international river systems is mainly determined by the location of the riparian states in relation to the watershed, as well as the division of power between the countries—be it economical, political or military.[3]

Domestic and municipal uses of river water rank highest on the priority list, since no community can survive without an adequate drinking water supply. Cities, with their expanding populations, face higher demands for water for drinking and sanitation purposes; and in cases where there may not be enough water to satisfy all demands, a question of priority arises.

In arid and semi-arid countries, diversion of water for agricultural irrigation is a high priority, while in countries which are well-supplied with water, generation of hydroelectric power and industrial use may be given greater priority.

Water use may be consumptive or non-consumptive. Non-consumptive use, such as navigation of international river systems, has led to international conflicts in the past. Today, however, because of well-established rules and existing international administrative regimes, navigational use of international river systems does not give rise to serious conflict (which is why navigation is excluded from this study). Other forms of non-consumptive water use, however, such as recreation and non-commercial fishing still cause serious national conflicts in several industrialized countries. And as more developing countries are turning to tourism as a source of national income, recreational use of international river systems will be given higher priority, which may lead to new IECs. Consumptive use covers various interests:

Domestic and municipal use

Increased demand for water is resulting in excessive pumping of groundwater aquifers, and a deterioration in quality of both surface and groundwater supplies.

The demand for water and its different uses depends on the numbers of individuals to be supplied. The larger the population, the less water is available on a per capita basis, making population growth a real dilemma in countries where the supply of water is scarce. (A modern urban household may use 400 to 800 litres of water daily.) A common characteristic of almost all semi-arid lands in the world is a relatively high rate of population growth, whether in Sub-Saharan Africa, India or southern California. It is estimated that by the end of the century, the world will gain an additional 1.1 billion people, with 20% of this population growth in arid and semi-arid regions.

The quality of available drinking water is also an issue of importance, as illustrated by events such as cholera epidemics. A satisfactory domestic water supply must be free from harmful bacteria, and chemicals that give it an unpleasant taste (whether or not they are actually harmful). As populations increase, and as manufacturing industries grow, it becomes increasingly difficult to find and maintain supplies of good quality water.[4]

Perhaps the most pertinent international effort seeking to improve standards in the provision of water supply and waste disposal was initiated with the launch of the United Nations International Drinking and Sanitation Decade in 1980. The Decade called for safe water and adequate sanitation facilities to be made available to all rural and urban areas by 1990.[5]

On a global scale, approximately 71% of the urban population (excluding China) has access to drinking water supplies. The availability of most services is greater in urban areas than in rural areas, and the supply of drinking water is no exception. At present, only 41% of the world's rural population has convenient access to adequate drinking water supplies.[6]

Irrigation in industrialized and developing countries

Industrialized countries

Although municipal and industrial water needs are growing, water use in industrialized countries continues to be dominated by irrigated agriculture, which globally accounts for about 73% of water used in arid and semi-arid regions.[7] Irrigation is normally water-intensive, with a higher consumption-to-withdrawal ratio than other water uses, which means that proportionately more of the water diverted from streams or aquifers evaporates from the soil or transpires from crops instead of returning to the sources for re-use. This ratio averages about 60%, compared to 25% in municipal use

and between 0% and 25% in industrial use.[8] There are some exceptions, however, as in the case of Israel with quite a low ratio average.[9]

In industrialized countries, much of the water supplied for agriculture originates in national water projects subsidized by tax-payers, as in the Columbia River Basin, or as in Scandinavia through district equalization policy. Water is therefore cheap for farmers and the subsidies offer no incentive to conserve surface water. Rising water costs have, however, generally triggered shifts to higher-valued crops and crops needing less water to grow.

Crops currently use only about half of the water applied with most irrigation methods. Efficiency varies, however, according to the type of technology employed and the capital investment in the land and physical structures, and may reach 75% of supplied water.

Developing countries

Irrigation in developing countries ranges from capital-extensive and labour intensive recessional systems, (water variations from lakes and rivers, as in the Gambia and Senegal river), to highly sophisticated capital-intensive systems (for example, in India and Pakistan).

Increasing populations and standards of living in developing countries require substantial growth in agricultural output (at least 3% per annum), which is unlikely to occur without an intensification of agriculture.

In many river basin countries, development of agriculture has the highest priority, because of its importance to the national economies. This implies that more and more land with arable potential will be cultivated, large-scale irrigation schemes will be promoted when funds are available,

Table 2. The Indus River System.
. manifest IEC related to water-flow / irrigation

Actors	Interests	Strategies
India	India contended it had proprietary rights over the water and was thus entitled to exclusive use of the waters of the eastern rivers of the Indus system.	The Sutlej waters feeding certain canals leading into Pakistan are considered to be closed.
Pakistan	Pakistan advocates the principle of territorial integrity.	The view of the West Punjab Government is that water cannot be stopped on any account whatsoever. Pakistan wanted to secure sufficient and regular supplies of usable quantities of water for agricultural irrigation.

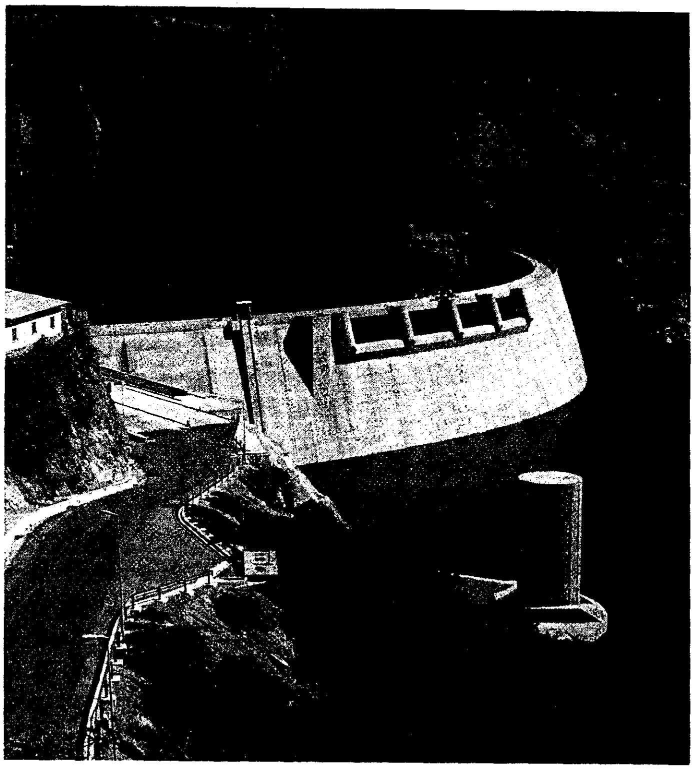
and increasing amounts of pesticides and fertilizers will be used.

Extension of agriculture into marginal land areas could help a little, but limited land resources and declining yields on marginal land restrict this. Intensification of rain-fed agriculture should be a major element, especially in areas of better rainfall. Progress in dry zones, however, will probably continue to be slow. Irrigated agriculture, with a shift towards perennial irrigation, will therefore play a more proportionate role. To ensure an overall growth in agricultural output by 3% per year, output from irrigated agriculture will have to increase much faster. Intensification of cultivation and higher yields on existing cropped areas under irrigation may account for part of this output, but most of it will have to come from an increase in double cropping and expansion of the irrigated area.

This suggests that a substantial growth in the irrigation-cropped areas and in the demand for irrigation water will be necessary over the next few decades. Because there are already local water shortages in arid and semi-arid areas, this also implies a need for improved efficiency in water usage.[10] The scope for improvements in overall irrigation efficiency may, however, be fairly limited. Conservation efforts are likely to cause a large increase in the need for additional irrigation water. (See Table 2–The Indus River System).[11]

Industrial purposes

There are few forms of manufacturing which do not require water at some stage. For example, the pulp and paper industry, the metallurgy industry, and brewing, chemical, and mining industries, are all heavy water users. Expanding industry, such as water cooling of fossil-fuelled power-stations, claims a substantial share of available water resources. Industrial water uses are mainly non-consumptive, and the water is often recirculated in order to save expense and conserve resources. The control of water discharge for this purpose is a frequent cause of IECs (such as in the Rhine or Danube in Europe).



Hydroelectric power (HEP) generation

Another important use of water in connection with urban and industrial life is for energy, with a great potential for further development of hydroelectric power (HEP) in almost all international rivers in developing countries. HEP can most conveniently be integrated in multi-purpose water resource projects intended also for irrigation and flood control. Even though HEP does not directly consume water in the produc-

Box 8

The Jordan River System
A manifest IEC over waterflow diversion

The Jordan River System is shared by Jordan, Syria, Israel and Lebanon. Competition for water in this area is greater than anywhere else in the world, because of the region's aridity, population pressure and geopolitical situation. Israel diverts water from the Sea of Galilee, through which the Jordan River passes, to its Kinnert-Negev conduit. Jordan diverts water from the Yarmuk River, a tributary to the Jordan River which forms the border between Syria and Jordan, to the East Ghor Canal, its national water artery. (Charnock, 1983)

Controversy over water issues, although until recently largely undocumented, is one of the reasons why no peace agreement has been achieved in the area since 1947. According to many scholars (e.g., Cooley 1984) the constant competition over the waters of the Jordan, Litany, Orontes, Yarmuk, and other life-giving Middle East rivers was a principal cause of the 1967 Arab-Israeli War, and could help spark new conflict again. It is also a major aspect of the Palestinian question and the struggle over the future of the West Bank.

In the case of the Jordan River Basin, it is evident that both Israel and Jordan already face serious problems, which can only worsen in years ahead. Israel uses more than the entire amount of its water allocation. After several winters with below average precipitation, the Sea of Galilee's water level is at its lowest in 60 years: just 50 cm over the red line where all pumping should stop. In the heat of summer, evaporation alone can lower the water level at least 1 metre in just a few months.

Jordan has not been using all of its water allocation, and its per capita use has been extremely low. The situation is precarious since Jordan produces an extremely small amount of staple food and at the same time has a yearly population growth rate of 3.8% (one of the world's highest). Consequently, to meet its growing water needs, Jordan is relying on incremental solutions, including deeper drilling for groundwater sources and such expensive technologies as drip irrigation.

Compared with its neighbours, Lebanon has plentiful water resources which could potentially be shared. Its numerous rivers and underground systems are reliably replenished from ample precipitation. However, because of lack of orchestrated water management at the national level, Lebanon has serious water problems: severe water shortages in Beirut, seawater intrusion in the coastal aquifer, lack of irrigation water, and pipelines as well as aquifers that have been severely damaged by civil war.

tion process, it usually demands a man-made reservoir, which implies resettlement of people; changes in the local environment; loss of discharge; and (at least in arid and semi-arid areas) more significant seepage and evaporation. This also means that HEP cannot be classified as non-consumptive use, as was generally done a few years ago. The dam entails control over the discharge which may cause severe implications politically as well as physically for downstream countries (for example, the Ataturk dam in Turkey with Iraq, Jordan, Israel and Lebanon downstream).

Recreation and tourism

International river systems and rivers in general are very attractive for recreational use. Rising real incomes and shorter working weeks have encouraged such river uses as swimming, boating, canoeing, rafting, fishing, hunting at the waterfront and sightseeing. The recreational capacity and value of rivers may sometimes be increased by the building of dams and creation of reservoirs. Incompatible values and interests may, however, develop between conservation of the environment and recreational user groups and other water resource users, such

Table 3. Actors, interests, and strategies in the Jordan River System

Actors:	**Interests:**	**Strategy:**
Syria	To secure sufficient quantities and regular supplies of usable qualities of water for the future. Protect the waters of the Orontes River for irrigation of farmland in western Syria.	To link the lower reaches of the Hasbani River with the Banias River. To link the headwaters of the Yarmurk River. To obtain guarantees that the headwaters of the Orontes River would never be controlled by Israel.
Lebanon	To secure sufficient quantities and regular supplies of usable qualities of water for the future.	To link the headwaters of the Hasbani River with the waters of the Litany River. Military defence and diplomatic negotiations.
Israel	To gain access to the lower reaches of the Litany River and the Orontes River. Israel perceived that the Arab diversion plans presented a serious threat to its security. Israel fears that the Wahda Dam on the upper Yarmuk River could seriously affect its ability to meet its growing water requirements, and it wants a fair share of the Yarmuk waters.	Israel has launched a pre-emptive strike on Syrian construction sites, damaging equipment. Israel has withheld its approval of the Yarmuk project, implying that the World Bank will not proceed with the financial support.
Jordan	To secure sufficient and regular supplies of usable qualities of water for the future.	To withdraw water from the sea of Galilee (depending on Israel's approval). To supply water from the Maqarin project on the Yarmuk River (depending on Syria's approval. To transfer water from the Euphrates River which could create a dependence on Iraq.

as manufacturing industries or water regulation projects for hydroelectric power generation. Many of these conflicts are national rather than international.

Water diversion, dams and reservoirs

Diversion and damming must be considered to be the most important sources of IECs, as they serve as means of increasing access to, and control of, water in order to satisfy the water uses described above.

The majority of IECs related to *diversion of water* fall into the category of consumptive uses. Since all water diversion projects directly affect downstream water quantity, these projects are an immense source of conflicts, particularly when the diversion of river systems goes beyond the area of national jurisdiction. (See box on the Jordan River System).

Dams and reservoirs aim to store water resources for more efficient water distribution. Water demands vary according to the season; and the time of peak demand may not correspond to that of peak supply. Therefore, water supply can be increased during certain periods of the year, or stabi-

Box 9

The Ganges River System

The Ganges River System, the basin of which is shared primarily by India and Bangladesh, passes through one of the poorest regions of the world. Its waters have traditionally been regarded as an inexhaustible gift of nature. The regional population explosion and the rapid development of agriculture and industry in both India and Bangladesh are, however, putting increasing strain on this water resource through greater consumption, and deterioration of water quality. (Choudhury & Khan, 1983)

An ongoing 30-year dispute over the sharing of the waters of the Ganges River System is focused mainly on water diversion by India at the Farakka Dam just upstream from the Bangladeshi border. The aim of the project is to flush more water through the Hoogly River and port of Calcutta in order to reduce siltation. Bangladesh is threatened by the decrease in the dry season flow that can be caused by this withdrawal. After some 20 years of fruitless negotiations on joint use of the river water, a temporary agreement on a six-week trial at Farakka Dam was finally reached in 1975. India, however, prolonged this diversion for more than two years, which created problems in Bangladesh, because the extremely dry seasons which followed produced a series of adverse effects. The extent of seawater intrusion was exacerbated by the extremely low water level in the river; the upstream penetration extending some 160 km further than usual. Groundwater salination occurred over vast areas. (Zaman, 1983)

Bangladesh brought the issue to the United Nations, and in 1976 the General Assembly urged the parties to meet in order to negotiate a fair and expeditious settlement. (UNGA, 1976; 31/404) In November 1977, a five-year Ganges Water Agreement was reached. This treaty among other things seeks a long-term solution for augmentation of the dry season flow. Unfortunately, Bangladesh and India have divergent points of view as to how to increase the dry season flow of the Ganges River: (see table below)

Table 4. Actors, interests and strategies in the Ganges River

Actors	Interests	Strategies
India	To solve the low flow problems in Bangladesh without water withdrawals from the Ganges River. To secure sufficient quantities of water to reduce siltation in the Hooghly River.	To transfer waters from the Brahmaputra River in Assam through Bangladesh.
Bangladesh	To secure sufficient water flow in the dry season in Bangladesh.	Bangladesh rejects the canal scheme (see India's strategy) as ecologically ruinous and technically and economically unfeasible. To build storage dams in the upper reaches of the river in Nepal and India that would store wet season flow for release during the low flow period.

lized by damming rivers, to help reduce local periodical water shortages.

However, significantly reduced discharge of an international river causes IECs, as for example in the case of the planned dam near Gao in Mali (triggering conflicts with Niger over the loss of essential water for irrigation) and in Senegal (adversely affecting the Gambia and Mauritania, who will experience salt intrusion moving inland from the coast, which will subsequently ruin recession agricultural systems).[12]

Large-scale dams are usually multi-purpose projects (for example HEP, irrigation flood control, and navigation). One objective is the regulation of flow by storage so that water is available when needed. Another is flood control, preventing danger by withholding flood waters until the flood peak has passed. Thirdly, flow regulation may keep stream erosion under control.

IECs related directly to access to, and control and use of, water often arise as a result of large scale dam projects since these projects reduce the flow of water to downstream countries (as, for example the highly contentious Ataturk dam in Turkey).

5.6 (B) Externalities from utilizing river systems as causes of IECs

Water quality is particularly important when water is to be used for domestic and industrial purposes. If quality at the source is poor, the cost of treatment is greatly increased. Often some adverse qualities, such as unpalatable taste, cannot be entirely removed by treatment (and in some circumstances the treatment process itself creates a taste problem because of high residual chlorine, as in the case of the Rhine in central Europe). For irrigation, the main quality problem relates to salt. Some reservoirs can raise the salt content of the water, particularly in arid zones where the reservoir holding time is long and evaporation rates are high. Also for industrial and domestic water, high salt content greatly increases treatment costs.

Eutrophication (when the increase in mineral and organic nutrients in the stored water is sufficient to reduce the dissolved oxygen) is also a major water quality problem.

Monitoring of water quality is an essential long-term activity for all rivers and reservoirs, and is usually focused on biological quality and on the associated oxygen content; and (in the longer term) on chemical quality.

The domestic and municipal sector

Large concentrations of people have always resulted in waste disposal problems. Historically, the most common method has been to throw waste into the nearest waterway (regardless of whether or not the waterway is also used to supply drinking water). As long as settlements are small, and waste disposal is low in relation to the absorption capacity, waste disposal is generally not a serious problem; river flow or the tide will eventually take refuse away from its source. As cities grow in size, however, more elaborate methods of waste disposal must be developed, as now urgently required by the Danube in the intersection between Austria, Czechoslovakia, and Hungary. Nevertheless many towns and cities still return raw sewage to rivers which may provide part of the water supply for other centres or countries, or to the estuaries and beaches where large numbers of people may go for recreation (see Chapter Six for further discussion).

Irrigation

The common decision to postpone implementation of expensive drainage systems to a later stage of an irrigation project means that short-term financial constraints get transformed into long-term, and even more expensive, degradation problems.

The major water quality problem in arid and semi-arid agricultural areas is salinity, which affects many river basins. River waters become increasingly saline from the headwaters to the river mouths as seepage and return flows from irrigated lands empty into the rivers. This is an obvious cause of IECs, where the quality of the water for downstream users is severely affected.

In many areas, groundwater is severely polluted by deep percolation of irrigation water and seepage from irrigation-conveyance systems. The groundwater system can act as a conduit for saline waste water to enter rivers or international aquifers.

Salinity is not just a problem of instream water quality. Soil salinity also poses a major threat to agriculture and can worsen as saline water is used for irrigation, or as waterlogging of poorly drained land occurs. The lack of drainage in many agricultural areas causes the water table to rise, subjecting the productive soil layer to severe salination, and reducing crop yields (waterlogging).

Each year, salinity and waterlogging cause millions of dollars of damage to agriculture, as well as to industrial and municipal water users, and these costs are increasing.

Industrial sector

Most industries do not include the negative environmental side effects of their activities in the price of their products. They therefore use water as free goods to dispose of wastes that accumulate in processing. Detergents have come into wide use, both domestically and industrially, and the production of synthetic materials and complex pesticides and chemicals has resulted in problems of a far greater order than those of a few decades ago. Many of these pollutants cannot be broken down and rendered harmless by natural self-purification.

Thermal pollution stems from water discharged from power stations and factory cooling plants. The water may be chemically and bacteriologically unexceptionable, and may have a much higher temperature than when it was pumped out. The animal and plant population of a river may therefore be adjusted to a temperature range which is exceeded by the artificially warmed water. They may be killed, leaving a barren stretch of water, or they may be replaced by other, perhaps less desirable, species.

Another externality of industrialization is water pollution by the accumulation of heavy metals, nutrients and toxic chemicals in the river bed mud in deltas and estuaries. Sediments that are dredged up normally cannot be used for such projects as landfills in populated or agricultural areas. IECs in arid zone developing countries relate to the water quality as well as quantity. The problem is exacerbated when industrialization based largely on industrial techniques imported from developed countries are adopted. Techniques that have been developed in countries with plentiful water resources often depend upon volumes of water that are unrealistic by arid zone standards. Among the consequences of adoption of such techniques is that the water coming to a downstream country during the dry season may be highly polluted.[13]

Water diversion and dam and reservoir projects

Dam and reservoir projects improve water supply for irrigation and households; they provide power, and control floods, which in turn reduces fossil fuel depletion and the negative environmental effects of fossil fuel burning. However, as with many other projects, particularly in the tropics, there may be adverse environmental impacts. Dam and reservoir projects normally affect a very large area, and can flood thousands of hectares of prime agricultural land, precious rainforests, highly productive cottonlands as well as timber and wildlife habitats. Construction of dams may also create easy access to tropical forests and wildlife that can be lost to indiscriminate harvesting.

Designing water projects, in the context of overall river basin and regional development plans, normally reduces the potential for unanticipated cumulative adverse environmental effects and intersectorial and regional international problems. Many critics, however, recognize that there is too much variation in the designs of large dam and reservoir projects to generalize about their socio-economic and environmental impacts.[14] Highly polarized IECs related to water diversion and dam and reservoir project, such as in the case of the Gabcikovo projects (affecting Czechoslovakia, Hungary, and Austria), reveal the need to pay attention not only to comprehensive environmental and socio-economic impact assessments, but also to the decision-making process itself through the participation of the parties involved.

Erosion and siltation

Erosion upstream in the catchment area leads to sedimentation or land slips which can impair storage (as in the case of the Aswan dam on the Nile river in Egypt). There may also be increased erosion of the river bed and structures below the dam, including deltaic and coastal changes (as might happen on the coast of the Gambia if Senegal built a dam upstream). Changes in stream flow and water releases from a large dam can cause increased river bed erosion, undermine downstream water structures, deplete nutrients which would otherwise be carried by fine sediments, and

also radically reduce groundwater levels, thus having negative effects on existing agriculture. The erosion rate along the coast of the delta also accelerates as a result of deprivation of silt nourishment after dam construction.

Wetland destruction

Reservoirs regulate downstream flow by increasing river flow during the dry season, or low water period, and by virtually eliminating annual flooding. As a result, riverine habitats, especially wetlands, below dams and often in another country, have been drastically reduced, as has the productivity of riverine communities (as in the Diama Delta in Senegal).

Resettlement

Land flooded by a dam is typically more productive than neighbouring uplands, and is therefore more densely populated by people and livestock. Displacement of the lowland population to the uplands often endangers the environment, as more people and livestock must survive on a reduced resource base. Demand for arable land, fuel, fodder, potable water, building materials and other resources may increase dramatically.[15] At the same time, the sustainability of upland areas may be quickly exceeded unless development assistance increases the productivity of the remaining resource base. Neither involuntary resettlement nor migration caused by a depleting resource base respect international borders, and there are many examples of conflicts, particularly national ones, as a result of this.[16]

Unfortunately, no way exists for avoiding disruption to the lives of people displaced by a dam or reservoir project. The flooding of land causes major economic losses and socio-cultural disruption, for instance to farming systems, and it leads to loss of arable lands and forests, and to the disappearance of land improvement. As a result, many small- and medium-scale farmers and other traders become impoverished.[17]

The contrast between technically elaborate dam design technology and the sociological inadequacies of resettlement components calls for improved policies, and a guarantee that resettlement standards meet the same exacting criteria required for other technical aspects of dam construction. (See further discussion on Environmental Refugees in Chapter Nine).

Health

Construction of dams and reservoirs, especially in warm climates, may increase water-related diseases (e.g., schistosomiasis and malaria) unless precautions or mitigatory measures are implemented. Reservoirs in tropical areas create favourable habitats for the breeding and survival of snails, mosquitoes and black flies which transmit these diseases. The typical development-induced disease is schistosomiasis. Wherever the snail vector is found, it is always in connection with projects such as reservoirs and irrigation (e.g., lower Aswan dam, Akosombo dam, Gezira irrigation).[18] Malaria is more often associated with irrigation systems, particularly for rice cultivation, than with the reservoirs and dams that serve them.

Proliferation of floating weeds (e.g., water hyacinth and water lettuce) can impair water quality and increase disease vectors. The control of these diseases is necessary in all reservoir areas, and imposes a large financial burden on the affected countries.

5.7 (C) Externalities from other activities affecting river systems as causes of IECs

The many factors described under this section underline the increased danger for IECs as water quality diminishes, particularly for shared waters and watersheds.

Eutrophication

A serious source of pollution of natural waters comes from fertilizers applied to agricultural land. Aerial top dressing with phosphates and other fertilizers is a common and accepted agricultural practice, at least in developed countries. The result is increased fertility, increased yields of crops and animals, and good vegetative cover which is vital in order to combat erosion. It is, however, almost impossible to prevent some of the fertilizers from finding their way into rivers and lakes. This results in an increase in the nutrient level of water, perhaps most noticeable in lakes where phosphates tend to be stored. One of the changes observed may be an increase in the growth of algae resulting in surface algal blooms, which can be toxic to animals. While consuming the nutrients, algae also use oxygen and may seriously reduce the oxygen content of the water. This may result in depletion of the fish population and other forms of animal life, and may increase certain kinds of lake weeds, causing clear water to be spoiled by vegetation masses.

Pesticides

In many developing countries, major ecological problems exist due to usage of such persistent pesticides as DDT. The downstream effects are often severe and a source of many IECs as in the case of pesticide pollution of the Rhine River Basin in Europe (triggering conflicts between Germany and the downstream countries).

Soil erosion and siltation of water sources following deforestation or over-grazing

Forests and vegetation are very effective in combating run-off and erosion, since they induce considerable storage of water in the ground, increase the natural permeability of the soil, and increase the evaporation rate. There is clear evidence that unless forestation and vegetation are integrated into water management plans, soil erosion, deforestation and over-grazing may contribute to large silt loads in the rivers and lakes and thus become a cause of IECs. (See, e.g., textbox 'Siltation of Sudanese Irrigation Schemes' in Chapter Eight.)

Wildlife

In general, wildlife is adversely affected by artificial variations in water discharge as well as water pollution. Hydroelectric power projects, agricultural and industrial development, and the sharp increase in population, have an adverse effect on wildlife in many river basin countries. Destruction of wetlands also eliminates valuable habitat (which in turn endangers many wildlife populations). All of these lead to loss of wilderness and subsequently wildlife. With dam projects, however this may be mitigated by including a wild-land management area equivalent to the flooded area.

Wildlife along international rivers is the object of significant, and increasing, tourist activity in many developing countries, bringing in much needed hard foreign currency.

In many countries, governmental actions have been taken to protect wildlife from the adverse effects of water projects, but problems and conflicts still arise when these different national views and actions necessarily have to be joined in common action plans for entire international river systems (as, for example, in the Nile River Basin). These problems are further complicated by national differences in the use and management of wildlife (see further discussion in Chapter Seven on forestry and biodiversity).

Social implications and economic aspects

Proper identification and analysis of the impact of a water project on socio-economic conditions must be carried out in conjunction with an effective monitoring and evaluation system. However, some environmental impacts are very hard to quantify.[19] For example, it is difficult in dam projects to evaluate in quantitative terms the flooding of archaeological sites, the elimination of rare species, or changes in landscapes. It is even more difficult to express these losses in economic terms.

While river basin development projects often favour hydroelectric power (HEP) generation for commercial, industrial and residential sectors to the benefit of some nations' economies many river basin development projects have actually degraded riverine habitats and worsened the plight of riverine populations. To date, the developmental potential of riverine habitats and production systems has been seriously diminished by river basin development strategies. Throughout tropical Africa, these strategies have damaged flood water agriculture, high and dry season grasslands for livestock, and fisheries.[20]

While the economies and lifestyles of riverside populations depend on annual flooding, too much flooding sweeps away crops, while too little leads to inadequate harvests and increased migration to cities. The elimination of downstream flooding has devastated many local production systems. Riverine habitats for flood water farming and livestock management are adversely affected, and fisheries' productivity and fish landings for consumption and commercial purposes are greatly reduced.

Negative effects of water projects, including dams or reservoirs, can be minimized by, for example, linking hydroelectric power and irrigation to dam-controlled downstream flooding and regular reservoir drawdowns. [21]

Debt repayment

Most developing countries use a great deal of their hard currency for debt repayment. Mexico, Peru and Brazil, for example, are in such oppressive debt crises that they are forced to exploit their natural resources on a short-term basis in order to pay foreign and international lending institutions, making long-term sustainable development and conservation almost impossible. The front-loading of any kind of investment in large dams puts a heavy burden on countries in the first years. Long-term objectives involving neighbouring state relations, as well as social and environmental conditions at a local level tend to be minimized.

5.8 Conflict management

International conflict management related to international river systems focuses on both water quality and water quantity. Both of these related aspects have environmental and socio-economic implications on an international level.

In view of the fundamental importance of water for different sectors of the economy, it is evident that protection from water-related natural hazards (flood and drought), from health hazards (waterborne diseases), and from hazards to aquatic ecosystems (pollutants) should form the cornerstones of national and international water management policy if IECs are to be effectively avoided and resolved.

Conflict management doctrines on international river systems

The outflow from upstream countries depends on the nature of water-consuming activities in these countries. Water-consuming activities, such as irrigation or water transfer out of the basin, reduce the inflow to the downstream country and often degrade its quality as well. In many river basins, downstream countries are at the mercy of their upstream neighbours. Measures taken by upstream countries which in some way threaten the water supply of downstream countries will create uneasiness among the latter. As a result, the location of a country along a river can have a considerable influence on its international relations. For example, diplomatic activities of such downstream countries as Jordan, Bangladesh and Egypt seem to reflect a concern that their future is being endangered in this way. The interdependence between riparian countries' environmental policies (i.e., the extent to which decisions taken by actors in one part of the river system affect (intentionally or unintentionally) other actors' policy decisions elsewhere in the river system) illustrates some of the potential risks involved in unilateral policymaking. (See boxes for discussion of different policy doctrines).

It is useful to relate different policies to different situations. In general, it can be said that the more polarized a conflict, the more extreme the policy adopted by the parties.

Box 10

Measures to minimize negative social and economic implications

Developing local involvement, and incorporating social impacts analysis in the planning process, is of vital importance but not widely recognized as such. In order for river basin development to be sustainable, current accounting of costs and benefits at the national level must be complemented by regional, international, and local environmental accounting. The short-sightedness of national economies accounting only for the benefits of the projects leads to the costs to riverine populations being discounted and ignored. Appraisals often place too little emphasis on the total resource base, on indigenous knowledge of it, and local systems for resource utilization. Too much emphasis is often placed on economic rates of return on a national level, while the redistribution of wealth and indirect effects are ignored. Least-cost solutions for electricity generation are especially inadequate, since they tend to compare dams with thermal stations and other power sources as if energy production were the only issue involved. Complexities and difficulties concerning water projects notwithstanding, the conflict between various departments and countries, and the disputes between environmentalists and water project designers, must be analysed thoroughly. In most cases, compromise consensus approaches need to be exploited. In the long run, developing countries, in urgent need of exploiting their water resources for social and economic development, will suffer most. (See also Cernea, 1985).

The most extreme policy models (see (a) and (b)) are said to be more or less abandoned today; nevertheless one may well imagine that states involved in a river conflict could still adopt these doctrines and positions. This is especially true in areas where some form of water scarcity is an underlying cause of a conflict between co-riparian states. That is, parties in a conflict tend to adopt extreme positions when for some reason the conflict becomes more polarized. This corresponds to the 'manifest conflict levels' in the Escalation Model (Chapter Four). The increased polarization may result from a mutual perception among the parties that there is greater competition for the amount of water available in the river system; either because of drought, increased population pressure, high levels of water pollution, too much diversion of water from the river system, or a combination of these causes.

Antagonism between co-riparian states, often rooted in regional historical events, may, in addition to increased competition for water, also contribute to such polarization.

The more moderate policy models ((see (c), (d) and (e)) reflect a balanced approach that may assume a surplus of water in the region—so that harsh competition for water is avoided. These situations correspond with the 'Potential Conflict Levels' in the Escalation Model. Third party intervention in the conflict may also enhance the chances that the parties to the conflict will adopt moderate rather than extreme policies (see Chapter One).

Most riparian states have, either implicitly or explicitly, expressed a list of priorities as to how they want to manage their water resources. In some situations, these official priorities prove incompatible with the needs and interests of the local population.

The positions, and thereby the policies adopted by the conflicting states, are to a large extent a reflection of these states' relative location in the river system. Whether the relationships between co-riparian parties to a river conflict are antagonistic or co-operative determines to a certain degree the positions taken by the parties.

New challenges in international river management

As socio-economic development proceeds, and supply and demand in the context of limited river resources become more difficult to balance, the need for more sophisticated water management mechanisms and policies arises.

As demand for water increases, water management changes from supply-oriented to demand-oriented.[22] In the early stages, measures are taken to satisfy the demands as they develop. As demands increase, water storage and redistribution projects regulate the supply. Finally, as river systems are developed and considered acceptable and there is no more water to allocate, further development must be supported by reallocation and control of demand; that is, by accepting water availability often as a *regional constraint*. Control of demand may lead to changes in crops, increases in the efficiency of irrigation (e.g., by changing from furrow irrigation to drip irrigation), recirculation and re-use of water.

Since the turn of the century, the exploitation of international rivers for economic purposes has required a radical solution, namely the internationalization of the entire basin of the river so that no single basin state may solely utilize any single branch or tributary situated in its territory, without regard for the other basin states.

Box 11

Conflict management doctrines on international rivers

(a) Absolute Territorial Sovereignty: Harmon Doctrine

According to the reasonings behind this doctrine, a state may adopt all measures deemed suitable to its national interest in regard to water courses within its territory, irrespective of their effects beyond its borders. Accordingly, it may freely dispose of waters flowing in its territory, but cannot demand the continued free and uninterrupted flow of water from upper-basin states.

Proponents of this doctrine argue that an international water course in the territory of a state constitutes part of the public domain of that state; and that since a state has dominion over its own territory, another state acquires rights only with the agreement of the first state. This doctrine clearly favours upper-basin states.

Today, 'absolute territorial sovereignty' is quite often abandoned because it neglects interdependence and co-operation between states. The principles are equally contradictory to the principle of territorial integrity of states provided in Article 2 (4) of the UN Charter.

(b) Absolute Territorial Integrity

This policy model is the direct opposite of the theory of absolute territorial sovereignty, and states a policy of water rights whereby a lower riparian state claims the right to the continued, uninterrupted (or natural) flow of the water from the territory of the upper riparian (basin) state. The doctrine is favourable to the lower-basin state.

The theory is sometimes criticized because it allocates rights without imposing corresponding duties. It has been invoked in situations where the continued flow of waters was critical to the survival of the state concerned (as in the case of Iraq and the River Euphat).

(c) Limited Territorial Sovereignty and Limited Territorial Integrity

Theories of limited territorial sovereignty and limited territorial integrity are in practice complementary; even identical. They state that every state is free to use the waters flowing in its territory, on the condition that such utilization does not prejudice the territory or interests of other states. In short, they state that states have reciprocal rights and obligations in the utilization of the waters of their international drainage basins.

(d) Community of Interests in the waters

Some authorities argue for a 'community' approach (i.e., state boundaries should be ignored and a drainage basin be regarded as an economic and physical unit). There would be a collective right of action by all basin states in such a manner that no state could dispose of the waters without consultation with and co-operation with the other states (as in the case of many rivers, such as the Senegal river). The doctrine claims that the water system ought to be managed as an integrated whole. This consideration leads to the implementation of basin-wide development programmes designed by all the riparian states in the river basin.

(e) The Doctrine of Equitable Utilization

This policy model has evolved gradually in the framework of the long-standing conflict among the competing theories discussed above (a, b, c and d), and proposes that each basin state has a right to utilize the waters of the basin, and is entitled to a reasonable and equitable share of the basin water.

The principle of equitable utilization reflects three fundamental concerns. First, it takes into account the socio-economic needs of the basin states through an objective consideration of various factors and conflicting elements relevant to the use of the waters; second, it aims at distributing the waters among the basin states in such a manner as to satisfy their needs to the greatest possible extent; and third, it seeks to distribute the waters so as to achieve the maximum benefit for each co-basin state with the minimum detriment.

One may argue that many of UNEP's international river basin initiations are based on a combination of (c), (d) and (e), depending on site-specific conditions and progress in accepting international law.

Source: Revised after Godana, 1985

Traditionally, every state exercised exclusive sovereignty over natural resources, including water. In effect, the implicit legal doctrine was absolute territorial sovereignty. These traditional concepts of national sovereignty are, however, no longer sufficient for a world altered by ever-increasing interdependence between nations on economic, ecological and security fronts (Chapter One).

In view of the peculiar characteristics of drainage basins, and particularly the fact that water generally does not respect political boundaries, the claim of absolute sovereignty over a portion of an international drainage basin meets with strikingly different problems from those generally associated with sovereignty over land territory. This inherent difference between the nature of land and water has led, in the latter case, to the emergence of conflicts of interests between co-basin states.

An interesting path to explore would be to assess the replicability of lessons of experience in water management at national levels where strong competitive interests exist. The Columbia River Basin, which is shared by several different states in the United States, provides one example.[23] Underlying political and administration infrastructures should not be overlooked (namely, the existence of a unified legal system with effective enforcement authority to ensure compliance and a developed economy which entails use of economic incentives for compensation and improved compliance).

Another example from the developing world is provided in the case of the Lake Chad Basin.[24]

Co-operation in the development and sound environmental management of these fresh-water resources can provide opportunities for political and diplomatic co-operation (as in the case of UNEP's Mediterranean Programme, described in Chapter Six). A general principle illustrated by international legal development in drainage basins is the emergence of a more dynamic concept of joint development. Integrated development presupposes co-ordinated or joint action for the development of water resources considering the basin as a unit; an approach which includes concerted action in data collection, investigation, planning, operation and management. The recent increase in the development of international river systems along such co-operative lines is practical and illustrates how states have realized both their mutual interdependence and the wide possibilities for development through co-operation (e.g., in the Rhine and the Danube River Basins in Europe).

Recent agreements concluded in the cases of the Niger, [25] Senegal, [26] Lake Chad Basin [27] and Zambezi River Basin [28] all testify to this trend and exemplify the increasingly important principle of mutual co-operation and joint development of international river systems.

International river systems are likely to form an important component in the future political relationships between the countries within these river systems. Co-operation or confrontation in the utilization of freshwater resources will characterize this relationship.

The existence of accepted regional legal regimes applicable for the conflicts enhances the potential for successful conflict management.[29] As the case from the Zambezi River Basin demonstrates it is important to strengthen existing national institutions and to have a national body or authority to co-ordinate national activities to become a focal point and represent national interests at the international level.