

# **Transboundary Water Challenges: Case Studies**

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# 1. Water Availability

(with Eric S. Hersh)

This section focuses on the availability of global water resources and their projected use over the next two decades, the distribution of transboundary water resources on the earth, and general problems of the management of transboundary water resources. Water is a unique resource for human development since it is essential to life, has no substitutes, is a renewable resource, and it is unevenly distributed in time and space (Postel, 2003). The availability and use of water resources at the global and regional scale poses special problems that water planners and managers must understand, especially when they appear in the transboundary or multinational setting. This section provides a brief introduction to the availability and use of global water resources, the distribution of transboundary watercourses, and comments about transboundary water management problems.

Several assessments of the water available for human activities and the effects of these activities on the global resource have been published over the past few years. The main documents describing the global availability of water have been prepared by the Russian hydrologists at the State Hydrological Institute in St. Petersburg (Korzun, et al., 1978; and Shiklomanov, 1998). In addition, the UN Commission on Sustainable Development has prepared an assessment of world water availability and its use (Lundqvist and Gleick, 1997). These reports, and the Shiklomanov assessment in particular, provide overall information about the availability and dynamics of water supply and use on the various continents and countries of the world. Several projections are made for the future availability of water over the coming decades (note that these assessments do not take explicit account of global climate change).

Globally, the average annual renewable water resources amount to 42,780 km<sup>3</sup>, resulting in a global water availability of 7,600 m<sup>3</sup>/person (Shiklomanov, 2000). Areas with the largest water resources are Asia and South America, and the smallest volumes are in Europe and Australia/Oceania. However, when looking at the availability of water per person, South America and Australia/Oceania are the highest regions and Asia and Europe are the lowest.

## Water Resources and Water Availability for Regions of the World

(Source: Shiklomanov, 2000)

Region	Resource km <sup>3</sup> /yr	Availability m <sup>3</sup> /person/yr
Asia	13,510	3,920
Europe	2,900	4,240
Africa	4,050	5,720
North America	7,890	17,400
South America	12,030	38,300
Australia and Oceania	2,404	83,800

In terms of global water withdrawal and consumption, agriculture receives 66 percent of total water withdrawal and in the future this is expected to decrease slightly relative to other uses, due to the expected growth of other water uses (Shiklomanov, 2000). Global irrigated area in 1995 was 253 million ha, and by 2025 it is expected to grow to 330 million ha.

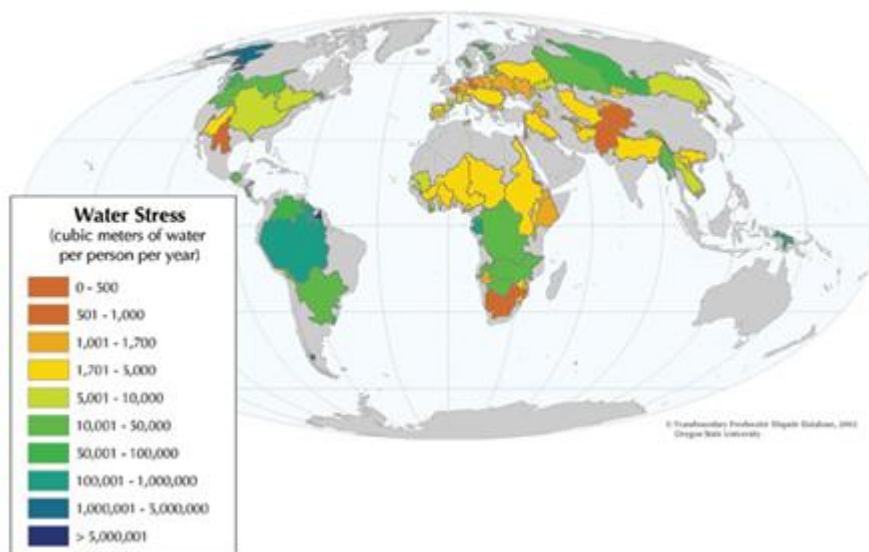
### Water Use in the World by Sector of Economic Activity

(Source: Shiklomanov, 2000)

Sector	Use in 1995 km <sup>3</sup> /yr	Projected in 2025 km <sup>3</sup> /yr
Agricultural Use	2,504	3,189
Municipal Use	344	607
Industrial Use	752	1,170
Total	3,788	5,235

Several authors make the point that there is not an overall shortage of water from the global perspective, but that if one considers the geographic distribution of water resources and the demand for water (current and projected) then there are large areas of the world that are either now, or will be in the future, experiencing water stress and scarcity. Not surprisingly, the geographic distribution of the water stressed or scarce regions of the world coincides with areas projected to have the largest population growth. Many specialists have accepted Swedish hydrologist Malin Falkenmark's threshold of water stress for a region or country as less than 1,700 m<sup>3</sup> of renewable runoff per person per year and water scarcity as 1,000 m<sup>3</sup>/person/year (Falkenmark, 1989). However, others question whether this is an appropriate measure of the access of populations to water resources necessary for various activities, particularly sanitation and food production.

### Water Stress by International River Basin



Water Stress by Basin

(Source: <http://www.transboundarywaters.orst.edu>)

The UN 1997 Assessment of Freshwater Resources (Lundqvist and Gleick, 1997) notes that in many cases the pathways for water use are not sustainable. Local and regional water quantity and quality problems in many areas result from: (1) poor allocation; (2) wasteful use; and (3) poor or inadequate management. Over the past century, water use has been growing at about twice the rate of human population. Current population is about 5.7 billion, and by 2025 it is projected to be 8.3 billion. Authors have noted that at the end of the 20th century, more than 2.8 billion people (approximately half the world's population) lacked access to adequate sanitary services, over one billion people (about one-fifth of the world's population) were without access to clean drinking water, and at least one billion people were undernourished (Gleick, 2001). One-third of the world's population live in countries experiencing high water stress, and by 2025, this number is expected to be approximately two-thirds of the population. The driving forces for increased water stress are population growth, increased consumption of food requiring irrigation (70% of all withdrawals today), and increased industrial production requiring water.

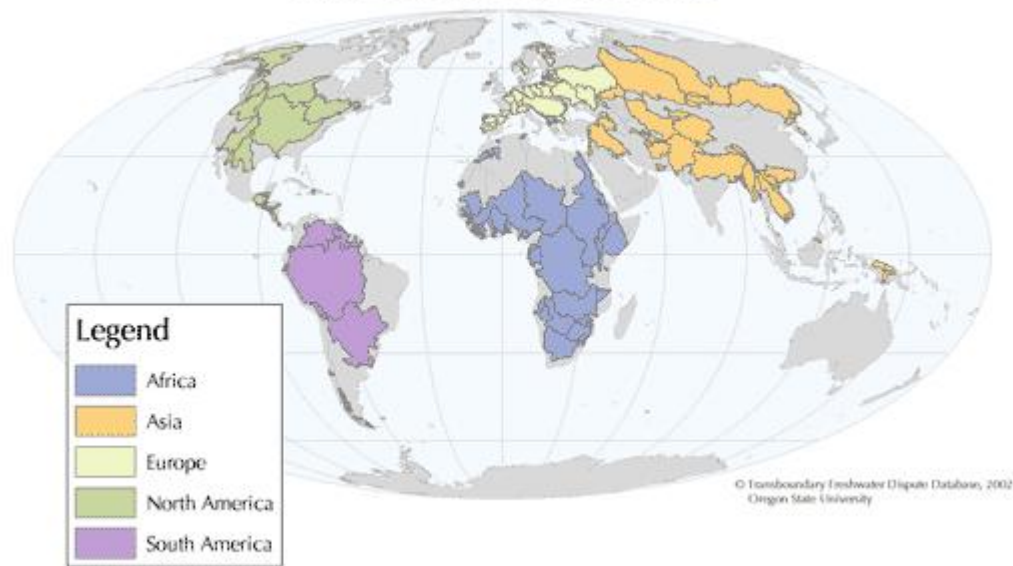
One of the targets set in the UN Millennium Development Goals (Target 10 of Goal 7, UN, 2000) is to "Halve by 2015 the proportion of people without sustainable access to safe drinking water and sanitation." While the MDGs provide quantifiable targets for water supply and sanitation improvements, the actual measurement of progress, including the indicators used for monitoring and the difficulties in defining and verifying "improved access" to water supply and sanitation, presents real challenges (UN, 2004). The likely total annual aid requirements to meet the MDGs, as measured in 2003 US dollars, will rise from 135 billion in 2006 to 195 billion in 2015 (UN Millennium Project, 2005). These totals represent 0.44 and 0.54 percent share, respectively, of the Organization for Economic Co-operation and Development - Development Assistance Committee (OECD-DAC) donor countries collective gross national product (GNP). 2004 aid from the DAC was approximately US\$79 billion, or 0.25% of GNP. Global cost estimates to meet the water supply and sanitation MDG target average US\$100 billion total for the period 2001-2015, or US\$6.7 billion per year.

Gleick (1999) suggests that the basic water requirement for human sustenance is about 50 liters per person per day (lpcd). Gleick (1996) predicted that by 2000, 2.16 billion people would live in 62 countries that report average domestic water use below the 50 lpcd level. He also noted that absolute water availability may not be the problem, since many countries have access to resources in excess of 1000 lpcd but they do not have the ability to access this water for their citizens. Clearly, the infrastructure for delivering a sufficient supply of appropriate quality water to the world's population is in need of upgrading. There are many who doubt that the world can keep up with the need for these improvements given current projections of population growth (Biswas, 2001; Gleick, 2001).

Wolf et al. (1999) note that as of 1999 there were 261 international river basins, covering 45.3% of the land surface of the earth, 145 nations include territory within

international basins, and 33 nations have more than 95% of their territory within international basins. These statistics have changed over the past decades as political boundaries throughout the world have shifted or appeared, especially in the areas of the former Soviet Union where several new international river basins have appeared in the early 1990s. Of the 25 largest rivers in the world, 20 of them are international and account for almost 50% of the total flow of the world's rivers.

### International River Basins



### International River basins

(Source: <http://www.transboundarywaters.orst.edu>)

The statistics above indicate that international sources of water are of growing concern to the nations of the world. Many people point to a looming global water crisis in the coming decades and the potential for conflict resulting from the competition for this scarce resource. Clearly, given projections of population growth and the resulting water demand, there are problems of providing adequate supply and appropriate quality of water for human activities. The various uses of water must continue to be provided for: municipal and industrial, agricultural, energy production, and ecosystem protection, to name a few of the more important uses. Irrigated agriculture must be maintained if the 2.4 billion people who now depend on this economic sector for food, income and employment are to be provided for. For the most part, easily accessible sources of water have already been developed throughout most of the world.

With population expected to double in the next 50 years and water consumption increasing at twice the rate of population, in the future, development of new water supplies will be more costly, will have greater environmental constraints, and will take longer to implement than in the past. This has caused many to suggest that a new paradigm for water planning must be developed and implemented (Biswas, 2001; Gleick, 2000). Given the large portion of the world's water in international basins and the projected use of these waters in the future, the need for international agreements

between countries on the utilization of this resource has become acute. In many cases, international lending institutions (e.g., the World Bank) tend to withhold loans for international water projects in the absence of an international agreement. The issue of water as an issue of national and regional security has been discussed by Chou et al. (1997) and the increased scarcity of water noted above, combined with asymmetric power relationships between riparian countries may lead to conflict in the absence of water sharing agreements in a basin.

## Questions

1. What are some major roadblocks to current efforts to provide water supplies for future generations?
2. Many authors call for international agreements on shared water use. Why is this and how will they help?
3. What role can multi- or bi-lateral development assistance programs play in helping to solve problems arising in international watercourses?
4. What is the difference for countries in a transboundary river basin setting versus a transboundary groundwater setting?
5. International agreements on transboundary waters tend to deal with management of an entire river "basin." What difficulties might arise in applying the "basin" concept in a transboundary setting?
6. Many authors have suggested that market forces can provide a good mechanism for allocating water in international basins. Why has this not proved successful?
7. Quantitative definitions of scarcity range from five liters per person per day (the amount required to sustain a human being) to 2740 liters per person per day (based on the average amount required to sustain a US standard of living). A number of specialists (Falkenmark started this off) describe a nation as "water-stressed" if water resources are less than 1,700 m<sup>3</sup> per person annually, and "water-scarce" if it is below 1,000 m<sup>3</sup> per person annually. This number is not correlated with the means of distributing the source to the demand, so is this a useful definition?
8. What factors lead to water scarcity? Different definitions of water scarcity have been proposed. How do they differ? What alternative definition(s) can you suggest?
9. A security threat can be defined as a threat to the values in the defense of which a country will use violence (Chou et al., 1997). These values include sovereignty, territory, public health, economic prosperity, and cultural identity. Situations that potentially or actually threaten such values are considered threats to security. What are some ways in which a country's security may be

threatened through water access or use? What are some indicators of threats to a country's national security that may cause water to enter into the national security agenda of a country?

10. Are the MDGs realistic and practical? Is an increase in Official Development Assistance to 0.7% simply the answer to meeting them?

An oft-repeated and rarely attained target for the ODA required to meet MDGs is 0.7 percent of the OECD donor countries GNP. This target was first agreed upon in a 1970 UN General Assembly Resolution, and reaffirmed by donor countries in 2002 at the International Conference on Financing for Development in Monterrey, Mexico and at the WSSD Conference in Johannesburg. As of June 2005, 16 of 22 OECD donor countries met, or committed to a timetable to meet, the 0.7 percent target by 2015, while only five countries have regularly met the target (Denmark, Luxembourg, Netherlands, Norway, and Sweden). The United States, which remains uncommitted to the target, contributes the largest share of international aid in real terms, US\$19 billion in 2004. However, this contribution represents only 0.16% of recent US GDP of US\$11.75 trillion, or US\$40,100 per capita.

Were the OECD donor countries to deliver upon their commitments of aid in meeting MDGs, it is believed that the available funding would be sufficient to meet the costs and also to provide funding to meet current and forecasted additional needs outside the scope of the MDGs, including: disaster relief, adjustments for climate change, and post-conflict reconstruction.

11. For the current case of limited ODA, should water supply and sanitation be priorities? Does the return, as measured in improvements to the human condition, of benefits to the receiving nation, or financial return to the donor(s) justify the expenditure?

12. Are you willing to pay 70 cents of every 100 dollars you earn per year to MDGs worldwide?

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## 2. Water Conventions

### Introduction

This section describes some of the major legal instruments for water allocation in international settings. Certain notions of sharing extend from human interactions to those between nations in the international arena. When a watercourse covers more than one nation and the resource has been developed and use of it is growing, then problems of defining entitlements to use appear. Within one nation, these issues can be controlled by the definition of water rights and institutions devised to equitably develop and use the resource. However, in the international setting, the notion of property rights does not hold between countries and institutions of law are enforced by agreement between countries, not by an overarching authority. When it comes to water resources, several attempts have been made to develop general rules of international law that guide the civilized sharing of water in transboundary settings. The principles generally hinge on the notions of equality, reasonableness, and avoidance of harming ones neighbors. In addition, the rules call for the prevention of conflicts through information sharing, notification and consultation with of basin riparians<sup>1</sup> over proposed works. These rules have developed under the auspices of the United Nations and they are embodied in three documents:

- **Helsinki Rules** on the Uses of the Water of International Rivers, International Law Association (ILA, 1966)
- **Helsinki Convention** on the Protection and Use of Transboundary Watercourses and International Lakes (UN-ECE, 1992)
- **UN Convention** on the Law of the Non-navigational Uses of International Watercourses (UN, 1997)

The Helsinki Rules and the UN Convention are intended to be framework documents providing guidance for the construction of more specific multilateral agreements governing particular transboundary situations (the SADC Water Protocol and the Mekong Basin Convention are good examples of this). The Helsinki Convention is an example of using these principles for the basis of a regional convention (e.g., the European Union Water Framework Directive). Below we consider many of the elements of these conventions.

### Some definitions

**Watercourse:** A system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus (UN Convention, 1997).

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<sup>1</sup> Riparians are other persons or entities that live or exist along the watercourse.

***Absolute territorial sovereignty (Harmon Doctrine):*** The concept of *absolute territorial sovereignty* is that a state has complete freedom of action with regard to the portion of an international watercourse that is situated within its territory, irrespective of any harmful effects that may ensue for other riparian states. Under this doctrine a nation may use any amount of water flowing into or originating on its territory for consumption or for disposing of pollution. This doctrine, which asserts the right of an upstream nation to use and pollute with no regard for adversely affected downstream nations. The most well known example of this doctrine (long-since discredited and abandoned) is the opinion of U.S. Attorney General Harmon in an 1895 response to Mexico's protest over U.S. diversions from the Rio Grande.

***Absolute territorial integrity:*** The doctrine of *absolute territorial integrity* states that a downstream nation has a right to an uninterrupted flow of a fixed quantity of usable water from upstream states. That is, an upstream state may do nothing that might affect the natural flow of water into a downstream state. An example of the application of this doctrine is the Lake Lanoux case regarding France's plans to divert water from the Carol River and replace it downstream with water from another basin. Spain claimed that the interbasin transfer would be inferior and subject to human control and thus not equivalent in quantity and quality to the original flows in the basin. Ultimately, Spain lost the argument in the International Court of Arbitration.

***Equitable utilization:*** The previous two principles have become discredited and rarely used to resolve conflicts. Adherence to absolute territorial sovereignty would allow unbridled actions irrespective of harm caused to neighboring states; and absolute territorial integrity provides veto power to downstream states over actions in upstream states. The rejection of these principles stems from need of a state to accept limited sovereignty in order to achieve resolution of some problems that can only be overcome through regional cooperation. The clear need for a compromise between these two principles leads to the notion of *equitable utilization*, or a balanced approach to allocating water among uses in a watercourse. The equitable utilization principle states that all countries in a watercourse share sovereignty over the resource and their interests must be reasonably balanced according to a range of factors (Hunter, et al., 2002).

***Limited territorial sovereignty:*** The doctrine of *limited territorial sovereignty* accepts the principle of riparian rights, that every nation bordering a watercourse has a right to use the water flowing in its territory provided that the use does not harm the territory or interests of other riparian nations. The doctrine recognizes the reciprocal rights and obligations of nations in the use of water. The sovereignty of a state over its territory is limited by the obligation not to use that territory in such a way as to cause significant harm to other states. This is the prevailing theory of international water rights and obligations (McCaffery, 2001, p. 137). An example of the application of this doctrine is the 1959 treaty between Sudan and Egypt on the Nile. Another example of the application of this doctrine is the dispute between Argentina and Brazil in the Parana basin.

**Community of interest:** The doctrine of *community of interest* states that no nation may use waters in its jurisdiction without consultation and cooperation with other riparian nations. A community of interests in the water is created by the natural, physical unity of a watercourse, and it is to be shared by the community as common property or public good (McCaffery, 2001, pp. 149-150). The Permanent Court of International Justice (Case of the River Oder Commission, 1929) found that the community of interests of riparian states becomes the basis of a common legal right and that all riparian states are equal in the use of the watercourse and excludes preferential privilege of any riparian state in relation to the others. An example of the application of this doctrine is in the case of the Gabčíkovo-Nagymaros Project on the Danube River.

### **National Sovereignty over Water**

National sovereignty over internationally shared waterbodies should consider equitably the needs of all involved, including the environment. Historically, this issue has been critical in the establishment of international water treaties and agreements. The evaluation of sovereignty requires a high level of regional understanding and is best expressed through cooperation and effective interdependence between states. Collaboration reinforces rather than diminishes the sovereignty of each state. Sovereignty of states over transboundary watercourses is interdependent with the needs of riparian neighbors, which requires that no state utilize the resources of a shared watercourse in such a way that neighboring basin states are deprived of basic levels of water and environmental security. Although this is a limitation of national sovereignty, it is essential to achieving water security for all people relying on a transboundary water source. Cooperation over international water resources may actually help in protecting the sovereignty of a state from internal and external pressures, thus maintaining its stability.

Water policy has traditionally been created and maintained within the governmental realm, however, for the true realization of national sovereignty there must be wider involvement and participation of those affected from every sector, including ethnic/religious minorities and indigenous people. The feelings of fear attributed to exclusion and disparities in the advancement of transition related reforms heighten national sovereignty awareness and sensitivity among those feeling rejected (Hübner, 2000). Public involvement, participation, and information dissemination between riparian states enhance the negotiation processes. National sovereignty needs to be addressed, however associated fears may be mitigated by riparian state communication and involvement.

The key issues associated with national sovereignty are determining the rights of states to waters that flow through their territory and the obligations they have to downstream riparians. In most resolved disputes, the leading negotiating tool has not been “rights-based,” in terms of a sense of entitlement, but rather “needs-based,” e.g., irrigable land, population, and requirements of specific projects. Often the needs of downstream riparians are favored in negotiations and protected in transboundary agreements with little mention of upstream needs except in humid regions.

Alternatively, some treaties make provisions for water allocations in conjunction with boundary delineation, provisions for water usage, division of boundary waters, or agreement over future river development.

In several cases, the principles of absolute sovereignty (India-Indus Waters Treaty, France-Lac Lanoux case, Palestine-West Bank aquifer) or absolute integrity (Spain-Lac Lanoux case, Egypt-Nile basin) have been claimed during negotiation. Rarely are these principles explicitly stated in the resulting agreements, rather the vague term of “equitable utilization” is often employed. The negotiation process inevitably requires time, patience, and a willingness to shift perception towards viewing water as a naturally shared resource. Consequently, the emerging theory of a “community of interests” in sharing international watercourses is receiving increasing attention in negotiations.

The attitude of riparian countries is prone to be influenced by the desire to maintain national sovereignty as countries attempt to preserve as much freedom and control as possible. As a result, many international agreements refer to certain aspects of water planning or particular developments rather than overall principles of planning and management. A more holistic approach is necessary to ensure that basic water needs are met while maintaining water quality and conservation practices for the future.

### **International Water Allocation Rules**

The allocation of water in transboundary watercourses is generally based on equitable apportionment with existing uses receiving higher priority. General international allocation rules or principles establish a framework for multipurpose river basin development and use pursuant to more detailed and site specific international agreements. The main allocation rules were spelled out in the International Law Association “Helsinki Rules” of 1966 and later codified in the UN General Assembly Convention of 1997.

**Helsinki Rules (1966):** Each basin State is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin (Article IV). What is a reasonable and equitable share within the meaning of Article IV is to be determined in light of “relevant factors” in each particular case (Article V.I.). Relevant factors to be considered include, but are not limited to (Article V.II.):

1. The geography of the basin, including in particular the extent of the drainage area in the territory of each basin State;
2. The hydrology of the basin, including in particular the contribution of water by each basin State;
3. The climate affecting the basin;
4. The past utilization of the waters of the basin, including existing utilization;

5. The economic and social needs of each basin State;
6. The population dependent on the waters of the basin in each basin State;
7. The comparative costs of alternative means of satisfying the economic and social needs of each basin State;
8. The availability of other resources;
9. The avoidance of unnecessary waste in the utilization of waters of the basin;
10. The practicability of compensation to one or more of the co-basin States as a means of adjusting conflicts among uses; and
11. The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.

The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable share, all relevant factors are to be considered together and a conclusion reached on the basis of the whole (Article V.III.). A use or category of uses is not entitled to any inherent preference over any other use or category of uses (Article VI).

**UN Convention on Non-navigational Use of International Watercourses (1997):** A river basin is defined from the Helsinki Rules. Riparian nations have a right to participate in the "optimal utilization" of the watercourse in an "equitable and reasonable manner" and a duty to cooperate in the protection and development of the resources. The cooperation includes obligations of information sharing, notification and consultation between the riparian nations. The 11 Helsinki Rules factors are combined to form 7 and the principle of no appreciable harm is invoked to protect downstream riparians. Below is an abbreviated presentation of some of the more important aspects of the Convention.

**Article 5. Equitable and reasonable utilization and participation:**

Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof and benefits there from, taking into account the interests of the watercourse States concerned, consistent with adequate protection of the watercourse. Watercourse States shall participate in the use, development and protection of an international watercourse in an equitable and reasonable manner. Such participation includes both the right to utilize the watercourse and the duty to cooperate in the protection and development thereof.

**Article 6. Factors relevant to equitable and reasonable utilization:** Utilization of an international watercourse in an equitable and reasonable manner within the

meaning of article 5 requires taking into account all relevant factors and circumstances, including:

- a. Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character;
- b. The social and economic needs of the watercourse States concerned;
- c. The population dependent on the watercourse in each watercourse State;
- d. The effects of the use or uses of the watercourses in one watercourse State on other watercourse States;
- e. Existing and potential uses of the watercourse;
- f. Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
- g. The availability of alternatives, of comparable value, to a particular planned or existing use.

**Article 7. Obligation not to cause significant harm:** Watercourse States shall, in utilizing an international watercourse in their territories, take all appropriate measures to prevent the causing of significant harm to other watercourse States. Where significant harm nevertheless is caused to another watercourse State, the States whose use causes such harm shall, in the absence of agreement to such use, take all appropriate measures, having due regard for the provisions of articles 5 and 6, in consultation with the affected State, to eliminate or mitigate such harm and, where appropriate, to discuss compensation.

**Article 9. Regular exchange of data and information:** Watercourse States shall on a regular basis exchange readily available data and information on the condition of the watercourse

**Article 10. Relationship between different kinds of uses:** No use of an international watercourse enjoys inherent priority over other uses; with special regard being given to the requirements of vital human needs.

**Article 11. Information concerning planned measures:** Watercourse States shall exchange information and consult each other and, if necessary, negotiate on the possible effects of planned measures on the condition of an international watercourse.

**Article 12. Notification concerning planned measures with possible adverse effects:** Before a watercourse State implements or permits the implementation of

planned measures which may have a significant adverse effect upon other watercourse States; it shall provide those States with timely notification thereof.

**Article 20. Protection and preservation of ecosystems:** Watercourse States shall, individually and, where appropriate, jointly, protect and preserve the ecosystems of international watercourses.

## Questions

1. The doctrine of equitable utilization is often considered the cornerstone of international watercourse law. It is primarily concerned with the allocation of shared water resources among riparian states. Upstream states obviously prefer equitable utilization to any standard of territorial sovereignty or “do no harm.” Is the 1997 UN Convention an “equitable utilization” convention or a “do no appreciable harm” convention?
2. Article 7 of the 1997 UN Convention states that countries have an obligation not to cause harm to other watercourse states. Does this article provide any protection to the environment or does it only apply to interference with the use of the water by watercourse states?
3. What other rules can you suggest for allocating water among competing uses?
4. Many Conventions, including the Danube, the Mekong, the Ganges, and the Rhine, reflect a move away from allocating water toward allocating benefits among countries (i.e., Community of Interests). Thus, countries may develop a river basin more efficiently and equitably if the focus is less on the volume used by each country and more on the economic benefits that can be derived from joint management. What are some difficulties in implementing the concept of benefits allocation? Do any of the standard models for international conventions support this idea?
5. Is compliance with the provisions of notification and consultation in the 1997 UN Convention sufficient to meet the standards of “good faith” negotiations?
6. Not all harm to the environment or to other uses is prohibited under the UN Convention. Articles 3, 7, and 21, require the harm to be “significant.” Significant adverse effects must be capable of being established by objective evidence and not be trivial in nature. What threshold of harm should be considered “significant?”

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### 3. Western Hemisphere

#### 3.1. Colorado River

(with Rebecca L. Teasley, and Jennifer R. Rasmussen)

#### Introduction

The Colorado River is approximately 2,334 km long, encompassing a drainage area of approximately 632,000 sq km. The headwaters are located in Wyoming and Colorado and the river travels through Utah, Arizona, Nevada and California before reaching Mexico and draining into the Gulf of California. About 86 percent of the annual runoff originates in the mountains of Colorado. The average flow from 1930 to 1996 was about 17.14 billion m<sup>3</sup> per year. The river is estimated to be overallocated to the basin states by approximately 20-25%. Storage capacity of major reservoirs in the basin is more than 74 billion m<sup>3</sup>. In 1997, the river provided water for nearly 25 million people, 1.2 million hectares of irrigated land, and 11.5 billion kilowatt-hours of hydroelectric power.



**Map of the Colorado River basin.**  
(Source: [www.udallcenter.arizona.edu](http://www.udallcenter.arizona.edu))

At the beginning of the 20<sup>th</sup> century, most of the Colorado River remained largely untouched. A 25.7 km ditch that crossed the continental divide into eastern Colorado was the largest diversion. However, in 1901 the 96.6 km long Alamo Canal was constructed to deliver water from to California’s Imperial Valley for irrigation. About 80.5 km of the canal ran through Mexico. Almost immediately problems occurred with levee breaks and Mexican laws impeded maintenance on the canal. Then in 1905, raging floods eroded the canal, and flooded an ancient sea bed creating the Salton Sea before the river was pushed back to its normal channel. With the constant threat of flood looming along the lower Colorado, demands grew for some sort of permanent flood control work on the river. The Imperial Valley farmers of California called for a canal that was completely within the United States and free of Mexican interference. By 1919, to the alarm of the people in the upper part of the basin, the Imperial Irrigation District had won the support of the federal Bureau of Reclamation to build the “All American” canal and a storage reservoir as part of the Boulder Canyon Project Act (later known as Hoover dam).

The people of Colorado, Utah, New Mexico and Wyoming feared that a storage reservoir would give more water to California and Arizona under the prior appropriations doctrine (“first in time, first in right”). The fear was that the faster growing, lower-basin states would establish prior rights before the upper-basin states could utilize the water flowing through their own states.

### **Colorado River Interstate Compact and 1944 International Treaty**

In 1922 the Colorado River Compact was created with the Colorado River Commission to apportion the beneficial consumptive use of the river’s water between the upper and lower basins. This was to ensure that California and Arizona did not establish rights to most of the water in the river. The basin was divided into an upper (Wyoming, Colorado, Utah and New Mexico) and lower (Arizona, Nevada, and California) basin with the dividing point set at Lee Ferry Arizona.

20.19 billion m<sup>3</sup> were allocated according to the table below. Note that the long-term average annual flow is 17.14 billion m<sup>3</sup> per year, so this allocation (which is made in absolute volume amounts) over-allocates the river.

<b>State</b>	<b>Billion m<sup>3</sup></b>	<b>%</b>
Arizona	3.49	17.27
Nevada	0.37	1.82
California	5.38	26.67
Colorado	4.72	23.39
New Mexico	1.03	5.09
Utah	2.09	10.36
Wyoming	1.27	6.30
Mexico	1.84	9.09
<b>Total</b>	<b>20.19</b>	<b>100</b>

In 1944 the US and Mexico signed a treaty involving the allocation water from the Colorado and Rio Grande Rivers. The treaty required that Mexico deliver 2.15 billion m<sup>3</sup> to the Rio Grande in five year cycles while the US must deliver 1.85 billion m<sup>3</sup> annually from the Colorado River. The obligations to Mexico were to be met out of surplus waters in the Colorado basin, however in the case of no surplus, both the upper and lower basins must bear equal responsibility in providing the water to Mexico.

The 1944 Treaty between the U.S. and Mexico says that in the event of extraordinary drought or serious accident to the irrigation system in the United States, thereby making it difficult for the United States to deliver the guaranteed 1.85 billion m<sup>3</sup> per year, the water allotted to Mexico will be reduced in the same proportion as consumptive uses in the United States are reduced. Exactly what constitutes an "extraordinary drought" remains to be defined through continuing negotiations to be carried out by the International Boundary Water Commission (IBWC).

### **California's Colorado River Water Usage**

California has a long history of taking more than its share of the Colorado River water. In 1964 the U.S. Supreme Court capped California's share at its allotted 5.38 billion m<sup>3</sup>. However, the U.S. Interior Secretary was given the authority to send California more than its share as long as there was a surplus in the river system. This worked for about 30 years with California using about 6.36 billion m<sup>3</sup>. Then a cycle of drought from 1987 to 1992 plagued the region and California was forced to uphold their end of the bargain and their allotment was cut by 30 percent.

Recently, the Metropolitan Water District, which provides water to San Diego County, began looking for a new water source. The Imperial Irrigation District, which is one of the largest users of Colorado River water became the target. On October 3, 2003 the Imperial Irrigation district approved a plan to sell water to the San Diego region after a lot of pressure from federal agencies. The Irrigation District agreed to sell "excess water" totaling about 36.7 billion m<sup>3</sup> over the next 75 years, allowing California to sign an agreement with the US Department of the Interior, promising not to exceed its allotment of Colorado River Water.

### **Colorado River Delta**

The Colorado River Delta is located in the Gulf of California. Before the construction of the major dams on the Colorado River, the delta was one of the largest desert estuaries in the world. With the construction of the dams that captured flood flows, freshwater no longer flowed to the delta. The loss of freshwater flows has reduced the wetlands in the delta and allowed invasion by non-native species. The loss of rich biodiversity in the region has prompted international concern. However, some groups believe that the resilient delta could regenerate itself with increased flows from the US.

The 1944 Treaty had stipulations only on water quantity and neglected the issue of water quality. High salinity is a major problem in the Colorado River Basin. At the headwaters of the Colorado, the salinity is approximately 50 parts per million (ppm). Where the river crossed the border into Mexico in the early 1900's, it was about 400 ppm, but rose to about 1200 ppm in the 1960's. With the significant decrease in quality of water, Mexico pursued renegotiations to reduce the level of salinity in water reaching Mexico from Arizona. In 1972 the US agreed to deliver water to Mexico with a salinity that would not exceed that of the water arriving at the Imperial Dam<sup>2</sup> by more than 115 ppm (IBWC, 1073).



**Map of Colorado River delta**  
(Source: [www.environmentaldefense.org](http://www.environmentaldefense.org))

Salinity of the Colorado River water delivered to Mexico is an issue of concern. One attempted solution to the salinity problem was the construction of a Desalting Plant at Yuma, Arizona. Salinity requirements continue to be met by the diversion of highly saline agricultural drainage waters through the Wellton-Mohawk Canal (see map below). This water is now depended on by wildlife in the Cienega de Santa Clara, promoting environmental groups to argue that the water should be replaced from other sources if the agricultural water source is stopped upon operation of the desalinization plant. This may become an issue when shortages occur within the Colorado Basin, because delivery to Mexico has been supplemented by surplus waters from the U.S. in an amount equal to the diverted waters of higher salinity. State claims to this water will be a strong legal force in opposition to the environmental claims for use of the water.

<sup>2</sup> Imperial Dam is located about 20 miles northeast of Yuma, Arizona, this is the diversion point for water flowing from the Colorado River to the All-American Canal

## Questions

1. The 1944 Treaty with Mexico states: "In the event of extraordinary drought or serious accident to the irrigation system in the United States, thereby making it difficult for the United States to deliver the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 m<sup>3</sup>) per year, the water allotted to Mexico under subparagraph (a) of this Article will be reduced in the same proportion as consumptive uses in the United States are reduced." The term "extraordinary drought" is undefined in the treaty; discuss some possible definitions. Since the waters of the Colorado River are overallocated, what types of problems (both within the states and between the U.S. and Mexico) may occur during an extended drought?
2. What are some ideas for protecting the ecology of the Delta region? Several groups have suggested an amendment to the 1944 Treaty, or the addition of an IBWC "Environmental Minute", similar to Minute 242 which currently regulates the salinity of waters delivered to Mexico. Since the U.S. is a party to the treaty, how does the U.S. Endangered Species Act come into play, considering the fact that there are several threatened and endangered species found in the Delta region?
3. California proposes to conserve 110 million m<sup>3</sup> (93,700 AF) of water through the concrete lining of portions of the All American Canal. Mexico has objected to this proposed project because water that presently seeps from the canal migrates into Mexico where it is recovered from groundwater aquifers and used for agriculture. The canal lining has caused concern in Mexico over groundwater rights that they considered to be "grandfathered" as existing rights at the time of the 1944 Treaty, although not expressly written in the Treaty. Does Mexico have a right to this groundwater? How might groundwater issues affect the ongoing negotiations between the U.S. and Mexico?
4. Since the creation of the Salton Sea, by accident, early in the 20<sup>th</sup> century, it has become a major wildlife habitat for migrating birds in the Pacific Flyway. Many of the proposals for improving water management in the Colorado basin involve reducing or eliminating the inflows to this accidental sea. Which should be a priority – protecting the Salton Sea or restoring the delta?

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### 3.2. Columbia River

(with Michael V. Konieczki, Stephen H. Pitman, Ryan C. Murdock, and Emma White)

#### Introduction

The Columbia River Basin, North America's 4<sup>th</sup> largest river basin, is a valuable resource in the western United States and the Canadian Province of British Columbia. The River is also a hotbed of contention over conflicting environmentalist vs. development views. The Columbia River Basin drains 669,512 km<sup>2</sup> (USGS, 2006) Fifteen percent of the basin lies in the Canadian Province of British Columbia, and the remaining 85% of the basin is shared between the states of Washington, Oregon, Idaho, Montana, Wyoming, Nevada, and Utah. The Columbia River starts 434.5 km north of the US-Canada border in British Columbia, continues flowing south through western Washington, and then turns west and flows along the Washington-Oregon border into the Pacific Ocean. The Columbia River flow at the US-Canada border is about 40% of the river's ultimate discharge into the Pacific Ocean. The mean annual discharge of the Columbia River is about 96.8 billion m<sup>3</sup>. The river's elevation change is 808 m, a drop twice that of the Mississippi, and in half the distance. The Columbia is considered to be one of the most heavily engineered waterways in the world with over 250 reservoirs and about 150 hydroelectric projects.



**Map of the Columbia River basin**  
(Source: encyclopedia.laborlawtalk.com)

The eight primary uses of the Columbia River are navigation, flood control, irrigation, electric power generation, fish migration, fish and wildlife habitat, recreation, and water supply and quality. Hydroelectric dams on the Columbia and Snake Rivers produce an annual average of 18,500 MW.

## **Columbia River Treaty**

The Columbia River Treaty (CRT) was designed to be a joint solution between Canada and the US to reduce flooding in the Columbia Basin region and to address the demand for greater energy. It represents an example of the continuing good relations between the US and Canada and sets a precedent for other transboundary agreements. Sixty years of purchased flood control expires in 2024, leaving options open to change or terminate the treaty. Ten years advance written notice must be given by either the US or Canada, making 2014 the first year any changes may be suggested. Currently, both Canada and the US are conducting modeling, analysis, and technical studies to determine the effects of numerous changes that could be made to the treaty.

In 1944 the International Joint Commission of the U.S. and Canada was given the task of assessing the possibilities for co-operative development of the Columbia River by Canada and the United States. The potential for successful development was high because the countries have a long peaceful history together. By 1960 when negotiations were underway for the Columbia River Treaty, the United States had already developed the Columbia River significantly for flood control and power, but there was no development on the main stem of the Columbia River in British Columbia. The United States was in need of additional flood protection, and needed more hydropower during periods of low flow.

The Columbia River Treaty was signed in January 1961 and ratified by the US Senate a few months later, but implementation of the treaty was delayed 3 years waiting for the definition of responsibilities between the Federal Government of Canada and the Province of British Columbia and final negotiations led to the 1964 agreement. The main Provisions of the Columbia River Treaty include:

- Canada agreed to build dams, and operate them to control flooding in U.S. Canadian storage projects would provide 19 billion m<sup>3</sup> storage for power and flood control in the US (dams built: Duncan 1967, Keenleyside-Arrow Lakes 1968, Mica 1973);
- Canada received an equal share of increased power produced in the US, and one-half the value of the US flood damage reduction. The U.S. eventually “bought back” the Canadian rights to power generated in the U.S.
- U.S. paid for flood control value of dams and for each instance when flood control operation requested
- The US was permitted to build a dam on the Kootenai River near Libby, Montana, whose headwaters extend into Canada;

- The treaty remains in force for at least 60 years from its ratification on September 16, 1964; and
- Both countries agreed not to divert flows that feed the Columbia

The International Joint Commission issued two “General Principles” to be applied in determining the resulting benefits from co-operative development, and the allotment of the benefits between the two countries. The General Principles provide the basis for guiding the development of the international river, but they also include provisions that allow for broad interpretation and application.

Many important lessons have been learned from the results of the Columbia River Treaty experience. There was greater interest in Canada to develop the Columbia than in the US, but the US also saw the treaty as a furtherance of good-neighborly relations. The original 1961 treaty had been signed by both parties and ratified by the United States, so it was inflexible to changes resulting from new administrations and policies. Krutilla (1967) suggests that treaty planning and operating details should have been left to a designated planning body, since decisions could be reviewed and modified as necessary and appropriate.

Krutilla (1967) also suggested that the treaty resulted in a large monetary gain for Canada, a large monetary loss for the US, and possibly a net loss overall. He also points out that some of the treaty dams may not have been necessary. Of course hindsight is 20-20, but this treaty is a good example of the complexity of international water policy, even when you only have two parties negotiating who are good friends.

## **History**

Prior to the 1940s, the development along the river provided power and navigation, but no storage. Periodic flooding in the area and an increase in population and economy gave rise to the need for adequate storage along the river and more energy resources. In 1944, Canada and the US requested that the International Joint Commission (IJC) conduct a basin study investigating the development of water resources. The IJC was formed by Canada and the US under the 1909 Boundary Waters Treaty to resolve any disputes over bodies of water bordering both countries. The study took fifteen years to complete and concluded that hydropower development along the upper Columbia River would provide benefits for both countries for cooperative use. The 1948 flood in Vanport, Oregon displaced more than 30,000 people and reinforced the need for upstream storage. The treaty was signed in 1961 and implemented on September 16, 1964 by President Lyndon Johnson, Prime Minister Lester Pearson, and Premier W.A.C. Bennett.

## **Treaty**

The treaty required Canada to provide 15.5 million acre-feet (Maf) of storage by building three dams along the upper Columbia River. The Canadian dams built were

Duncan Dam, with 1.4 Maf of storage, Arrow Dam (later named Hugh Keenleyside Dam), with 7.1 Maf of storage, and Mica Dam, with 7 Maf of storage. The treaty also gave the US the option to build the Libby Dam, which was constructed in 1973 with 5 Maf of storage. The four dams more than doubled the storage capacity of the river after completion.



Both countries received flood protection and increased power generation at downstream facilities. Canada received an upfront payment of 50% of the estimated value of flood damages prevented in the US through 2024, which they sold to the US for \$64.4 million. The treaty also allocated 50% of downstream power benefits through 2024 to Canada, called the “Canadian Entitlement.” Canada sold the first 30 years of the Entitlement to US utility companies for a lump sum of \$254 million. Since 2003, the Entitlement has been fully returned to British Columbia. The Treaty established a US entity and a Canadian entity each with the power to implement not modify or terminate the treaty. The US entity was created by the President and consists of the Administrator of Bonneville Power Administration (BPA) and the Northwest Division Engineer of the US Army Corps of Engineers. The Canadian Entity was created by the Canadian Federal Cabinet and consists of British Columbia Hydro and Power Authority (BC Hydro). The Permanent Engineering Board (PEB) was created by the two entities to monitor the results of the treaty and to assist with technical disputes between the two entities.

**Possible Changes**

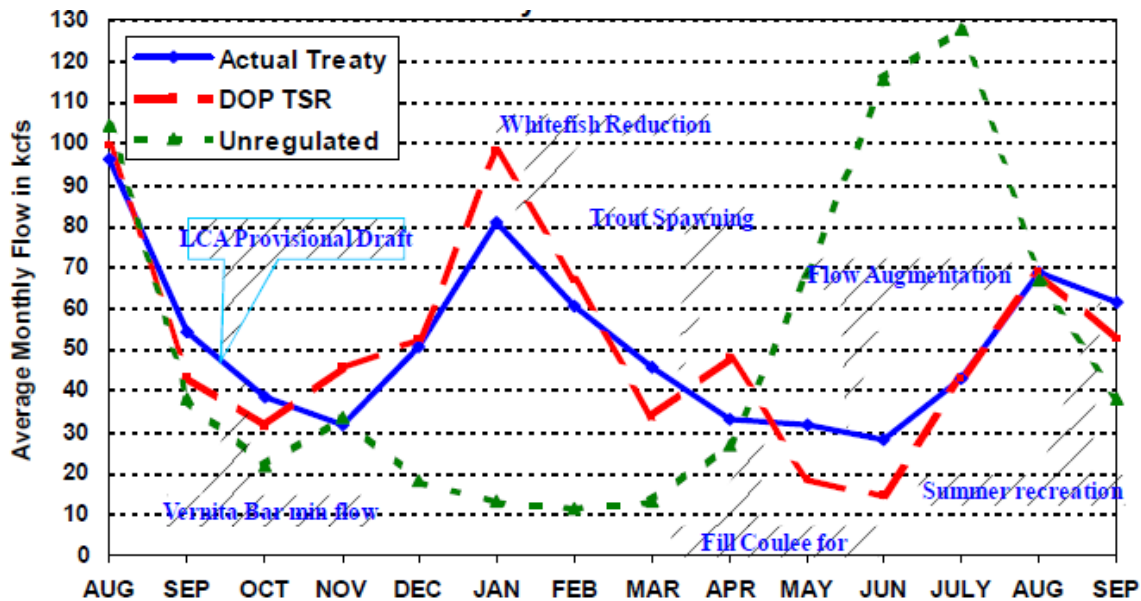
The CRT has no specified termination date but, in 2024, the sixty years of purchased flood control from Canada expires. The treaty states that after 2024, the flood control assistance changes to “called upon” assistance, where the US calls upon Canada for extra flood control and pays Canada for operating costs and any energy losses accrued while assisting the US. The treaty also requires that 10 years advance written notice be given to both governments, making 2014 the first year any changes or

termination can be suggested. Studies are currently being conducted to determine the benefits of changes or termination of the treaty. Three possible scenarios are being discussed:

- Study I: New agreement to continue the treaty and current flood control operating plans
- Study II: Treaty continues with no modifications, the Entitlement continues, “called upon” assistance begins
- Study III: Treaty is terminated, the Entitlement ends, “called upon” assistance begins

### **Factors Effecting Treaty Changes**

When the treaty was developed, hydropower and flood control were the two main objectives. The treaty did not contain any criteria for ecosystem management or other non-power objectives. Now, other non-power issues are becoming more important and there is a public demand to address these concerns in the treaty, including fish and wildlife, cultural resources, recreation, and water supply. Construction of the four treaty dams was completed in 1973 and, by the late 1980s, 13 species of salmon and sturgeon were listed in the Endangered Species Act (ESA). In the mid-nineties, the National Marine Fisheries Services completed the 1995 Biological Opinions, requiring the monitoring of species and the unimpeded passage of adult and juvenile species upstream and downstream. In response, fish ladders and other bypass systems were installed at many dams. Because the treaty is only concerned with hydropower and flood control, other non-power issues are included in the Detailed Operating Plan (DOP). The DOP supplements the Assured Operating Plan (AOP), which is a one-year plan developed six years in advance of the operating year. The DOP includes the aforementioned factors, such as fish and wildlife, recreation, and water supply that the AOP and the CRT leave out.



Also, in the beginning stages of the treaty, there was a lack of communication with residents of the Canadian Columbia Basin. After the dams were built, 2,300 people were displaced, archaeological sites were buried, and 500 km<sup>2</sup> of fertile land was flooded. In response, the Columbia Basin Trust was created in 1995 to support First Nations, the Aboriginal peoples in Canada, and local communities within the basin and to protect their rights. As studies are being conducted to determine any changes to the treaty, the above concerns and many other regional interests are being addressed. The effects of climate change are also being addressed. While average peak discharge is estimated to decline, there is potential for severe flooding when heavy spring rains occur on snowpack in the Rocky Mountains of British Columbia. Only 30% of the Columbia River's annual runoff can be stored in reservoirs, which is much smaller than the reservoir storage capacity of the Missouri and Colorado rivers (Bruce 2003). Fish and wildlife, recreation, and navigation are most vulnerable to climate change due to low stream flow. Energy and flood control are predicted to be the least impacted; however, because of set storage requirements for fish flow, it is predicted that there would be losses in hydropower production by about 15% by 2050 (Bruce 2003). Regional interests, such as fish and wildlife, and climate change influences will further increase competition for an already limited water supply. Great care is being taken to appease tensions in the US and Canada and to provide an effective solution to treaty changes that allow the Columbia River Treaty to continue to be a precedent in international water boundary agreements.

## Anadromous Fish

Within the last century, the Columbia River basin has seen a drastic decline in the anadromous fish<sup>3</sup> population within the region. While a myriad of factors can be

<sup>3</sup> Fish that hatch and rear in fresh water, migrate to the ocean (salt water) to grow and mature, and migrate back to fresh water to spawn and reproduce.

attributed to this trend, economic development with the basin can be best linked to water quality degradation. The Columbia basin streams, both main and tributaries, have been designated as “water quality impaired” under the Clean Water Act (Federal Caucus, 1999).

Historically, 10 to 16 million salmon and steelhead returned to spawn in the basin each year, but by the 1960's that number was reduced to 5 million (Federal Caucus, 1999). The population was further reduced to about a million by the late 1990's, with most of these produced in hatchery operations (Wright, 2000) Due to this steep reduction in population the National Marine Fisheries Service (NMFS) has listed 12 stocks of salmon and steelhead as threatened or endangered under the Endangered Species Act (ESA). In addition, the U.S. Fish and Wildlife Service listed bull trout, Kootenai River White Sturgeon, and 5 other aquatic species as threatened or endangered (Federal Caucus, 1999). Under the ESA the NMFS is responsible for developing a plan to restore anadromous species populations (United States Fish and Wildlife, 1973).

A fisheries restoration effort has been ongoing in the Columbia basin since the late 1990's. The level of institutional cooperation and public participation is extremely high with a multitude of organizations; federal, state, and local coming together to formulate a comprehensive means for restoration. Various alternative solutions have been developed on a number of issues based on the interests of the various actors within the basin. These solutions run the gambit from “do nothing,” to complete natural river restoration.

## Questions

1. Would the principles of cooperative use in the 1961 U.S.- Canada treaty on the Columbia (essentially resource and benefits sharing) work in other basins or in cases with more than 2 basin countries?
2. Should compensation be paid to one riparian whose activities on his reach of a river benefit his downstream neighbor?
3. Krutilla relied on benefit-cost analysis to examine the effectiveness of the Columbia River treaty. Is this an appropriate tool to use in this setting?
4. What are some challenges in incorporating long term planning and flexibility into water transboundary water treaties?
5. It is possible, as Krutilla suggests, that the returns to Canada and the United States combined are less than they would have been if each country had proceeded independently?
6. If money is loaned or given to developing countries to build dams, should donors require recipients to include fish-friendly features in the designs?

7. If the CRT is revised to continue as it is written presently, should the current main objectives (flood control and hydropower) be changed to include other non-power objectives, such as fish and wildlife?
  - a. If other non-power issues are not included as main objectives, should they be included in the Assured Operating Plan (AOP)?
8. The AOP is developed six years in advance of the operating year. Should a shorter time frame be set for these plans to better combat climate change influences?
9. Remember, the CRT is representative of an effective transboundary agreement between two nations and sets a precedent for other countries.

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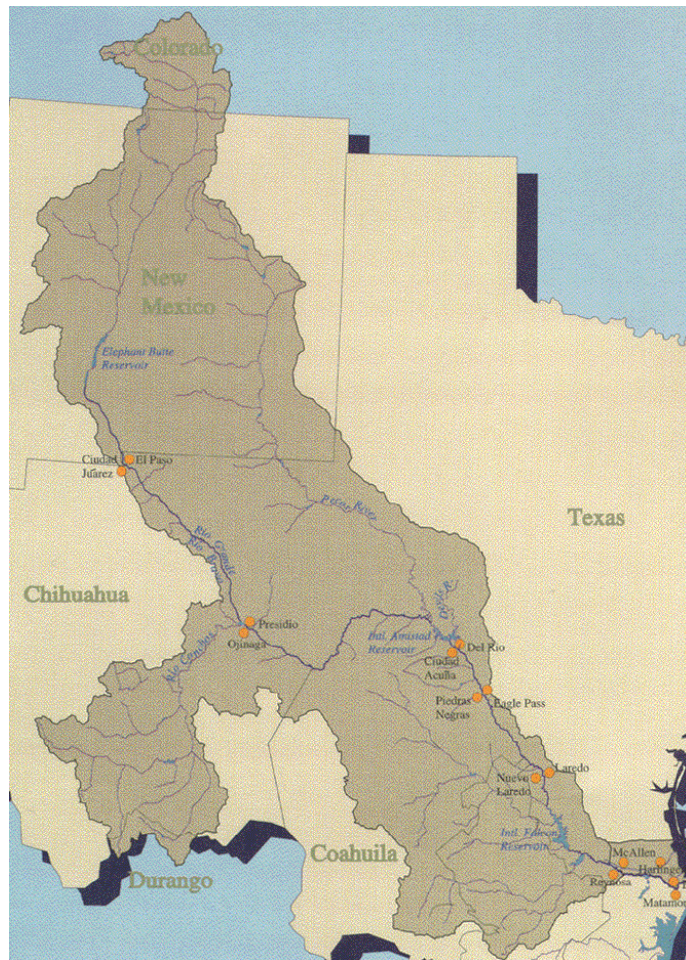
### 3.3. *Rio Grande*

(with Carlos Patiño–Gomez, Marcel P. Dulay, and Beatriz Garcia-Fresca)

#### Introduction

The Rio Grande originates in the San Juan Mountains of southern Colorado, flowing 989 km from its headwaters through the State of New Mexico. It enters Texas about 32 km northwest of El Paso and then continues 2053 km to the Gulf of Mexico. As a result of the U.S.-Mexican War of 1846-1848, the Rio Grande was established as the international border from the Gulf of Mexico to the El Paso area.

The Rio Grande is the fifth longest river in North America, and among the 20 longest rivers in the world. The river collects rain, snowmelt and springwater from an area of about 869,000 sq. km. The Rio Grande drainage basin includes parts of three states in the U.S. (Colorado, New Mexico and Texas) and five states in Mexico (Chihuahua, Durango, Coahuila, Nuevo Leon, and Tamaulipas).



**Map of the Rio Grande Basin**

(Source: [www.rioweb.org](http://www.rioweb.org))

Only about half of the area of the basin directly contributes water to the Rio Grande. Of the part of the basin that does directly contribute surface water to the river, about half is in Mexico and half in the U.S. The river receives most of its water near the headwaters in the mountains and in the monsoon affected areas near the Gulf Coast. The river carries little water compared to other rivers of its length and it has been called an “exotic” stream (Rio Grande Basin Coalition, 2006), meaning that it tends to shrink in size as it flows downstream. Principal tributaries to the river include the Conchos, San Rodrigo, Alamo, and San Juan Rivers in Mexico, and the Pecos and Devils Rivers in Texas. The Rio Grande water resources are almost entirely allocated and used by the time the river passes El Paso and the river has intermittent flow until it reaches the confluence with the Rio Conchos. For management purposes, it is convenient to divide the river into an upper and lower portion, with the dividing point at Fort Quitman, Texas below El Paso.

The second half of the 19th century brought dramatic changes to the Rio Grande basin with major irrigation projects completed in the headwaters and in New Mexico. By 1890, diversions of Rio Grande water for irrigation in Colorado and New Mexico began to cause shortages in the El Paso/Juarez area. Erosion also increased the river’s sediment load and accelerated the process of aggradation by which the river fills in its channel. The river’s habit of changing course began to cause diplomatic problems. It was frequent for people living along the river to find themselves in a different country after one of the river’s frequent course changes. Then the river’s channel was straightened, deepened, and even lined with concrete, and dams were built to control flooding and store water.

Economic activity has a special resonance for the 2053 km of river which forms the border between Texas and Mexico. The region is so poor that four of the ten highest poverty rates are found in counties along the Texas side of the border; their Mexican neighbors on the other side of the river are even worse off. Pollution from the discharge of raw sewage and other liquid wastes from six large twin cities along the border has been a source of major concern and tension between Texas and Mexico.

## **Current water use and apportionment**

**1906 Convention** - Mexico and the United States have two treaties and various cooperative regulations that govern allocation of the water resources they share. The two nations signed the “Convention for the Equitable Division of the Waters of the Rio Grande for Irrigations Purposes” in 1906 (IBWC, 1906). This treaty allocated the water in the upper basin above Ft Quitman, Texas. Mexico agreed to the development of Elephant Butte Dam in New Mexico (completed in 1916), and the United States committed to providing Mexico with 74 million m<sup>3</sup> of water for irrigation in the Ciudad Juarez area. One of the reasons the United States constructed Elephant Butte dam was to facilitate these deliveries. This agreement contains a provision specifying that in the event of drought, water deliveries to Mexico may be reduced in the same proportion as deliveries to U.S. users in that stretch of the river are reduced.

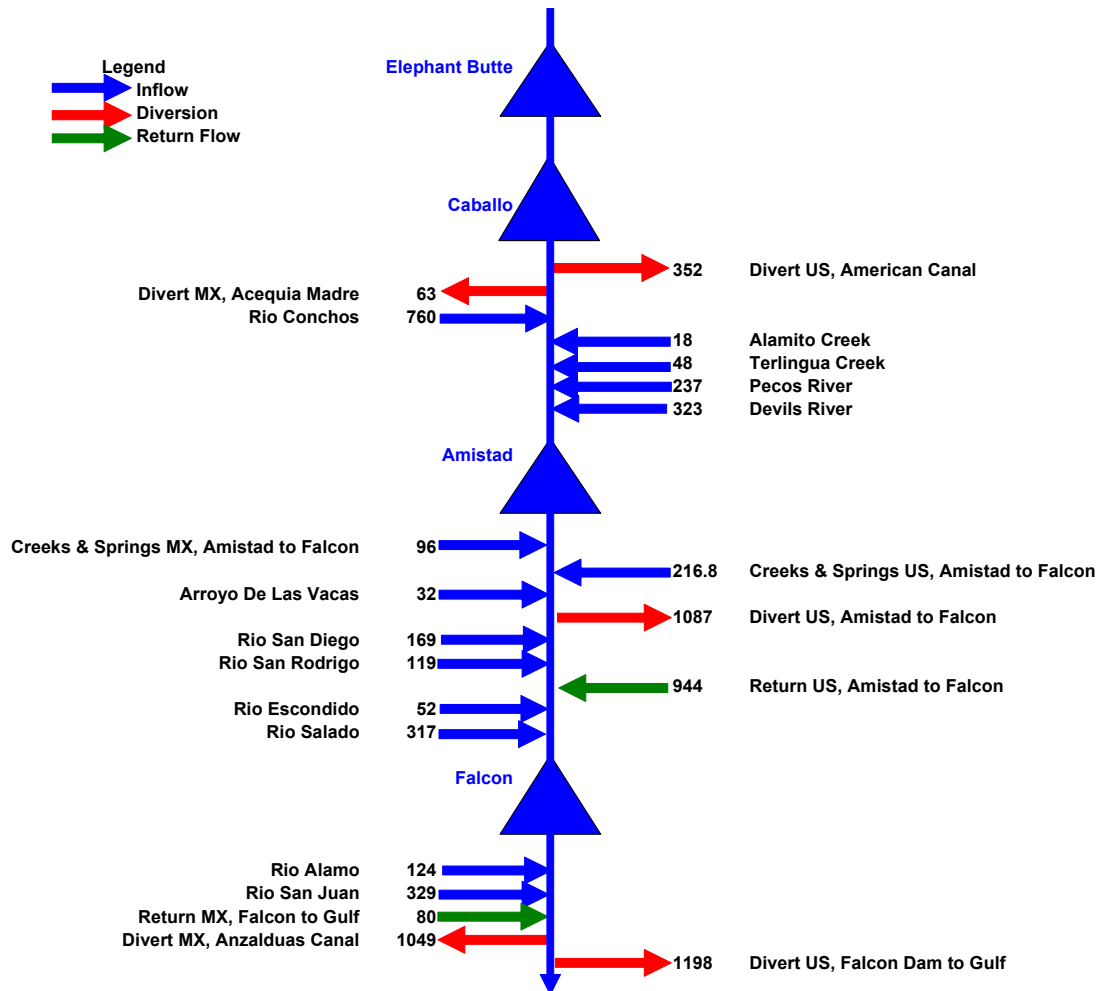
The volumes specified in the 1906 treaty are so small that fulfilling them posed no apparent problems for the first 30 years the Convention was in force. The records registered from 1924 to 1937 showed that nearly one third of the river's average flow of 709.3 million m<sup>3</sup> was left in the river after all U.S. and Mexican consumption. Subsequently, the U.S. developed Caballo Dam and the American Canal (completed in 1938), then U.S. water users were able to divert 80 percent of the river at once. Water for use on the U.S. side of the border (326 million m<sup>3</sup> annually) is diverted into the American Canal at El Paso, while Mexico diverts part of the remainder (74 million m<sup>3</sup>) through the Acequia Madre.

**1944 Treaty** - In 1944, the United States and Mexico signed a Treaty for the "Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande" allocating the water of the lower Rio Grande from Fort Quitman to the Gulf of Mexico (IBWC, 1944). The pact authorized the construction of two international reservoirs, Amistad (6.5 billion m<sup>3</sup> capacity, completed in 1968) and Falcon (4.9 billion m<sup>3</sup> capacity, completed in 1953). These dams and other water projects control the floods and allow farming to the flourish along the river.

According to the 1944 treaty, each country receives half of the water in the main stem of the Rio Grande, and full use of the waters in their tributaries (IBWC, 1944). However, there was an important exception to this last point: the treaty provides that one-third of the flow reaching the main channel of the Rio Grande from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo is allocated to the United States, provided that this third is not less, on average in cycles of five consecutive years, than 431 million m<sup>3</sup>/year (2.15 billion m<sup>3</sup> over five years). The vast majority of this water comes from the Rio Conchos basin, as flow in the other tributaries is minimal during much of the year. In exchange, Mexico receives 1.85 billion m<sup>3</sup> from the Colorado River further west on the international border. In case of drought, deficits from Mexican deliveries can be made up over the following five-year period. As a result, the United States holds rights to 58 percent of the Lower Rio Grande/Bravo water, with the remaining 42 percent going to Mexico.

Today the Rio Grande supports a thriving agriculture. It also provides water for drinking, hydroelectric power, sewage disposal, industry, and recreation for more than five million people that live in this basin. Mexico irrigates about 445,154 ha in the basin, while United States irrigates about 401,852 ha.

Current diversions from the river below Falcon dam go primarily to agriculture (more than 87 percent). Mexico relies on the Anzalduas Canal near Reynosa to divert the bulk of its water to an irrigation system. Both Mexico and the U.S. divert about the same amount of water from the river. Water management infrastructure efficiency is low in this zone, home to the largest irrigation district (250,000 ha) in northwestern Mexico.



### Average Annual Flows in the Rio Grande/Bravo Basin

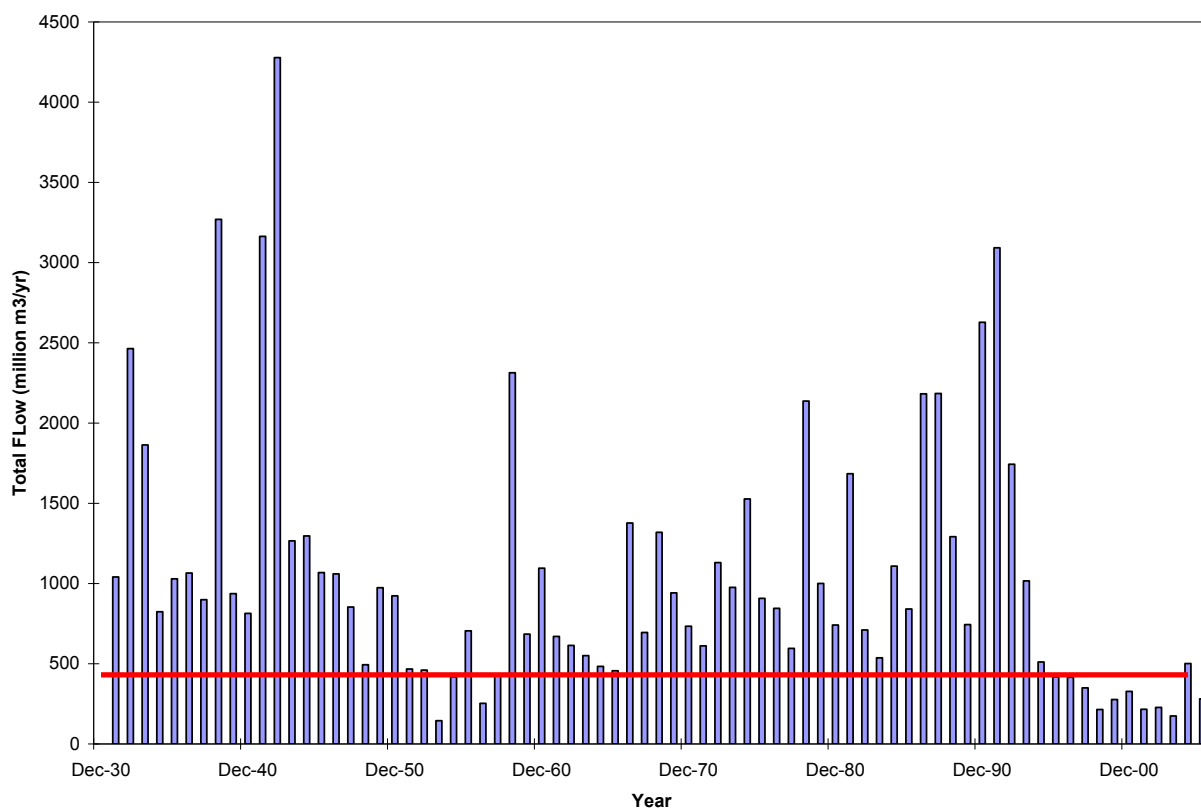
(Source: [www.ibwc.state.gov/wad/histflo1.htm](http://www.ibwc.state.gov/wad/histflo1.htm); adapted from Eaton and Hurlbutt, 1992)

Population growth in the lower part of the Rio Grande basin is estimated at about 2.2 percent per year. This increasing population results in increased municipal demand and an increase in the conversion of agricultural water use to municipal use (given highest priority in both Texas and Mexican water law). About 98 percent of Laredo's water needs are currently supplied by the Rio Grande. Laredo is satisfying its municipal water needs by purchasing water rights from agricultural users upstream, but this acquisition is a large strain on agricultural water use. Due to growing population in the McAllen/Reynosa area, water quantity problems could become severe in the future. Quantity problems in the Brownsville/Matamoros area are similar to those faced by McAllen/Reynosa. Groundwater is generally not a feasible alternative to surface water in the area because the region's aquifers are highly saline, recharge slowly, and are susceptible to subsidence.

Drought has been a persistent problem in the Rio Grande basin. Indeed, a recent drought event lasted longer than was ever anticipated in the negotiations of the

1944 treaty between the U.S. and Mexico (see Figure below). This drought lasted more than 10 years and created numerous difficulties in the lower Rio Grande basin below Ft. Quitman, Texas. As a result of the drought, Mexico was unable to deliver the quantities of water required under the 1944 Treaty and accumulated a “water debt” at the end of two consecutive five-year treaty accounting cycles. As the figure below indicates, meeting that obligation became extremely difficult for Mexico during the recent drought.

Prolonged droughts raise an important question regarding the 1944 Treaty. First, the term “extraordinary drought” is not defined in the treaty and if a drought is of this magnitude, then, according to the treaty, Mexico can seek relief from deliveries of the treaty water. A drought extending over more than six years would tend to be “extraordinary.”



**Total annual Rio Grande flow below the confluence with the Rio Conchos (million m3/year).** The solid line indicates the 1944 Treaty obligation of 432 million m3/year.

## Questions

1. What characteristics make water management in this basin similar or different from that in other international basins?

The fact that the river does not *cross* the boundary between the countries, but rather forms the *boundary* of the two countries for a very long distance.

2. Do you think that the sharing of water resources between Mexico and the U.S. could be a source of tension in the future and affect other treaties or agreements between the two countries?
3. What are the principal uses of water in the Rio Grande basin and how do these affect the environment and ecological process in the basin?
4. Do you consider the current distribution of water in the Rio Grande basin adequate for each nation? What changes in the management of water or the infrastructure are necessary if the U.S. and Mexico are improved their use of water from the Rio Grande.
5. Why would the United States limit Mexico's diversion of water to no more than the level called for in the 1906 Convention in wet years? Why would Mexico not take the water even though it has been available?

The U.S. practice of not sharing extra water with Mexico began soon after the opening of the American Canal and its diversion dam in 1938. Mexican officials attribute these cases to the fact that the Acequia Madre Canal is old and small; during days of extremely high flow, Mexico has to let water go undiverted because the canal is full to capacity. Even if the United States were to practice more equitable apportionment of the river, Mexico would have to expand the capacity of the Acequia Madre Canal in order to capture additional water (Eaton and Hurlbut, 1996).

6. Given that the term "extraordinary drought" has serious implications for treaty compliance, what are the possible consequences due to the lack of definition of this term? Should it be defined?

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### **3.4. Lake Titicaca**

(with Eusebio Ingol - Blanco)

#### **Introduction**

The Lake Titicaca basin, Desaguadero River, Lake Poopo, and the Salt Lake Coipasa system (TDPS) is managed by the Binational Lake Titicaca Authority (ALT) of Peru and Bolivia in South America. This organization was created in 1996 to carry out the Binational Master Plan for the integrated development of the water resources, promoting the sustainable development in the region. Despite the efforts performed in the development integrated of the region, the Lake Titicaca System presents serious threats for its sustainable use. This section presents briefly some of the problems that have been identified in the system. It also provides some recommendations to improve the integrated water management of the Lake Titicaca basin.

#### **Background**

The Lake Titicaca system is located at an altitude of 3810 m in the Andes Mountains on the border between Peru and Bolivia. The system is comprised of the hydrographic basins of Lake Titicaca, the Desaguadero river, Lake Poopo, and Copiasa Lake; which are called TDPS system (Figure 1). The TDPS system is a closed basin enclosed by the Andes Mountains. The area of the system is about 143,900 km<sup>2</sup> of which about 40% is the Lake Titicaca basin with a volume of 930 million m<sup>3</sup> and a surface area of 8400 km<sup>2</sup>. Lake Titicaca is considered the highest commercially navigable lake in the world and the largest in terms of volume in South America.

Precipitation occurs mainly in the summer season (Dec to Mar), and it varies from 800 mm/yr on Lake Titicaca to 250 mm/yr on Coipasa Lake. The most important source of inflow to Lake Titicaca is from precipitation, and river and streams provide about 45% of the inflow. The main tributaries are located on the Peruvian site, including the Rivers Ramis, Huancane, Coata, llave, and Illpa, that contribute about 180 m<sup>3</sup>/s. On the Bolivian side, the most important rivers are Suchez, Mauri, Huayco, and Catari, with a total flow of 20 m<sup>3</sup>/s. The Ramis River is the most important which average flow is 75 m<sup>3</sup>/s. The average flow in the Desaguadero River is 35 m<sup>3</sup>/s, which represents 20% of the inflow from the main tributaries. There is a high volume lost to evaporation in the system. Groundwater contributes about 4 m<sup>3</sup>/s. Irrigation and domestic water use in the TDPS system constitutes 10.5 m<sup>3</sup>/s from which 70% is for agriculture. The main economic activities in the region are agriculture, cattle raising, and fishing. Mining is relatively important in the region and it causes some pollution problems in the rivers such as in the upper Ramis basin in Puno, Peru where Mercury and Arsenic concentration have been found.

The main objective of Binational Lake Titicaca Authority is to carry out integrated management of the water resources including flood control and prevention in the area around Lake Titicaca, biodiversity conservation, environmental preservation, as well as

the development of several hydrological and hydraulic projects. Since the organization was created, the main activities have been the regulation of floodgates of Titicaca Lake, environmental zonification in which thematic maps have been built, and planning using mathematical models, hydrological and hydraulic projects, studies of Titicaca Lake contamination, systematization of meteorological and hydrological data for the basin, improvement of batimetry information in the lake and Desaguadero river. Likewise, hydrological simulation models were used to determine the water balance. Additionally, several studies related to the social, economic, irrigation, natural resources, were carried out.

Present activities have a main objective of assessing real problems in the TDPS system; as well as to propose recommendations to improve the integrated management of water resources in the basin.



Figure1. Location of Lake Titicaca, the Desaguadero River, Lake Poopo, and the Lake Coipasa system.

### Critical Issues

The main problems found in the Lake Titicaca basin are related to the uncertainty and variability of the water resources, deficient water regulation, water pollution, problems related to melting glaciers located in the Andes due to climatic variability, and social and economic issues.

*Uncertainty and variability of water resources.* Extremes events such as flood and drought occur in the altiplano region due to climatic variability. Agriculture is the main activity in the region and it is affected with both events, for instance the drought from 1982 to 1983 caused damage of more than \$125 million (80% from agriculture). Flooding causes serious impacts on the economy of the region despite water regulation in Lake Titicaca; protection against flood is only effective during normal hydrologic events. Economic damage has been estimated at \$890 million for agriculture, infrastructure, and livestock. Additionally, important floods have occurred along to the Desaguadero River, around Lake Poopo and Uru-Uru affecting the Oruro city. Another common extreme event is frost that has very negative consequences for crops and animals. Minimum temperatures vary from -10 to -7°C and maximum temperatures range from 18 to 23°C.

*Lake Titicaca Regulation.* The Lake Titicaca has a large water volume; however, that does not guarantee water supply for several uses. More than 90% of the lake input is evaporated due to the altitude effects such as high radiation, low humidity, and low air pressure. In addition, problems are developing due to lack of adequate water regulation. There is a limited amount of outflow from Lake Titicaca; therefore, water uses for irrigation need to be prioritized on the basis of hydrological conditions, and economic, social, and environmental criteria.

*Water Pollution and Environmental Degradation.* Urban waste and mining are causing organic and bacteriological contamination. There is not enough information about the pollution, but Mercury and Arsenic have been found at concentrations of about 0.4 ppm in Puno bay. The Lake Titicaca has a salinity level less than 1 g/L, and the southern part of Lake Poopo has levels of about 100 g/L. Soil erosion is another important problem; more 35,000 km<sup>2</sup> is vulnerable to erosion due to water, eolith and geologic actions.

*Problems Related to Melting Glaciers Located in the Andes Due to Climatic Variability.* Now it is taking relevant interest in the Lake Titicaca region. During drought periods, glaciers are an important source of drinking and irrigation water in the altiplano region of Peru and Bolivia. However, the glaciers are currently diminishing in volume and area due to climate variability associated with global warming. A clear example is the volumetric variation and area of the Chacaltaya glacier. According to the data compiled in the TDPS system the Chacaltaya glacier had lost significant volume and area in the period 1960 to 2003.

*Social and Economic Issues.* There is an important migration from rural areas to urban areas in Peru and Bolivia. The trend indicates that the rural population is decreasing while the urban population is growing fast. The main income for the rural population in

the altiplano region is agriculture developed in very small areas or parcels. Rural property was fragmented considerably and most agriculture is for subsistence. In addition, this population sector experiences the highest level of poverty in the countries. This situation does not allow farmers to mechanize and modernize irrigation systems.

## **Conclusions**

Beside efforts carried out by the Binational Lake Titicaca Authority in managing the system, there are several problems that need to be faced in order to ensure sustainable use in the future. The main problems in the Lake Titicaca basin were briefly described above. These problems are linked to the negative impacts of floods and drought on the economy of the region. Second, lack of adequate water regulation does not allow efficient use of the water resources. Another issue is contamination of rivers as a consequence of urban and mining activities. In addition, climate change impacts on the glaciers are affecting the availability of water resources. Finally, social and economic factors are important to take into account in the planning of the system.

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## **Questions**

1. Considering climate change impacts on the sources of water resources of the Lake Titicaca system, what changes would you recommend to revise the Binational Master Plan for the Lake Titicaca System?
2. What policies could be implemented to promote mechanization and new irrigation systems?

## 4. Europe

### 4.1. Rhine River

(with Pierre G. Gueudet, and Alexandre Truchot)

#### Introduction

The Rhine River originates on the Gotthard Massif in Switzerland and meanders over a distance of 1,320 km before discharging in the North Sea. It drains its water from Switzerland, Italy, Austria, Liechtenstein, Germany, France, Luxembourg, Belgium, and the Netherlands. Its flow, length and catchment area (200,000 km<sup>2</sup>) makes the Rhine the most important West-European river. Some 50 million people live and work in this basin. On a world scale however, the Rhine is actually a minor river.



**Map of the Rhine River basin**  
(Source: en.wikipedia.org)

Rhine water fulfills multiple societal functions. Worldwide, the Rhine figures among the inland waterways with the highest traffic density (Klein et al., 2003). It is navigable over a distance of 883 km stretching from Basle to its mouth in the

Netherlands. Rotterdam is the largest seaport and Duisburg is the largest inland port in the world. In 1997, more than 20 million people depended on Rhine water as a source of drinking water (Dieperink, 1997). The Rhine catchment area is one of the most important industrial areas in the world. For instance, about 20% of the world production of chemical substances is produced in this river basin (Dieperink, 1997). The Rhine is used as a sewer both for industrial and municipal wastewater. Rhine water is also used for irrigation (Netherlands) and hydropower production (France).

Historically, the development of the states of the Rhine basin has been unique but along the same lines. All basin states are free market democracies and have developed to a similar economic and technical level. There are differences in culture and relations but overall the major values have been comparable. The Rhine itself was never the object of conflict, although the river was of importance to ensure a safe border against aggressive neighboring states and as a major shipping route.

### **Pollution of the Rhine**

The development of civilization within the Rhine basin has altered the river both physically and chemically, changing its ecosystem. To establish the river as a navigable waterway the river was channelized and a system of locks and dams was constructed. Channelization included dredging and straightening its course by removing meanders and side channels. These structural changes reduced habitat diversity and affected the biological composition of the river. Migratory fish, such as salmon, were no longer present in the Rhine due to these structural changes. Channeling the river also had an effect on the distribution and residence time of contaminants in the river. The main functions of the Rhine explain the high level of pollution:

- Navigation: Europe's most densely navigated shipping route;
- Vast industrial complexes (Ruhr and Main areas), and the most important chemical plants in Europe;
- Energy generation: hydropower, and nuclear; and
- Recreational activities and drinking water.

### **Management of the Rhine basin**

Population growth and industrialization in the 1800s and in the first half of the 19th century resulted in the destruction of the Rhine ecosystem. Soon after World War II, experts foreseeing difficulties began to look for means to improve international protection of the Rhine. The International Commission for the Protection of the Rhine against Pollution (ICPR) was established in 1950. It is made up of Switzerland,



Germany, France, Luxembourg, the Netherlands, and the European Union (joined in 1976). The “Convention on the International Commission for the Protection of the Rhine against Pollution” signed in 1963 details the tasks of the ICPR:

- Analyze the state of the Rhine;
- Propose actions to protect the Rhine; and
- Prepare international agreements related to the Rhine

The ICPR has no executive or coercive power, but, when approved by the Environment Ministers of the member states, its recommendations have the force of international law.

During its first twenty years, though, the ICPR accomplished little, because the commission lacked the popular and political support necessary to act decisively. But at least countries had decided to take regular samples of the Rhine's water, which led to a system to monitor water quality along the river's entire length. During the mid-1970s, as the Rhine's sorry state made international news, the ICPR-member nations started to spend billions of dollars to improve the river's water quality by tightening and more strictly enforcing pollution controls on industries and cities. In 1976, the “Convention on the Protection of the Rhine against Chemical Pollution” and the “Convention on the Protection of the Rhine against Chloride Pollution” were signed. These agreements set maximum concentration levels for hazardous substances and salt. However, population and industrial growth offset virtually all the advances in water quality.

**Rhine Action Program (ended in 2000)** - In 1986, tons of chemicals and mercury were discharged in the Rhine during an accidental chemical spill. This disaster enabled the ICPR to set higher goals in its 1987 Rhine Action Program for Ecological Rehabilitation (RAP):

- Improve of the Rhine ecosystem;
- Guarantee that Rhine water may continue to be used as a source for drinking water supply;
- Enable sediment deposition on land without any problems; and
- Protect the North Sea.

The implementation of the RAP has been very successful. Industrial and municipal wastewater discharges have been reduced considerably and highly valued species like salmon and sea trout have returned to the Rhine basin. During the execution of the RAP in 1987-2000 the rehabilitation of the river Rhine made great progress. In particular, the water quality improved. A sharp reduction of the emissions of communities and industries was realized. This was the result of the joint efforts of the ICPR and the implementation of measures by the contracting Parties. As the salmon

have again ascended the Rhine, the first ecological success became evident. The implementation of the Action Plan on Floods had a successful start. In this field the Commission has an interesting task: informing the public and promoting risk awareness.

In 1998, the ICPR-member states signed a new “Convention on the Protection of the Rhine,” which replaced all the preceding conventions and agreements. The new Convention’s main target is to sustainably develop the Rhine ecosystem. It goes far beyond the old 1963 Convention which only focused on limited aspects of Rhine water pollution.

**Rhine 2020** – This recently adopted Program on the Sustainable Development of the Rhine (Rhine 2020) follows the successful RAP and sets goals for the next twenty years. The focal points of future Rhine protection policy are further improvement of the Rhine ecosystem, improvement of flood prevention and protection, and groundwater protection. Continued monitoring of the state of the Rhine and further improvement of water quality remain essential. The targets can be summarized as follow:

- **Public participation** since the management of the basin concerns the security of the public (e.g., in 1986, an accidental chemical spill affected the drinking water supply for a major part of the basin);
- **Flood prevention and flood protection** in the Rhine lowlands where risks of flood damage are to be reduced 25% by 2020 (relative to 1995 levels);
- **Improvement and restoration of habitats** typical of the Rhine and the ecological patency (up- and downstream migration) of the Rhine from Lake Constance to the North Sea as well as the patency of the tributaries figuring in the Program on Migratory Fish;
- **Groundwater protection and restoration** to achieve a balance between abstraction and recharge of groundwater; and
- **Water quality** improvement to the level that the production of drinking water is possible only using simple treatment procedures. The water constituents or their interaction must not have any adverse effect on plants, animals or microorganisms. Fish caught in the Rhine, mussels and crayfish, must be acceptable for human consumption. It must be possible to bathe in suitable places along the Rhine. It must be ensured that the disposal of dredged material does not have any adverse impact on the environment.

The targets of the ICPR have been gradually broadened from measures to improve water quality to integrated water management for the Rhine aiming at the restoration of the ecosystem as a whole, including quantitative aspects such as flood protection.

## Questions

1. What factors serve to facilitate cooperation among the riparian countries of the Rhine river basin?
2. Which characteristics make the Rhine basin states different from those in many other river basins?
3. The rehabilitation of the Rhine ecosystems and the return of healthy salmon runs to the river have come at a large economic price. Is such a compromise between human and ecological needs possible in developing country river basins?
4. The ICPR was created in the 1950s once the Rhine ecosystem was almost dead. Do we still need this kind of incentive before we really try to solve a basin's problems today?
5. What are the key factors that might explain the success of the management of the Rhine basin? Do you think these could be applied to other basins?
6. The effect of climate variations on the basin is a major issue (especially in recent summers with particularly high temperatures). Because of the heat, the European Union standards couldn't be applied in the Rhine and a temporary derogation was given to keep industry running (even if tons of fish were killed). We may face this situation more and more in the future. Should priority be given to industry or to the environment?

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## 4.2. Danube River

(with Charlotte C. Amato, Pierre G. Gueudet, and Kristina A. Schneider)

### Introduction

The Danube River has been used as an important means of transportation for commerce and military operations for nearly 2,000 years because it is the only major European river that flows west to east. Due to the Danube's physical and economic geography the control of the river has played a critical role in European history and continues to be a focal point of the regions vitality. The Danube is the second largest river basin in Europe, linking west to east. It has a length of 2 850 km, an area of 801,463 sq. km, and an average discharge to the Black Sea of 6 500 m<sup>3</sup>/s (European Rivers Network, 2006). The river starts in the Black Forest of Germany and empties out into the Black Sea. The climate is considered dry, receiving approximately 450 mm of rainfall per annum. Eighteen countries share the Danube River Basin, which makes it the world's most international river basin (ICPDR, 2006).

#### Countries of the Danube River Basin (DRB)

(Source: IPCDR, 2006; CIA World Factbook, 2006; WRI, 2006)

Country	Percent of Basin (%)	Percent of Basin in country (%)	Population in Basin (mln)	GDP per capita (2005)	Renewable Water Resources, (m <sup>3</sup> /person)
Romania	29.0	97.4	21.7	8,200	9,486
Hungary	11.6	100.0	10.1	16,300	10,541
Serbia & Montenegro	11.1	90.0	9.0	5,000	19,815
Austria	10.0	96.1	7.7	32,700	9,629
Germany	7.0	16.8	9.4	30,400	1,878
Bulgaria	5.9	43.0	3.5	9,600	2,734
Slovak Republic	5.9	96.0	5.2	16,100	9,265
Bosnia & Herzegovina	4.6	74.9	2.9	6,800	8,603
Croatia	4.4	62.5	3.1	11,600	22,654
Ukraine	3.8	5.4	2.7	7,200	2,868
Czech Republic	2.9	27.5	2.8	19,500	1,283
Slovenia	2.0	81.0	1.7	21,600	16,070
Moldova	1.6	35.6	1.1	1,800	2,726
Switzerland	0.2	4.3	< 0.1	32,300	7,464
Albania	< 0.1	< 0.1	< 0.1	4,900	13,178
Italy	< 0.1	0.2	< 0.1	29,200	3,330
Macedonia	< 0.1	0.2	< 0.1	7,800	2,633
Poland	< 0.1	0.1	< 0.1	13,300	1,598

The Danube is broken into three sections, the Upper Basin extends from the source of the Danube in Germany to Bratislava in Slovakia, the Middle Basin runs from Bratislava to the dams of the Iron Gate Gorge on the border between Serbia and Romania, and the lowlands, plateaus and mountains of Romania and Bulgaria form the Lower Basin (ICPDR, 2006). This division facilitates the organization of the Danube's 300 tributaries. Sixty of the Danube's tributaries are navigable making it a major transportation route for Europe. In addition, it is part of the Rhine-Main-Danube canal, which links the Black Sea with the North Sea, improving the connection between

Eastern and Western Europe through a system of linked waterways that impact trade on the continent.

The Danube, home to almost 80 million people, passes by numerous large cities, including four national capitals; Vienna, Bratislava, Budapest, and Belgrade. In this water rich basin, the issues facing the riparian nations are mainly focused on navigation, flood control and the environment. As with the Rhine basin, industrialization and increased population have affected the quality of the water in the Danube. The industries of the basin are largely responsible for most of the discharges of hazardous substances into the Danube basin. Agricultural practices contribute to the large nutrient load in the river and high levels of nitrate in drinking water derived from the river. Commercial transport is also a large source of oil pollution and lead contamination.



**Map of Danube River Basin**  
(Source: en.wikipedia.org)

Management of the Danube River brings to the forefront the economic and social differences between the riparian nations of the basin. While the upstream nations have long been established in the world market and can afford to tackle many environmental concerns, the downstream nations are struggling with economic transition after the collapse of communism. In addition, the Danube flows through the volatile Balkan region which has added to the complexity that normally accompanies negotiations of shared water resources. Centuries old rivalries and the need for a clean source of water often conflict when the countries of the Danube come together.

The Danube has been acknowledged as an international water body for many centuries. In the early Middle Ages (3<sup>rd</sup> Century) the Danube formed the northern boundary of the Roman Empire. The Goths, Huns, Slavs, and other groups crossed the Danube in order to invade the Roman Empire. The Danube served as a route for the crusaders into Byzantium and then the Holy Land. The Ottomans used the route to advance into western and central Europe. By the 19th century, the Danube served as a link between the industrial centers of Germany (Austrian Empire) and the agricultural areas of the Balkan Peninsula (Ottoman Empire). After the collapse of the Ottoman Empire, Austria and other European powers signed the Treaty of Paris in 1856 to prevent Russia from acquiring the strategic Danube delta.

After World War I, the European Commission administered the river. World War II brought more changes and the establishment of the Danube Commission in 1948 restored sovereignty of the basin riparians. The Commission oversees river navigation, river inspection, and flood control. The original members were Czechoslovakia, Hungary, Romania, Ukraine, the Soviet Union, and Yugoslavia, and the commission was dominated by the USSR since most member states were Soviet satellites. Austria later joined the commission and Germany was an observer. The Danube Commission was not established to deal with river management questions, therefore there are many bilateral agreements between the countries of the Danube. Recently, some multinational agreements have been reached to deal with problems that are facing the lower Danube and an Environmental Programme for the Danube has been created after the model of the Rhine.

### **Gabcikovo-Nagymaros Conflict**

Hungary and Czechoslovakia signed a treaty in 1977 that outlined a plan to build the Gabcikovo-Nagymaros (GN) project and use the Danube for hydroelectric power. The project was to include a series of dams, canals, and hydropower plants along the river, which bordered and flowed through the two countries. The two countries had discussed the hydroelectric potential of the Danube since the 1950s. Construction of the project started in 1978 and was slated to be completed in 1990. In September 1981 criticism from professional engineers and biologists temporarily halted construction in the Czechoslovak region. In October of the same year, Hungarian environmentalists exerted strong opposition to the project. Two years later, the Council of the Hungarian Academy of Sciences called for a halt to the construction of the GN project pending a complete investigation of the environmental impact of the project.

Protests grew in Hungary, but the government confirmed continuing construction. Construction proceeded faster in Czechoslovakia. Through 1987 and 1988 Hungary continued to pledge to speed up construction. In 1989, the Hungarian Parliament debated the GN project and placed strict environmental restrictions on the project. One year later the Hungarian government halted construction at Nagymaros, which was 30% complete. The countries met to discuss altering the original treaty, which Czechoslovakia rejected. In 1990-1992 the two countries met a number of times but no solution could be found. Hungary insisted the ecological effects of the project must be

investigated before construction could proceed. Czechoslovakia stated it could not abandon the project because of economic reasons. The Gabčíkovo Dam was completed in 1992 and Czechoslovakia began diverting Danube waters into a canal for hydroelectric power generation. The water level of the river dropped two to four meters, large fish kill was reported, and in many area adjacent groundwater wells dried up. Soon after, Hungary withdrew from the 1977 treaty. In January of 1993, Czechoslovakia dissolved and the Slovak Republic replaced it in the discussions concerning the project.



**Map of Proposed Gabčíkovo-Nagymaros Project**  
(Source: International Court of Justice, [www.icj-cij.org](http://www.icj-cij.org))

After numerous consultations between the Slovak Republic, Hungary, and the EU, it was decided in April of 1993 to submit the GN project case to the International Court of Justice (ICJ) for arbitration. Hungary claimed the project would:

- pollute drinking water supplies;
- alter water tables;
- ruin unique ecosystems;
- produce 3 to 5 percent of intended electricity; and
- displace the Hungarian minority in Slovakia.

Slovakia claimed the project would:

- produce half their energy needs;
- enable full year utilization of the river for shipping and flood control;
- save marshlands; and



- prevent lowering of water tables.

The Court reached its decision in September, 1997. The Court did not consider the issue of transboundary environmental harm but based its decision on traditional international treaty law. It found that Hungary's concerns of environmental harm were justified but not sufficient to establish "grave and imminent peril" which would allow for the cancellation of the treaty. Slovakia's right to respond to Hungary's actions was acknowledged but it was determined that Slovakia's act of diverting the river "differed sharply" from the cooperative nature of the 1977 treaty and thus constituted an "internationally wrongful act."

## **Environmental Programme of the Danube River**

The need to rehabilitate and preserve the environmental condition of the Danube River and its Delta prompted the creation of the Environmental Programme of the Danube River in 1992. The main environmental issues facing the basin were:

- High pollutant loads from point and non-point sources. Contaminants include copper, lead, agricultural runoff, and oil wastes. Many factories and towns lack waste treatment facilities;
- Changes in the natural flow of the river have reduced the flood peak, which has caused a decline in water circulation and an increase in soil erosion;
- Reduced purification capacity of the wetlands that occupy the Delta due to construction of dams, dikes, and channels in the Delta which is affecting the aquatic ecosystems of the Black Sea; and
- Disturbances of aquatic ecosystems, biodiversity, and habitat caused by human activities in the delta have impacted the food web of the ecosystem.

The Programme focuses mainly on the Delta area but recognizes that most environmental problems are created upstream. The short-term goal of the Programme was to establish a basis for the sustainable management of the environment in the basin, with long-term goals:

- To maintain and improve the availability and quality of water in the Danube River;
- To develop regional water management cooperation;
- To establish control of hazards from accidental spills; and
- To reduce negative impacts in the Danube River Basin on river ecosystems and the Black Sea.

The quality of the Danube River has steadily improved since the initiation of the Programme and it is likely to make a recovery similar to the Rhine's. Environmental

incidents still occur such as the in January 2000 spill of cyanide-tainted mining wastewater into tributaries in Romania and Hungary. This accident was met with outrage and provided an impetus for a summit in May 2001 that produced a new agreement on environmental protection and sustainable development in the Basin. A “Green Corridor for the Danube” sanctuary was established that covers 600,000 hectares in Moldova, Ukraine, Romania, and Bulgaria.

## Questions

1. What examples of cooperation among nations carved out by arbitrary political boundaries does the Danube River case provide?
2. Does modeling the Danube River Environmental Programme after the Rhine’s program make sense?
3. Is it possible to have balance between economic development and environmental protection?
4. “It is one thing to agree to goals and targets in timeframes; it is another thing to, for example, agree to shut down a polluting factory, or to create and enforce industrial wastewater pretreatment standards, or to develop rigorous monitoring and enforcement regimes.” Do you think the conventions are strong enough and clear enough to promote improvements in the environmental health?
5. Do you agree with the International Court of Justice Ruling? Do you think the result would have been different had both nations been EU members?

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### **4.3. *Lake Skadar-Shkoder***

**(Under development 2009-10)**

## 5. Africa

### 5.1. Nile River

(with Elaine B. Darby, Seyoum Ayele-Asamenaw, and Stephen H. Pitman)

#### Introduction

Currently, ten states (Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Eritrea, Kenya, Rwanda, Sudan, Tanzania and Uganda) have territories within the Nile Basin; all with different forms of government and vastly differing terrain. The area of the basin is about 3,112,000 km<sup>2</sup>. Egypt is recognized as the most powerful, economically and militarily of the ten states; however it is totally dependent on the water provided by the Nile River that is generated in the up-stream riparian states. Egypt has been the major power in the region for millennia, yet all of the water that sustains Egypt comes from upstream states. These upstream states are some of the poorest, youngest, and most contentious states on Earth.

#### Countries of the Nile River Basin (NRB)

(Source: NBI, 2006; CIA World Factbook, 2006; WRI, 2006)

Country	Percent of NRB (%)	Percent of country in NRB (%)	Population Total (mln)	GDP per capita (2005)	Renewable Water Resources, (m <sup>3</sup> /person)
Sudan	63.6	79.0	31.7	2,100	1,981
Ethiopia	11.7	32.4	65.8	900	1,666
Egypt	10.5	32.6	65.2	3,900	830
Uganda	7.4	98.0	22.8	1,800	2,663
Tanzania	2.7	8.9	34.4	700	2,472
Kenya	1.5	7.9	30.7	1,100	947
Eritrea	0.8	20.5	4.2	1,000	1,578
DR Congo	0.7	0.9	52.4	700	23,639
Rwanda	0.7	75.5	7.9	1,500	638
Burundi	0.4	47.6	6.9	700	538

The Nile Basin includes the sub-basins of two main tributaries, the White Nile and the Blue Nile. Flowing north from Lake Victoria, which sits astride the Equator, the White Nile carries water from Kenya, Tanzania, Burundi, Rwanda, Uganda, and the Democratic Republic of Congo into Sudan. Lake Victoria in the White Nile Basin has the second largest surface area of any freshwater lake in the world, second only to Lake Superior in North America. The Sobat River from Ethiopia joins the White Nile in southern Sudan. Further north at the Sudanese capital, Khartoum, the Blue Nile, also originating in Ethiopia, joins the White Nile and the two become the Nile proper. The Blue Nile Basin provides 75% of the annual total flow in the Nile River. Due to elevation drops, hydroelectric development potential is high in Tanzania, Uganda and Ethiopia. The Atbara, flowing from both Ethiopia and Eritrea, empties into the Nile in northern Sudan. More than a hundred kilometers before it crosses the Sudan-Egypt border, the Nile becomes Lake Nasser, a 6000 km<sup>2</sup> reservoir created by Egypt's Aswan High Dam. Below the dam, the Nile continues north, with virtually all of Egypt's development and population contained in its narrow valley. The Nile forms a large delta and empties into the Mediterranean Sea some 6,650 km from the source of the White

Nile. From Khartoum, Sudan to the Mediterranean Sea, no substantial rainfall or other perennial sources of water is added to the flow of the Nile.



**Map of the Nile Basin**  
(Source: [www.worldbank.org](http://www.worldbank.org))

Though development along the Nile in Egypt has taken place for centuries, it was only in the early twentieth century that the prospect of development in upstream areas

began to threaten significant effects on Egypt's water resources. While most of the countries in the basin were under European colonial rule<sup>4</sup>, there was minimal conflict over water. Egypt was the first to achieve independence from colonial rule, in 1922. The upstream states gained independence, starting with Sudan in 1956 and followed shortly thereafter by the other basin states except Eritrea<sup>5</sup>. At this point, unsure about the new neighboring governments and faced with likely upstream development, Egypt entered a brief period of hostility with Sudan which ended when a Sudanese military coup installed a government friendly to Egypt (Waterbury, 2002).

Egypt's inauguration of the Aswan High Dam in 1971 (constructed with significant assistance from the Soviet Union) represented a major achievement for the nation and has since allowed Egypt to more fully exploit the waters of the Nile, with current usage estimated at 99% of the available flow (Kiser, 2000). The ability of upstream states to affect Egypt's water resources is underscored by the fact that 86% of the water reaching the Aswan High Dam originates in Ethiopia (Kiser, 2000). Ethiopia has done little to develop its own water resources potential in the northern highlands where this flow originates. This is certainly due in some part to a long civil war followed by several shorter wars with neighboring Eritrea. In 1978 when the Ethiopian government announced plans to divert water from the Blue Nile for irrigation, Egypt threatened to bomb any facilities that would impede the Nile's flow (Beschoner, 1992). Doubtless these threats weighed heavily on Ethiopian policy makers as Egypt made peace with Israel that same year and became a recipient of a large continuing stream of aid from the United States. This aid, much of it in the form of military hardware, has widened the power gulf between Egypt and the other Nile Basin countries.

## **Treaties on the Nile**

**Anglo-Italian Protocol (1891)** – Signed by Great Britain and Italy in 1891, article III of this treaty refers to the Nile waters: "the Italian government engages not to construct on the Atbara River, in view of irrigation, any work which might sensibly modify its flow into the Nile." This river did not flow in territory claimed by Italy nor was Italy colonizing regions near the Atbara River. The reference to the Atbara River makes sense on the part of Britain as the Atbara flows through Sudan and Egypt (Zewdie, 1976).

**Treaty between Great Britain and Ethiopia (1902)** - The aim of this treaty was to establish the border between Ethiopia and Sudan. Article III related to the use of Nile waters. The English version, as reviewed by Britain and later by Sudan, read: "His Majesty the Emperor Menilik II, King of Kings of Ethiopia, engages himself towards the Government of His Britannic Majesty not to construct or allow to be constructed any

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<sup>4</sup> Ethiopia is the only state in the region that was never truly colonized, though Italy occupied the region of the country that is now independent Eritrea. Italy did make some agreements with other European powers purporting to represent all of Ethiopia, but the various governments of Ethiopia have never acknowledged the validity of any of these agreements.

<sup>5</sup> Eritrea gained independence from Ethiopia in 1993 after a nearly 40 years of armed resistance to Ethiopian rule.

work across the Blue Nile, Lake Tana, or the Sobat, which would arrest the flow of their waters except in agreement with His Britannic Majesty's Government and the Government of Sudan" (Okidi, 1994; Tilahun, 1979).

**Tripartite Treaty (1906)** – Britain, France, and Italy entered into a treaty in 1906, and Article 4 (a) of this treaty dealt with the use of the Blue Nile waters. It states: "To act together... to safeguard; ... the interests of Great Britain and Egypt in the Nile Basin, more especially as regards the regulation of the waters of that river and its tributaries (due consideration being paid to local interests) without prejudice to Italian interests". This treaty denied the sovereignty of Ethiopia over the water resource. It resulted in Ethiopia immediately notifying its rejection of the agreement by indicating that no country had the right to stop it using its own water resource (Zewdie, 1976).

**Agreement between Egypt and Sudan (1929)** - According to Whittington and Guariso (1983), this agreement included:

- An allocation of the Nile waters between Egypt (48 billion m<sup>3</sup>, 92.3%) and Sudan (4 billion m<sup>3</sup>, 7.7%), leaving 32 billion m<sup>3</sup> per year unallocated;
- The flow of the Nile during the dry season would be reserved for Egypt;
- Reserved the right to Egypt to monitor the Nile flow in the upstream countries;
- Egypt assumed the right to undertake Nile river related projects without the consent of upper riparian states; and
- Egypt assumed the right to veto any construction projects that would affect her interests adversely

Egypt, while independent at the time, was still under British influence in 1929 and neither Sudan nor the remaining riparians aside from Ethiopia were independent.

**Nile Waters Agreement between the Sudan and Egypt (1959)** - In the 1950s, Egypt was planning the Aswan High Dam project to collect the entire annual flow of the Nile waters (Collins, 1993). In November 1958 a military takeover in Sudan resulted in a regime open to negotiations with the Egyptian Government. Within a year, the two countries signed the 1959 Nile Waters Agreement based on the construction of the Aswan High Dam and on the assumption that the annual mean flow at Aswan is 84 billion m<sup>3</sup>, of which Egypt was allocated 55.5 billion m<sup>3</sup> (66%) and losses were estimated to be 10 billion m<sup>3</sup> (Le Moigne, 2002 citing Kirmani and Rangeley, 1994). The Agreement stipulated that Sudan's yearly allocation would be 18.5 billion m<sup>3</sup> (22%), but it did not reserve any water for the upstream riparian countries. However, the agreement does indicate that, in the event that another riparian made a claim to the water, the two countries would "study together these claims and adopt a unified view thereon. If such studies result in the possibility of allocating an amount of Nile water to one or the other of these territories, then the value of this amount shall be deducted in equal shares from the share of the two Republics."

**Tecconile to the Nile Basin Initiative (1992-2001)** - After the end of cold war the riparian nations of the Nile basin held a series of conventions with aid of Multilateral and Bilateral agencies. In December 1992, Technical Cooperation Committee for the Promotion of Development and Environmental Protection of the Nile Basin (Tecconile) or the Nile Initiative came into being with six member states: Egypt, Sudan, Rwanda, Uganda, Tanzania and Zaire. Ethiopia, Kenya, Eritrea, and Burundi were observers. Between 1997 and 2001, considerable progress was made in designing structures and institutions of a new regime in the basin. Tecconile was replaced by the Nile Basin Initiative (NBI) in 1999 (Waterbury, 2002), with Ethiopia joining as a full member.

## **Water in Egypt's National Security**

While Egypt's development history, with its significant economic and military advantages, may have served to prevent armed conflict over water for several decades, this stability continues at the expense of potential benefits in the upstream countries. Perhaps the most undesirable result of this has been inhibited development. Ethiopia and several other upstream states have significant undeveloped hydroelectric and/or irrigation potential.

While militarily and economically the strongest state in the basin, Egypt is the most vulnerable with respect to water. Egypt's policies have effectively inhibited development of water resources in other basin countries by threatening their national security. Colonial governance in the early Twentieth Century and the influence of superpowers during and since the Cold War has added to the power imbalance that favors Egypt and to the inequitable development of basin resources.

Egypt's unilateral development of the Aswan High Dam enabled more regulated and efficient usage of the waters of the Nile. This allowed Egypt to increase its use of the water that flows across the Sudan-Egypt border – in fact nearly all of it. As a result Egypt has become a country with water resources that are near full utilization and vulnerable. Egypt's greatest concern with water is that upstream states will reduce or manipulate the flow in a way that conflicts with its usage.

Considering the future of the Nile Basin, it is not clear how much the emergence of Eritrea as an independent state will affect water policies. A much more worrisome change is the possible two-state solution to Sudan's long-running civil war. In the unlikely event Sudan were divided into a predominately Arab northern state, almost certain to maintain close ties to Egypt, and a predominately Christian southern state, more likely to oppose Egypt and perhaps side with Ethiopia, the entire political landscape of the Nile Basin would experience a major change. It is unlikely that the tensions that have fueled Sudan's civil war would dissipate entirely with a two-state solution, and any remaining disputes would now be interstate disputes, representing non-water tensions.



## Nile Basin Initiative

With beginnings as early as 1993 and culminating with the formation of the Nile Basin Initiative (NBI) in 1999, representatives of the riparian states in the Nile Basin have begun negotiations to develop a regional partnership for the cooperative development of the water resources in the Nile Basin. The goal of the NBI is “To achieve sustainable socioeconomic development through the equitable utilization of, and benefit from the common Nile Basin water resources” (NBI, 2006). The future for such cooperation and development in the Nile Basin will depend on recognizing “equitable and reasonable” allocations along with acknowledgement of the historical precedence of water usage in Egypt and Sudan.

In 1992, the Council of Ministers (Nile-COM) from six riparian states began discussions of forming a framework for the co-operation and development of the Nile Basin. In 1995 this group asked the World Bank to play a lead role in coordination of external financial and engineering agencies. In 1997, the request was reiterated and the World Bank agreed with a partnership with the United Nations Development Programme. In 1998, two action plans were developed, the Shared Vision Plan and the Action on the Ground plan. In 1999, the project was officially named the Nile Basin Initiative. The Shared Vision Plan project portfolio was approved in August, 2000. Of the ten riparian states in the basin, only Eritrea did not participate. By June, 2001, donors pledged over 80% of the SVP preparation budgets. In 2003, 2004 and 2005 SVP Grant agreements were signed providing \$59.3 Million in development aid to various projects, including:

- Applied Training Project – building skills within each NBI country for integrated water resources management;
- Nile Transboundary Environmental Action Project – working to protect and manage the environment and ecosystem;
- Nile Basin Regional Power Trade Project – developing regional power markets;
- Water for Agriculture Project – increasing the availability and efficiency of water use in agriculture;
- Water Resources Planning and Management Project – developing skills in each country to manage their water resources;
- Confidence-Building and Stakeholder Involvement Project – increasing involvement of broad range of stakeholders; and
- Socio-economic Development and Benefit Sharing Project – building a network of professions across the board to explore alternatives for Nile Development

The Nile Basin Initiative is funded by contributions from NBI countries and support from outside donors. The Nile Basin Trust Fund was established in 2003 and

administered by the World Bank. Funding for specific water projects will have to be funded by world wide funding sources.

## Questions

1. How did Egypt come to dominate the region?
2. How did colonialism influence the development of water resources in the Nile basin?
3. How effective are the water projects that have been undertaken?
4. How could cooperation improve the management of the Nile's waters?
5. What factors impinge on the reaching agreement among the Nile River Riparian nations?
6. In 1979, Egypt announced its intentions to construct a fresh water canal passing through the Suez Canal and out into the northern Sinai Peninsula. It was to be called the "peace canal". Although Israel was never mentioned, there were strong suppositions that Israel was the Ultimate destination of the canal. (The Nile Basin, Waterbury 2002, P-70). Assuming the peace canal project materializes, what would have been the consequence of extra basin transfer of water from the Nile Basin?
7. What should be the role of multilateral donor agencies to minimize the incidence of conflict in the Nile Basin?
8. Egypt is the second financial aid recipient (next to Israel) from US. Does this creates power imbalance in the region?
9. After signing the historic Camp David peace accords with Israel, in 1979 Pres. Sadat is reported to have said the only reason his country might go to war again with any of its neighbors would be a dispute over water (Elhance, 1999). With the current condition of the Nile basin states, what is the plausibility of the that remark?
10. Beaumont (2002) proposes a water allocation scheme to fit the "equitable and reasonable" call in the 1997 UN Convention on a 50% generation/50% historical split. Is this is applicable to the Nile River Basin? (Reference pages 486 – 488 and pages 491 – 494). In contrast to the Egyptian's Century Storage Scheme of 1946 (reference pages 70 -74, Elhance) the Nile Basin Initiative did not start with specific water projects, but rather education, development of skilled personnel and inclusiveness of all stakeholders. Will this work? What will be the primary factors in achieving development in a reasonable time frame?

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## 5.2. Niger River

(with Stephen H. Pitman)

### Introduction

The Niger River, Africa's third longest at 4,100 km, flows through ten African countries (Guinea, Côte d'Ivoire, Mali, Burkina Faso, Algeria, Benin, Niger, Chad, Cameroon, and Nigeria), some of them among the world's least developed and poorest countries. Relied upon by a population estimated at 84 million and growing at 3% per year, the waters of the Niger Basin are a transboundary natural resource of increasing importance. The Niger basin covers about 2.27 million km<sup>2</sup> (FAO,1997).

#### Countries of the Niger River Basin

(Source: FAO, 1997; CIA World Factbook, 2006)

Country	Percent of Basin (%)	Percent of country in basin (%)	Population Total (mln)	GDP per capita (\$, 2005)	Irrigated Land (ha)	Renewable Water Resources, (m <sup>3</sup> /person)
Nigeria	25.7	63.2	131.8	1,400	282,000	2,384
Mali	25.5	46.7	11.7	1,200	236,000	8,320
Niger	24.8	44.5	12.5	900	73,000	2,891
Algeria*	8.5	8.1	32.9	7,200	569,000	460
Guinea	4.3	39.4	9.6	2,000	95,000	26,964
Cameroon	3.9	18.8	17.3	2,400	26,000	18,378
Burkina Faso	3.4	28.0	13.9	1,300	25,000	1,024
Benin	2.0	41.2	7.8	1,100	12,000	3,741
Côte d'Ivoire	1.0	7.4	17.6	1,600	73,000	4,853
Chad*	0.9	1.6	9.9	1,500	30,000	5,125
<b>Total</b>	<b>100.0</b>		265.0		1,421,000	

\*Algeria and Chad contribute almost no water resources to the basin.

The Niger is commonly divided into the Upper, "Internal Delta," Middle and Lower sections. Beginning at about 800m elevation in the wet forested highlands of Guinea, only 250 km from the Atlantic coast, the Upper Niger flows into Mali and onto a large plain where it spreads out into several channels in the area called the Internal Delta. The wet season in the highlands creates an annual flood in the Internal Delta that is very important, both ecologically and economically. The Internal Delta has a number of lakes, large and small, mostly natural, but some man-made, that fill during the annual flood and drain during the dry season. Since it sits on the edge of the Sahara Desert and has fairly permeable soils, the Internal Delta loses a significant amount of water to infiltration and evaporation. These "losses" are significant enough that, even though several large tributaries flowing from Côte d'Ivoire and Burkina Faso join the Niger in Mali, the Niger's flow out of Mali is less than it is entering the country.



**Map of Niger River basin**  
 (Source: [www.wikipedia.org](http://www.wikipedia.org))

Leaving the Internal Delta in Mali, the Middle Niger flows through very dry areas of Mali and Niger, along the border of Niger and Benin and eventually into Nigeria where it becomes the Lower Niger. Major tributaries enter in Nigeria, some from within the country and some bringing water from Cameroon and Chad. The flow of the river increases significantly in Nigeria, such that Nigeria is not extremely dependant on the river's flow out of Niger (the country).

The flow of the Niger and its tributaries experience large seasonal fluctuations but also respond markedly to multi-year periods of wet or dry weather common to West Africa (the 1980's were a particularly dry decade).

### **Economic and Social Factors**

Many of the basin's inhabitants subsist with diverse means of support, so they are not completely reliant on steady flow in the Niger. Nonetheless, this subsistence lifestyle is characterized by very low average income and per capita GDP. The vagaries of water supply in the basin are among factors that limit an increase in standard of living and development.

Governments of basin countries are focused on making water resources more reliable and accessible for the population and to enable further development. The basin has significant untapped hydroelectric and irrigation potential, and a large number of projects have been envisaged to harness this potential. A much smaller number have been constructed, largely because the countries in the basin lack resources necessary for large development projects.

## **Politics, Cooperation and Conflict**

On balance, the basin experiences significantly more cooperation than conflict, but cooperation with minimal financial resources goes only so far towards real development. The Niger Basin Authority (NBA) includes nine of the ten countries in the basin, excluding Algeria, which is neither a significant contributor nor a major user of basin water.

The aim of the NBA is to promote cooperation among the member countries and to ensure integrated development in all fields through development of its resources, notably in the fields of energy, water resources, agriculture, forestry exploitation, transport and communications, industry.

The Objectives of the NBA are to:

- to harmonize and coordinate national policies for the development of the resources in the basin;
- executing an "Integrated Development Plan of the Basin;" and
- to design, realize, exploit and maintain common works and projects.

No member nations have ceded any sovereignty over their resources to the Authority, so its ability to execute plans and projects can be hampered by politics and political instability. Nonetheless, the existence of an organization that includes (almost) all basin players is still a very positive step towards cooperative management of water resources.

In addition to poverty and lack of resources for development, the basin also faces some significant environmental challenges including desertification, deforestation and pollution of the rivers by agriculture and industry. These factors add to the complexity of development in the region.

## **Questions**

1. Should the Niger Basin Authority focus on funding and executing development projects or developing a basin-wide plan for development and management?
2. How much autonomy and authority should the Nile Basin Authority have?
3. How can the Niger Basin Authority be most effective? How can the international community help?
4. Are there any lessons – either positive or negative – that other basins can learn from the Niger Basin?

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### 5.3. Senegal River

(with Andrew F. Judd, and Pamela J. Kearfott)

#### Introduction

With a length of 1,800 km, the Senegal River is West Africa's second longest river and drains an area of 483,181 sq. km (FAO, 1997). The Senegal River Basin is spread over four countries: Guinea, Mali, Mauritania, and Senegal. The Senegal River and its main tributaries, the Bafing, Bakoye, and Faleme Rivers, have their source in the Fouta Djallon mountains in Guinea. The basin can be divided into three distinct parts based on their physical characteristics: the upper basin (the mountainous region), the valley, and the delta (near the mouth of the river to the Atlantic Ocean). While all three regions are important and unique for ecological reasons, the delta area is of particular importance as a source of biological diversity and wetlands. The climate in the basin is typical of sub-Saharan desert. The region has a distinct hot, rainy season (often monsoon-like and with sometimes extensive flooding) that extends from June/July to October/November. The remainder of the year is dry and hot. The Senegal is similar to the Nile in that a major portion of its flow is supplied by precipitation falling in the upper part of its basin which then flows through a much more arid region in the middle and lower portions of its basin before ultimately flowing into the ocean. This is significant because it means that the water in the Senegal River becomes increasingly essential to the people and environment in the middle and lower parts of the basin because of the limited amount of water received through precipitation in those areas.



Map of Senegal River basin

(Source: [www.unesco.org](http://www.unesco.org))

The Senegal River Basin has a population of 3.5 million, 85% of whom live near the river. It has been said that irrigation is the “motor of development” in the basin, especially in the valley and delta regions. On average 100,000 hectares of land are cultivated in the basin annually (60,000 during the rainy season and 20,000 during the dry season). The raising of livestock and migration of herds is very important, especially for some ethnic groups. Fishing is the largest economic activity in the basin after agriculture, especially in the delta and among the populations directly along the river. Productivity of the fishing sector has declined over the last 15 years. Some attribute the drop in fish catches to river development (changes in flow, decreased salinity, eutrophication, proliferation of water plants). Navigation is currently very limited along the river. The basin states are eager to expand this area, especially by creating an access route to the Atlantic Ocean for Mali. The industrial sector in the basin states is only slightly developed.

### **Countries of the Senegal River Basin**

(Source: FAO, 1997; CIA World Factbook, 2006)

Country	Percent of Basin (%)	Percent of country in basin (%)	Population Total (mln)	GDP per capita (\$, 2005)	Irrigated Land (ha)	Renewable Water Resources, (m <sup>3</sup> /person)
Mauritania	50.2	23.7	3.2	2,200	490	4,029
Mali	28.8	11.2	11.7	1,200	2,360	8,320
Senegal	14.9	36.5	12.0	1,800	1200	3,977
Guinea	6.1	12.0	9.6	2,000	95,000	26,964

Flow in the Senegal River depends primarily on upstream rainfall (the upper basin in Guinea receives about 2,000 mm/yr). Rainfall amounts are usually much lower in the valley and delta (rarely exceeding 500 mm/yr). The biggest drought in recent history occurred in the early 1970s. As a result of the annual rainy season, the flood stage of the river occurs between July and October and the low period occurs between November and June.

There are currently two major dams in the basin, the Manantali Dam (11.3 billion m<sup>3</sup>) in Mali and the Diama Dam (300 million m<sup>3</sup>, Mamadou, 2003) just upstream of the mouth of the river on the border between Senegal and Mauritania. The Manantali Dam functions as the region’s largest hydroelectric power source, as well as to attenuate extreme floods and store water from the rainy season to augment flows during the dry season. The initial expectation of hydroelectric power penetration was 800 GWh/yr. The Diama Dam was built in order to help block seawater intrusion at the mouth of the river and to raise the level of the upstream river to help with irrigation and allow for dry-season farming.

### **History of Water Management in Basin**

The basin countries have over 40 years of experience in shared water management of the Senegal basin. Guinea, Mali, Mauritania, and Senegal signed the Bamako Convention in 1963 for the Development of the Senegal River Basin. This convention declared the Senegal river to be an “international river” and created an

interstate committee to oversee its development. The four basin states signed the Labé Convention in 1968, which created the OERS (Organization of Boundary States of the Senegal River). This convention replaced the Interstate Committee and broadened the field of subregional cooperation.

In response to an extended drought in the 1970's the Organization for the Development of the Senegal River (OMVS, Organisation pour la mise en valeur du fleuve Sénégal) was created in 1972 and includes Mali, Mauritania, and Senegal (Guinea didn't join because of political tensions.). The purpose of the OMVS was to create greater food production and eliminate food and water scarcity through the development of the Senegal River. In conjunction with the establishment of the OMVS, the member countries also signed a treaty which designates that the river water must be allocated among the various sectors of use (NOT allocated to riparian states based on volumes of water or flows, but rather on uses as a function of possibilities.). The major projects carried out by the OMVS were the construction of the Diama Dam (1986) and the Manantali Dam (1990). The Diama Dam Management Company in Mauritania and the Manantali Energy Management Company in Mali were created in 1997 to oversee management, operation, and maintenance of the dams.

In 1997, OMVS started to collaborate with the World Bank to develop a GEF project for the Senegal River basin. A technical program has been established that focuses on creating a viable, integrated resource management strategy that focuses on water, biodiversity and environment. The program focuses on establishing a series of activities at national levels that together form a cohesive strategy for the river basin. The Environment Impact Mitigation and Monitoring Program was created in 1998 and receives funding from the World Bank and the African Development Bank. An Environmental Observatory was established in 2000 to monitor environmental change in the basin. OMVS created Senegal Water Charter Current in 2002, a navigable channel from the mouth of the river to 900km upstream to enable ships to access Mali, southern Mauritania, and northeastern Senegal

## **Impact of Dams**

The Diama Dam is located near the mouth of the Senegal River. Its main purpose is to store water for irrigation and stop the dry-season intrusion of sea water up the river channel, which during dry years increased soil salinity to levels that prevented agriculture in much of the delta area. The Manantali Dam is located in Mali approximately 1200 km upstream of the Diama Dam on the Bafing River, the main tributary to the Senegal. The purpose of the Manantali Dam is to provide flow regulation for downstream irrigation supply and generate hydropower. The ultimate objective of these dams was water supply, hydropower, and flow control to increase the production, income, and quality of life of the people in the Senegal Basin. While some of the aspects of that objective have been realized, many have not been and as a result of the dams, there have been a few unforeseen consequences that have required the OMVS to reconsider their original Senegal River development plan.

In the Senegal River basin, a significant portion of the population employs traditional agricultural, fishing, and herding practices for their livelihood. These methods of subsistence are directly dependent on the river system to provide certain environmental conditions for their implementation. A change to the flow regime of the river can cause a drastic change to the natural environments that the river supports. This has a greater effect on the people using a portion of the river's ecosystem for their livelihood than people that just use the river as a water supply resource.

With the construction of the Diama and Manantali Dams, the OMVS intended to increase agricultural production and shift the remaining segments of the population using traditional floodplain recession agriculture to irrigated agriculture. This has been more difficult to carry out than the pre-construction planning suggested. Although more productive, irrigation based agriculture is a much more labor and capital intensive approach than recession agriculture and much of the population does not possess the means to put the potential farmland into production. Fishing, which in the river valley historically occurred in flooded areas used by fish for feeding and habitat, was severely impacted by the dam operation, which reduced the area flooded during the wet season which in turn reduced the fish population. Fishermen at the downstream, estuarine portion of the river were similarly affected at the Diama Dam, as the fluctuating salinity used by fish species for breeding and other life cycle functions, was inhibited by the dam's flow regulation. Pastoralism, a nomadic practice of domestic animal grazing was also affected as the decrease in floodplain area reduced the amount of natural vegetation available for grazing.

Other problematic issues created by the dam project were endemic increases in invasive species and water-borne disease outbreaks. Large areas of riverine forest and marshes were also devastated. Negative impacts were not just isolated to one portion of the basin, but because of the close ties and interrelation of the basin's societal and natural systems to the river environment, the effects were extensive. This is not to suggest that the dams only had harmful results, the increase in freshwater availability and hydropower production are a necessary component of the region's development, however due to the unanticipated and greater severity of negative environmental impacts; a change was required.

## **Mitigation and Management**

Under the OMVS, river structures, such as the Diama Dam and the Manantali Dam are owned cooperatively by the three member nations with all three investing construction and operation costs (along with the usual foreign involvement) and sharing benefits. Water allocation in the basin is not divided between the riparian countries based on a specific water withdrawal for each nation, but is distributed amongst several distinct sectors which are defined by the OMVS as: agriculture, inland fishing, livestock raising, fish farming, tree farming, fauna and flora, hydroelectric energy production, urban and rural drinking water supply, health, industry, navigation, and the environment. Previously, the environmental factors were not a significant concern, but following the troubles caused by the Diama and Manantali Dams and some influence by several

international studies and organizations, the OMVS has developed a new environmental management strategy.

One objective of the environmental management strategy is the continuation and improvement of an artificial seasonal flood that has been released from the Mantanali Dam since 1988. Initially this artificial flood was part of a temporary operational plan that allowed time for flood-recession farming communities to transition to irrigation based agriculture. However, after the damages incurred during the first two years of dam operation, when the reservoir was filling up and flood waters were not released, it was realized that the transition to an irrigation-based agriculture system was more difficult and not as economically beneficial as originally thought. Thus, the perception of the value of the artificial flood increased. Another significant factor in the situation is how the perception of the value of traditional livelihood practices and the floodplain ecosystems of the OMVS and other involved organizations was shifted over the last several years. This shift in management philosophy, like most of the issues surrounding the Senegal River Dams, was a fairly complicated process, but was mostly accomplished through the increased involvement of local stakeholders and a more comprehensive analysis of the actual benefits produced by the dams and the environmental impacts caused the dams.

## **Lessons Learned**

With the Senegal River flow regulated by the OMVS divided between various use sectors rather than on a national basis, the process of revising the management strategy of the basin has been a more efficient process than it would have been if the riparians had to negotiate and compromise flow allocation between each country. Some of the lessons learned from the development and operation of the Diama and Manantali Dams are:

- All potential factors and impacts involved in altering the established conditions of a watershed system should be considered and analyzed in order to achieve an accurate assessment of a water resource development project's benefits and costs;
- If the objective of a project is to benefit a certain segment of people and it is going to impact the way in which these people live their lives, it is important to include them throughout the project development process or the benefits of the project may not be realized (Adams, 2000); and
- Because of the complex nature and broad array of impacts of large scale water resources projects, it is important for these projects, as well as the management organizations and regulations guiding the projects, to have a certain degree of flexibility to adapt to achieve a more optimal management strategy.

## Questions

1. What are the pros and cons of allocating water on the basis of use (benefits) rather than a volume basis (fixed or percentage)? What factors should be included when prioritizing different uses?
2. The OMVS is comprised of only 3 of the 4 basin states. What impact does Guinea's absence have on the basin's development?
3. Should action be taken to mitigate the negative effects of the dams? How can the positive and negative impacts be balanced?
4. Both the Manantali and Diama Dams are owned and controlled by all three basin states. What benefits does this have? What problems could it pose?
5. What measures could be taken to help ensure successful projects in this basin in the future?
6. What role can international aid and development organizations play in helping developing countries with regard to their shared water resources?
7. With the implementation of efforts to re-operate projects to rehabilitate or mitigate damages from past mistakes, regulation and management agencies tend to support operation strategies that have very specific definitions of water allocation volumes and water quality levels. However, river systems tend to react more favorably to more flexible operation strategies. How can these opposing management strategies be combined to produce more effective water resource re-operation plans?

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#### **5.4. *Volta River***

**(Under development 2009-10)**



## 6. Near East/Asia

### 6.1. Jordan River

(with Stephen H. Pittman, Reem Khalil, Gil Strassberg, and David R. Kracman)

#### Introduction

The Jordan River is not among the longest (228 km) or largest (18,300 sq. km) in the world originating at Mount Hermon and terminating at the Dead Sea, and a predevelopment annual discharge of 1.2 billion m<sup>3</sup> (Haddadin, 2003). Despite its modest size, the Jordan River looms large in terms of importance to the Middle East region. The Jordan is shared by four nations, Israel, Jordan, Syria and Lebanon, along with Palestinians living within the basin area. Over the years, water issues pertaining to the Jordan have sparked military conflicts and exacerbated existing political tensions.



**Map of the Jordan River basin.**

(Source: [www.glowa-jordan-river.de](http://www.glowa-jordan-river.de))

To understand the hydropolitics of the Jordan River basin requires at least a basic understanding of the history of Palestine and Israel. While the history of the region stretches back thousands of years, the period following the fall of the Ottoman

Empire is particularly important for understanding contemporary issues. After World War I, the former empire was largely divided between France and Great Britain, with the British obtaining the Mandates of Mesopotamia and Palestine, the latter of which included much of the land that now comprises present day Israel. Border disagreements between the British and the French during the demarcation process set the stage for decades of dispute over international borders in the Middle East.

### Countries of the Jordan River Basin

(Source: FAO, 1997; CIA World Factbook, 2006)

Country	Percent of Basin (%)***	Percent of country in basin (%)***	Population Total (mln)	GDP per capita (\$, 2005)	Irrigated Land (ha)	Renewable Water Resources, (m <sup>3</sup> /person)
Israel			6.3	24,600	194,000	265
Jordan			5.9	4,700	75,000	169
Syria			18.8	3,900	1,333,000	1,791
Lebanon			3.9	6,200	104,000	1,219
Palestine*			3.9	920*	15,000	**115

\* Population weighted average of Gaza and West Bank

\*\* Greencross, 2006

\*\*\* Difficult to determine due to ongoing border disputes

In the period leading up to World War II, the idea of establishing a sovereign state in Palestine for Jewish settlers became more prominent. After the end of World War II, the United Nations became the vehicle for the creation of Israel when Great Britain, in 1947, turned over the fate of Palestine to the UN. The UN General Assembly decided, in the same year, to partition the former Mandate into two nations -- Palestine and Israel. While the Jewish representatives approved of the plan, the Arab states in the region did not, resulting in the 1948 Arab-Israeli War. As a result of the conflict, the Rhodes Armistice Demarcation Line was created, which established a new border for Israel. In addition, regions which the UN had intended would be part of a new Palestinian state were instead subsumed by neighboring Arab countries, including Jordan and Egypt.

The armistice line remained the unofficial border until 1967, with the eruption of "The Six Day War." As a result of the hostilities, Israel acquired the West Bank from Jordan, the Gaza Strip and Sinai from Egypt, and the Golan Heights from Syria. While Israel later relinquished the Sinai to Egypt through the 1979 Israeli-Egyptian peace agreement, the borders created as a result of the 1967 War largely remain intact today.

### Hydrology of the Jordan River Basin

The Jordan River Basin makes up the northern section of the Dead Sea drainage system, in which all ground and surface water flows into the landlocked sea. Flows in the Jordan originate from a series of tributaries, mainly in the upper portion of the basin, and several wadis (ephemeral streams). The main tributary is the Yarmuk, which begins in Syria and discharges about 300 million m<sup>3</sup> per year into the Jordan River below Lake Tiberias. Other tributaries in the upper basin, above Lake Tiberias, include

the Dan, Bayas, Bareightit and Hasbani Rivers, all of which begin as springs near the slopes of Mount Hermon. Water in the main stem of the Jordan River passes through Lake Tiberias (also known as the Sea of Galilee or Lake Kinneret), which can hold a maximum of about 4 billion m<sup>3</sup>. Water not evaporated in Lake Tiberias descends to an elevation of around 398 meters below sea level before entering the Dead Sea, which is largely devoid of life due to its extreme salinity.

Groundwater is also an important factor in the basin, particularly for the Mountain Aquifer in the West Bank area. The underground water is believed to consist of three aquifers, known respectively as the western, northeastern and eastern aquifers. While most of the aquifer lies within the West Bank area, the groundwater flows of the western and northeastern aquifers flow out of the region into Israel proper. It is estimated that Israel withdrawals about 450 million m<sup>3</sup> from the aquifers, while Palestinians are limited to 105 million m<sup>3</sup> annually. With new Israeli settlements extracting an additional 40 to 50 million m<sup>3</sup> from the West Bank, there is a strong sentiment among Palestinians that their resources are being stolen by Israel.

Hydraulic structures of note in the basin include the National Water Carrier, a 200 km long water conveyance system completed around 1964, which transports over 500 million m<sup>3</sup> of water each year from Lake Tiberias to southern agricultural areas within Israel. The East Ghor Canal is a 70 km long canal in Jordan that conveys around 180 million m<sup>3</sup> annually from the Yarmuk River, and other sources, to farmland on the eastern slope of the river valley. In addition, Lake Tiberias, which was once a natural lake, is now regulated by a control structure to allow for storage during high runoff periods.

## **Hydropolitics of the Jordan River**

Water is often a part of political discussions in the Middle East, mainly due to the fact that it is a scarce resource. More than 50 percent of the territory covered by Israel, Jordan and Syria receives less than 250 mm of precipitation per year. Per capita water availability in 1990 for Israel and Jordan was 470 and 260 m<sup>3</sup>/person/year respectively - both of which are well below the 1,000 m<sup>3</sup>/person/year threshold for water scarcity adopted by many water experts. Population growth throughout the region continues to place increasing pressure on already stretched water reserves.

In the 1950's, Israel, Syria and Jordan all crafted plans for use of the waters in the Jordan Basin. The United States, hoping to score a victory for cooperation in the region, also crafted a plan, known as the Johnston Plan, in cooperation with Israel, Jordan and Syria. After securing tentative agreement from technical representatives of all sides, the plan fell apart when it was rejected by political leaders. Reportedly, Israeli leaders were unwilling to sign away any rights to the upper Jordan and Sea of Galilee and Arab leaders were unwilling to agree to anything that could be interpreted as recognition of the State of Israel (Klare, 2001). Another view is that the U.S. refusal in 1956 to fund construction of the Aswan High Dam in Egypt caused Egypt's President Nasser to abandon the Johnston Plan, thus ruling out Arab approval (Cooley, 1984).

Unilateral development plans continued, with Israel constructing the National Water Carrier (completed in 1964), a system of canals, pump stations and tunnels, to transport water from the Sea of Galilee to coastal areas and southern Israel. This transfer is significant from a technical standpoint because it moves water out of the basin, going against a commonly stated international principle that water should not be diverted outside an international basin unless all states in the basin have enough water. The National Water Carrier was steadfastly opposed by the Arab states, and in 1953 Syrian artillery fired on construction sites, forcing relocation of some facilities (Cooley, 1984). Separately, Jordan proceeded, aided by an agreement with Syria and funding from the United States, with a plan to divert irrigation water from the Yarmuk River upstream from Israel. The East Ghor Canal (completed in 1963) was built to transport the water south to agricultural areas.

The Arab states and Israel were each unhappy with the other's diversion plans and tensions rose throughout the early 1960's. At an Arab summit in 1960, unhappiness with Israel's National Water Carrier led to an "All-Arab" plan to divert water from tributaries of the upper Jordan, effectively routing it around the intake of the National Water Carrier. Learning of the plan, Israeli leaders issued stern warnings that Israel would treat any diversion as an attack on its vital interests and a threat to peace. When construction of the diversion works began four years later, Israel made good on its threat, repeatedly bombing and shelling the construction sites. Confrontation between Israel and the Arab states, primarily Syria and Egypt, grew over this and other issues, culminating in the Six Day War of June 1967.

In the Six Day War, Israel occupied the Golan Heights and the West Bank, accomplishing what no other nation has done by force in recent times: changing its status from lower to upper riparian. Occupation of the Golan Heights gave Israel control over the headwaters of the Banyas as well as complete control over the shores of the Sea of Galilee and strategic terrain essential to protect key low-lying water resources in Israel. By denying this terrain to Syria, Israel ensured the security of its most critical and vulnerable water resources.

Occupation of the West Bank gave Israel increased access to the Jordan River, but more important to Israel's water security, it gave Israel control over the Mountain Aquifer. This aquifer underlies most of the western half of the West Bank and flows toward Israel. Not only does occupation of the West Bank give Israel increased access to the Mountain Aquifer, but it allows Israel to control all withdrawals from the aquifer and limit activities that might pollute the groundwater before it flows into Israel.

Since 1967, discussion of the occupied territories and demands for their return to Syria and the Palestinian people has overshadowed the debate over water resources. To some extent the occupation has made the water situation more stable, though not more equitable in the Jordan Basin. Since Israel is both the most powerful state and an upper riparian (with the exception of the Hasbani and Yarmuk rivers), there is less chance of conflict over water. Nonetheless, all the countries concerned still have

significant and growing water needs in the face of a finite or perhaps diminishing supply. Water resources policy in the region remains interwoven with national security and national identity.

Cooley (1984) writes that the water issue was central to the formation and the policies of the Palestine Liberation Organization (PLO) and Yasir Arafat's group, Fatah. He concludes that it was no accident that the first attack carried out by Fatah against Israel was an attempt to sabotage the Israeli National Water Carrier in December 1964 (Cooley, 1984). Tension between Palestinian groups and Israel continued into the 1980's and spread to include larger portions of the Palestinian population when the first *intifadeh* began in 1987. Concern over unfair water policies in the occupied territories and the Israeli "usurpation" of water is cited as a one of many factors fueling the uprising (Klare, 2001).

The 1990's saw renewed peace efforts and some limited results. Israel and the Palestinian Authority recognized each other in 1993. Jordan and Israel signed a peace treaty in 1994 that included a section on water which allocated the flow of the Yarmuk between the two countries. In 1995 the Palestinian Authority and Israel signed an Interim Agreement that acknowledged certain Palestinian rights to water and allowed the Palestinian Authority a role in water allocations in the West Bank. Since 1995, the general situation in the occupied territories has worsened and there has been little additional progress on the diplomatic front.

### **The importance of the river to its riparian states**

**Jordan** - The most water scarce country among all the riparian countries in the region. It consumes only about 36% of the water that it shares with Syria (the Yarmuk River). It shares the Disi aquifer with Saudi Arabia, but there are many problems on the allocation of this fossil aquifer between the two countries. Although the upper part of the Yarmuk River is of high quality, the water that supplies Jordan's territory is polluted and has a high salinity and a large sediment load. In water allocation negotiations, Jordan has claimed the absolute integrity of the river system since it's a middle riparian in the Yarmuk River and co-riparian in the Jordan River.

**Syria** - There are two main rivers that originate in Syria and they are tributaries to the Jordan: the Banyas River; and the Yarmuk River. Syria has other water and natural resources, since it shares the waters of the Euphrates and Tigris basins with Turkey and Iraq, and the Orontes River runs in its territories. These resources make the Jordan River of less importance to Syria than it is to other riparian states but it still plays a vital role because it shares waters in more than one basin. Since Syria is the upper most riparian country for both the Yarmuk and Banyas Rivers, Syria has claimed the absolute territorial integrity and sovereignty principle in water allocation negotiations.

**Lebanon** - Lebanon doesn't benefit much from the waters of the Jordan River since it depends on other resources. Since Lebanon is the uppermost riparian country for the

Litani River it has claimed the principle of absolute territorial integrity and sovereignty in negotiations.

**Palestine** - Palestine is the only country of the five riparian countries of this basin that is occupied by another country (Israel since 1948). The Jordan River is a major source of water for its irrigation systems but there are many restrictions placed on the use of this water by Israel. Because of that Palestine depends mostly on rainwater for irrigation. Although Lake Tiberias is in Palestine territory, Israel does not allow Palestine to use its water for irrigation or other domestic uses. Palestine has claimed the absolute integrity and unchangeable rights on the flow of the waters underneath its land in negotiations.

**Israel** - Israel came into existence after the partitioning of Palestine in 1948. Although it is the newest state among the other riparian states in the basin and the water it uses originates completely outside of its borders, Israel consumes the largest amount of water in the basin. Since Israel is the lowermost country in the basin it has claimed the principle of community of interests, but after 1967 (when it became an upper riparian) it started to claim absolute integrity and sovereignty principles in negotiations.

### **Water resources and national security linkages**

The strong policy linkage between water resources and national security that exists in the Jordan Basin needs to be viewed in the context of the Arab-Israeli conflict. Water concerns contribute to the conflict itself, but the conflict also has an effect on water policies, causing basin states and the Palestinian people to view water in the context of national security.

The basin underwent major change in the 1940's as states gained independence from European Mandate authority. Formation of the State of Israel in 1948 and the three subsequent wars between Israel and its neighbors have been defining political changes. Until the mid-1990's unilateral development was the norm in the basin, with Jordan, Syria and Israel each undertaking major projects at one time or another. The Jordan basin is perhaps the best example of non-water tensions influencing a link between water resources and national security. Finally, scarce/vulnerable water conditions are found in Jordan and Israel – both countries are extremely dependent on the Jordan River.

Scarce/vulnerable water conditions seem almost certain to prevail in the future unless desalination becomes more affordable and much more widely used. Non-water tensions will persist until Israel, its Arab neighbors and the Palestinian people make peace. Ironically, any such peace settlement will most likely produce new major changes in basin politics and political boundaries. The riparian claims of any new Palestinian state are almost sure to conflict with the current usage of Jordan River waters by Israel and Jordan. Significant unilateral development seems like the indicator least likely to recur. Jordan and Israel have shown a willingness to cooperate on water projects, and Israel and the Palestinian Authority even cooperate to some extent in the

water sector. On the other hand, Israel's recently increased interest in unilateral security solutions may cast doubt on this assumption.

## Questions

1. Should Syria and Lebanon be allocated water originating in their territories? Obviously this will effect Israel's and Jordan's allocations downstream.
2. Israel's solution to continuing and increasing water scarcity is desalination; will this new water source hurt Israel in future water negotiations with Syria and the Palestinian Authority?
3. Water and agriculture are used for political/ideological reasons. How does that affect hydropolitics in the region?
4. Is the Jordan-Israel agreement a good model for agreements? Why weren't water rights discussed in the Jordan-Israeli agreement?
5. What are the water resources related effects on both Jordan and Israel if the Palestinian state comes into existence?
6. How can Israel conclude an agreement with its neighbors when a major aspect will be the declaration of their water rights (both surface and ground water) when it is making full use of most, if not all, of these resources within its territory?
7. All stakeholders in the Jordan basin may not be as aware of the hydrogeology and hydrology of the region as Israel is. Doesn't this hinder their management and reaping benefits from these resources on the same scale as Israel?

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## 6.2. Tigris and Euphrates Rivers

(with Adam J. Czekanski, Stephen H. Pitman, Ziad Al Awar, and Mustafa Akcay)

Both the Tigris and Euphrates Rivers arise in Turkey's southeastern highlands and eventually flow into the Arabian (Persian) Gulf (UNEP, 2001). Almost all the water of the Euphrates and a major part of the Tigris come from within Turkish borders. The Euphrates flows south from Turkey into Syria, flowing then southeast through the most populated areas of the country and crossing into Iraq, where it continues southeast until it meets the Tigris. The Euphrates is the longest river in southwest Asia (3000 km length, area 579,314 km<sup>2</sup>) and its average annual discharge varies from 28.4 – 32.4 billion m<sup>3</sup> (UNEP, 2001). The discharge of the Tigris basin varies from 49.2 to 52.6 billion m<sup>3</sup> per year (UNEP, 2001). The Tigris River (length 1862 km and area 371,562 km<sup>2</sup>) flows southeast from Turkey across a short stretch of Syrian territory before entering Iraq. The Euphrates-Tigris River basin (combines area consists of 4 riparian states: Iran, Iraq, Syria and Turkey (with a very small portion of Saudi Arabia included). The two rivers nearly converge in central Iraq, near Baghdad, and from there they follow generally parallel courses through southern Iraq before joining to form the Shatt-al-Arab which flows on to the Gulf. The border between Iraq and Iran runs down the center of the wide Shatt-Al-Arab for a time, and several small tributaries flowing from Iran join the Shatt shortly before it empties into the Gulf.



**Map of Tigris Basin**  
(Source: [www.lib.utexas.edu](http://www.lib.utexas.edu))

Syria is highly dependent on the Euphrates and Iraq is completely dependent on the two rivers. Though not as dependant as its southern neighbors, Turkey has the most ambitious development plans for the rivers. The Southeastern Anatolia Project (commonly known by the Turkish abbreviation GAP) is an ongoing \$32 billion multi-year effort involving the construction of 21 dams and extensive infrastructure to spur economic development and job creation in Turkey's southeast.

**Countries of the Tigris – Euphrates River Basin**  
(Source: UNEP, 2001; CIA World Factbook, 2006)

Country	Percent of Euphrates Basin (%)	Percent of Tigris Basin (%)	Percent of Total Basin (%)	Percent of country in Euphrates basin (%)	Percent of country in Tigris basin (%)	Percent of country in total basin (%)
Iraq	49.0	38.3	44.8	64.6	32.5	97.2
Iran	0.0	47.2	18.5	0.0	10.6	10.6
Turkey	21.1	14.3	18.4	15.6	6.8	22.4
Syria	16.5	0.3	10.2	51.5	0.5	52.0
S.Arabia	13.4	0.0	8.1	3.9	0.0	3.9

**Countries of the Tigris – Euphrates River Basin (continued)**

Country	Population Total (mln)	GDP per capita (\$, 2005)	Irrigated Land (mln ha)	Renewable Water Resources, (m <sup>3</sup> /person)
Iraq	26.7	3,400	3.52	3,111
Iran	68.7	8,300	7.65	1,900
Turkey	70.4	8,200	5.22	3,344
Syria	18.9	3,900	1.33	1,541
S.Arabia	27	12,800	1.62	111

## Water Use Agreements in the Region

History records numerous conflicts over and involving water in this basin – some are more than two thousand years old; not particularly informative in the context of modern water resources or national security. Of the basin riparians, Iraq has practiced heavy use of the waters of both rivers for agricultural irrigation, with little diversion of waters from Syria or Turkey. In recent decades, however, both Turkey and Syria have undertaken significant projects to alter, store, and use flows from both rivers. The agreements reached between the basin states include:

- **1946** – “Treaty of Friendship and Neighborly Relations” between Turkey and Iraq that restated an earlier commitment made by Turkey, while Iraq was under British mandate, not to change the flow of the Euphrates or construct waterworks projects without consulting Iraq (Lupu, 2002).
- **1982** - Iraq and Turkey formed a Technical Committee which resulted in some exchange of technical information;
- **1983** - Syria joined the Technical Committee formed by Turkey and Iraq;

- **1987** - Turkey and Syria signed a Protocol of Economic Cooperation in which Turkey agreed to maintain a minimum flow of 500 m<sup>3</sup>/sec from its dams on the Euphrates (Lupu, 2002) in exchange for Syrian cooperation with Kurdish rebels within its borders; and
- **1990** - Iraq and Syria signed a bilateral water sharing agreement which gives Syria 42% and Iraq 58% of the Euphrates flow regardless of the flow variation from year to year.

The lack of formal agreements between all of the basin riparians, along with a lack of clarity within existing agreements, has prevented significant progress with respect to resolving issues of water allocation. Numerous meetings of the Joint Technical Commission, involving representatives from all three nations, were conducted between 1981 and 1992 with little resolution over the issues at hand due in large part to Iraq claiming absolute territorial sovereignty and insisting that the Tigris be considered its own to control and refusing to negotiate the basin as a whole (Altinbilek, 2004). Rigid stances such as this from all major players in the basin have been largely responsible for the lack of progress on any clear or relevant agreement between the riparians. The Situations and proposals of the riparians can be summarized as:

**Turkey** – Turkey does not generally recognize the 1946 agreement with Iraq, but more or less honors the terms of their bilateral agreement with Syria. Turkey is the provider of a significant amount of the waters of the Tigris and almost all of the waters of the Euphrates, thus, owning territorial claims. It also holds the advantage of having the strongest economy, military, and the most political clout as the country with the closest ties to the Western nations and as a member of NATO (this may be arguable in light of recent events in Iraq). The construction of numerous projects on the Tigris and Euphrates Rivers over the past 30 years as part of the GAP has given Turkey the ability to unilaterally control all water flow in the Euphrates and almost half of the flow of the Tigris. The extensive quantities of water being harnessed through the GAP have the overarching goal of increasing the standard of living and economic development in the southeastern portion of the country. The GAP has created jobs for the people of this region, generated power, and increased cultivated lands significantly. The secondary benefit or goal of this project can be presumed to be the assimilation and appeasement of the large Kurdish population in this region through increased economic prosperity and development. Although Turkey has been cooperative in sharing their development plans as the GAP has progressed, they generally maintain their view of absolute territorial sovereignty over the waters of both rivers flowing from their border. In the process of negotiations, Turkey has proposed reasonable and equitable utilization of basin water resources, suggesting:

- An inventory of land resources (soil classification, drainage criteria, irrigation and leaching water requirements);
- An inventory of water resources (exchange data for quantity and quality of water); and

- An evaluation of water and land resources (irrigation type, minimizing water losses, modernization and rehabilitation of the projects under operation, total water consumption, simulation model, determining the economic viability of the planned projects)

**Syria-** Syria is the middle riparian in both the Tigris and Euphrates and historically it has relied on waters from the Yarmuk, Banyas and Orontes Rivers to satisfy the majority of its water needs. Syria will likely continue an equitable utilization stance with Turkey and Iraq due to its weaker military, economic and political clout, and due to the fact that it sits as an upper riparian in the Jordan basin and does not rely solely on the Tigris – Euphrates for its survival. Syria has drastically increased its use of the Euphrates through construction of the Tabqa Dam in 1973 (11.2 billion m<sup>3</sup> total capacity), and a series of smaller dams in recent decades, to supply irrigation waters for a vast region of Syria. Syria is driven by the need to cultivate more lands in order to feed a population that continues to grow at a steady rate. Although they share a small portion of the Tigris, Syria has made no significant claims to use its waters. They believe in the “shared resources” approach to the waters of both rivers and negotiate from that stance. In the process of negotiations, Syria has proposed allocation based on shared water resources:

- Each State shall declare its demand on each river separately; and
- The yield of both rivers in each country shall be calculated. If the demand does not exceed the supply, the water shall be shared according to stated figures; otherwise, the exceeding amount should be deducted proportionally from the demand of each state.

**Iraq –** Iraq is the lower riparian and has historically been the heaviest user of waters of both rivers for irrigation in both the Tigris and Euphrates basins. Iraq has an established “historical use” claim and a need for a set amount of fresh water to sustain agricultural production that it can not easily obtain from other sources. They invested heavily in construction along both rivers in the 1950s and 1960s to harness resources for power production and irrigation and continued to invest in water projects in recent decades. The altered river flow and increased water use by Turkey and Syria, coupled with their continued need and heavy use of freshwater resources, has placed them in the most precarious position of the three basin riparians. In the process of negotiations, Iraq has proposed allocation based on historic use:

- Each state will notify the others of its water demand for each completed project as well as for the projects under construction or planned;
- Hydrologic data will be exchanged on the Euphrates and Tigris Rivers; and
- The Joint Technical Committee (JCT) will calculate the water demands of the projects under operation, under construction, and planned.

Following the 1973 Arab-Israeli war, Iraq openly criticized Syria's military losses on a number of occasions, and the Syrians responded by altering the flow of the Euphrates to interfere with Iraqi agriculture. In 1975, Syria impounded much of the spring flood of the Euphrates to fill the reservoir behind the Tabqa dam. Iraq, accustomed to receiving the entire spring flood and counting on it for its farmers, reacted with angry rhetoric. Tensions ratcheted up quickly. The two countries cancelled commercial air links, withdrew military attachés from each other's capitals and stationed additional armed troops on their shared border. Only through mediation by the Saudi Crown Prince and the Soviet Union did the two countries back down and Syria agree to release additional water to Iraq. Though Saudi Arabia proposed a plan for sharing the waters of the Euphrates, Syria and Iraq did not reach agreement until the next crisis convinced both countries of the need to do so in 1990.

In meetings throughout the 1980's it became clear that the claims of the three countries on the waters of the Euphrates significantly exceeded the average flow. Turkey agreed to provide Syria a minimum flow, but the flow equaled the amount demanded by Iraq, which would leave Syria able to consume nothing (Elhance, 1999).

In late 1989, Turkey announced plans to use the entire flow of the Euphrates for one month to begin filling the reservoir behind the Ataturk Dam, the largest dam in the GAP (48.5 billion m<sup>3</sup> total capacity). Though Syria and Iraq protested, Turkey went ahead with the diversion for exactly one month and the flow of the Euphrates subsided to a trickle. Though this event occurred during the winter and caused little actual harm, it convinced Syria and Iraq of the need for a water sharing agreement. They signed one several months later.

Following the Ataturk Dam incident, Iraq was occupied with its invasion of Kuwait and subsequent ejection by the United States and a large coalition. Syria, less occupied but unable to seriously challenge Turkey militarily, stepped up support for Kurdish Workers Party (PKK) rebels, most significantly by allowing the use of bases in Syria. Throughout the 1990's the conflict between Turkey and the PKK intensified until Turkey declared in 1998 that Syria's support for the PKK constituted an undeclared war. Turkey moved large numbers of troops to the border region and threatened an air assault and ground invasion. Regional leaders met to try to diffuse the crisis and in October 1998 Syria agreed to close PKK bases and hand over the PKK leader to Turkey.

Elhance concludes that Turkey's position as upper riparian and most powerful state in the basin allows it to treat the two rivers as though they are not international rivers to which Syria and Iraq have rights (Elhance, 1999). Klare (2001) suggests that recent history and Turkish development plans for the two rivers have set the stage for a series of recurring crises over water in the Tigris-Euphrates Basin. It seems clear that Syria and Iraq will continue to maintain a strong link between their national security and water resources policy, especially since Turkey appears to be continuing a development policy that gives its southern neighbors reason to worry about the future quality and quantity of their main water resources.

## **Water Quantity**

Water requirements generated by the GAP have caused the most severe strains on the waters of both rivers, but most drastically affecting the flow of the Euphrates. With the completion of the Ataturk Dam in 1990, Turkey declared that it will only guarantee a flow from its border equal to half the original flow of the river (Beaumont, 1999). Although this represents the “minimum” amount that will be provided from the Turkish border for use by Syria and Iraq, the more important issue will be the discharge patterns established by Turkey. Power production will likely be maximized during the winter months, resulting in the peak discharge from the dam occurring in the months of December – January. The river flow will consequently be at a maximum during these months as well, in contrast to the traditional peak discharge months of April – May (Beaumont, 1999). If the additional water released by Turkey during peak discharge periods is not adequately captured by both countries in reservoirs, they will be left with a significant shortage during periods of peak use by farmers. Even with reservoirs to hold such waters (Lake Assad, Lake Habbaniyah, etc), evaporation due to the extreme temperatures will continue to strain these resources. Furthermore, although irrigation is the reason for the increased water demand, the increasing populations along the rivers and the potential increase in industries requiring significant water sources will place additional strain on water resources of the basin. The extensive use of waters for irrigation and industrial use will also undoubtedly lead to waters reentering the river system with higher levels of salinity, chemical content, and in a generally untreated and contaminated state. This issue will most severely affect Iraq as they will be the receiver of discharges by both Turkey and Syria. Depending on the severity of such use in the future, Iraq could potentially experience drastic effects to their agricultural industry and on their ability to sustain populations and industry along the river.

## **Issues of national security**

In the Tigris-Euphrates Basin, past conditions reflect a strong linkage between water resources and national security policy of the basin riparians. Turkey’s Southeastern Anatolia Project (GAP) is unilateral development that has had a great impact in the basin. The diversion of 100% of the Euphrates’ flow for a month to fill Ataturk dam was a major physical change, albeit temporary, for Syria and Iraq, and it signaled Turkey’s power and willingness to manipulate their scarce/vulnerable water resources. Though Turkey has not taken such dramatic actions again, both downstream countries remain vulnerable to Turkey’s continued plans to develop the rivers within its own borders. Significant non-water tensions existed between Turkey and Syria over the Kurdish separatist movement.

Looking forward, the future of post-Saddam Hussein Iraq appears to be the largest single source of major political change in the basin. The recent war, occupation and ongoing transition to a democratic government are significant political changes for the region. It remains to be seen if any new alliances will emerge in the basin. Should Iraq devolve into multiple independent states rather than the federation currently envisioned, one of those states would almost certainly be a Kurdish majority state in the

north of today's Iraq. This state would be a lower riparian from Turkey but an upper riparian with respect to the remainder of Iraq. The impact on Tigris-Euphrates hydrogeopolitics of such a redrawing of borders could be dramatic.

It is also unclear today whether the political changes in Iraq will increase, decrease or just change tensions in the region. It is likely that some non-water tension will remain, especially between Turkey and whatever Kurdish entity eventually emerges in or from Iraq. There is a high likelihood of a continuing, perhaps strengthening, water resources-national security policy linkage.

## **Possible Solutions**

The most important step toward solving the water issues of the Tigris-Euphrates river basin is for all three riparian nations to sit down to seriously negotiate the issues surrounding the water resources of the basin. Turkey unquestionably holds the most power in this situation, but both Syria and Iraq have shared interests that, if presented as a common front, may have more weight in political negotiations. Iraq has the most to gain from developing some kind of a formal agreement on water use in the region as the historical heaviest user of a resource that will only continue to be consumed at an ever increasing rate upstream. The fact that Turkey controls much less of the Tigris than the Euphrates leaves the option of flow diversion as a possible solution to Iraq to supplement a decreased flow rate from the Euphrates. Challenges of increased salinity levels of the water, as well as capacity restrictions of Lake Tharthar and of the Tharthar Canal could also limit this option. As Iraq continues to stabilize and improve its infrastructure and economy, it will also have the possible option, along with Syria, of trading valuable oil resources to Turkey in exchange for increased flows of water. Lastly, cooperation from both Syria and Iraq along their borders to control the activities of Kurdish rebels will have political overtures that could be translated into goodwill gestures or agreements with Turkey for increased flow rates.

## **Questions**

1. Do Iran and Saudi Arabia have a role in the decision-making process for allocating the waters of the Euphrates and Tigris rivers?
2. How can each basin riparian's position be seen in light of the Helsinki Rules (1966) and Convention on the Law of the Non-navigational Uses of the International Watercourses (1997)?
3. What might be the most difficult factors affecting an agreement on the allocation of water between the basin states in the Tigris and Euphrates basins?
4. Should the water allocation in this Tigris and Euphrates be dealt with as two rivers forming one basin or would it be better to have different agreements on each of the two rivers?

5. Knowing that the Euphrates is more vital to Syria than the Tigris, how can this be used in reaching agreement between Syria and Iraq?
6. Does the existence of the GAP Project establish a historical water right for Turkey in the basin?
7. Are the treaties signed by the Iraqi government at the time of Saddam Hussein binding on Iraq?
8. What affect will US presence (and interests?) in Iraq have on the dynamics of water resources development and management in the basin?

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## 7. South/Central Asia

### 7.1. *Indus River*

(with Stephen H. Pittman, Paula Kulis, and Kristine S. Shaw)

#### Introduction

Though the recent primary issue of contention between India and Pakistan has been the status of disputed Kashmiri territory, their water policies were for a time linked to national security policies. Some analysts conclude that water policy in the Indus Basin may again enter the national security arena if current trends of rapid population growth and environmental decline lead to food shortages in the future (Klare, 2001).



**Map of Indus Basin.**

(Source: Encarta.msn.com)

The Indus River has an area of 944,574 sq. km. and an average annual flow of 226 km<sup>3</sup> (Pakistan Water Gateway, 2006). The source of the Indus is at 17,000 feet above sea level in western Tibet and flows briefly through Chinese territory before entering Indian controlled Kashmir and then flowing into Pakistan. In northern Pakistan it is joined by the Kabul River, which flows out of Afghanistan. Four other rivers which arise in northern India or Indian controlled Kashmir, the Jhelum, Ravi, Chenab and Sutlej combine to form the Panjnad River, which joins the Indus in central Pakistan. From this point, the Indus remains in Pakistan along its 2897 km course to the Arabian Sea. The flow of the Indus fluctuates seasonally, with melting of Himalayan glaciers accounting for almost 90% of the water in the upper basin coming from remote glaciers in the Himalayas (Rizvi, 2001). Although most of the Indus Basin lies in a zone of deficient

rainfall (< 254 mm annually), abundant flow is present during the monsoon season (July-September), which accounts for 51% of the annual flow. Nearly 10% of the rainfall is lost by evaporation and nearly 50.5 billion m<sup>3</sup> is lost by seepage from unlined canals, which results in waterlogging rendering the land useless for agriculture.

### Countries of the Indus River Basin

(Source: Pakistan Water Gateway, 2006; CIA World Factbook; 2006, WRI, 2006)

Country	Percent of Basin (%)	Percent of country in basin (%)	Population Total (mln)	GDP per capita (\$, 2005)	Irrigated Land (mln ha)	Renewable Water Resources, (m <sup>3</sup> /person)
Pakistan	56.0	65.8	166	2,400	18.2	1,384
India	26.1	7.5	1,100	3,300	55.8	1,822
China	9.8	1.0	1,314	6,800	54.6	2,186
Afghanistan	8.0	11.7	38	800	2.7	2,790

\*14 million hectares irrigated in the basin

Modern development of water resources in the Indus Basin began under British colonial rule in 1859. By 1915, canals crisscrossed the basin, providing for irrigation and flood control. In one of the earliest examples of basin-wide management, the British harnessed much of the potential of the rivers to greatly increase the region's agricultural productivity. In August 1947, the partition of colonial India into the states of India and Pakistan resulted in a split in the basin's water resources. The territory of Pakistan included the majority of the basin's canal network and agricultural land, but the upper reaches of the Indus as well as the headwaters of all the major tributaries of the Panjnad lay in India. This placed India, already the more powerful state, in the position of upper riparian, though most of the benefit of the basin's waters was given to Pakistan.

**Standstill Agreement (1947)** - As a result of the boundary delineation between Pakistan and India, Punjab was separated into Eastern and Western regions. A Punjab Partition Committee was established to resolve disputes regarding division of assets between the divided provinces. Both East and West Punjab agreed that "the position existent at the time of partition will not be disturbed and waters shall be divided equally." However, in 1948, India stopped the flow of water from East Punjab to West Punjab based on the principle of absolute sovereignty. The results were massive crop failure in Pakistan and widespread famine (Klare, 2001). Pakistanis reacted angrily with calls for military action, but the Indians downplayed the issue as a misunderstanding. Negotiations led to another temporary agreement.

**Inter-Dominion Accord (1948)** - The Inter-Dominion Accord of 1948 was a temporary agreement that required India to release sufficient waters to Pakistani regions in return for annual payments from the Pakistani government to India.

**Indus Waters Treaty (1960)** - In 1952 the World Bank began mediating the contentious Indus basin dispute. Eight years of mediation finally produced the historic Indus Waters Treaty (1960) between the two countries. Though the treaty did not re-establish basin-

wide development and management, its scheme of divided operation has held up through a war in 1965 and continuing tension between the two states (Klare, 2001).

## **Impacts of the Treaty**

The tension between India and Pakistan was exacerbated by the issue of Kashmir, which is still in dispute between the two nations. Kashmir's population is largely Muslim, and for this reason, among others, Pakistan claims it. However, it was officially made part of India when British control left the region. The tension over Kashmir not only decreased cooperation between the two nations, but particularly impacted water rights because Kashmir contains the upstream source of many of the tributaries that flow into Pakistan; Pakistan control over Kashmir would allow Pakistan to control almost the entire basin.

The Indus Waters Treaty is regarded as one of the most successful settlements of a transboundary water basin conflict. Although there was significant dialogue regarding historical rights to water versus the inappropriateness of using prior use allocate water, a compromise was reached, in which India was granted the three eastern tributaries (Ravi, Beas, and Sutlej) upon payment to Pakistan of the “cost of replacement works” (62 million pounds) and Pakistan was granted the flow of the three western rivers (Indus, Jhelum, and Chenab). The World Bank and other international agencies provided \$870 million to Pakistan and \$200 million to India to defray infrastructure costs. Other provisions of the treaty enabled construction of two additional dams in Pakistan (Mangla and Tarbela) and created new linkage canals and barrages to develop and sustain agricultural activities in Pakistan, such as the canals that provide water to western Rajasthan and Kalabagh desert.

**Tarbela Dam** - The Tarbela Dam Project, which was part of the World Bank's development of Pakistan's water supply (stemming from the 1960 Treaty), resulted in 11.5 billion m<sup>3</sup> of storage on the Indus, making it the biggest dam project in the world at that time. This massive project had its benefits and disadvantages. The Tarbela Dam storage supplements a great deal of the water lost to India under the 1960 treaty. In addition, the irrigable lands in Pakistan were increased after the dam was built, although crop production did not increase as much as was hoped. Hydropower and flood control were also benefits of the project. Growing Pakistani cities have also relied on the supply of freshwater provided by the dam.

Being the largest project of its kind in the world, many problems with the dam were not foreseen. Over-irrigation of poorly drained farmland resulted in waterlogged and saline soil. Costly drainage systems are not yet fully operational. In addition, fisheries relying on the river flows and freshwater inflows to the estuary were adversely impacted by the change in flow patterns and water quality. Adverse ecological impacts on coastal mangrove forests were not considered in the planning process. Another major problem had to do with the people displaced by the dam and reservoir; their number was vastly underestimated, they received compensation late, and they were moved to regions of different ethnic majorities than they came from.

## Issues of National Security

India's early military dominance in the Indus Basin has been somewhat equalized since Pakistan revealed its own nuclear capability, but India still maintains large advantages in conventional military forces and economic power. The linkage between water resources and national security developed rapidly in the antagonistic atmosphere that surrounded the partition. Another key factor was that infrastructure built in the colonial period did not lend itself to workable operations in the post-partition political layout of the basin.

The partition and independence of India and Pakistan in 1947 represented a major political change for the Indus Basin. Non-water tension over Kashmir rapidly emerged. When the standstill agreement for operation of the shared canal network expired in 1948, India curtailed flow in key canals feeding Pakistani agriculture. This represented a major physical change for Pakistan. It also highlighted Pakistan's vulnerable water position as lower riparian. Signing of the Indus Waters Treaty in 1960 has so far effectively suppressed water resources related national security issues in the basin. The likelihood of a reemergence of water resources as a national security issue for Pakistan or India in the Indus Basin looks fairly low.

A recent example of the treaty compliance is the Baglihar Hydropower Project on the Chenab River in Indian Held Kashmir. Initially, Pakistan claimed that building the dam would be a violation of the Treaty because the dam would allow India to withhold water, drying up canals emanating from the Chenab River. Pakistan and India tried to negotiate a solution but failed and had to invoke the dispute resolution clause of the treaty, which calls for the World Bank to appoint a neutral expert to rule on the merits of the dispute. The final hearing of the independent expert was held in May 2006, but in the meantime, India has proposed to review and redesign of the dam to reduce water storage capacity and not divert the water for irrigation. In addition, to avoid a similar conflict over dam development in the basin, India has recently informed Pakistan that it has changed the design of another hydropower project (Kishanganga) in the Jammu region.

The Indus Waters Treaty is still in effect, 45 years after its beginning. Since this time, environmental conditions have changed as population in the region has skyrocketed. In addition, climate changes and the conflict over Kashmir have not lessened tensions between India and Pakistan. The workability of the treaty in the future is very much in question.

## Questions

1. Although the border between Pakistan and India was incompatible with the previously operating irrigation canal system in the region, why was the boundary between Pakistan and India delineated the way it was?

The Radcliffe Line was a hasty and ill-defined line, drawn by Sir Cyril Radcliffe, who

never left the Viceroy's House during the time he spent on the task (Dayal, 1998). The line obeyed no geographical features and simply used census data to evenly divide between Muslim and Hindu populations, often running through the center of villages and sometimes house. According to Chester (2002) Radcliffe arrived in India for the first time on July 8, 1947 and learned, apparently for the first time, that the boundary must be completed by August 15 (Dayal claims that he worked for 4 months, still a short time to accomplish this task.). He was almost completely ignorant of the information and procedures necessary to draw a boundary. He lacked any advisors versed in even the basics of boundary-making. The Commission's extremely tight timetable made it impossible to gather the survey and other information vital to a well-informed decision, but speedily provided all parties with the international boundary that was a prerequisite for the transfer of power.

2. In this settlement, the World Bank and other neutral party arbitrators were very instrumental in development of the Indus Water Treaty. Why do you suppose that this was more effective rather than negotiations initiated by the countries within the Indus Basin?
3. Eugene Black, former president of the World Bank, asserted that the "Indus dispute could most realistically be solved if the functional aspects of disagreement were negotiated apart from political considerations." How can this be achieved?
4. Is the treaty sustainable or is it out-dated? If it is out-dated, how can the treaty be kept up-to-date with changing situations, given that the countries sharing this basin have such strained relations?
5. What important lessons can be learned from the Tarbela Dam project?
6. Would it be beneficial for Pakistan and India to integrate their water systems? Is it possible without conflict?

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## 7.2. Ganges and Brahmaputra Rivers

(with Meghan C. Strand, and Jean-Philipp Laurent)

### Introduction

The Ganges River covers an area of 1,080,000 sq km and it has its source in the Gangotri Glacier, a vast expanse of ice at the base of the Himalayas. This glacier forms the Bhagirathi River which joins the Alaknanda River to form the Ganges. The Brahmaputra River covers 580,000 sq km, flowing for most of its length under various names through Tibet/China then joining the major stream of the Ganges (along with the Meghna tributary – 85,000 sq km) near Dacca in Bangladesh to become the Padma River. A large number of tributaries join and flow from the Ganges to drain the Northern part of India and Bangladesh. The Ganges flows some 2494 km through China, India, Nepal, and Bangladesh. The basin is also shared by the sovereign state of Bhutan. About 80% of the basin is in India, 7% is in Bangladesh, and the remainder is shared by Bhutan, Nepal, and China. Rainfall in the basin varies from less than 600 mm in the northwestern region to more than 1,700mm in the eastern coastal zone.



**Map of the Ganges Basin**

(Source: encarta.msn.com)

The Ganges Basin is one of the most fertile, densely populated, and richest regions in the world in terms of the multiple-use potential of its abundant water resources, and covers an area of . It has vast economic potential for irrigation, power generation, industrial development, fisheries, and navigation. The basin is endowed with tremendous hydroelectric potential; however, a very miniscule portion of this potential has been tapped. Despite the endowment of resources, the basin is one of the

least developed regions of the world, where abject poverty and environmental degradation are prevalent.

### Countries of the Ganges – Brahmaputra River Basin

(Source: Bricchiere-Colombi and Bradnock, 2003; CIA World Factbook; 2006, WRI, 2006)

Country	Percent of Ganges Basin (%)	Percent of Brahmaputra Basin (%)	Percent of Meghna Basin (%)	Percent of Total Basin (%)	Percent of country in Ganges basin (%)	Percent of country in Brahmaputra basin (%)	Percent of country in Meghna basin (%)	Percent of country in total basin (%)
India	79.7	33.6	57.6	63.3	26.2	5.9	1.5	97.2
China	3.1	50.5	0.0	18.7	0.3	3.1	0.0	10.6
Nepal	13.0	0.0	0.0	8.0	99.4	0.0	0.0	22.4
Bangladesh	4.3	8.1	42.4	7.4	31.9	32.6	25.0	52.0
Bhutan	0.0	7.8	0.0	2.6	0.0	95.7	0.0	3.9

### Countries of the Ganges – Brahmaputra River Basin (continued)

Country	Population Total (mln)	GDP per capita (\$, 2005)	Irrigated Land (mln ha)	Renewable Water Resources, (m <sup>3</sup> /person)
India	1,100	3,300	55.8	1,822
China	1,314	6,800	54.6	2,186
Nepal	28	1,300	1.2	8,703
Bangladesh	147.3	2100	4.7	8,444
Bhutan	2.3	1400	0.04	43,214

At the time of partition in 1947, East Pakistan (later Bangladesh) made little use of the Ganges – Brahmaputra waters passing through its territory (10% of the catchment) (Bricchiere-Colombi and Bradnock, 2003). At the same time, India had made significant use of the Ganges since the previous century.

India diverts a large quantity of the Ganges at Haridwar into the Upper Ganges Canal, built by the British in 1854 for irrigation. This has caused severe deterioration to the water flow in the Ganges, and is a major cause for the decay of the Ganges as an inland waterway. Downstream, the barrage at Farakka, located close to the point where the main flow of the river enters Bangladesh, diverts dry-season flow from the Ganges into the Hugli Canal. This barrage, built by India to counter water deterioration at the port of Calcutta, diverts fresh water from the Ganges into the Bhagirathi River via the canal. The barrage and its water flow management have been a long lingering source of dispute with Bangladesh. Bangladesh claims that the Farakka Barrage deprives the country of a valuable source of water on which it depends, because the Ganges waters are vital to irrigation, navigation, and prevention of saline incursions in the Bangladesh Ganges delta region. It seems the barrage was designed without any consideration of possible downstream negative affects or possibilities for mutual benefit. This included neglecting delta area water requirements, future irrigation development, and lack of mutually perceived benefits from cooperation (Bricchiere-Colombi and Bradnock, 2003). Asserting the principle of equitable utilization, Bangladesh holds that there should be joint control of the river as it is an international river.



Disputes and negotiations between India and Bangladesh over water resource development have resulted in several interim agreements including the Ganges Waters Agreement in 1977 and the Ganges Waters Treaty in 1996 ('Treaty between the government of the Republic of India and the government of the People's Republic of Bangladesh on sharing of the Ganges/Ganges Waters at Farakka'). The Ganges Waters Treaty allocates the flows of the Ganges at Farakka for each 10-day period between 1 January and 31 May each year. Almost all India's share is diverted to the Bhagirathi-Hugli Canal (capacity of 1134.8 m<sup>3</sup>/sec) with 5.7 m<sup>3</sup>/sec reserved for use in India downstream of Farakka. The following table represents the allocation:

<b>Availability at Farakka</b>	<b>India Share</b>	<b>Bangladesh Share</b>
1985.9 m <sup>3</sup> /sec or less	50%	50%
1985.9 - 2127.8 m <sup>3</sup> /sec	Balance of flow	993 m <sup>3</sup> /sec
2127.8 m <sup>3</sup> /sec or more	1134.8 m <sup>3</sup> /sec	Balance of flow

If the flow falls below 1418.5 m<sup>3</sup>s the two parties will hold emergency consultations to make adjustments in accordance with the principles of equity, fair play and no harm to either party. The terms of the water allocation have already come under question as the predicted average flows have not matched actual flows in the Ganges since 1996.

All riparian states, except China, are members of the United Nations, the World Bank, the International Monetary Fund, and the South Asian Association for Regional Cooperation (SAARC) created in 1983. There are many highly controversial issues between the riparian states including domestic politics and interstate relations. The contentious nature of these differences has so far prevented the possibility of multilateral cooperation. One hopeful sign that may create more tolerant and cooperative relations among the countries is the growing rapprochement between India and China. Once at war, these countries have recently been attempting several moves to normalize their relations, to open diplomatic channels, and to promote travel and trade.

Hydropolitics in the basin are focused mainly on Bangladesh, Bhutan, India, and Nepal, because China, to date, has not made any substantial claims related to its uppermost riparian status on the Brahmaputra or on any of the tributaries originating in Tibet. China is also separated by the unique physical and economic geography of the basin. However, this does not mean that China's presence on the borders of South Asia does not cast long shadows on hydropolitics in the basin.

Without China's active participation, India is by far the strongest riparian state in the basin. India has selectively used its strong riparian position to unilaterally construct water projects, to withhold hydrological data, to control the nature and timing of negotiations, to delay and block international efforts, and to curtail the degrees of freedom of the smaller neighbors in the basin. India is a member of SAARC, India has preferred bilateral and project-by-project negotiations rather than a holistic approach to cooperation with its neighbors over shared water resources. But, India's potentially hegemonic position in hydropolitics in the basin is undermined by its poverty and

regional disparity, by its cultural, ethnic, religious, and linguistic diversity, and by its class and caste differences among its population. India's dominating position is also moderated by the physical, economic, and geographic features of the smaller riparian states. Nepal has the potential to help India with substantial hydroelectric supplies. Bangladesh can delay economic development in India by denying navigational and transshipment rights to India through its territory and by withholding cooperation on an Indian scheme for constructing a canal to link the Ganges and the Brahmaputra through Bangladeshi territory. Finally, Bhutan's strategic location between the two Asian rivals has caused India to be sensitive to the economic and social well-being of its dependent neighbor.

Although the area is very well endowed in terms of its hydroelectric, agricultural, fishery and navigational potentials, it is one of the poorest regions of the globe. The World Bank estimates that 40% of the poor in the developing world live in the basin, the situation being especially critical in Bangladesh where more than 80% of the population is estimated to live in poverty. The major economic activity of the region is agriculture, with 80% of the total population having an agricultural-based employment. Despite the tremendous irrigation potential of the basin, most of the agriculture heavily relies upon the monsoon season. Also, the fast growing population threatens the food self-sufficiency achieved by the riparians, and India in particular. For these reasons, development of irrigation in the basin would greatly benefit all the countries.

The potential for cooperative development of the basin exists since the countries have complementary needs. In particular, the development of the hydroelectric potential in Nepal could supply the huge electricity needs of India. Similarly, construction of storage reservoirs in India to increase irrigation would benefit Bangladesh in terms of flood control. There is also the common interest of developing navigation, especially for landlocked countries such as Nepal.

Many barriers to cooperation exist in the basin. One is geography: each country's solutions to its problems lie within the boundaries of its neighbors. In a climate of distrust and fear of leadership inherited from colonization, negotiations are hard to conduct.

Many Hindu myths are also associated with the Ganges. One of these is that bathing in its waters at Haridwar will wash away sins "as great as the murder of Brahmins". Hindus use the water to cleanse any place or object for ritual purposes. Bathing in the Ganges is a lifelong mission for many Hindus near and far and they congregate in incredible numbers for religious festivals. Hindus also cast the ashes of their dead in the river in the belief that this will guide the souls of the dead straight to paradise. It is this belief that leads to the high number of corpses in the Ganges.

## Questions

1. Why have the riparian states sharing the basin not taken advantage of the vast economical potential of their water resources?

2. What effect may the Hindu religious beliefs regarding the Ganges have on future water agreements?
3. What effect will China's lack of participation in basin water resources management and development have on any decision made by India, Bangladesh, Bhutan, and Nepal?
4. Is the Ganges Water Treaty between Bangladesh and India a good solution to the water allocation issues between the two states? What effects could harsh weather conditions have on the agreement?
5. Should an agreement such as the Ganges Water Treaty include agreements regarding pollution, additional water projects, and environmental issues, or should one issue be tackled at a time?

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### **7.3. Syr Darya**

#### **Introduction**

Since independence in 1991, the former Soviet republics of Central Asia have been striving to develop fair and rational bases for sharing and using their water and energy resources. These republics depend on the rivers of the Aral Sea Basin for drinking water, irrigation, and hydroelectric power. In the upstream countries of Kyrgyzstan and Tajikistan the rivers are used for hydroelectric power, especially during winter months, while downstream, in Turkmenistan, Kazakhstan, and Uzbekistan; they are used as a source of summertime irrigation water. Water allocation, both quantity of water and timing of deliveries, is a major issue for the Republics.

#### **The Aral Sea Basin**

The Aral Sea Basin (1.51 million km<sup>2</sup>) comprises most of the Kyrgyz Republic, all of Tajikistan, Turkmenistan, and Uzbekistan, and parts of Afghanistan and Kazakhstan. Topographically, the Aral Sea Basin extends from tremendous mountain ranges in the east (Pamirs and Tien Shan) to vast desert plains in the west. The basin's water resources are mainly surface waters formed in the mountain ranges and feeding the Syr Darya and Amu Darya, the major rivers of the Aral Sea Basin.

The mountainous countries of Tajikistan and Kyrgyzstan produce about 77 percent of the water in the Aral Sea Basin, and Afghanistan contributes about 10 percent. Historically, demand for water in Aral Sea basin has been dominated by the downstream needs of agriculture, which accounts for more than 90 percent of total water use in the basin.

Central Asia's agricultural expansion and population growth during 1950-90 placed tremendous strain on the water resources of the region. In 1960, the Aral Sea had a surface area of 66,000 km<sup>2</sup> and a volume of 1,060 billion m<sup>3</sup>. Since 1960 the population in the Basin grew from 13 million to more than 40 million people, annual water diversions increased from 60 to 105 billion m<sup>3</sup>, and irrigated lands increased from 4.5 million hectares (ha) to just over 8 million ha. As a result, the Aral Sea lost more than half of its surface area and two thirds of its volume and became an environmentally challenged area.

#### **Syr Darya Basin Framework Agreement on Water and Energy Use**

The Syr Darya Basin, with average annual flow of 37.2 billion m<sup>3</sup> and area of about 484,000 km<sup>2</sup>, stretches some 2,337 km from the Naryn River headwaters in Kyrgyzstan through the Fergana Valley shared by Kyrgyzstan, Uzbekistan and Tajikistan, the Hunger Steppe in Uzbekistan, the Kyzyl Kum desert in Kazakhstan, before finally reaching the Aral Sea. Kyrgyzstan's Toktogul reservoir is the largest in the Syr Darya Basin and the only one with multiyear storage capacity (14 billion m<sup>3</sup>

usable storage volume). The reservoir was designed and constructed in the Soviet period to operate in an irrigation mode with minimal winter season releases. Prior to independence in 1991, surplus power generated by summertime, irrigation releases from Toktogul was transmitted to neighboring regions of the Soviet Union. In return for this electricity and irrigation water, those regions sent electric power and fuels (natural gas, coal and fuel oil) back to Kyrgyzstan for winter heating needs.



**Map of the Syr Darya Basin (Source: WARMAP, 1996)**

This situation changed drastically when independent states were established in Central Asia in 1991. Because of complications in intergovernmental relations and account settlements, the introduction of national currencies, and increasing prices of oil, coal, natural gas, the supply of wintertime fuels and electricity sent to Kyrgyzstan from the other Republics was reduced. This created a winter heating crisis to which the Kyrgyz responded by increasing wintertime releases from Toktogul for hydroelectric generation thus depleting reservoir storage during the middle 1990's.

To alleviate these problems, the Syr Darya basin countries authorized the formation of a group to negotiate an interstate agreement on the use of water and energy resources in the Syr Darya Basin. This resulted in an agreement that created a framework addressing trade-offs between the competing uses of water for energy and irrigation in the Basin. Under the agreement, compensation is paid for compliance with a Toktogul release schedule that takes into account both upstream (Kyrgyz) winter energy needs and downstream (Uzbek and Kazakh) summer irrigation water demand. To date, the system has remained stable without major conflict and the agreement has entered the second five-year implementation period without major revision.

A critical element in the negotiations of the Syr Darya agreement was helping the parties understand the trade-offs between the conflicting objectives of winter electricity releases and summer irrigation releases. A multiobjective optimization model was developed to promote understanding of, and aid in the development of, efficient and sustainable water allocation options for the republics. The multiple objectives combined in the model included (1) minimizing upstream winter power deficits and maximizing downstream irrigation water supply. By integrating these objectives with the system's physical, political, and operational constraints in an optimization model, the tradeoffs

between the conflicting objectives of satisfying agricultural water demand, and generating hydroelectric power were elaborated and used to develop a number of water allocation scenarios to aid decision making.

## Questions

1. The republics are moving from a centralized government to free market democracies. What avenues should be taken to help the populace move from the Soviet culture (citizens as subjects) to this new culture (citizens have an active voice)?
2. USAID has focused on working separately in the two river basins, as opposed to the Aral Sea basin-wide approach that other donor organizations have taken. Which is a more effective, given that each river basin has global and local concerns?
3. Will the barter agreement developed in the Syr Darya basin have longevity?
4. If the World Bank is funded by the United States, why does USAID not cooperate with World Bank and other donor organizations? If donors get frustrated with inter-donor conflict, will the donors leave the region?
5. USAID's goals are broader than just environmental protection; therefore several of its other aid programs have conflicted with its water and environment programs. How should USAID balance its interests with that of the basin? Whose responsibility is it to justify the soundness of each project?
6. Are donor agencies playing too big of a role in the development of these republics (replacing Soviet control over the decisions of the region with donor control)?
7. Three attempts have been made to create a dike to separate the Small Aral Sea from the Large Aral Sea, however it keeps getting washed away. When the dike is in operation, positive results are seen in the Small Aral Sea – increases in water levels, moderation of the climate, increases in biodiversity and decreases in salinity. Should efforts be made to create a permanent dike? Is it feasible to restore the Aral Sea (in part or whole) or should it be considered a loss? Should the focus of donor money be placed on development of water resources and energy in the river basins, or to preserve and restore the Aral Sea?

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## 8. East Asia/Pacific

### 8.1. Mekong River

(with Constance L. Danner, Cynthia Lancaster, and Lee C. Sherman)

#### Introduction

Every river basin is unique, but the Mekong River basin has some particularly interesting political, hydrological and economic characteristics that present both opportunities and obstacles for cooperative management of basin resources. It is politically unique in that, among major international river basins, the Mekong has the longest-standing comprehensive river basin management organization. However, the largest and most powerful riparian country in the basin, China, has not opted to become a member of this organization even though they participate with the region in other ways. A fascinating hydrological feature of the Mekong is that one of its tributaries, the Tonle Sap, reverses its flow during the wet season when the Mekong floods back up into the Tonle Sap. This flood cycle is conducive for numerous species of migratory fish. Economically, fish represent the major protein source for a sizable portion of the lower basin population. Lastly, the basin has a history of grand schemes for development of its enormous hydropower potential, but only a handful of relatively small dams have been constructed. The significant exception to this is China's ongoing construction of dams in the upper reaches of the Mekong.



Map of Mekong Basin

The Mekong River has an area of 795,000 km<sup>2</sup> and a length of 4,200 km and includes six Asian countries: Burma (Myanmar); Cambodia (Kampuchea); China; Laos; Thailand; and Vietnam and it is the primary economic base for its 90 million inhabitants. Water use is dominated by agriculture needs, primarily irrigation. Rapid economic growth in the region and large population shift from rural to urban areas, have put growing pressure on water resources both in terms of water supply as well as quality. In most cases, management and protection of water resources has lagged far behind the pace of population growth and development.

### Countries of the Mekong River Basin

(Source: MRC, 2003; CIA World Factbook, 2006; WRI, 2006)

Country	Percent of Basin (%)	Percent of country in basin (%)	Population Total (mln)	GDP per capita (\$, 2005)	Irrigated Land (mln ha)	Renewable Water Resources, (m <sup>3</sup> /person)
Laos	25.4	85.3	6.4	1,900	0.2	60,318
Thailand	23.1	35.8	64.6	8,300	5.0	6,371
China	20.8	1.7	1,314	6,800	54.6	1,822
Cambodia	19.5	85.6	13.9	2,200	0.3	34,561
Vietnam	8.2	19.7	84.4	2,800	3.0	11,109
Myanmar	3.0	3.5	47.4	1,700	1.9	21,358

Behind the scenes of the Mekong's development lies a long-term political game, involving the future balance of power between Japan and China, with Indochina in between. China may be viewed as a threat to the Mekong region's future security. Strategists in Japan and Southeast Asia see a need to prevent China from dominating the region both politically and economically.

### Hydrology of the Basin

The Mekong River is the 12th-longest in the world - 4,200 km - and the 10th-largest by volume - annual discharge of over 475 billion m<sup>3</sup> (MRC, 2005). It drains an area of 795,000 km<sup>2</sup>. Amongst the six riparian states approximately 90 million people rely on the Mekong River. This area of Southeastern Asia has been affected by colonization, the Cold War and is now working together to develop this most underutilized river basin in the world.

The exact source of the river is not known, however the river's tributaries originate in Himalayan mountain ranges of Tibet at an elevation greater than 5 km. The stretch of the river through China, approximately half of its length, consists of deep gorges and inaccessible terrain. The total length of the river is approximately 4,200 km. Following this, the river forms the border between Myanmar and Laos for 200 km. The river then divides Laos and Thailand, before a stretch passing through Laos alone. In Laotian territory the river is characterized by an inconsistent course through gorges, rapids, and depths that vary from 0.5 to 100 m. The river again marks the Lao-Thai border followed by another short stretch through Laos alone. Finally reaching Cambodia, the Sambor rapids are the first obstacle that impedes navigation to the North. Just above Phnom Penh is the confluence with the Tonle Sap, the main

Cambodian tributary. The Tonle Sap acts as a natural reservoir within the Mekong River system and is the largest lake of Southeast Asia. In the dry season the lake drains southeast to the Mekong River, whereas in the monsoon season (June–November) the high waters of the Mekong reverse the flow and fill the lake. This unique natural system, that automatically changes flow direction based on the high and low waters of the Mekong, ensures a fresh water flow to the Mekong delta in Vietnam and prevents flooding downstream. In addition, the constant flow minimizes salt water intrusion from the South China Sea into the delta. The variability of the flood plain is risky for its residents who depend on the Mekong Basin, yet the rhythmic movement of the waters furnishes much of what is needed to improve the land. High waters deposit a layer of fertile silt, leaving the ground ready to support rich crops.

The extreme hydrological cycles of the Basin create opportunities for joint development in the construction of storage reservoirs to help moderate the hydrological extremes and thereby reduce damaging floods. They would also store water for dry season irrigation purposes, and produce hydroelectric power which can be distributed on a regional basis.

### **Geopolitical Basis for Intra-basin Dynamics**

The Mekong River has not been a source of regional tension for the riparian states. The area is so well-watered that allocations have not been a major issue. China and Myanmar are not participants in basin planning and, until recently, they have had no development plans which would disrupt the downstream riparians. Negotiations for joint management of the Mekong were not initiated due to crisis, rather through the foresight of the United Nations with the willing participation of the lower riparian states.

Some regional politics between the riparians have been played out through the basin commission (more on this below). Thailand, with the strongest economy and greatest resource needs has been pushing in recent years for revisions in the commission's rules which currently allow an effective veto of Thai projects by downstream riparians. Thailand has found its own funding for four Mekong projects within its own territory and has plans for several more, some of which will probably be opposed by downstream riparians.

Current plans to develop the Mekong include building dams on its upper reaches in China, as well as its tributaries and possibly the main stream in lower riparian states. The construction of such dams could have profound social and economic effects for downstream inhabitants.

### **Cultural and Political Factors**

A striking characteristic of the Mekong basin is the extent to which the river is "international" in nature; not only is it a boundary river for over 1,000 km, but it also constitutes essentially all of the water resources of Laos and Cambodia as well as the northeast of Thailand and the Vietnamese "rice bowl" in the Mekong Delta.

The states of the Mekong Basin appear to have ample scope for cooperation in order to address their common interests. The states have incentives to cooperate in order to reap the benefits of integrated development. Furthermore, the basin states may want to establish an orderly process for water allocation as the regional economy grows and competition for water resources increases.

The lands through which the Mekong flows are bywords for conflict. Tibet and Myanmar have been nearly cut off from the outside world for decades, while Vietnam, Cambodia and Laos were engulfed by warfare. Only Thailand is on the path of economic development. With peace restored to the region, so is the opportunity to work cooperatively to tap the river's full potential.

## **History**

Southeast Asia has a long history with influences of both the Chinese and Indian cultures along with their religions of Hinduism and Buddhism. Animosity exists between China, Vietnam, and Thailand, where Laos and Kampuchea have been the buffer zones in between. China has not played a direct role in the Mekong River since the Han Dynasty occupied Vietnam in 939 AD. China however has influenced the politics of Southeast Asia and taken various sides to gain economic advantages. The French Colonization of Vietnam, Cambodia, and Laos in the late 1800s and early 1900s affected the region until today due to the national boundary lines that were created. Myanmar was colonized and occupied by the British and after occupation they choose to isolate themselves from the world political arena. Japanese influence was also felt in this region during WWII when they occupied Vietnam, Laos, and Kampuchea. Only Thailand avoided colonization and occupation due to the various treaties and alliances they negotiated with the stronger nations. In recent history, the Cold War and Vietnam took the biggest toll on the region and halted a majority of the development of the there. The war not only cost lives but also affected the ecosystem of the region.

The current political makeup and control of each riparian state is as follows: China – communist, Myanmar – military rule, Laos – communist, Thailand – constitutional monarchy, Kampuchea – democracy, and Vietnam – communist. The nations of the lower Mekong have common social problems within their societies such as the accelerating spread of AIDS, drug addiction, corruption, and human trafficking. These nations need to work together to combat these issues along with their efforts for development of the basin.

Various rivalries exist within the region. One rivalry is between Thailand and Vietnam for political and economic domination of the region with the buffer states of Laos and Kampuchea. Another rivalry is between Thailand, Vietnam, and China over oil in the South China Sea Islands. Additionally history has created distrust by Thailand and Vietnam of the China's intentions in their realm of influence. Another concern of Vietnam and Thailand is the economic power of Japan within the region and the potential for Japan to increase their influence in more than just finances.

## **Platforms of the Riparian States**

**China** - China, the upper most riparian state, has not played a direct role in the development of the basin due to the geography of the river within its borders. However, China is the most powerful riparian state both economically and militarily. Only 1.7% of the basin area is within China's borders and they can only regulate approximately 25% of the flow. Recently, China has developed a broader interest in the hydrogeopolitics of the Mekong for hydropower and navigational access to the South China Sea. They are engaged in extensive dam-building and have completed one dam at Manwan and a second one is under construction at Dachaoshan. China is considering another 12 dams in the region. China is not a full member of the MRC (but they are a "Dialog" member since 2002), therefore the lower riparian states are concerned that the developments in China will prevent adequate sediment transport, which could endanger agriculture and fishing downstream. China has begun to clear out rocks, sandbars and other obstacles that hinder navigation in the river. This could increase the flow of water and erosion damaging the highly valuable fish stocks in the river.

**Myanmar (Burma)** - Myanmar has not held a significant role in the Mekong Basin for three reasons. First, the Mekong does not pass through their territory (it is only a boundary river) and only 3.5% of the basin lies within their territory. Second, the military regime has isolated their country both politically and economically. Lastly, the geography of the Mekong within their borders makes it difficult to utilize the river. Myanmar became a "Dialog" member of the MRC in 2002.

**Laos** - Laos controls approximately 85.5% of the Mekong River Basin. They have an immense water supply, however the region is very mountainous, and only a small portion of the land is irrigated. Navigation of the Mekong would greatly improve the economics of this landlocked country. They also desire to develop hydroelectric power for export, similar to the Nam Ngum Dam, and agriculture for export.

**Thailand** - Thailand one of the two most powerful states of the lower Mekong. Thailand has always played a vital role in the politics, economics, and hydrogeopolitics of the region. As the only country to avoid colonization and Japanese occupation they are strategically placed as a key component of the development of the basin. Thailand, as a middle riparian state with only 35.9% of the basin within their borders, seeks to develop the Northeast section of the country with the Mekong. This region of Thailand is the poorest due to limited water supply. Thailand's desires include developing this region, diverting water to Bangkok via another river, and producing additional hydropower. They have had a long history of tension with Vietnam and China; however they have consented to consultation with both the upper and lower basin nations in their developmental plans through the commission.

**Cambodia (Kampuchea)** – Cambodia has been underdeveloped due to the Vietnam War and numerous subsequent civil wars. Over 80% of their irrigated land has fallen out of use because of these wars. Prior to 1970 Kampuchea was a major exporter of

rice; however today less than 7% of the rice fields are irrigated. Cambodia comprises 85.4% of the Mekong River Basin including the Tonle Sap. The Tonle Sap ecosystem is one of the most productive inland fisheries in the world, supporting over 3 million people, and providing over 75% of Kampuchea's annual inland fish catch and 60% of the protein intake. Cambodia has emerged from domestic conflict to once again become involved with the hydro-politics of the region; however they will not be able to develop any of their water resources without outside assistance and cooperation of the other riparian states.

**Vietnam** - Vietnam is the lowest riparian in the basin and competes with Thailand for power within the region. The Vietnamese were the first people in Asia to master the art of irrigation and have made the Mekong Delta their most important rice producing region. The Delta produces half of the nation's annual production and is home to approximately 15 million people. Vietnam only comprises 19.9% of the Mekong River Basin the smallest percentage amongst the Lower Mekong Basin and the countries participating in the commission. Vietnam is concerned with upstream development, deforestation, and logging that reduces the agricultural potential of the delta. The Vietnamese are plagued by saltwater intrusion and acidic soils. They desire to develop the delta in order to achieve two to three rice crops a year.

### **International Involvement and the Mekong River Commission (MRC)**

Mekong River Basin stands out as an example of extensive international involvement in the development of the basin for over four decades. During the time of development the area was highly impacted by the Cold War and the politics that surrounded it, which hindered development. The UN began to be involved in the basin in 1949 at the conclusion of WWII when they established the Economic Commission for Asia and the Far East (ESCAFE). The first report on the potential development of the Lower Mekong Basin was completed by the ESCAFE in 1952; this report recognized the Mekong as an international watercourse.

From 1949 to the 1990s the UN and international involvement was somewhat ineffective and only one major project was completed in the Basin, the Nam Ngum Dam in Laos. The Nam Ngum Dam was completed in 1971 with generating capacity of 150 MW. This dam generates most of the electricity for Laos and exports the surplus to Thailand.

The benefits of the UN and International involvement during this period of the Cold War provided scientific and technical studies that are being used today for basin wide cooperation and development. It was also demonstrated that the cooperation was possible even though there was an ongoing, continuous conflict.

### **The Mekong River Commission**

In 1995 the basin states (except China and Myanmar) signed the "Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin" for the

establishment and commencement of the Mekong River Commission (MRC) between Vietnam, Laos, Cambodia, and Thailand. The MRC established a Basin Development Plan (BDP) divided into two phases: Phase 1 established and maintained a participatory form of basin planning; and drafted and obtained agreement on a basin development plan aiming at a balanced mix of social, economic, and environmental factors. Phase 2 included identifying and implementing development projects and programs.

The 1995 agreement includes many of the principles and much of the wording of the Helsinki rules and the 1997 UN Convention on the Law of the Non-navigational Uses of International Watercourses. Article 1 of the agreement includes the aim of optimizing benefits. Article 5 stated an objective of “reasonable and equitable utilization.” Article 7 states the aim “to make every effort to avoid, minimize and mitigate harmful effects that might occur to the environment from the development and use of the Mekong River Basin water resources”

The Mekong agreement goes somewhat further than the UN Convention in several ways. Each MRC member agreed to “cease immediately the alleged cause of harm” when presented by another member with proper and valid evidence of substantial damage. Article 8 then specifies the procedure for further dispute resolution. An additional agreement requires a six-month time frame for consultation between affected countries before a proposed development can begin. The seasonality of flows in the Mekong is addressed by differences in what is allowed during wet and dry seasons. Also, Article 6 addresses “maintenance of flows on the mainstream”. There are 3 specific provisions:

- 1) Flows are not to be allowed to drop below the minimum monthly natural flow during the dry season;
- 2) Flows are to be maintained to enable the acceptable natural reverse flow of the Tonle Sap to take place during the wet season; and
- 3) There is intent to prevent average daily peak flows greater than what naturally occur on the average during the flood season.

## **The Role of China and the GMS**

The reorganization of the MRC in 1995 specifically opened the door for China to become a member, but it has thus far opted only to participate as a Dialog Member (as has Myanmar). China controls the uppermost reaches of the basin and, by refusing to join the MRC, is exempt from its requirements, most notably notification and consultation. China is currently constructing a cascade of large dams on the Upper Mekong. Environmental impact assessments associated with these projects have fallen far short of conventional standards for such studies. The size, population, power and money of China dwarf that of all the other Mekong countries combined. China is a donor country for some of these neighbors, having provided funds for some much-

needed development projects. This makes it very difficult for the MRC countries to strongly protest actions by China.

Besides the MRC, the region is home to another influential cooperative organization: the Greater Mekong Subregion (GMS). This group was formed in 1992 under the leadership and direction of the Asian Development Bank (ADB). The GMS includes all six riparian Mekong countries: China, Myanmar, Thailand, Vietnam, Laos and Cambodia. Recent GMS developments include the signing of a power trade agreement. A study is currently underway to work out the specific operating rules and guidelines for technical coordination and pricing schemes. Hydropower is the power source of choice.

Hydropower has long been considered a key component of development schemes for the Mekong basin. An early development scheme for the basin, developed under U.S. auspices, called for construction of a series of large dams on the Mekong mainstream. The development plans has gradually been scaled back. Tributaries are considered more suitable than the Mekong mainstream. "Run-of-the river" dams are favored over larger reservoirs. The GMS Power Trade Agreement seems to be re-setting the stage for large-scale hydropower development in the basin to finally get underway.

One of the biggest challenges the MRC will face in the near future is how to strike a balance between hydropower development and the preservation of conditions necessary for maintaining fish production, if indeed such a balance is possible. The plans for hydropower development in the basin are highly contentious. Several recently constructed dams in the basin have caused some serious social and environmental problems and have been strongly opposed by local citizenry and by international environmental groups. The Pak Mun Dam, completed in 1994 west of the confluence of the Mun and Mekong rivers in Thailand, was constructed by the Electricity Generating Authority of Thailand (EGAT) with support from the World Bank. The Dam had such a detrimental effect on fish populations that local and international opposition eventually succeeded in persuading the government to open the dam until a more complete study could be undertaken. Villagers are still campaigning for permanent decommissioning of the dam. Similar problems are reported in relation to the Yali Falls Dam (Vietnam and Cambodia) and diversion dam at Theun-Hinboun in Laos.

## Questions

1. Should the MRC be viewed as a model of success? What are the successes? What are the failures? What factors favor a successful future? What are some of the obstacles to cooperation in the Mekong River basin?
2. Should the international community pressure China to join the MRC or at least act more responsibly towards downstream neighbors? What types of pressure could be applied?



3. What are some of the tradeoffs between the various water uses in the Mekong basin? Specifically, how do you weight the obvious subsistence dependence on fishing and agriculture against the objective of increasing the standard of living by providing hydropower to further economic development?
4. Can the states and peoples sharing the basin realize the dream of equitable, integrated, and sustainable development of their shared hydrological resources? What circumstances and factors may lead to such an outcome?
5. How would the hydropolitics of the Mekong River Basin be different if China played a more direct role in the agreements prior to today? How will the balance of power shift if China decides to participate in the MRC?
6. How is the ecosystem of the Mekong River Basin affected by the development?

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