Hydropolitical Vulnerability and Resilience along International Waters

ASIA

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Hydropolitical Resilience and Vulnerability along International Waters: Asia is the fifth of a five-part series of continental reports. This volume was compiled in collaboration between UNEP-DEWA; OSU's Transboundary Freshwater Dispute Database; the Asian Institute of Technology, Water Engineering and Management Department; and Yunnan University, Asian International Rivers Center. "Hydropolitical Resilience and Vulnerability: Series Introduction (Chapter 1)" was authored by Aaron T. Wolf, OSU Department of Geosciences. "Background on the Concepts of Vulnerability and Resilience as Applied to the South and Southeast Asian Regions" (Chapter 2) was authored by Shalini Kanwar and Ashim Das Gupta, Asian Institute of Technology; and Joshua Newton, Tufts University, Fletcher School of Law and Diplomacy. "Hydrovulnerability of West Asia" (Chapter 3) was authored by Geoffrey T. Klise, Alyssa M. Neir, Amy Ewing, and Berrin Basak Vener, University of New Mexico; Michael E. Campana, OSU's Institute for Water and Watersheds, and Department of Geosciences; and Alistair Rieu-Clarke, University of Dundee, International Water Law Research Institute. And "Hydropolitical Vulnerability and Resilience in International River Basins in China" (Chapter 4) was authored by Feng Yan, Yunnan University; and Darrin Magee, Hobart & William Smith Colleges, New York. Maps throughout the report and tables in the appendices were compiled by the Transboundary Freshwater Dispute Database Research Team (Department of Geosciences, OSU), which includes Marloes Bakker, Melissa Carper, Ryan Dey, Nathan Eidem, Barbara Geren, Samuel Littlefield, Erick Stemmerman, Yoshiko Sano, Kendra Hatcher, and Patrick MacQuarrie.

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Acronyms

ASBP	Aral Sea Basin Programme
ASEAN	Association of Southeast Asian Nations
BCM	Billion Cubic Meters
DEWA	Division of Early Warning and Assessment
ESCWA	Economic and Social Commission for Western Asia
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
GAP	Southeastern Anatolia Project
GBM	Ganges-Brahmaputra-Meghna
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information System
GLP	Good Laboratory Practice
GMS	Greater Mekong Sub-Region
GNP	Gross National Product
ICWC	Interstate Commission for Water Coordination
IFAS	International Fund for Saving the Aral Sea
IHP	International Hydrological Programme
IJC	International Joint Commission
ISARM	International Shared Aquifer Resource Management
IWLRI	International Water Law Research Institute
IWRM	Integrated Water Resources Management
JRMP	Joint River Management Project
LMB	Lower Mekong Basin
MDGs	Millennium Development Goals
MRC	Mekong River Commission
QA	Quality Assurance
QC	Quality Control
RBOs	River Basin Organizations
SAARC	South Asian Association for Regional Cooperation
TACIS	Technical Assistance to the Commonwealth of Independent States
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
WFD	Water Framework Directive

Preface

There is an increasing annual demand for water drawn from Asia's international rivers for domestic, agricultural, industrial, and environmental purposes. As a result, nations sharing river systems, lakes and aquifers are vulnerable to tensions and conflicts, which in many places are intensified by climate variation and climate change. Therefore monitoring, predicting and pre-empting transboundary water conflicts will become central issues for future human and environmental security.

Contrary to earlier beliefs, historical records reveal that nations across the world have been choosing to cooperate on water issues through "hydro-diplomacy" and "hydrological cooperation" rather than resorting to conflict. In addition, scientific findings are full of lessons learnt from the past which can guide current and future policy-making and water management.

This report focuses on the challenges and opportunities facing Asia—a continent with intensively utilized groundwater and surface water resources. The transboundary basins show signs of resilience, but also of vulnerability. In most instances it is politics and the lack of institutional agreements that play a major role in causing these vulnerabilities. At the regional and sub-regional level, there are entities, often supported by the international community, working to develop, manage, and share the multiple-use potential of shared water resources.

These entities, like UNEP, are guided by the 2002 World Summit on Sustainable Development targets for safe water supply and improved sanitation and by the work of UN-Water. UNEP's activities relating to freshwater also compliment these strategies by applying an ecosystem management approach that includes climate change considerations.

This publication presents a comprehensive assessment of the hydropolitical vulnerabilities and resiliencies of Asia's international waters, including detailed information on existing and forthcoming cooperative agreements that will inform policies at regional,

sub-regional, and national levels and enhance cooperation across the diverse social, political, and economic boundaries that characterize the Asia region.

ACHIM STEINER

United Nations Under-Secretary General

Executive Director,

United Nations Environment Programme

Foreword

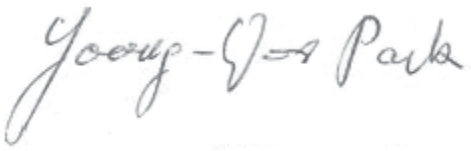
Water scarcity heightens the potential for conflicts among riparian countries in Asia and increases their vulnerability. A regional water resource cooperation mechanism would enhance collaboration and increase resilience so that water becomes an instrument for cooperation and unity rather than conflict. Historical evidence shows that we have more incidences of cooperation than conflict. We can build on lessons learned from these past experiences and safeguard the future of shared waters. With increasing climatic variation and climate change, these riparian countries will need to work towards collaboration in their governance systems, beginning with joint monitoring and assessment of shared water resources. This involves the application of the Integrated Water Resources Management (IWRM) within river basin ecosystems and gathering credible information for decision making. This approach would bring countries closer to achieving the Millennium Development Goals (MDGs) of access to safe water and sanitation by 2015.

Asia is presented with the challenge of increasing competition for freshwater resources because of higher demand and water pollution. Management of resources is compounded by the fact that different countries have different needs and are at different stages of development. The challenges of sharing water resources are therefore complex. One of these is the development of an equitable and sustainable sharing mechanism, in an environment where the use of water is subject to political considerations, different cultural norms and development goals. Another is to have in place a mechanism to resolve riparian issues and the establishment of institutional systems with legal and judicial mechanisms to reconcile differences. Riparian countries often face the syndrome of the "big regional brother" dominating other riparian countries either upstream or downstream. This syndrome needs to be eliminated and replaced with cooperation and equitable sharing of benefits and quantities.

This publication is a collaborative effort of the United Nations Environment Programme (UNEP) and Oregon State University and its network of partners in the region. It provides an insightful assessment of the hydropolitical atmosphere in Asia and offers lessons to enhance

future cooperation mechanisms. Most of the countries need to address a number of development issues, particularly those related to water, sanitation, and human settlements. Despite the region's endowment of adequate water resources, population growth and the continuing exploitation of resources for domestic and industrial use has led to water stress in many parts of the region. Poor water management practices have also compounded the negative impact on water quality and the ecosystems of the region. However it is encouraging to note that in several river basins, there has been progress in adopting basin-wide approaches to resolving issues.

There is a clear need in the region to establish practical frameworks for the management of shared water basins, including the protection of catchments areas, aquifers, wetlands and transitional waters. In this context, I welcome this publication, *Hydropolitical Vulnerability and Resilience along International Waters: Asia*. The close collaboration between the governments of Asia, UN agencies and the international community continues to generate increased awareness of the vulnerabilities of the region's shared water resources, as well as the benefits of collective actions at the national, sub-regional, and regional levels to confront these challenges. This publication should inspire the continuing development of intergovernmental dialogues and collective actions to halt and reverse the water challenges facing our world.



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This project, exemplary of the unifying force of transboundary waters, was built on the spirit of incredible collaboration among researchers and staff at the United Nations Environment Programme, and two of the partners in the Universities Partnership for Transboundary Waters: the Oregon State University's Department of Geosciences and Institute for Water and Watersheds and the University of New Mexico's Water Resources Program, both in the United States, as well numerous other individuals from around the world who responded to our requests for data, information, and reviews.

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This was an extraordinarily data-intensive project, which relied on the generosity of many researchers around the world who are committed to open distribution of their incredibly rich data sets, among them Charles Vorosmarty and Ellen Marie Douglas, from the Complex Systems Research Center, Institute for the Study of Earth, Oceans and Space, University of New Hampshire, who generously provided their five-year-mean historical global runoff data.

Chapter 1. Hydropolitical Vulnerability and Resilience: *Series Introduction*

Aaron T. Wolf

Water management is, by definition, conflict management. Postel (1999) describes the roots of the problem: Water, unlike other scarce, consumable resources, is used to fuel *all* facets of society, from biologies to economies to aesthetics and spiritual practice. Moreover, it fluctuates wildly in space and time, its management is usually fragmented, and it is often subject to vague, arcane, and/or contradictory legal principles. There is no such thing as managing water for a single purpose—*all* water management is multi-objective and based on navigating competing interests. Within a nation these interests include domestic users, agriculturalists, hydropower generators, recreators, and environmentalists—any two of which are regularly at odds—and the chances of finding mutually acceptable solutions drop exponentially as more stakeholders are involved. Add international boundaries, and the chances decrease exponentially yet again (Elhance, 1999).

Surface and groundwater that cross international boundaries present increased challenges to regional stability because hydrologic needs can often be overwhelmed by political considerations. While the potential for paralyzing disputes is especially high in these basins, history shows that water can catalyze dialogue and cooperation, even between especially contentious riparians. There are 263 rivers around the world that cross the boundaries of two or more nations, and untold number of international groundwater aquifers. The catchment areas that contribute to these rivers comprise approximately 47% of the land surface of the earth, include 40% of the world's population, and contribute almost 80% of freshwater flow (Wolf et al., 1999). Twenty-five of these international or transboundary basins cover some 37% of the land area of seven nations in Central America.

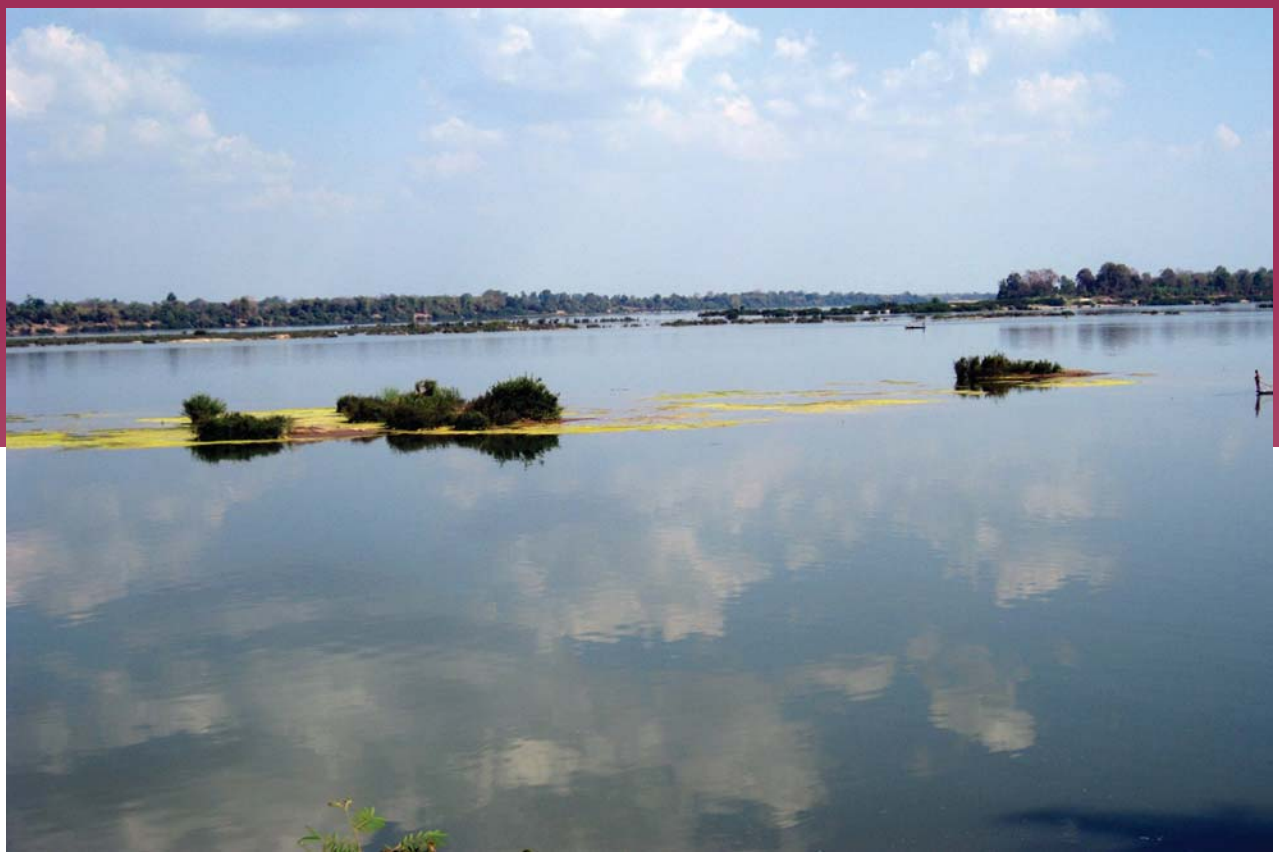
Within each international basin, allocations from environmental, domestic, and economic users increase annually, while the amount of freshwater in the world remains roughly the same as it has been throughout history. Given the scope of the problems and the resources available to address them, avoiding water conflict is vital. Conflict is expensive, disruptive, and interferes with efforts to relieve human suffering, reduce environmental degradation, and achieve economic growth. Developing the capacity to monitor, predict, and preempt transboundary water conflicts, particularly in developing countries, is key to promoting human and environmental security in international river basins, regardless of the scale at which they occur.

1.1 Hydropolitical Vulnerability and Resilience

In general, concepts of "resilience" and "vulnerability" as related to water resources are often assessed within the framework of "sustainability," (Blaikie et al., 1994), and relate to the ability of bio-physical systems to adapt to change (e.g., Gunderson and Pritchard, 2002). As the sustainability discourse has broadened to include human systems in recent years, so too has work been increasingly geared towards identifying indicators of resilience and vulnerability within this broader context (e.g., Bolte et al., 2004; Lonergan et al., 2000; Turner, 2003). In parallel, dialogue on "security" has migrated from traditional issues of war and peace toward also beginning to incorporate the human-environment relationship in the relatively new field of "environmental security" (see UNEP, 2004; Vogel and O'Brien, 2004).

Figure 1.1 International river basins of Asia.

Figure 1.2 International river basins, countries, territories, and areas of Asia.



Mekong River near Steung Treng, Cambodia. Photo credit: Stephanie Garvey.

The term "hydropolitics" (coined by Waterbury 1979) came about as the potential for conflict and violence to erupt over international waters began to receive substantial new attention. Hydropolitics relates to the ability of geopolitical institutions to manage shared water resources in a politically sustainable manner, i.e., without tensions or conflict between political entities. "Hydropolitical resilience," then, is defined as the complex human-environmental system's ability to adapt to permutations and change within these systems; "hydropolitical vulnerability" is defined by the risk of political dispute over shared water systems. Wolf et al. (2003) suggested the following relationship between change, institutions, and hydropolitical vulnerability: "The likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change."

This suggests that there are two sides to the dispute setting: the rate of change in the system and the institutional capacity. In general, most of the parameters regularly identified as indicators of water conflict are actually only weakly linked to dispute. Institutional capacity within a basin, however, whether defined as water management bodies or treaties, or generally positive international relations, is as important, if not more so, than the physical aspects of a system. It turns out, then, that very rapid changes, either on the institutional side or in the physical system, that outpace the institutional capacity to absorb those changes, are at the root of most water conflict. For example, the rapid institutional change in "internationalized" basins, i.e., basins that include the management structures of newly independent States, has resulted in disputes in areas formerly under British administration (e.g., the Nile, Jordan, Tigris-Euphrates, Indus, and Ganges-Brahmaputra), as well as in the former Soviet Union (e.g., the Aral tributaries and the Kura-Araks). On the physical side, rapid change most outpaces institutional capacity in basins that include unilateral development projects *and* the absence of cooperative regimes, such as treaties, river basin organizations (RBOs), or technical working groups, or when relations are especially tenuous over other issues (Wolf et al., 2003).

The general assumption of this series, then, which will be explored in each regional study, is that rapid change tends to indicate vulnerability while institutional capacity tends to indicate resilience, *and* that the two sides must be assessed in conjunction with each other for

a more accurate gauge of hydropolitical sustainability. Building on these relationships, the characteristics of a basin that would tend to enhance resilience to change include

- international agreements and institutions, such as RBOs
- a history of collaborative projects
- generally positive political relations
- higher levels of economic development

In contrast, facets that would tend towards vulnerability would include

- rapid environmental change
- rapid population growth or asymmetric economic growth
- major unilateral development projects
- the absence of institutional capacity
- generally hostile relations
- natural climatic variability—naturally variable rainfall patterns with frequent periods of floods and drought.

1.2 Water and Security

Water disputes revolve around one or more of three issues: quantity, quality, and timing. The dynamics of those three issues play out very differently within various scales related to water and security, whether internationally, intranationally, or regionally and indirectly. Each setting might be characterized as follows (for examples, see Table 1.1):

1. *International waters:* very little violence, but long processes from tension to cooperation, resulting in exacerbated political relations, inefficient water management, and ecosystem neglect; long, rich record of conflict resolution and development of resilient institutions; institutional capacity is at the heart of whether environmental stresses lead to conflict or cooperation.
2. *Intranational waters* (between subnational political units, including states/provinces, ethnic/religious groups, and/or economic sectors): violence potential higher than in international setting; rationale for international involvement more difficult, given greater issues of national sovereignty.
3. *Regional instability (indirect)/political dynamics of loss of irrigation water:* potential for politically destabilizing processes of mass migrations to cities and/or neighboring countries when water supplies for broadly irrigated regions are threatened due to a drop in quantity (including lowering of groundwater levels) or quality; issues of poverty alleviation and distribution of wealth are tied directly to amelioration of security concerns.

1.2.1 International Waters

Water is a unique and vital resource for which there is no substitute. It ignores political boundaries, fluctuates in both space and time, and has multiple and conflicting demands on its use—problems compounded in the international realm by the fact that the international law that governs it is poorly developed, contradictory, and unenforceable. It is no wonder, then, that water is perpetually suspect—not only as a cause of historic armed conflict, but as the resource that will bring combatants to the battlefield in the 21st century. What is the likelihood that "the wars of

Water in a canal from Banias Springs, the source of the Jordan River, Golan Heights. Photo credit: Aaron T. Wolf.

TABLE 1.1 SELECTED EXAMPLES OF WATER-RELATED DISPUTES.

QUANTITY

Cauvery River, South Asia

The dispute on India's Cauvery River sprang from the allocation of water between the downstream state of Tamil Nadu, which had been using the river's water for irrigation, and upstream Karnataka, which wanted to increase irrigated agriculture. The parties did not accept a tribunal's adjudication of the water dispute, leading to violence and death along the river.

Mekong Basin, Southeast Asia

Following construction of Thailand's Pak Mun Dam, more than 25,000 people were affected by drastic reductions in upstream fisheries and other livelihood problems. Affected communities have struggled for reparations since the dam was completed in 1994.

Okavango-Makgadikgadi Basin, Southern Africa

In the Okavango-Makgadikgadi Basin, Botswana's claims for water to sustain the delta and its lucrative ecotourism industry contribute to a dispute with upstream Namibia, which wants to pipe water from the Okavango River to supply its capital city with industrial and drinking water.

QUALITY

Rhine River, Western Europe

Rotterdam's harbor had to be dredged frequently to remove contaminated sludge deposited by the Rhine River. The cost was enormous and consequently led to controversy over compensation and responsibility among Rhine users. While in this case negotiations led to a peaceful solution, in areas that lack the Rhine's dispute resolution framework, siltation problems could lead to upstream/downstream disputes.

QUANTITY AND QUALITY

Incomati River, Southern Africa

Dams and water transfers in the South African area of the Incomati River basin reduced freshwater flows and increased salt levels in Mozambique's Incomati estuary. This altered the estuary's ecosystem and led to the disappearance of salt-intolerant plants and animals that are important for people's livelihoods.

TIMING

Syr Dar'ya, Central Asia

Relations between Kazakhstan, Kyrgyzstan, and Uzbekistan—all riparians of the Syr Dar'ya, a major tributary of the disappearing Aral Sea—exemplify the problems caused by water flow timing. Under the Soviet Union's central management, spring and summer irrigation in downstream Uzbekistan and Kazakhstan balanced upstream Kyrgyzstan's use of hydropower to generate heat in the winter. But the parties are barely adhering to recent agreements that exchange upstream flows of alternate heating sources (natural gas, coal, and fuel oil) for downstream irrigation, sporadically breaching the agreements.

Sources: Wolf et al. 2005; Jägerskog 2003; Allan 2001; Elhance 1999; Bulloch and Darwish 1993; Starr 1991; Israeli-Jordanian peace treaty (www.israel- mfa.gov.il/mfa/go.asp?MFAH00pa0); Israeli-Palestinian interim agreement (www.mfa.gov.il/mfa/go.asp?MFAH00qd0#app-40, and www.nad-plo.org/fact/annex3.pdf).

Washing up in water from a qanat, a subterranean form of water infrastructure still used to provide water for drinking and irrigation in arid and semi-arid climates. Photo credit: Babak Sedighi.

the next century will be about water," as some have predicted?[1]

1.2.1.1 Examining the Record

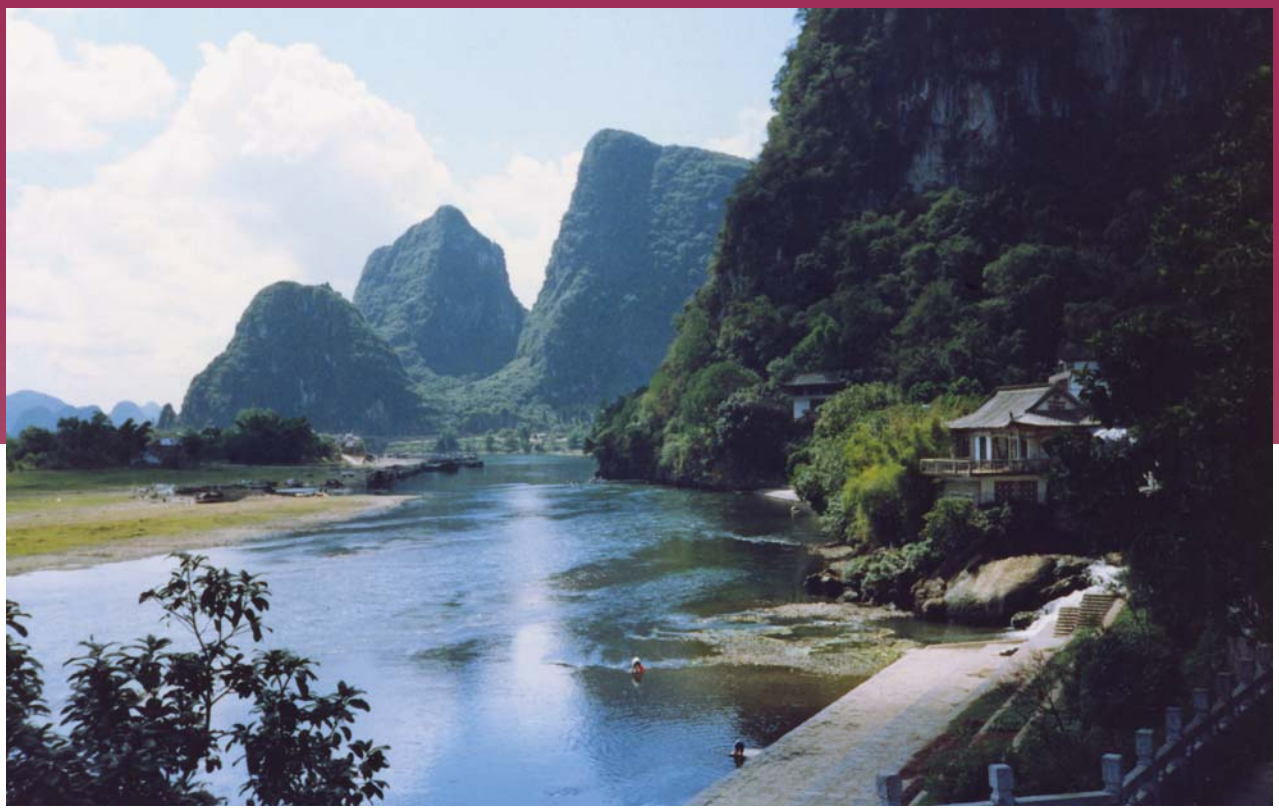
In order to cut through the prevailing anecdotal approach to the history of water conflicts, researchers at Oregon State University (OSU) undertook a three-year research project, which attempted to compile a dataset of *every* reported interaction between two or more nations, whether conflictive or cooperative, that involved water as a scarce and/or consumable resource or as a quantity to be managed—i.e., where water was the *driver* of the events,[2] over the past 50 years (Wolf et al., 2003). The study documented a total of 1,831 interactions, both conflictive and cooperative, between two or more nations over water during the past 50 years, and found the following:

First, despite the potential for dispute in international basins, the record of acute conflict over international water resources is historically overwhelmed by the record of cooperation. The last 50 years have seen only 37 acute disputes (those involving violence); of those, 30 were between Israel and one or another of its neighbours, and the violence ended in 1970. Non-Mideast cases accounted for only five acute events, while, during the same period, 157 treaties were negotiated and signed. In fact, the only "water war" between nations on record occurred over 4,500 years ago between the city-states of Lagash and Umma in the Tigris-Euphrates basin (Wolf, 1998). The total number of water-related events between nations of any magnitude are likewise weighted towards cooperation: 507 conflict-related events, versus 1,228 cooperative events, implying that violence over water is neither strategically rational, hydrographically effective, nor economically viable.

Second, despite the occasional fiery rhetoric of politicians—perhaps aimed more often at their own constituencies than at an enemy—most actions taken over water are mild. Of all the events, some 43% fell between mild verbal support and mild verbal hostility. If the next level on either side—official verbal support and official

[1] World Bank vice-president Ismail Serageldin, quoted in the *New York Times*, 10 August 1995. His statement is probably most often quoted. For fear of water wars, see Joyce R. Starr, "Water Wars," *Foreign Policy* (Spring 1991): 17–36; and John Bulloch and Adel Darwish, *Water Wars: Coming Conflicts in the Middle East* (London: Victor Gollancz, 1993).

[2] Excluded are events where water is incidental to the dispute, such as those concerning fishing rights, access to ports, transportation, or river boundaries. Also excluded are events where water is not the driver, such as those where water is a tool, target, or victim of armed conflict.



Li River (Li Jiang), tributary of the Pearl River, near Guilin, China. Photo credit: Tom and Heidi Powell.

verbal hostility—is added in, the share of verbal events reaches 62% of the total. Thus almost two-thirds of all events were only verbal and more than two-thirds of those had no official sanction (Wolf, 1998).

Third, there were more issues of cooperation than of conflict. The distribution of cooperative events covered a broad spectrum, including water quantity, quality, economic development, hydropower, and joint management. In contrast, almost 90% of the conflict-laden events related to quantity and infrastructure. Furthermore, almost all extensive military acts (the most extreme cases of conflict) fell within these two categories (Wolf, 1998).

Fourth, despite the lack of violence, water acted as both an irritant and a unifier. As an irritant, water can make good relations bad and bad relations worse. Despite the complexity, however, international waters can act as a unifier in basins with relatively strong institutions.

This historical record suggests that international water disputes do get resolved, even among enemies, and even as conflicts erupt over other issues. Some of the world's most vociferous enemies have negotiated water agreements or are in the process of doing so, and the institutions they have created often prove to be resilient, even when relations are strained.

The Mekong Committee, for example, established by the governments of Cambodia, Laos, Thailand, and Vietnam as an intergovernmental agency in 1957, exchanged data and information on water resources development throughout the Vietnam War. Israel and Jordan have held secret "picnic table" talks on managing the Jordan River since the unsuccessful Johnston negotiations of 1953–1955, even though they were technically at war from Israel's independence in 1948 until the 1994 treaty. The Indus River Commission survived two major wars between India and Pakistan. And all 10 Nile Basin riparian countries are currently involved in senior government-level negotiations to develop the basin cooperatively, despite "water wars" rhetoric between upstream and downstream states.[3]

In Southern Africa, a number of river basin agreements were signed in the 1970s and 1980s, when the region was embroiled in a series of local wars. Although complex to negotiate, the

[3] Mekong Committee from Ti Le-Huu and Lien Nguyen-Duc, *Mekong Case Study*, PCCP Series No. 10 (Paris, France: UNESCO-IHP 2003); Indus River Commission from Aaron T. Wolf, "Water and Human Security," *AVISO Bulletin,* Global Environmental Change and Human Security Project, Canada (June 1999); and Nile Basin talks from Alan Nicol, *The Nile: Moving beyond Cooperation*, PCCP Series No. 16 (Paris, France: UNESCO-IHP 2003).

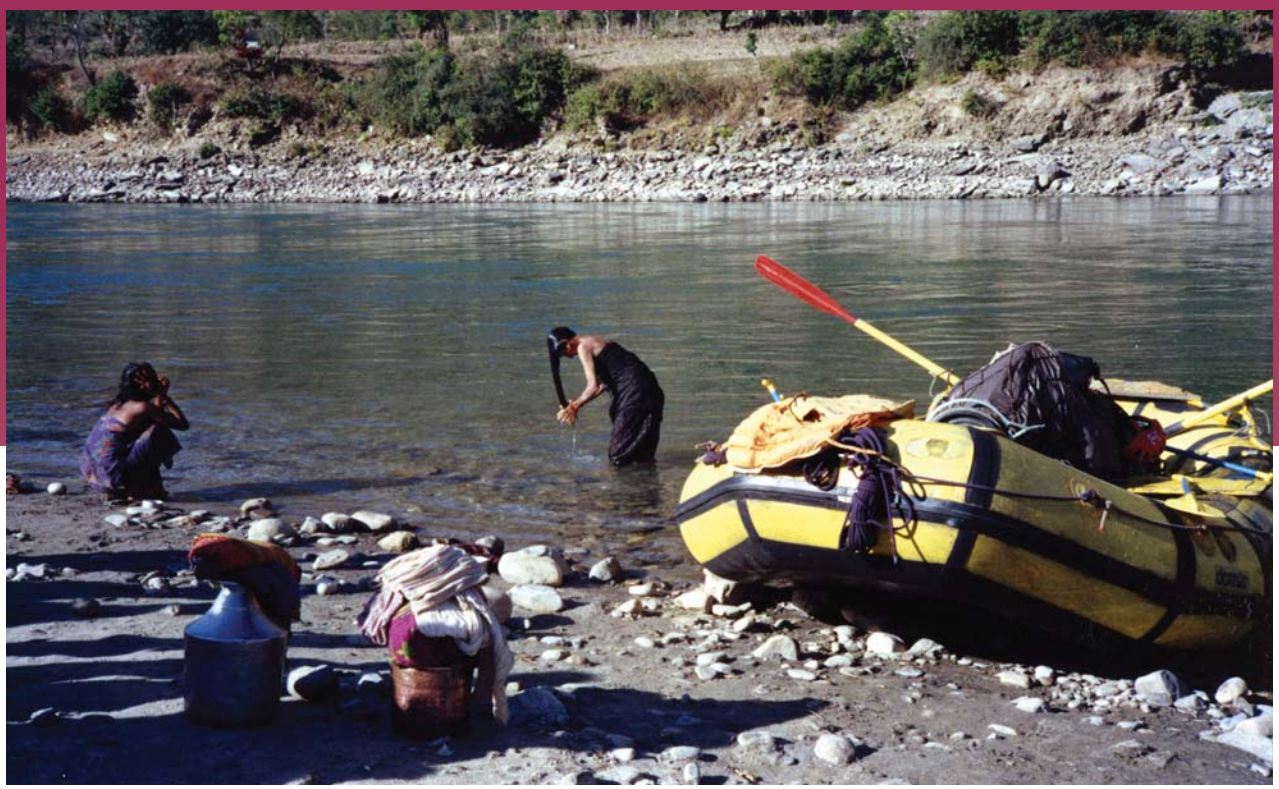
Schoolboys crossing the Sirwan/Diyala River, a tributary of the Tigris, in Kurdistan, Iran. Photo credit: Babak Sedighi.

agreements, once established, were one of the rare arenas of peaceful cooperation between countries. Now that the wars in the area have ended, water cooperation is one of the foundations for regional cooperation (Turton, 2004). Some have identified cooperation over water resources as a particularly fruitful entry point for building peace; however, it is unclear what conditions are required for environmental cooperation to play a major role (Conca and Dabelko, 2002).

1.2.1.2 Tensions and Time Lags: Causes for Concern

So if there is little violence between nations over their shared waters, what's the problem? Is water actually a security concern at all? In fact, there are a number of issues where water causes or exacerbates tensions, and it is worth understanding these processes to know both how complications arise and how they are eventually resolved.

The first complicating factor is the time lag between when nations first start to impinge on each other's water planning and when agreements are finally, arduously, reached. A general pattern has emerged for international basins over time. Riparians of an international basin implement water development projects unilaterally—first on water within their own territory—in attempts to avoid the political intricacies of the shared resource. At some point, one of the riparians, generally the regional power, will implement a project that impacts at least one of its neighbours. In the absence of relations or institutions conducive to conflict resolution, the project can become a flashpoint, heightening tensions and regional instability, and requiring years or, more commonly, decades, to resolve—the Indus treaty took 10 years of negotiations, the Ganges 30, and the Jordan 40—and, all the while, water quality and quantity degrades to where the health of dependent populations and ecosystems is damaged or destroyed. This problem gets worse as the dispute gains in intensity; one rarely hears talk about the ecosystems of the lower Nile, the lower Jordan, or the tributaries of the Aral Sea—they have effectively been written off to the vagaries of human intractability. During such periods of low-level tensions, threats and disputes rage across boundaries with relations as diverse as those between Indians and Pakistanis and between Americans and Canadians. Water was the last and most contentious issue resolved in negotiations over a 1994 peace treaty between Israel and Jordan, and was relegated to "final



Villagers bathing near boats from a whitewater rafting party on the banks of the Sun Kosi, Nepal. Photo credit: Tom and Heidi Powell.

status" negotiations—along with other of the most difficult issues such as Jerusalem and refugees—between Israel and the Palestinians.

The timing of water flow is also important; thus, the operation of dams is also contested. For example, upstream users might release water from reservoirs in the winter for hydropower production, while downstream users might need it for irrigation in the summer. In addition, water quantity and water flow patterns are crucial to maintaining freshwater ecosystems that depend on seasonal flooding. Freshwater ecosystems perform a variety of ecological and economical functions and often play an important role in sustaining livelihoods, especially in developing countries. As awareness of environmental issues and the economic value of ecosystems increases, claims for the environment's water requirements are growing. For example, in the Okavango Basin, Botswana's claims for water to sustain the Okavango Delta and its lucrative ecotourism industry have contributed to a dispute with upstream Namibia, which wants to use some of the water passing through the Caprivi Strip on its way to the delta for irrigation.

Water quality problems include excessive levels of salt, nutrients, or suspended solids. Salt intrusion can be caused by groundwater overuse or insufficient freshwater flows into estuaries. For example, dams in the South African part of the Incomati River basin reduced freshwater flows into the Incomati estuary in Mozambique and led to increased salt levels. This altered the estuary's ecosystem and led to the disappearance of salt-intolerant flora and fauna important for people's livelihoods (the links between loss of livelihoods and the threat of conflict are described below). The same exact situation exists on the border between the United States and Mexico, where high salinity problems have not only reduced agricultural productivity, but have severely altered ecosystems in the Colorado and Rio Grande rivers and impacted marine flora and fauna in the Gulfs of California and Mexico, where the respective rivers terminate.

Excessive amounts of nutrients or suspended solids can result from unsustainable agricultural practices, eventually leading to erosion. Nutrients and suspended solids pose a threat to freshwater ecosystems and their use by downstream riparians, as they can cause eutrophication and siltation, respectively, which, in turn, can lead to loss of fishing grounds or arable land. Suspended solids can also cause the siltation of reservoirs and harbours: for example, Rotterdam's harbor had to be dredged frequently to remove contaminated sludge deposited by the Rhine River. The cost was enormous, and consequently

River-boat passenger, Mekong River, Laos. Photo credit: Alison Jarrett.

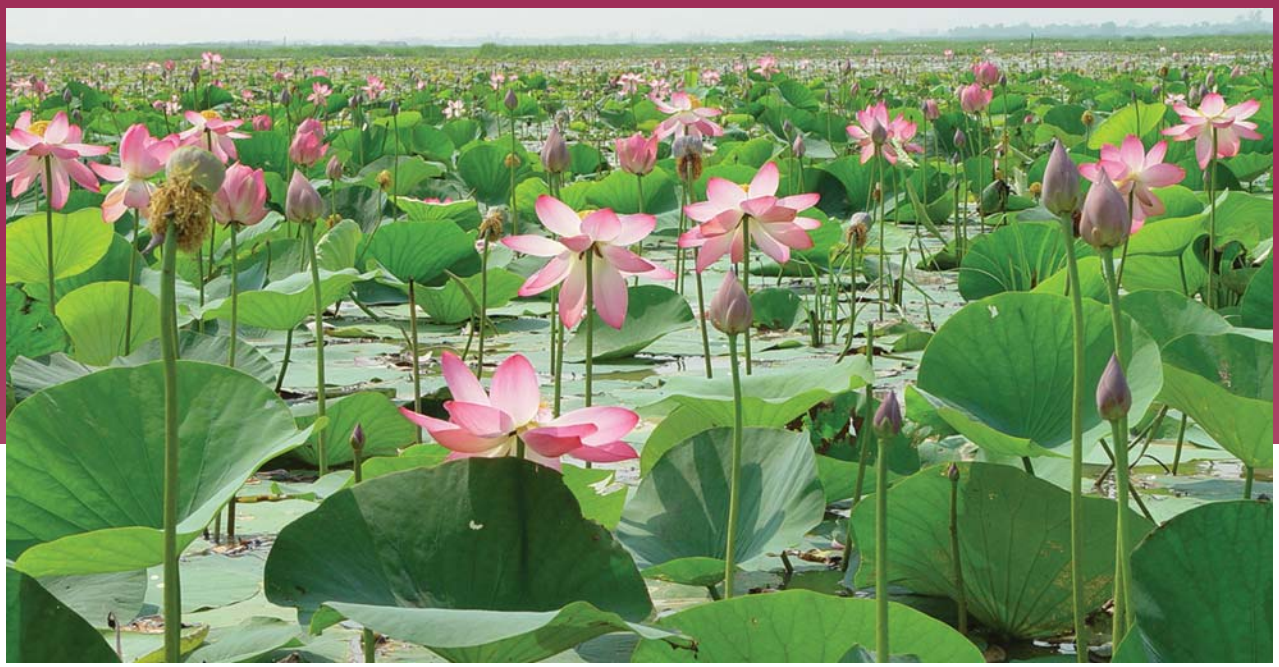
led to conflict over compensation and responsibility among the river's users. Although negotiations led to a peaceful solution in this case, without such a framework for dispute resolution, siltation problems can lead to upstream/downstream disputes such as those in the Lempa River basin in Central America (Lopez, 2004).

1.2.1.3 Institutional Capacity: The Heart of Conflict Management

Most authors who write about hydropolitics, and especially those who explicitly address the issue of water conflicts, hold to the common assumption that it is the scarcity of such a critical resource that drives people to conflict. It feels intuitive—the less there is of something, especially something as important as water, the more dearly it is held and the more likely people are to fight over it.

The three-year OSU study worked to tease out just what the indicators of conflict are. A 100-layer Geographic Information System (GIS) was compiled—a spatial database of all the parameters that might prove part of the conflict/cooperation story, including physical (e.g., runoff, droughts), socioeconomic (e.g., GDP, rural/urban populations), and geopolitical (e,g., government type, votes on water-related UN resolutions) parameters. With this GIS in place, a statistical

Drawing water from a birkeh, *used to collect and store water for community use in southern Iran. Photo credit: Babak Sedighi.*



Aquatic plants in restored wetlands, Hail Haor, Bangladesh. With the restoration, water flows from larger rivers have been improved and native fish species have been reintroduced. Photo credit: USAID.

snapshot was developed of each setting for each of the events over the last 50 years of conflict or cooperation.

The results were surprising, and often counterintuitive. *None* of the physical parameters were statistically significant—arid climates were no more conflictive than humid climates, and international cooperation actually *increased* during droughts. In fact, when the numbers were run, almost no single variable proved causal—democracies were as conflictive as autocracies, rich countries as poor countries, densely populated countries as sparsely populated ones, and large countries the same as small countries.

It was close reflection of aridity that finally put researchers on the right track: institutional capacity was the key. Naturally arid countries were cooperative: if one lives in a water-scarce environment, one develops institutional strategies for adapting to that environment. Once institutions—whether defined by formal treaties, informal working groups, or generally warm relations—and their relationship to the physical environment became the focus, researchers began to get a clear picture of the settings most conducive to political tensions in international waterways.

We found that the likelihood of conflict increases significantly whenever two factors come into play. The first is that some large or rapid change occurs in the basin's physical setting—typically the construction of a dam, river diversion, or irrigation scheme—or in its political setting, especially the breakup of a nation that results in new international rivers. The second factor is that existing institutions are unable to absorb and effectively manage that change. This is typically the case when there is no treaty spelling out each nation's rights and responsibilities with regard to the shared river, nor any implicit agreements or cooperative arrangements. Even the existence of technical working groups can provide some capability to manage contentious issues, as they have in the Middle East.

The overarching lesson of the study is that unilateral actions to construct a dam or river diversion *in the absence* of a treaty or institutional mechanism that safeguards the interests of other countries in the basin is highly destabilizing to a region, often spurring decades of hostility before cooperation is pursued. In other words, the red flag for water-related tension between countries is not water stress *per se,* as it is within countries, but rather the unilateral exercise of domination of an international river, usually by a regional power.

In the Jordan River basin, for example, violence broke out in the mid-1960s over an "all-Arab" plan to divert the river's headwaters (itself a pre-emptive move to thwart Israel's intention to

Yemen water canal project has improved irrigation for farmers and has created many jobs. Photo credit: USAID.

siphon water from the Sea of Galilee). Israel and Syria sporadically exchanged fire between March 1965 and July 1966. Water-related tensions in the basin persisted for decades and only recently have begun to dissipate.

A similar sequence of events transpired in the Nile basin, which is shared by 10 countries—of which Egypt is last in line. In the late 1950s, hostilities broke out between Egypt and Sudan over Egypt's planned construction of the High Dam at Aswan. The signing of a treaty between the two countries in 1959 defused tensions before the dam was built. But no water-sharing agreement exists between Egypt and Ethiopia, where some 55% of the Nile's flow originates, and a war of words has raged between these two nations for decades. As in the case of the Jordan, in recent years the Nile nations have begun to work cooperatively toward a solution thanks in part to unofficial dialogues among scientists and technical specialists that have been held since the early 1990s, and more recently a ministerial-level "Nile Basin Initiative" facilitated by the United Nations and the World Bank.

1.2.2 Intranational Waters

The second set of security issues occurs at the sub-national level. Much literature on trans-boundary waters treats political entities as homogeneous monoliths: "Canada feels . . ." or "Jordan wants. . . ." Analysts are only recently highlighting the pitfalls of this approach, often by showing how different subsets of actors relate very different "meanings" to water. Rather than being simply another environmental input, water is regularly treated as a security issue, a gift of nature, or a focal point for local society. Disputes, therefore, need to be understood as more than "simply" over a quantity of a resource, but also over conflicting attitudes, meanings, and contexts. Throughout the world, local water issues revolve around core values that often date back generations. Irrigators, indigenous populations, and environmentalists, for example, can see water as tied to their very ways of life, and increasingly threatened by newer uses for cities and hydropower. Moreover, the local setting strongly influences international dynamics and vice versa.

If there is a history of water-related violence, and there is, it is a history of incidents at the sub-national level, generally between tribes, water-use sectors, or states/provinces. In fact, the recent research at OSU suggests that, as the scale drops, the likelihood and intensity of violence rises.[4] There are many examples of internal water conflicts ranging from interstate violence and death along the Cauvery River in India, to the

[4] Giordano, M. A., and Wolf, A. T. 2003. Sharing waters: Post-Rio international water management. *Natural Resources Forum*. 27: 163-171.

USA, where California farmers blew up a pipeline meant for Los Angeles, to inter-tribal bloodshed between Maasai herdsmen and Kikuyu farmers in Kenya. The inland, desert state of Arizona in the USA even commissioned a navy (made up of one ferryboat) and sent its state militia to stop a dam and diversion on the Colorado River in 1934.

Another contentious issue is water quality, which is also closely linked to water quantity. Decreasing water quality can render it inappropriate for some uses, thereby aggravating its scarcity. In turn, decreasing water quantity concentrates pollution, while excessive water quantity, such as flooding, can lead to contamination by sewage. Low water quality can pose serious threats to human and environmental health. Water quality degradation is often a source of dispute between those who cause degradation and the groups affected by it. As pollution increasingly impacts upon livelihoods and the environment, water quality issues can lead to public protests.

After a water users association and irrigation plan were put into place, farmers in the Rudaki region of Tajikistan saw substantial increases in both harvests and incomes. Photo credit: Virginija Morgan, USAID/CAR.

One of the main causes of declining water quality is pollution, e.g., through industrial and domestic wastewater or agricultural pesticides. In Tajikistan, for example, where environmental stress has been linked to civil war (1992–1997), high levels of water pollution have been identified as one of the key environmental issues threatening human development and security. Water pollution from the tanning industry in the Palar Basin of the Indian state of Tamil Nadu makes the water within the basin unfit for irrigation and consumption. The pollution contributed to an acute drinking water crisis, which led to protests by the local community and activist organizations, as well as to disputes and court cases between tanners and farmers (Carius et al., 2003).

1.3 Regional Instability: Political Dynamics of Loss of Irrigation Water

As water quality degrades—or quantity diminishes—over time, the effect on the stability of a region can be unsettling. For example, for 30 years the Gaza Strip was under Israeli occupation. Water quality deteriorated steadily, saltwater intrusion degraded local wells, and water-related diseases took a rising toll on the people living there. In 1987, the *intifada,* or Palestinian uprising, broke out in the Gaza Strip, and quickly spread throughout the West Bank. Was water quality the cause? It would be simplistic to claim direct causality. Was it an irritant exacerbating an already tenuous situation? Undoubtedly.

An examination of relations between India and Bangladesh demonstrates that these internal instabilities can be both caused and exacerbated by international water disputes. In the 1960s, India built a barrage at Farakka, diverting a portion of the Ganges flow away from its course into Bangladesh, in an effort to flush silt away from Calcutta's seaport, some 100 miles to the south. In Bangladesh, the reduced upstream flow resulted in a number of adverse effects: degraded surface and groundwater, impeded navigation, increased salinity, degraded fisheries, and endangered water supplies and public health. Migration from affected areas further

As he passes raw sewage and garbage on his way home from school in Nasiriyah, an Iraqi child greets a foreigner. The lack of a drainage system, a high water table, and the open-air sewage canals have created health issues in Iraq. Photo credit: Thomas Hartwell, USAID.

compounded the problem. Ironically, many of those displaced in Bangladesh have found refuge in India.

Two-thirds of the world's water use is for agriculture so, when access to irrigation water is threatened, one result can be movement of huge populations of out-of-work, disgruntled men from the country-side to the cities—an invariable recipe for political instability. In pioneering work, Sandra Postel identified those countries that rely heavily on irrigation, and whose agricultural water supplies are threatened either by a decline in quality or quantity. The list coincides precisely with regions of the world community's current security concerns, where instability can have profound effects: India, China, Iran, Pakistan, Uzbekistan, Iraq, Bangladesh, and Egypt (Postel and Wolf, 2001).

Water management in many countries is also characterized by overlapping and competing responsibilities among government bodies. Disaggregated decision-making often produces divergent management approaches that serve contradictory objectives and lead to competing claims from different sectors. And such claims are even more likely to contribute to disputes in countries where there is no formal system of water-use permits, or where enforcement and monitoring are inadequate. Controversy also often arises when management decisions are formulated without sufficient participation by local communities and water users, thus failing to take into account local rights and practices. Protests are especially likely when the public suspects that water allocations are diverting public resources for private gain or when water use rights are assigned in a secretive and possibly corrupt manner, as demonstrated by the violent confrontations in 2000 following the privatization of Cochabamba, Bolivia's water utility (Postel and Wolf, 2001).

Finally, there is the human security issue of water-related disease. It is estimated that between 5 and 10 million people die each year from water-related diseases or inadequate sanitation. More than half the people in the world lack adequate sanitation. Eighty percent of disease in the developing world is related to water (Gleick, 1998). This is a crisis of epidemic proportions, and the threats to human security are self-evident.

Showering in a waterfall of the Ganges.
Photo credit: Tom and Heidi Powell.

Chapter 2. Background on the Concepts of Vulnerability and Resilience as Applied to the South and Southeast Asian Regions

Shalini Kanwar, Ashim Das Gupta, and Joshua Newton

In South and Southeast Asia, the combined factors of population growth, urbanization, industrialization, and economic development exert pressure on natural resources, particularly water resources. Competition for freshwater resources is increasing because of higher demand and a greater variety of uses and users, as well as depletion of some water resources due to pollution. Management of water resources becomes more complex as multiple countries share these resources. Transboundary water systems are shared by two or more countries. Fair and rational development of transboundary water resources poses a unique challenge as different uses are subject to the politics, cultures, stages of development, and differing development goals of riparian countries sharing the resources. Proper institutional systems with legal and judicious mechanisms may not be in place to reconcile the differences. In most cases, a politically dominant and powerful country dictates and controls the development process. Often the dominant country is upstream and its unilateral action, in turn, becomes a breeding ground for conflicts. For example, when one riparian country builds dams on the main stems of international rivers and/or on major tributaries, the flow regime in downstream countries could be significantly affected, which brings adverse consequences for water use and the riparian environment. Environmental degradation results as a consequence of overexploitation and contamination of the resource. In order to address these issues, some form of communication between the riparian countries at both technical and political levels is required to establish a dialogue, reconcile the differences, and frame a joint strategic plan for development and environmental protection.

International-, regional-, and local-level conflicts regarding access to and use of freshwater pose a serious threat to both human security and the security of countries, especially in those regions of the globe that are already severely affected by water scarcity. Certain critical facets of national and regional security (e.g., food, economic, environmental, and human security) predominantly depend on water security. Countries sharing a river basin can have varying hydro-climatic conditions, have different political systems in place, and may be at different levels of socioeconomic development that frame a highly complex and dynamic interdependent hydropolitical system. A key question is how to create a politically feasible environment to arrive at a viable solution. Historically, there are incidences where the scarcity of water resources has been instrumental in forging cooperation among riparian countries. However, in many cases, for effective development of a process of engagement and discussion, external parties such as international organizations can be involved for mediation and process financing.

The South and Southeast Asian regions face considerable challenges in reaching the goal of sustainable development. Most of the countries need to address a number of development issues, particularly those related to water, sanitation, and human settlements. Climatic conditions vary from the semi-arid in Pakistan, to the tropical monsoon and hot-dry/humid-dry in the rest of the South Asia region, to the humid tropical in the Southeast Asia region. Despite the regions' endowment of adequate

quantum water resources, spatial variability, and seasonal variability, water stress has resulted in many parts of the region due to population growth and exploitation of resources. Poor water management practices have also compounded the negative impact on water quality and the ecosystems of the regions. Transboundary water resource issues are highly complex and sensitive, as they involve national sovereignty of riparian countries. Despite these difficulties, progress has been made in adopting basin-wide approaches to resolve some issues. Examples of transboundary cooperation in the South and Southeast Asian regions include the Indus Basin water-sharing accord between India and Pakistan, the water-sharing treaty between India and Bangladesh, the India-Nepal cooperation in Ganges-Brahmaputra-Meghna Basin, and the long-standing cooperation among the four riparian countries of the lower Mekong Basin under the Mekong Agreement in harnessing transboundary rivers. A major challenge is changing the fragmented sectoral approaches to water management, which has caused conflicts and competition in the past. Another challenge is bringing in an integrated mechanism for planning, design, and implementation of development projects that take into consideration the sectoral interplay and development goals of the individual countries.

2.1 General Description of the South and Southeast Regions

2.1.1 Physical Geography and Climate

The South Asia region, consisting of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka covers an area of approximately 4.8 million km^2 (World Bank, 2006; Figure 1.2) with a population of approximately 1.47 billion people (World Bank, 2007). The region's population density of 306 persons per square kilometer is more than seven times the world average. Not as densely populated as South Asia, but still well above the world average, the Southeast Asian region has a population density of 125 inhabitants per square kilometer, with a land coverage of roughly 4.5 million km^2, and a total population of 560 million (ASEAN, 2006).

The South and Southeast regions of Asia are diverse in their geography, both in altitude and topography, as well as climate. This has brought about a range of vegetation that goes from tropical to desert. The topography ranges from the world's highest point, Mount Everest (8,848 m above sea level in the Himalayas), to the world's lowest, the coastal areas of the Indian and Pacific Oceans, with temperate, arid, and tropical areas in between. Over 18.6% of the South Asian region is still covered by forest, comprising 2.7% of the world's forests, and is also home to approximately 15.5% and 12% of the world's flora and fauna, respectively (UNEP, 2001).

South and Southeast Asia are characterized by a variety of climatic conditions ranging from tropical/subtropical to alpine climates (Map 1(A)). A monsoon climate, characterized by wet summers and dry winters, generally prevails over both South and Southeast Asia, yet semi-arid climates can be found in Pakistan, as well as hot- and humid-dry climates in other parts of South Asia (Map 1(B)). However, the river discharges of the regions reflect the monsoonal/dry seasons that are found through the regions, as approximately 80% of the total annual flow is discharged from June to September and 20% occurs during the rest of the year (World Bank, 2003).

In Southeast Asia, the southwest wet monsoon dominates the summer months between May and October with heavy rainfall, much like in South Asia. In contrast, the dry season occurs from November to February, which is the result of the northeast cool, dry monsoon. The high variability in water levels of the region's rivers is due to the fact that 75% of the rainfall comes during the wet season. In the case of the Tonlé Sap, the level can vary up to 20 m between the wet and dry seasons (FAO, 2008).

Four of the major transboundary river basins of the region, which will be the focus of this chapter, are the Ganges-Brahmaputra-Meghna (GBM) River, Indus River, the Mekong River, and the Salween River basins (Figure 1.1). The climate

Family on Mekong River boat, Laos. Photo credit: Alison Jarrett.

of GBM Basin is largely conditioned by the southwest monsoon originating from the Bay of Bengal. The mean annual rainfall decreases from approximately 3000 mm in the coastal area of Bay of Bengal in the east to about 350 mm in the west (Pun, 2001).

The Mekong Basin's climatic condition varies from the tropical zone, with the annual range of temperature below 5°C, to the temperate zone, where temperatures predominantly average around 22°C, but with smaller temperate sub-zones with cool, short summers where temperatures can go down to 10°C. The Salween Basin climate varies from the polar (40% of basin coverage) to a temperate climate with a temperature range of 10°C to 20°C (Bahadur, 1993). The Indus Basin falls mostly (74%) within a dry climatic zone where temperatures range from cool to averaging over 18°C subtropical deserts. Conversely, the GBM River Basin is primarily in a temperate climate (61%), with almost equal amounts of area in tropical/dry and polar regions. Generally, the climate in the South and Southeast Asian regions varies from the tropical to the temperate, with polar regions in the Himalayas. The climate is generally humid and tropical as the region receives abundant rainfall, averaging from 1,600 mm to 3,000 mm annually. The humid climate yields average total water resources availability for the region that exceeds 5,500 km^3 per year, present in both surface water and groundwater components. The runoff in the GBM Basin is 442,000 mm/year, 58,400 mm/year in the Indus, and 167,000 mm/year in the Mekong (Fekete et al., 1999; TFDD, 2003).

2.1.2 Water Resources and Water Use

The rivers of South and Southeast Asia, like in most parts of the world, are the life source of the peoples in those regions because their livelihoods depend on the waters. The Himalayas serve as the source of some of these major rivers, providing routes for navigation, hydropower, flora and fauna, freshwater for domestic consumption,

agriculture and industry, and other uses that are often not taken into consideration, such as recreation and spiritual uses.

Water availability in South and Southeast Asia is primarily dependent on snowmelts and monsoons. Most of the river basins in these regions exhibit a remarkable temporal and spatial variation in the availability of water. The distribution of river flow is uneven over time and space; distribution is strongly affected by the northeast and southwest monsoons and typhoons. The river basins of South and Southeast Asia have very large quantities of water resources with an overall runoff that exceeds 1,500 billion cubic meters (BCM) per year (Bandhopadhyay and Gyawali, 1994). The Ganges-Brahmaputra-Meghana (GBM) river system carries the highest volume of water of all the South and Southeast Asian regional rivers with 586 (BCM) per year, followed by the Ganges and Indus Rivers with 525 BCM and 181 BCM, respectively (Reddy et al., 2002).

Increasing population growth in river basins is putting pressure on water resources and leading to water scarcity in the region, particularly in South Asia. When compared to most of the regions of the world, the South and Southeast Asian regions have adequate renewable water resources. In the year 2000, the annual internal water resource per person was about 12,900 m^3, but the volume of water actually available per person for use was considerably lower at 4,900 m^3. Generally, the desirable annual water supply is 1,700 m^3 per capita. When the availability of freshwater falls below 1,000 m^3 per person per year, countries experience water scarcity; if it falls below 500 m^3 per person, it leads to water stress (Falkenmark et al., 1989). Due to the uneven distribution of rainfall and existing geological formations, many river basin countries are having to confront issues of water scarcity even when annual per-capita availability is high (UNEP, 2001). Furthermore, the soaring population growth and diversification of activities into other sectors (e.g., urbanization and industrial growth) increases the demands for domestic and industrial uses. The demand for water will continue to rise in the regions as the population grows. Singapore is already experiencing water scarcity, where the city is well below 1,000 m^3 per capita of water available per year (Lap Duc Nguyen, 2004). The projected water stress for the year 2025 varies from 1,700–5,000 m^3 of water per person per year in the Indus and GBM basins; 5,000–10,000 m^3 of water per person per year in the Mekong; and more than 50,000 m^3 of water per person per year in the Irrawaddy and Salween (TFDD, 2003).

The use of water resources for agricultural purposes is increasing rapidly. While drinking water supply has a higher priority than agriculture, the majority of water is still utilized by agriculture, as all the countries are agrarian economies. In addition, there is an increasing demand for hydroelectric power for industrial development and other uses as nations look toward options for energy security.

2.1.3 Major River Systems

There are a number of major rivers systems that start in the Himalayas and descend towards the Pacific and Indian oceans. These river systems shape the physical geography and the human settlement patterns of South and Southeast Asia. Most of these travel through alluvial plains and end in fertile deltas, which allow for an intense rice-based agriculture, sustaining the dense populations of the region. Four of these extensive systems, namely the Ganges-Brahmaputra-Meghna, the Indus, the Mekong and the Salween basins, are of a transboundary nature. These four transboundary systems in the South and Southeast Asian regions will be the focus of this chapter due to their regional importance for development, the size of the populations within the basins, and the cooperative regimes, or lack thereof, in place to mitigate potential disputes.

2.1.3.1 Ganges-Brahmaputra-Meghna (GBM) River

The GBM River system originates partially in three different countries: Bhutan, China, and Nepal (see section 2.3.1). It then flows through India and Bangladesh and discharges into the Bay of Bengal. The Ganges flows a total of 2,525 km while the Brahmaputra stretches approximately 2,900 km. The Meghna River, having flown in a

Ferryboats on the Lancang-Mekong. Photo credit: Gene Molander.

southwesterly direction draining northeastern Bangladesh and several states in eastern India, joins the Padma River, the conglomeration of the Ganges and Brahmaputra, at Chandpur, then flows 160 km and empties into the Bay of Bengal (UNEP, 2001).

2.1.3.2 Indus River

The Indus River originates in China on the Tibetan Plateau and flows into Pakistan, where it empties into the Arabian Sea after having travelled 2,800 km (see section 2.3.2). There are seven major tributaries feeding the Indus, two west flowing, the Kabul and the Swat, and five east flowing, the Beas, Chenab, Jhelum, Ravi, and Sutlej. The total length of these tributaries is some 5,600 km.

2.1.3.3 Mekong River

The Mekong originates from the Himalayas in Tibet, passes through the deep and sparsely populated gorges of China's Yunnan province, and enters the Lower Mekong Basin near the Burmese-Laotian border (see section 2.3.3). It continues through Laos to mark out the Thai-Laos border. At the Khone Waterfalls, the river enters Cambodia before it slows down and discharges into the South China Sea through the Mekong Delta in the southern part of Vietnam. With its length of 4,800 km and average discharge of 15,000 cubic meters per second (m^3/s), the Mekong River is the largest water resource in Southeast Asia. At low flow, it carries 1,600–2,000 m^3/s, which makes it the third largest river in Asia after the Yangtze in China and Ganges in India (Öjendal, 1995). The Mekong River is essential to the people living in the basin area. With a total of 244 fish species, the river provides remarkable fish catches, which is a major source of protein, particularly in Cambodia (Revenga et al., 1998).

2.1.3.4 Salween River

After rising in eastern Tibet, the Salween flows several hundred kilometers through southern China (see section 2.3.4). Soon after entering Myanmar, it establishes the border with Thailand for approximately 110 km then continues in eastern Myanmar to empty into the Andaman Sea. The average annual discharge of the Salween is over 3,900 m^3/s (TFDD 2003), but it has a fluctuating water volume due to seasonal rains (FAO 2008).

2.1.4 Groundwater

Many countries in South and Southeast Asia have extensive groundwater resources (see Map 2 (A). The usage of groundwater is mainly for domestic and industrial consumption, particularly in Thailand. Groundwater is the dominant source of industrial water. Groundwater extraction for irrigation and drinking purposes is very common in India, Bangladesh, and Pakistan. In the Ganga Plain, due to the reduced quality of the surface water of the Ganges River, groundwater has become more crucial for meeting people's needs. In Bangladesh, for example, almost 85% of the drinking water comes from groundwater (Government of Peoples Republic of Bangladesh, 2005). This has caused groundwater withdrawals to exceed the rate of recharge; therefore, the intrusion of seawater into the aquifers is a common phenomenon in coastal areas, along with other water quality issues.

Groundwater has remained somewhat of a mystery worldwide, due to its hidden nature and the underdeveloped state of the science. However, an inventory of the transboundary aquifer systems on the entire continent of Asia was begun in 2008 under the International Shared Aquifer Resource Management (ISARM) project, which is led by UNESCO in a multi-agency effort (ISARM 2008).

2.1.5 Environmental Issues

2.1.5.1 Floods

Due to the monsoonal seasons and the resulting high variability of flow discharge, floods are prevalent in South and Southeast Asia. While floods usually make the news headlines for their destructive nature, there are also benefits that are not reflected in the news of the day. Without the floods, crop production following the monsoons would be hindered because the floods leave silt, which is beneficial to agriculture (Hirsch and Cheong, 1996).

Floods become problematic when the snow melts in the Himalayas or during the monsoon

Family in Kaski, a mountainous region of central Nepal, with a new system that provides both safe drinking water and drip irrigation technology. Photo credit: Winrock International, courtesy of USAID.

Victims of Cyclone Sidr in Bangladesh awaiting USAID-supported relief supplies including drinking water. Photo credit: Sue McIntyre, USAID.

season when there is too much water. Due to the unprecedented rainfall in the South and Southeast Asian regions, floods arise in the river basins and flow out into the sea instead of replenishing the groundwater. This is due to a lack of storage structures in the catchment areas. Therefore, floods are very common in India and Bangladesh. This is also the case for Cambodia, Laos and Vietnam where floods are affected by the amount of discharge from the Mekong and its tributaries during the monsoon seasons (Bildan 2003).

In the context of transboundary waters, floods become more problematic as they can cross borders and affect citizens of another nation. The impacts are not confined by national borders. More importantly, one nation's unilateral development can increase the flood risk of another nation. This is why it is important to have basin-wide governance regimes between nations that coordinate the exchange of data and information, coordinate flood management action, share the benefits of floodplains, plan jointly in land- and water-resources management, and implement notification and dispute resolution procedures (WMO/GWP 2007).

2.1.5.2 Water Pollution

Rapidly deteriorating water quality is one of the most serious environmental problems in the river basin countries. For example, in the South and Southeast Asian regions, high population densities, conventional agricultural practices, rapid urbanization, increasing industrialization, and a general lack of pollution-control facilities are exerting growing pressure on the water resources. If allowed to persist, this increased pollution will reduce the amount of potable water available for use in the future. As cities and industries in the region continue to expand and remain without proper wastewater treatment plants, rivers and streams are being used increasingly as receptacles for their waste. Almost 90% of the wastewater in the region is discharged directly into the streams, rivers, lakes, and coastal waters. The primary source of pollution in the region is from organic matter originating from

sewage and processing industries (UNEP, 2001). Furthermore, evidence is now available which states that the leaching of fertilizers into water bodies and groundwater is a significant source of water pollution. The water resources in the area have especially been found to have nitrates and other nutrients from fertilizer (UNEP, 2001). While water pollution laws and regulations are generally present, they are not effectively implemented and enforced in both South and Southeast Asian regions.

India has some of the most polluted rivers amongst South Asian countries. Approximately 70% of India's surface water is contaminated. The country boasts some 3,119 towns, but, of these, only 8 have modern collection and treatment facilities while another 209 have partial systems and the other 2,902 have nothing at all (*India Today,* 1999). The Ganges River, one of the most holy and revered rivers in the region, typifies the issue of contamination. Of the 2,525 km of its length, approximately 600 km are dangerously contaminated with animal and human wastes. Another growing concern is the increasing amounts of toxic runoff from industries and agriculture (UNEP, 2001).

The degradation of water quality has been a major problem in the river basin areas, most seriously in the Ganges River where agricultural runoff has caused severe arsenic problems in the drinking water. Water pollution is caused mainly by the discharge of untreated or inadequately treated wastewater from domestic, industrial, and agricultural point sources of pollutants as well as surface runoff from non-point sources. Rivers and coastal waters near large cities, such as Manila and Bangkok, are severely polluted by domestic and industrial wastewater. In rural areas, water pollution is normally caused by agricultural and localized industrial waste discharges. The region's use of fertilizers reached nearly 7 million tons in 1998. The intensification of agriculture in recent years has also been accompanied by the extensive use of pesticides (herbicides, insecticides, and fungicides).

Due to the fragility of different ecosystems such as wetlands, groundwater abstraction that is neither planned nor regulated can have an adverse impact. Additionally, groundwater is becoming a critical issue in urban areas throughout South Asia (Bhatti, 2002). There have been reports of fluorides (India), nitrates (Nepal and India), arsenic (India and Bangladesh), chromium (Sri Lanka) and iron (Chittagong, Sylhet, and Rajshahi in Bangladesh and some pockets in India) in the water. Due to the extraction of groundwater for irrigation and domestic use in South Asia, water tables have been falling and water quality has been deteriorating. This has been compounded by the problem of extraction that exceeds the recharge rates in coastal areas, and saltwater intrusion is not uncommon.

It is clear that the rapid industrialization of much of South and Southeast Asia has led to the potential for heavy metal contamination of soils in a variety of ways and on a variety of scales. In addition to the above-mentioned water pollution issues, one must focus on the transboundary water pollution as well. Without mutual understanding among river basin countries and proper legislation and standards related to water use and water sharing, this may severely affect the quality of water in the downstream countries.

2.1.6 Urbanization, Economic Trends, and Regional Economic Co-operation

Two of the major transboundary river basins in South and Southeast Asia are the Ganges-Brahmaputra-Meghna (GBM) River Basin and the Mekong River Basin. The GBM region's total population numbers about 600 million, and that number is set to grow at a rate of over 2% per year. The population growth leads to enormous pressure on land and water resources throughout the region. The Mekong River Basin is important in the region as it supports approximately 60 million people, many of whom are dependent on natural resources for their livelihood. Throughout the entire Mekong Basin, the population is not distributed evenly. The delta, in Vietnam, has some of the higher population densities, with as many as 400 inhabitants per km^2 (Hirsch and Cheong, 1996). In general, the South and

Canal on the Mekong Delta, Vietnam. Photo credit: Gene Molander.

Southeast Asian countries with large populations and high urban densities, coupled with low affluence levels, tend to face severe environmental conditions.

Even after rapid urbanization, the majority of people in the river basin countries still live in rural areas and will do so for many years to come. The population growth in major urban centers is largely driven by rural-urban migration, and the increased trend towards urbanization has further increased the water shortage and stress. Rural-urban migration is associated with proliferation of low-income settlements in urban areas leading to potential environmental hazards (UNDESA, 2001). In the river basin regions, the style of urbanization towards the bigger cities is increasing the environmental and social stress.

The Gross National Product (GNP) per capita is considered to be a significant indicator of the economic level of a country and most of the river basin countries in the South and Southeast Asian regions have GNPs that are considered low-income, below USD$760. Despite the low levels, these regions are also considered key global economic zones for two reasons:

- The large population makes these regions attractive for markets.
- Of all the world's economic zones, these are growing at the second-fastest rate. With this growth comes problems of rapid development, including increased pressure on natural resources (UNEP, 2001).

There have been cooperative movements both in the South and Southeast Asian regions. An example of this is the Greater Mekong Subregion (GMS) Economic Cooperation Programme, which is the largest initiative to promote regional economic cooperation. It was set up in 1992 by the Asian Development Bank to promote investment and trade among its member states as well as aid in the resolution and mitigation of cross-border issues. The members are the four Lower Mekong Basins countries, Myanmar, and Yunnan Province in China (ADB, 2008).

Villagers and farmers work together to clear this 3.5-km-long irrigation canal in the village of Sir Ajmaira, in Pakistan's northern Battagram District. Once cleared, it will irrigate 375 acres of wheat, rice, and vegetables. Photo credit: Kaukab Jhumra Smith, USAID.

2.1.7 Irrigation-dependent Agriculture

The largest water user on a regional scale is the agricultural sector, with more than two-thirds of the water abstracted from the region's rivers, lakes, and aquifers used for irrigation. Agriculture is mainly dependent on irrigation in the South and Southeast Asian regions (Barker and Molle, 2004). The food security of the regions is dependent on irrigated agriculture and the countries in the regions are mostly agricultural economies. In South and Southeast Asia, like in most parts of the world, irrigation accounts for the highest use of water, totalling over 90% of the total annual available water in the region. Agriculture provides 40–50% of the Gross Domestic Product (GDP), as well as nearly 70% of the rural employment. Without the availability of adequate amounts of water, the above mentioned figures may not depict the actual scenario. In the South and Southeast Asian regions, studies have revealed the priorities of the

Abdul Khaliq, a farmer from Mahool Baloch village, Balochistan, Pakistan, gathers part of his harvest from drought-tolerant wheat. Photo credit: Kaukab Jhumra Smith, USAID.

other sectors compared to irrigated agriculture. Therefore, on the basin level, the quantum of water that is available for irrigation-dependent agriculture is questionable. Unless the users from this sector manage to efficiently use the available water, the development of this sector would not be in a desirable position. Even when all the irrigation potential is developed in India, more than 60% of the cultivable land will still be under rain-fed cultivation. Water is thus a serious constraint for expanding the irrigated area. Large quantities of water used for agriculture is wasted and results in problems such as water logging and salinisation. The percentage of renewable water resources used for agriculture varies from around 91–100% in the Mekong Basin to 71–80% in the Indus and Ganges-Brahmaputra-Meghna Basins (TFDD, 2003).

2.2 Issues, Scale of Conflict, and Cooperation

In the situation of increasing water demand, international rivers may become a ground for breeding disputes among the co-riparian states. "We have found that cooperation between countries over the past 50 years has outnumbered conflicts by more than 2:1. But things can go wrong," says Professor Aaron T. Wolf of Oregon State University.[1] South and Southeast Asia, with a large number of rivers and river basins, have recorded the highest incidence of water disputes, though none went beyond an outburst of political rhetoric. Studies have listed more than 200 incidents in South Asia and over 100 in Southeast Asia. Paradoxically, volatile regions are also more likely to seek a peaceful solution. There have been over 200 interactions in South Asia as a result of disputes, around 350 in Southeast Asia and nearly 100 in East Asia. The Ganges-Brahmaputra-Meghna, Jordan, Tigris-Euphrates, and the Mekong are among the most conflict- and dispute-prone river basins in the world (Boyd, 2003).

Forty percent of the world's population is directly dependent upon freshwater from rivers and about two-thirds of these people live in developing countries. Because international rivers flow from one country to another, use and misuse of water in upstream countries affects the quantity, quality, and usage in downstream countries. The earlier and on-going differences between the upper and lower riparian countries in South and Southeast Asia over the building of dams is one of the primary causes of conflicts and disputes related to water. In many situations, the upper riparian countries in these regions need more water resources than do the lower riparian countries due to various factors like greater geographical extent, higher population growth, powerful economy, rapid industrialization, and power supply needs. This disparity in demand for water resources creates a situation of dispute or conflict in these regions.

2.2.1 Treaties, Commissions and Basin-focused Programs

Transboundary cooperation around water in the region stems from a drive for sustainable development in the face of shared stress. Water management is a highly complex and extremely political endeavor (Carius et al., 2004) in which balancing competing interests over water allocation and managing water scarcity requires strong institutions. In the South and Southeast Asian regions, transboundary water institutions have proven resilient, even as conflict is waged over other issues. The Mekong River Commission in the sub-region of Southeast Asia, and the Indus River Commission, active in India and

Villagers in the arid Marwar region of Rajasthan, India, fill up at a rainwater harvesting structure, which has made water readily available for drinking, agriculture and sanitation during the dry season. Photo credit: Jal Bhagirathi Foundation, courtesy of USAID.

[1] Wolf, A. T., Yoffe, S. B., and Giordano, M. 2003. International waters: identifying basins at risk. *Water Policy.* 5 (1): 29-60.

Pakistan, both exemplify the institutional water co-operation in the region. As has been observed in many instances, a water peacemaking strategy can provide dividends beyond water for stakeholders and can also indirectly facilitate more cooperation among states in others spheres of issues.

2.2.1.1 The Indus Waters Treaty

The Indus Waters Treaty, signed between India and Pakistan in 1960, is a landmark as far as water-dispute resolutions are concerned. The dispute can be traced back to the Partition of the Indian Sub-Continent in 1947. The source rivers of the Indus Basin remained in India, leaving Pakistan concerned by the prospect of Indian control over the main supply of water for its farmlands. The newly formed states could not agree on how to share and manage the cohesive network of irrigation, which was impossible to partition. Brokered by the World Bank, the treaty, which covers a very large irrigated area of around 26 million acres under a single river system, has survived two wars and provides an on-going mechanism for consultation and conflict resolution through inspections, exchange of data, and visits. The treaty demonstrates how functional co-operation on both sides can be achieved, though most other contentious issues remain deadlocked (Hazarika, 2001a).

Small dam in Khai near Bhaun, Pakistan, used along with groundwater from wells to irrigate agricultural land in Bhaun, Thoa, and Khai (Indus River basin). Photo credit: Syed Usman Ali, via Wikimedia Commons.

In recent years, the South Asia region has seen closer international cooperation over the major rivers. The region has an institutional framework in the form of South Asian Association for Regional Cooperation (SAARC). Several important treaties and agreements have been signed between the South Asian states, spurring greater hope to more efficiently harness the water resources of the region. Five important treaties or agreements were signed between these neighbours in 1996 and 1997, amid a background of greater regional economic and nongovernmental contact (Crow and Singh, 1999), which could be instrumental in mitigating flooding and drought, providing a basis for greater regional cooperation, and sustaining irrigation expansion and industrial development. Furthermore, these agreements seem to offer negotiation on a wider range of issues than has previously been considered, and to expand the range of institutions involved in negotiations. This integration of diplomacy and economics could have far-reaching implications elsewhere, as well as in South Asia (Crow and Singh, 1999).

2.2.1.2 The Mahakali River Treaty, the India-Bangladesh Water-sharing Agreement, and the Mekong Agreement

In January 1996, Nepal and India signed the Mahakali River Treaty, advancing a decades-old river development proposal. In the same year, India and Bangladesh signed a 30-year treaty, the India-Bangladesh Water-sharing Agreement, seeking to resolve the dispute between the two nations over the sharing of the Ganges waters. The agreements signed between Nepal and India, and India and Bangladesh were very important cooperation moves in the Ganges-Bramhaputra-Meghna (GBM) Basin. Two other agreements were signed, establishing procedures for power supply from Nepal and Bhutan to India. These agreements established innovations, which were new in South Asia and with only limited precedent elsewhere, bringing new resources and initiative to harness the geographical assets of South Asia. In effect, the four agreements began creating a regional trade in hydroelectric power development and began sharing the costs, risks,

The Mahakali/Kali River at the border between Nepal and India. Photo credit: Mayankkatiyar, via Wikimedia Commons.

and benefits of joint river development. In April 1997, a fifth agreement, albeit of a more tentative nature, was signed when representatives of India, Bhutan, Nepal, and Bangladesh considered forming a sub-regional economic group within the SAARC framework that would include the shared rivers of the four nations.

While the 1996 India-Bangladesh Water-sharing Agreement was a giant step towards resolving decades of acrimony over the sharing of the water from the Ganges between the two countries, the Mahakali River Treaty settled Nepal's entitlement to water flows and electricity from the Indian side, improving a 1992 agreement and also concerning the integrated development of the Mahakali River, including Sarada Barrage, Tanakpur Barrage, and the Pancheshwar Project (Malla et al., 2001). The treaty faced opposition from various Nepali groups, however, who claimed it was unfair to the country's interests. At a meeting in Kathmandu in April 1997, discussions included the prospect of forming a sub-regional group, comprising India, Bhutan, Nepal, and Bangladesh, within the SAARC framework, which would help to identify an economic program to be taken up jointly by the four nations. The idea of forming a sub-group was based on the notion of being connected by the shared rivers. "If there are floods in this region, this will affect only our four nations. It is on the basis of this reality that the present initiative is being taken," remarked the Bangladesh Foreign Secretary when asked by the journalists on the purpose of the group. This initiative may not reach fruition; nonetheless, it marks a more promising approach to multilateral negotiations in the South Asian region.

When SAARC was established in the 1980s to provide a forum for discussion primarily on trade, contentious topics like water resource negotiations were totally excluded from its brief. Yet, the South and Southeast Asian regions have a commendable record in the realm of water sharing, developed through a combination of civil society pressure, political sagacity, and technical co-operation.

In the Southeast Asian region, the countries have a long history of intra-regional cooperation through the Association of Southeast Asian Nations (ASEAN) framework and other mechanisms, such as those governing the Greater Mekong Sub-region (GMS) and the Mekong River Commission (MRC). The Mekong River has long been a symbol of the natural linkages among the riparian countries, but the idea of addressing development and management of water resources cooperatively is relatively recent. The Mekong River Committee (MRC), created in 1957, comprises Thailand, Laos, Cambodia, and Vietnam, and originally sought to generate hydropower from the lower Mekong River. The organization's mandate was expanded in the 1995 Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin (the Mekong Agreement), which established the Interim Mekong Committee in its current form. This is regarded as one of the regional associations to survive the difficult period of conflict in Indochina. The commission works toward more effective flood control, water allocation, water quality monitoring, and more integrated basin development based on the principle of fair and equitable utilization. The agreement also called for the institutionalization of capacity to recognize and address socioeconomic and environmental issues associated with large-scale water management. With the official start of the MRC Basin Development Plan in 2002, the commission has made a significant step towards realizing its interest in a more ambitious role in coordinating activities in the basin. Notably, China and Myanmar are not members of the MRC, as they have found little common interest with the lower basin nations regarding water management, but they do have limited engagement with the commission through their "dialogue partner" status (MRC, 2003).

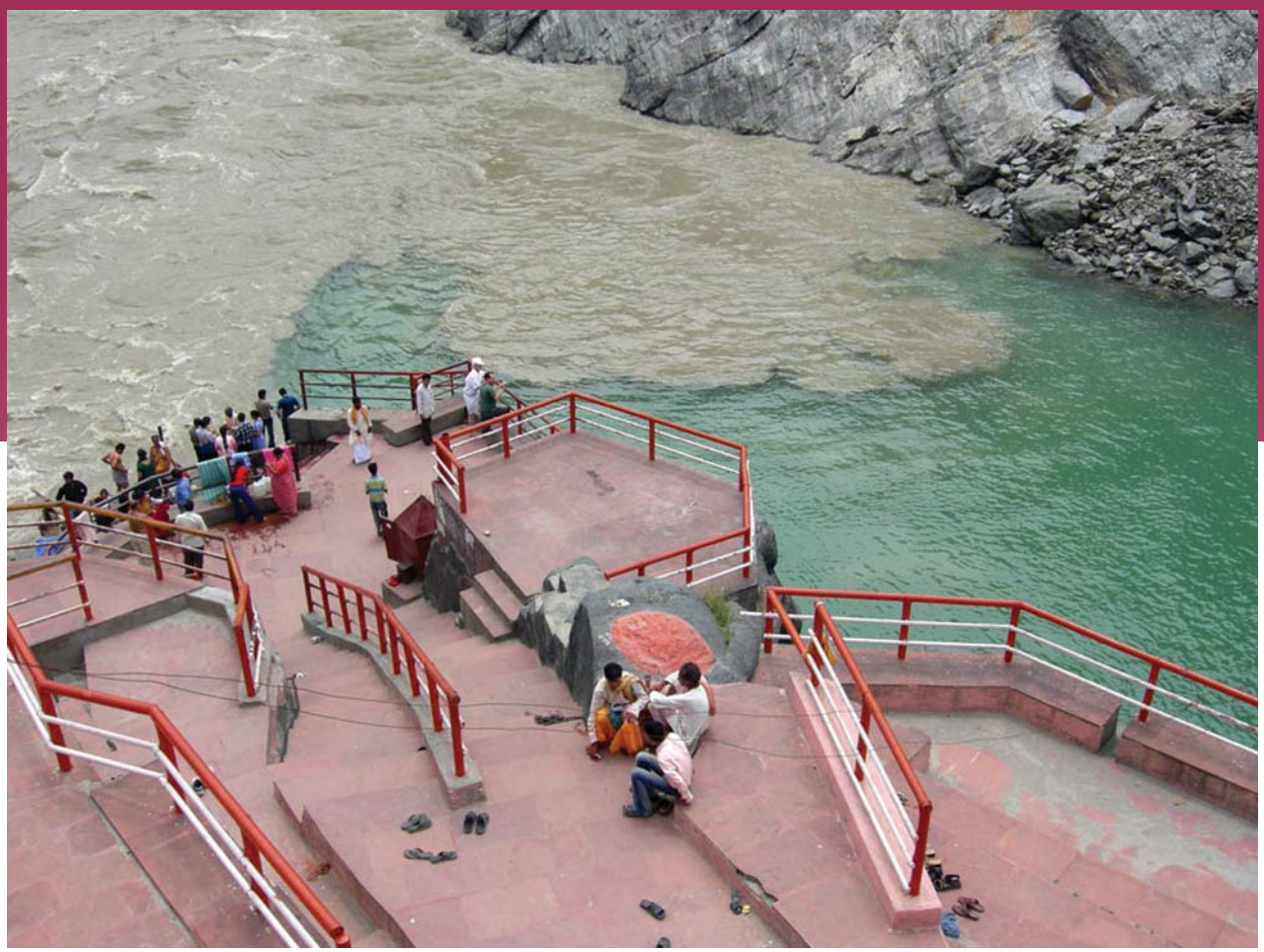
2.2.2 Issues and Disputes

Even if international disputes over water-related issues do not typically cause violent conflict, they have at times led to interstate tensions and significantly hampered development, such as along the Mekong and Ganges Rivers in the regions under consideration. While conflicts often remain local, they can also impact stability at the national and regional levels. Based on extensive analysis of the world's 263 international river basins, Aaron T. Wolf and his team hypothesize that "the likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change."[2] Sudden physical changes or reduced institutional capacity are more conducive to disputes. Key examples, as they point out, include (1) uncoordinated development of a major project that affects flow (such as a dam) in the absence of a treaty or commission; (2) "internationalized basins" such as in post-Soviet Central Asia; and (3) general animosity among parties.

Access to adequate water supplies, livelihood loss, and civil conflict are some of the major linkages between conflict and water. Conflict is most likely to occur over water when disputes involve access to water of adequate quantity and quality. Water is a basic resource for agriculture, which is traditionally the largest source of livelihoods. In the event that this livelihood is no longer available, people are often forced to search for job opportunities in the cities or turn to other more precarious ways to make a living. In most cases, however, it is not the lack of water that leads to conflict, but the inadequate way the resource is governed and managed. There are many reasons why water management fails, including lack of adequate water institutions, inadequate administrative capacity, lack of transparency, ambiguous jurisdictions, overlapping functions, fragmented institutional structures, and lack of necessary infrastructure.

Despite having a large number of cooperation activities in South and Southeast Asia, disputes and conflicts have been continuing until today. Since 1947, there have been four conflicts between India and Pakistan over the Indus Basin, as well as acrimonies between India and Bangladesh over the water sharing of the GBM Basin; conflict between India and Nepal over the Ganges water sharing; and frequent

[2] Wolf, A. T., Yoffe, S. B., and Giordano, M. 2003. International waters: identifying basins at risk. *Water Policy*. 5 (1): 29-60.



Confluence of the Bhagirathi and Alaknanda Rivers to produce the Ganges at Devprayag, India. Photo credit: Mark A. Wilson (Department of Geology, The College of Wooster), via Wikimedia Commons.

conflicts inside the Mekong River basin between neighbouring countries. Overall, South and Southeast Asia have recorded the highest incidence of disputes, though none went beyond an outburst of political rhetoric. The Oregon State University study listed 231 incidents in South Asia and 134 in Southeast Asia. There have been 237 interactions in South Asia as a result of disputes, and 371 in Southeast Asia. Two of the seventeen highly disputed basins in the world are located in the region: Ganges-Bramhaputra-Meghna and the Mekong. A few of these conflicts in the South and Southeast Asian region are described in the following sections.

2.2.2.1 GBM Basin Issues

There have been issues between India and Nepal with the Ghaghara sub basin (a part of the Ganges River), in the Uttaranchal region about a small reservoir submergence of a small area in Nepalese territory due to the construction of the Tanakpur Barrage and Power Project in Indian territory (Parajuli et al., 2003). Generally, the problem is with the downstream regions when there are specific water-related activities in the upstream regions, but in this case, Nepal is an upstream country and India is a downstream country and the issue is mainly due to the problems faced by Nepal.

Another dispute appears visible on the horizon which centers on the Brahmaputra, a river that flows through Tibet (China), India, and Bangladesh. The main issue of contention is the lack of sharing of data that led to catastrophic results. In the summer of 2000, a landslide in Tibet caused a dam to collapse, unleashing a 26-metre wall of water that destroyed every bridge on the Siang, as the Brahmaputra River is known in the Indian border state of Arunachal Pradesh. The water then rushed through the Indian state of Assam and, within a week, devastated parts of Bangladesh. Human casualties were light, but damage to property was extensive. According to Indian officials, the

Chinese had not shared any information on the build up of water pressure and the heavy rains in the upstream catchment area of the river, known as the Tsang-po in Tibet (Hazarika, 2001b). There have also been recent concerns about alleged Chinese plans to divert the waters of the Tsang-po with the help of nuclear tunneling in order to tap its huge hydro-energy potential. The lack of proper and adequate sharing of the information is a very important cause for the disputes/ conflicts.

Controversy has arisen between Nepal, India, and Bangladesh over the interlinking of a river project proposed by India, which India says is still in infancy. A number of disagreements already exist between Nepal and India regarding several existing water-sharing arrangements. But on the project, till now Nepal has not vociferously objected. However, Nepal feels that it should have been included in the feasibility discussions. Related to this project, Bangladesh fears vast quantities of water would be diverted from the Ganges and Brahmaputra Rivers to India's southern states, directly threatening the livelihoods of people in the country as well as the environment. In this case, India is an upstream country and Bangladesh is a downstream country. Thus, despite huge water resources in the region, the mismanagement and the inability of countries in the region to reach mutually beneficial agreements could invite more conflicts in the days ahead. India and Bangladesh share many rivers, which can survive only through joint management. What is required is an international initiative, regional cooperation and the implementation of sustainable development strategies in the days to come. If the river-linking project in India is implemented properly, keeping in view environmental and sociological concerns, it can benefit the entire region. A decision on this project should be taken on merit and not on the basis of the adversarial politics, which unfortunately plagues this region (Kumar, 2003).

Bhote Koshi hydropower project, a 36-megawatt powerhouse in a remote area of Nepal, on the Bhote Koshi, a river fed by snowmelt from the Himalaya Range. Photo credit: USAID.

2.2.2.2 Indus Basin Issues

Pakistan has registered its objection to various projects that India has started. The Kishan Ganga Project on River Jhelum and the Baglihar Hydropower and Dam Project on Chenab are two cases that have caused controversy. Pakistan believes that these projects are in violation of the 1960 Indus Water Treaty, according to which it has exclusive rights over water of the three western rivers: Jhelum, Chenab, and Indus. The $1-billion dam project launched in June 1999 has been built up on the Chenab River. The Baglihar Dam is 150 km away from north of Jammu in Indian-controlled Kashmir. Chenab is one of the many rivers that flow into Pakistan from occupied Kashmir; Islamabad has raised serious objections to the design of the Baglihar Dam, as it would affect water flows downstream, and the country has the exclusive rights to Chenab waters. On the other hand, India claimed that the 450-megawatt power project will be used only to produce electricity and does not propose any water storage. These dams are seen by Pakistan, the lower riparian of almost all tributaries in the Indus Basin, as a likely source of future water shortage. However, Pakistan, in disputing the specifications of the Baglihar Dam that was being constructed by India on the Chenab River in Kashmir, initiated dispute-resolution mechanisms that were assisted by the World Bank. Both countries abided by the final verdict, given by Raymond Lafitte, the World Bank-nominated arbitrator (BBC, 2007).

2.2.2.3 Mekong River Conflict

In the Mekong River Basin, China is the most upstream country and has often been considered to exhibit unilateral behavior toward the lower Mekong River Basin. China is a non-signatory of

Fishing boats near near Kampot, Cambodia. Photo credit: Stephanie Garvey.

the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin and a non-member of the Mekong River Commission. Further, its vote against the 1997 UN Convention and its dam development in the upper Mekong without notification to the downstream countries all add to its being viewed as being unilateral in harnessing the water resources in the region (Onishi, 2005). China's pursuit of large-scale hydropower development on transboundary rivers in the upper Mekong region has become a point of contention over recent years. A partially completed cascade of eight dams on the Lancang (upper Mekong) River has provoked strong opposition by a variety of individuals, NGOs, and governments (Magee, 2005). Such large-scale development works on the river could alter the river's flow regime with a potential to threaten the complex ecosystem of Mekong River Basin and the livelihoods of millions who depend on it. Some reports have indicated that the scheme will drastically change the river's natural flood-drought cycle and block the transport of sediment. These environmental changes will have the potential to affect the livelihoods of millions of people living downstream in Myanmar, Thailand, Laos, Cambodia, and Vietnam.

Various development projects carried out in the Mekong region have also raised the attention of downstream users, environmentalists, and the general public on the harms caused in the form of deforestation, depletion of wildlife habitats, and other adverse environmental impacts. One of the highly controversial development projects causing environmental concern in Southeast Asia is the 136MW Pak Mun Dam, completed in 1994 on one of tributaries of the Mekong, the Mun River, which flows through northeastern Thailand. Livelihoods of more than 10 million people living in the Mun River Basin depend on the richness of river basin ecosystems and their natural resources. It is recorded that there were around 250 species of fish in the Mun River. From the outset, the project was highly controversial due to the predicted impacts on the rich and productive fisheries of the river. Between 1990 and 1997,

Nu-Salween River. Photo credit: He Daming.

there was intense opposition to the dam by thousands of people living in local communities along the Mun. It is alleged by IRN reports that the dam has affected more than 20,000 people due to drastic reductions in fish populations upstream of the dam site and other changes to their livelihoods.

Differences in political ideologies have also bred distrust in the region. Fortunately, there has been significant cooperative effort in the form of Mekong River Commission, one of the only regional institutions to survive the difficult period of conflict in Indochina. The Upper Mekong Navigation Improvement Project, funded by the Chinese government, would allow large ships to freely navigate from Simao, China to Luang Prabang in Laos. The first stage of the project would destroy 11 major rapids and 10 scattered reefs along a 331-km section of the Mekong from the China-Myanmar border to Ban Houayxai in Laos. Two rapids have already been blasted along the Laos-Myanmar border. The second and third stages would involve further channelization of the river. The destruction and blasting of rapids, shoals, and scattered reefs may have widespread ecological impacts along the entire length of the Mekong. While the navigation project directly affects people living in China, Myanmar, Laos, and Thailand, it is also likely to have impacts on people in downstream countries. Cambodian and Vietnamese officials have raised concerns that the project could alter water flow, cause riverbank erosion, and increase pollution when navigation accidents occur (IRN, 2002).

2.2.2.4 Salween River Conflict

Large-scale hydropower development plans on the Nu River (upper Salween) by China, whereby it plans to build a 13-dam cascade project, has provoked opposition from individuals, NGOs, and governments. Most opposition has centered on concerns that dams have not been subjected to sufficiently rigorous social and ecological impact assessment and that the negative social and ecological impacts of such dams outweigh the benefits (Magee, 2005).

Discussions are underway between Burma's military government and the Electricity Generation Authority of Thailand (EGAT), since December 2002, on the possibility of constructing two mega dam projects on the Salween: the Tasang Dam in Shan State, and the Upper and Lower Salween Border Dams on the

Thai-Myanmar (Burma) border. In addition to the projects planned on the mainstream Salween in Thailand and Myanmar, China's plans to build a cascade of 13 dams on the Nu River (Nujiang), the portion of the Salween River that flows in China, increase the complexity of the possible adverse environmental effects. Hydropower dams on the river have the potential to damage the ecosystem and biodiversity downstream and upstream of the dams. Because the dams would block the flow of the river, the amount of nutrients carried by the water would decrease and the fertility of soil would diminish. The dams also would contribute to the destruction of riverbanks and to the build up of sediment at the bottom of reservoir beds. Dam-related reservoirs would spur the spread of diseases and destroy forests. In addition, the enormous volume of water in the reservoirs might become a high-risk factor for earthquakes. Such physical destruction would directly harm the local societies and cultures that are founded on the Salween ecosystem.

2.2.3 Internal Conflicts

There are also many disputes within the countries regarding the equitable distribution of water between states or provinces. As the populations of the countries increase, and water availability declines, tensions over water rights are likely to increase as well. Some of the internal conflicts in these regions are described in this section.

2.2.3.1 South Asian Countries

Most of the areas in India are relatively arid and mechanisms for allocating scarce water are critically important to the welfare of the people. Water contributes to welfare in several ways, such as health (e.g., clean drinking water), agriculture (e.g., irrigation), and industry (e.g., hydroelectric power). Because India is a federal democracy, and because rivers cross state boundaries, constructing efficient and equitable mechanisms for allocating river flows has long been an important legal and constitutional issue. Numerous interstate river-water disputes have erupted since independence. A recent dispute over use of the Yamuna River among the states of Delhi, Haryana, and Uttar Pradesh was resolved by conferences involving three state chief ministers, as well as the central government. This approach was adopted only after prior intervention by the Supreme Court had failed. Not all disputes have happy endings, however. For example, the larger dispute between Karnataka and Tamil Nadu over the waters of the Cauvery River rages on, and interstate water disputes like this continue to fester. Such disputes are a persistent phenomenon in India (Richards and Singh, 2002).

2.2.3.1.1 The Cauvery Water Dispute

The Cauvery water dispute relates to the re-sharing of waters that are already being fully utilized. Here, the two parties to the dispute are Karnataka (old Mysore) and Tamil Nadu (the old Madras Presidency). The Cauvery Water Dispute tribunal was constituted on June 2, 1990. There has been a basic difference between Tamil Nadu on the one hand and the central government and Karnataka on the other in their approach towards sharing of Cauvery waters. The government of Tamil Nadu argued that since Karnataka was constructing the Kabini, Hemavathi, Harangi, and Swarnavathi dams on the Cauvery River and was expanding the irrigation work, Karnataka was unilaterally diminishing the supply of waters to Tamil Nadu. The government of Tamil Nadu also maintained that the Karnataka government had failed to implement the terms of the 1892 and 1924 Agreements relating to the use, distribution, and control of the Cauvery waters. In contrast, Karnataka questions the validity of the 1924 Agreement. According to the Karnataka

Bharachukki Falls of Cauvery River in Karnataka, India. Photo credit: Anamika144, via Wikimedia Commons.

Open floodgates on the Srisailam Dam, River Krishna, India. Photo credit: Chintohere, via Wikimedia Commons.

government, the Cauvery water issue must be viewed from an angle that emphasizes equity and regional balance in future sharing arrangements.

2.2.3.1.2 The Krishna-Godavari Water Dispute

The Krishna-Godavari water dispute among Maharashtra, Karnataka, Andhra Pradesh (AP), Madhya Pradesh (MP), and Orissa could not be resolved through negotiations. Karnataka and Andhra Pradesh are the lower riparian states on the River Krishna, and Maharashtra is the upper riparian state. The dispute was mainly about the interstate utilization of untapped surplus water (Richards and Singh, 2002).

2.2.3.1.3 The Ravi-Beas Water Dispute

The Ravi-Beas dispute involves Punjab and Haryana. The main parties in this dispute are both agricultural surplus states, providing large quantities of grain for the rest of India. Because of the scarcity and uncertainty of rainfall, irrigation is the mainstay of agriculture. An initial agreement on the sharing of the waters of the Ravi and Beas after partition was reached in 1955, through an interstate meeting convened by the central government. The present dispute between Punjab and Haryana about Ravi-Beas water started with the reorganization of Punjab in November 1966, when Punjab and Haryana were carved out as successor states of erstwhile Punjab. The four perennial rivers: Ravi, Beas, Sutlej, and Yamuna, flow through both of these states, which are heavily dependent on irrigated agriculture in this arid area. Irrigation became increasingly important in the late 1960s with the introduction and widespread adoption of high-yielding varieties of wheat. As a result of the protests by Punjab against the 1976 agreement allocating water from Ravi-Beas, further discussions were conducted (now including Rajasthan as well), and a new agreement was accepted in 1981. This agreement, reached by a state government allied to the central government, became a source of continued protest by the political opposition and lobbies outside the formal political process. Punjab entered a period of great strife and a complex chain of events led to the constitution of a tribunal to examine the Ravi-Beas issue in 1986 (Richards and Singh, 2002).

2.2.3.1.4 The Indus River Dispute

The international treaty on the Indus River in 1960 is a source of conflict in Pakistan between the Sind province in the South and the Punjab province in the center. The southern region accuses the central region of drawing off too much water for irrigation, which causes a lack in the coastal regions. With less freshwater from the Indus River to push back the sea, the land becomes infertile from the salt; when there is little rainfall, there is desolation and death and the region is deserted. Currently the Indus River does not provide enough water and the sea is pushing in; over 1.2 million acres of farmland have been covered by salt water. Millions more acres inland have been destroyed by salt deposits. Scientists in Sind province want more water released upriver for the ecological needs of the lower basin. The report of the Mumbai-based body said Pakistan's per capita water availability had declined from 5,600 m^3 at the time of independence to 1,200 m^3 in 2005. It was expected to reach the threshold level of 1,000 m^3 before 2010.

2.2.3.2 Southeast Asian Countries

2.2.3.2.1 The Nam Theun 2 Hydropower Project

The Nam Theun 2 Hydropower Project is supposed to generate revenue for the Lao government by exporting hydropower to neighbouring Thailand. The Nam Theun 2 Hydropower Project potentially poses enormous social, environmental, and economic threats to the people of Laos. The dam would severely impact a river system on which more than 120,000 people now depend for fishing and their livelihoods (IRN 2007).

2.2.3.2.2 The 60–MW Nam Leuk

The 60-MW Name Leuk project is located in the Phou Khao Khouay National Protected Area in Vientiane Province in Laos. Thousands of Laotians have reportedly suffered from impacts on their livelihoods and health because of Nam Leuk. The $130 million project, which diverts water from the Nam Leuk to the Nam Xan River, has caused declines in fish populations, submerged riverbank vegetable gardens, and disrupted access to water supply.

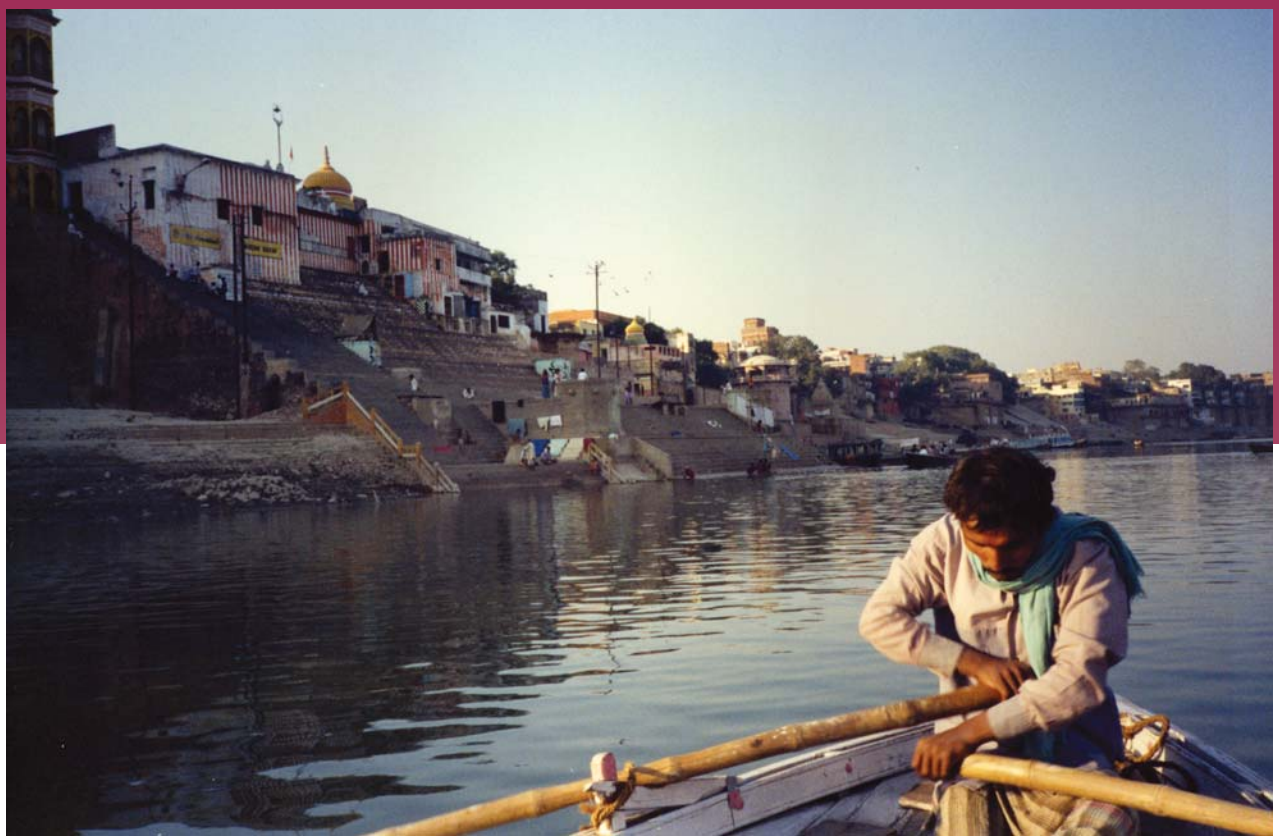
2.2.3.2.3 The Rasi Salai Dam

The Rasi Salai Dam, located just upstream from Pak Mun Dam on Thailand's Mun River, has been controversial. The International River Network (2007a) alleges that Rasi Salai Dam has had huge impacts on local villagers and the environment. People lost their farmlands, the dam blocked fish migration routes and destroyed the largest freshwater swamp forest in the Mun River Basin, which provided a source of food and traditional medicine for the villagers, fish habitat, flood control, and water treatment. On July 6, 2000, Thailand's Science Minister agreed to open all seven sluice gates of Rasi Salai to let the river run free for at least two years for environmental recovery and to conduct studies to determine who was affected by the project. Up until the writing of this report, the Rasi Salai sluice gates remain open (IRN, 2007a).

2.2.3.2.4 The Mun River and the 136MW Pak Mun Dam

The Mun River (tributary of the Mekong) and its tributaries flow through northeastern Thailand with a length of 3,200 km. Livelihoods of more than 10 million people living in the river basin depend on the richness of the river basin eco-systems and the natural resources. It is recorded that there were around 250 species of fish in the Mun River. The 136MW Pak Mun Dam, which was completed in 1994, was built by the Electricity Generating Authority of Thailand with US$24 million in financing from the World Bank. From the outset, the project was highly controversial due to the predicted impacts on the rich and productive fisheries of the Mun River, the largest tributary of the Mekong River. Between 1990 and

The confluence of the Mun River at the Mekong River, Thailand. Photo credit: Oatz, via Wikimedia Commons.



Boat on Ganges River near Varanasi, in Uttar Pradesh, India. Photo credit: Tom and Heidi Powell.

1997, there was intense opposition to the dam by thousands of people living in local communities along the Mun River. It is alleged by IRN reports that the dam has affected more than 20,000 people due to drastic reductions in fish populations upstream of the dam site and other changes to their livelihoods. In a victory for villagers, the Thai government agreed to open the dam gates in June 2001 while studies were conducted on fisheries, social impacts, and the contribution of the dam to Thailand's electricity supply.

2.3 Case Studies

In most of the countries in the South and Southeast Asian regions, the internal water resources available at the national level that can be economically and technologically exploited are already developed or are in the process of full development. The only major sources of water that can be developed to meet the increasing demand for socioeconomic development are generally transboundary resources that require treaties/agreements in order to create fair and rational utilization of transboundary waters by riparian countries. In the absence of proper governance mechanisms, one or more riparian countries, depending on the political and hydrostrategic interests, could dominate utilization of the resources of transboundary basins. This may lead to intensification of problems for water dependent activities downstream that could lead to conflict and impact the stability at the national and regional level. Historically, most of the interactions over sharing international freshwater resources were cooperative in nature, but there were incidences of strong verbal expressions displaying hostility in interaction, political/economic hostile actions and even small-scale military acts (Wolf et al., 2003).

The major river basins of transboundary nature in South and Southeast Asia are the Indus River Basin, the Ganges-Brahmaputra-Meghna River Basin, the Irrawaddy River Basin, the Salween River Basin, the Mekong River Basin, and the Red River Basin. The Transboundary Freshwater Dispute Database or TFDD (www.transboundarywaters.oregonstate.edu) at Oregon State University contains information for 263 international river basins, references to water related treaties, and interaction events of cooperation and conflicts. This chapter reviews

several case studies, including three (the Ganges-Brahmaputra-Meghna, Mekong, and Salween basins) taken from the TFDD website, and provides a brief overview on the state of the basin, an account of events of interactions, and the inferences drawn from the lessons learned. The "Basins at Risk" project's analytical tool helps to identify historical indicators of international freshwater cooperation and conflict and to create a framework to identify and evaluate international river basins at potential risk for future. Yoffe et al. (2003) provided details on the methodology adopted for analyzing basins at risk and the outcome of the project. The methodology adopted a 15-point BAR scale with numbers ranging from +7, the most cooperative event (voluntary unification into one nation over water), to –7, the most conflictive (formal declaration of war over water); and 0 represents neutral. A summary of the number of historical events of cooperation and conflicts for the selected case studies, based on this scale, is provided.

2.3.1 Ganges-Brahmaputra-Meghna (GBM) Basin

The GBM river system originates partly in China, Nepal, and Bhutan and flows through India and Bangladesh (Figure 2.1). In central Bangladesh, the Ganges coming through India from the west is joined by the great Brahmaputra from the north and by the Meghna River from the northeast. Their combined water (the Lower Meghna) then flows south and discharges into the Bay of Bengal through an extensive and ecologically diverse delta. The Ganges Basin area is nearly 1 million km^2 and is densely populated with 420 million people. Agriculture is intensive in the basin area and 71% of the basin area is cultivated. Nepal contributes 60% of the annual discharge of the Ganges whereas its share of the basin area is only 14%. Brahmaputra is the biggest trans-Himalayan river system and has the highest average annual runoff. The river has flooded more often and with greater severity in recent

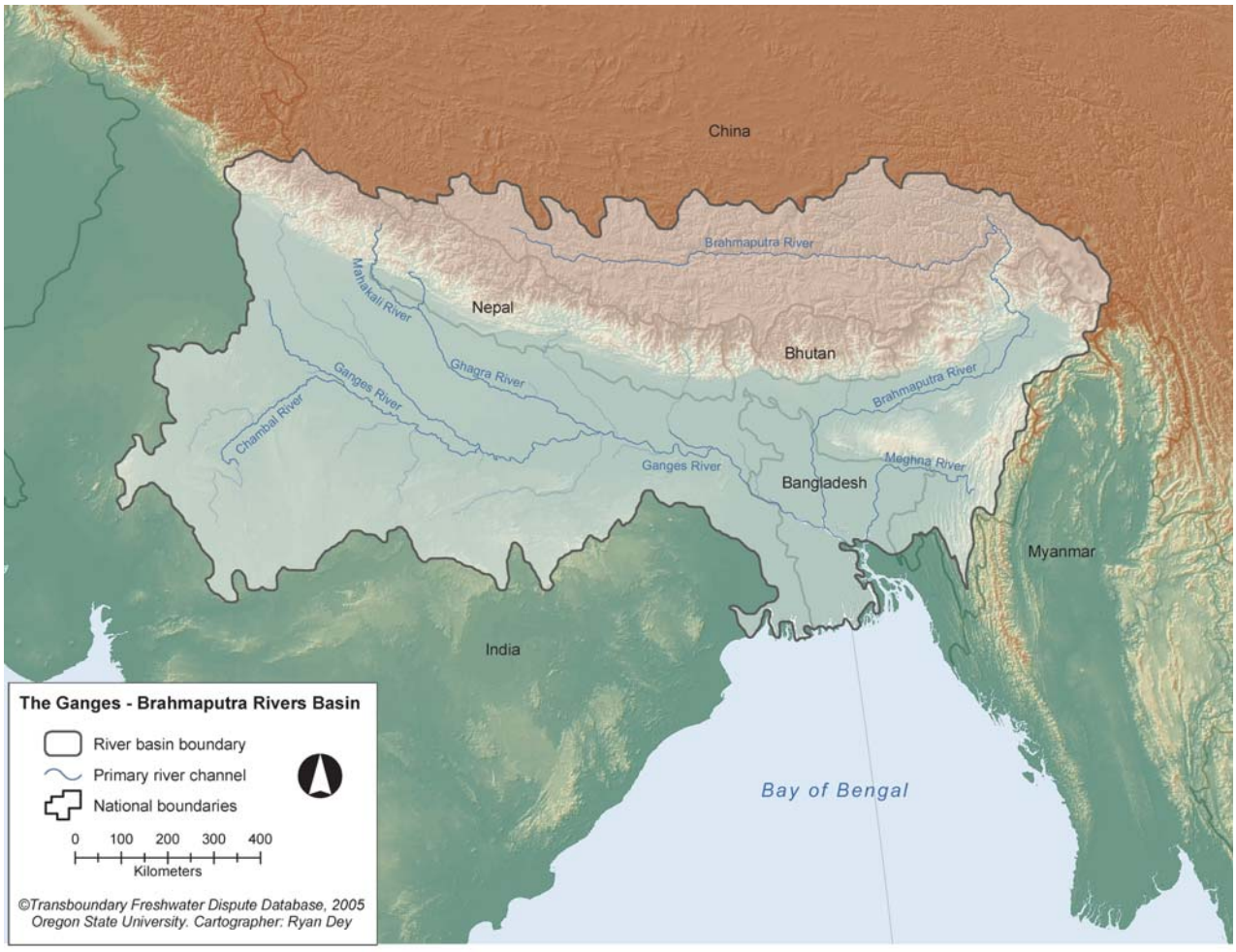


Figure 2.1 Ganges-Brahmaputra-Meghna (GBM) Basin.

years due to rapid deforestation of the Himalayas. The growth of heavy river transport has been important to the continuing development of the economic resources in the lower Brahmaputra valley, including tea estates, forests, and oil, coal and natural-gas deposits in Assam, and jute in Bangladesh. Increasing water scarcity, floods, excessive sedimentation, drastic changes in river morphology, reduced dam safety, salinization of fresh waters, loss of arable lands, and environmental degradation of unique habitats such as the mangrove forests of the Sundarbans in the delta are affecting the environmental condition and the socioeconomic security of millions of people in the basin.

2.3.1.1 Issues and Efforts for Conflict Management

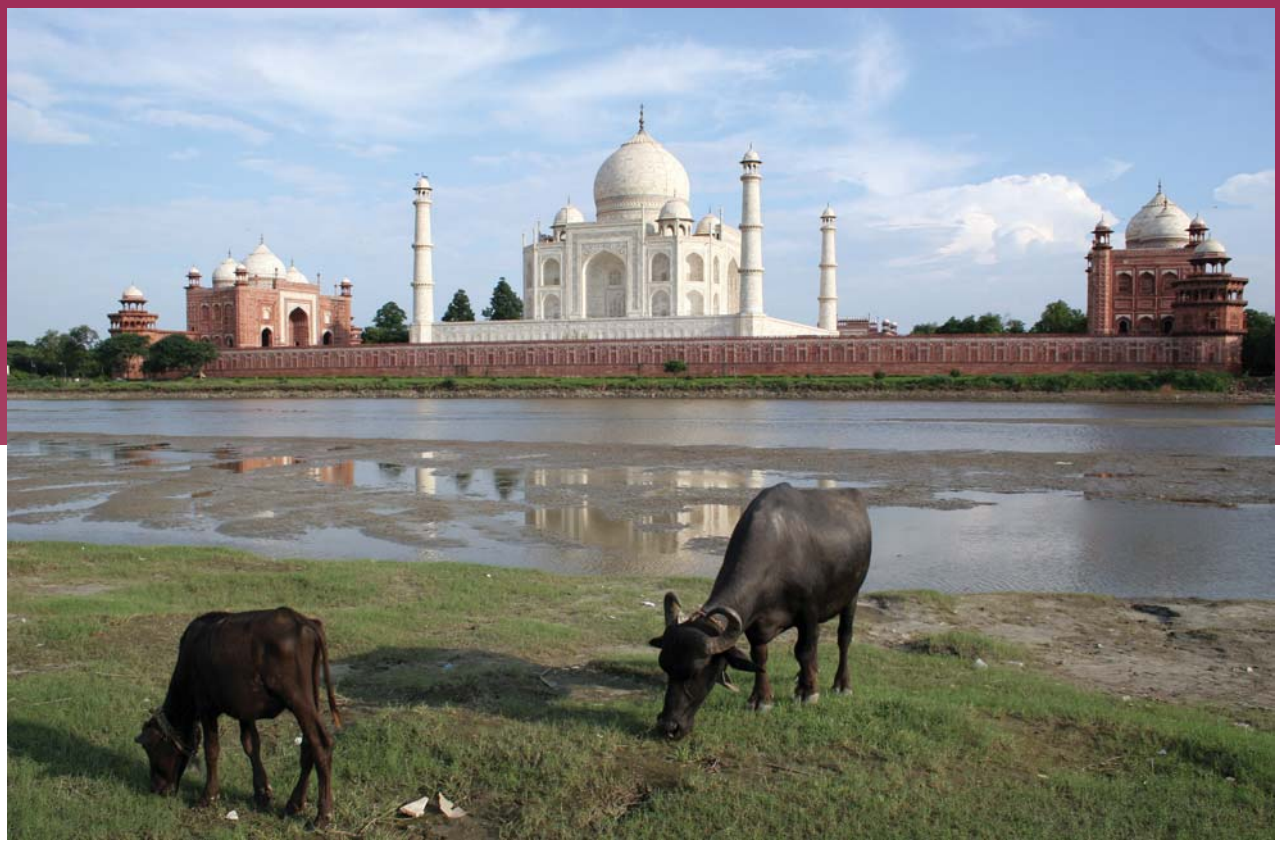
The disputes and conflicts over the water sharing of the GBM Basin date back to the early 1950s. The problem over the use of water is a typical example about the issues of upstream dominance and the effect on the needs of the downstream riparian. While blessed with an abundance of water resources, much of the management problems of the Indian subcontinent come from the dramatic seasonal variations in rainfall. Furthermore, the headwaters of the Ganges and its tributaries lie primarily in Nepal and India where snow and rainfall are heaviest. Flow increases downstream, even as annual precipitation drops, as the river flows into Bangladesh. Bangladesh, being in the downstream and delta portion of a huge watershed, has been most vulnerable to the water quality and quantity that flows from upstream. The ways rivers are used in one country can indeed have far-reaching effects on nations downstream. When India built the Farakka Barrage in the 1960s, Bangladesh (then East Pakistan until its independence in 1971) watched helplessly as the barrage wreaked havoc. In the dry season, the barrage blocked the natural flow of water into the country, causing drastic water shortages. And in the rainy season, sudden water releases caused floods and extensive damages, including the loss of property and human lives.

A number of official exchanges and discussions were held that led to treaties and cultural and scientific agreements to resolve the water issues over this basin. A brief summary of the number of events of cooperation and conflict by relating them to the BAR Scale is provided below:

- 11 events in all have taken place, which include international freshwater treaty and major strategy alliance
- 9 events in all, which include cultural or scientific agreement or support (non-strategic)
- 28 events in all, which include non-military economic, technological or industrial agreement

Table 2.1 Agreements in Water Sector for GBM Basin

No	Date	Treaty Basin	Countries	Treaty Name
1	12/12/1996	Ganges	Bangladesh, India	Treaty between Bangladesh and India on sharing of the Ganges waters at Farakka
2	12/02/1996	Mahakali	India, Nepal	Treaty between India and Nepal, concerning the integrated development of the Mahakali river including Sarada Barrage, Tanakpur Barrage, and Pancheshwar Project
3	07/04/1978	Kosi	India, Nepal	Agreement between India and Nepal ` on the renovation and extensions of the Chandra canal, pumped canal, and distribution of the Western Kosi canal



The Taj Mahal in Agra, India, seen from the banks of the Yamuna River. Photo credit: David Castor, via Wikimedia Commons.

- 47 events in all were for minor official exchanges, talks, or policy expressions–mild verbal support
- 1 event was for military economic or strategic support
- 3 events involved diplomatic-economic hostile actions.

A listing of treaties and agreements among the basin countries reached at different times is provided in Table 2.1. An elaboration on the issues and the emergence of conflicts, and the negotiation process leading to the signing of treaties and agreements, is provided in Section 2.2. The Ganges Waters Agreement signed between Bangladesh and India in December 1996 covered the sharing of waters of the Ganges at Farakka and possible long-term solutions for augmentation of the dry season flows of the Ganges. The Mahakali Treaty, signed between India and Nepal in February 1996, stresses integrated development of the Mahakali River, including Sarada Barrage, Tanakpur Barrage, and the Pancheswar Project. The Kosi Agreement, signed in 1978 between India and Nepal, dealt with the renovation and extensions of the Chandra Canal, Pumped Canal, and distribution of the Western Kosi Canal.

2.3.1.2 Inferences

- Countries sharing the basin are at different levels of socioeconomic development. The unequal power relationships from the historical and political perspective often hinder the process of cooperation. This dominancy leads to mistrust, but it has been observed in the past that a strong third-party involvement can bring the parties together for a dialogue leading to amicable cooperation. Therefore, the inference drawn is stated as follows: "Unequal power relationships, without strong third-party involvement, create strong disincentives for cooperation."
- Requests for increasingly detailed data clarifications can be an effective delaying tactic. Agreeing on the minimum data necessary for a solution or delegating the task of data gathering to a third party may speed the pace of negotiations. The long-term challenge would be to integrate information about

Traditional boats next to whitewater rafts on the banks of the Sun Kosi, Nepal. Photo credit: Tom and Heidi Powell.

the natural system, for example, integration of information of the water resources, agriculture, and ecological systems, in order to formulate policies and strategies for proper utilization of the shared resources.

- Short-term agreements, which stipulate that the terms are not permanent, can be useful steps in long-term solutions. However, a mechanism for continuation of the temporary agreement in the absence of a long-term agreement is crucial. Proper legal and institutional setup is needed for the governance as per agreement. Furthermore, most of the agreements are of bilateral nature, whereas basin level development and management requires multilateral agreements and treaties.

2.3.2 Indus River Basin

The Indus River originates in the Tibetan Plateau of Tibet, China, flows into Pakistan, and travels the entire length of the country before emptying into the Arabian Sea. While 53% of the basin area (597,000 km^2) falls within Pakistan, there are significant amounts of the catchment area in India (381,600 km^2), China, and Afghanistan (76,200 and 72,100 km^2, respectively). The total area of the basin is 1,138,800 km^2 and the river travels a length of 3,200 km from the Tibetan Plateau to the Arabian Sea. The total discharge of the Indus River is 15 km^3/year (TFDD 2003).

2.3.2.1 Issues and Efforts for Conflict Management

Even before the partition of India and Pakistan, the Indus posed problems between the states of British India. The problem became international after partition, and the increased hostility and the lack of a supra-legal authority only exacerbated the issue. Pakistani territory, which had relied on Indus water for centuries, now found the water sources originating in another country, one with whom geopolitical relations were increasing in hostility. The question over the flow of the Indus is a classic case of the conflicting claims of upstream and downstream riparians.

Eugene R. Black, President of the World Bank, after reading an article about the nations' water issues, contacted the prime ministers of Pakistan and India in 1952, inviting both countries to accept the Bank's good offices in

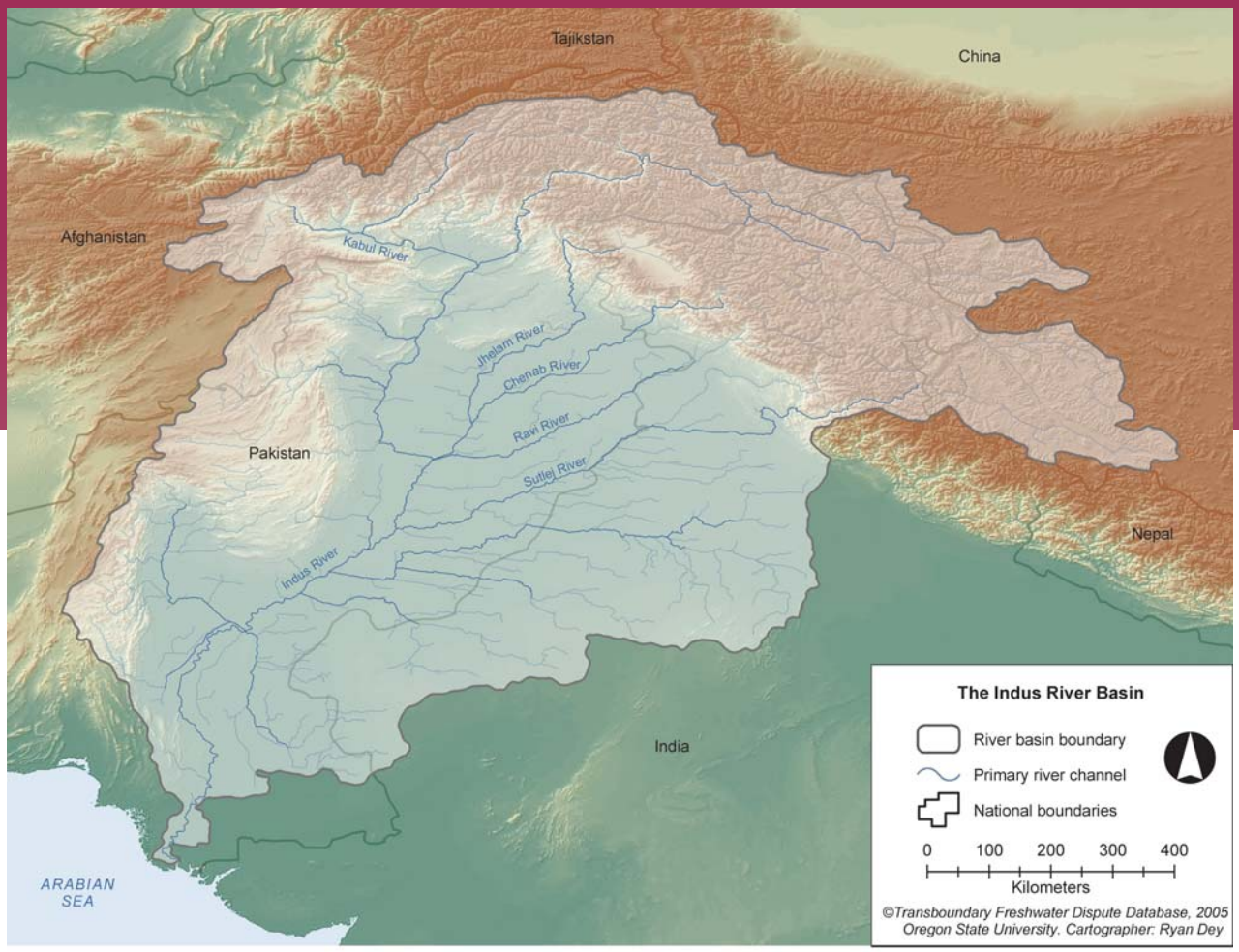


Figure 2.2 Indus River Basin.

helping solve their dispute. In a subsequent letter, Black outlined "essential principles" that might be followed for conflict resolution. These principles included the following: that water resources of the Indus basin should be managed cooperatively; and that problems of the basin should be solved on a functional and not on a political plane, without relation to past negotiations and past claims. Black suggested that India and Pakistan each appoint a senior engineer to work on a plan for development of the Indus Basin. A Bank engineer would be made available as an ongoing consultant.

Both sides accepted Black's initiative. The first meeting between the sides included Indian and Pakistani engineers, along with a team from the World Bank, as envisioned by Black, and took place in Washington in May 1952. After the two sides met repeatedly, but were stymied by a stalemate, the World Bank was forced to abandon its goal of the integrated development of the Indus Basin for a proposal that favored separation. The Bank's proposal called for the entire flow of the eastern rivers to be allocated to India, and all of the western rivers, with the exception of a small amount from the Jhelum, to be allocated to Pakistan. According to the proposal, the two sides would agree to a transition period while Pakistan would complete link canals dividing the watershed, during which India would continue to allow Pakistan's historic use to continue to flow from the eastern rivers. After several more rounds of negotiations detailing the specifics of infrastructure funding, the World Bank organized a consortium of donors, which raised $900 million USD in addition to $174 million USD that was promised by India. As a result, the Indus Waters Treaty was signed in Karachi, Pakistan on September 19, 1960.

A number of official exchanges and discussions were held that led to treaties and agreements to address the issue of sustainable development of the basin. A brief summary of the number of events of cooperation and conflict by

Baltit Fort, Hunza Valley (Indus River basin), Pakistan. Photo credit: Tom and Heidi Powell.

relating them to the BAR Scale is provided below:

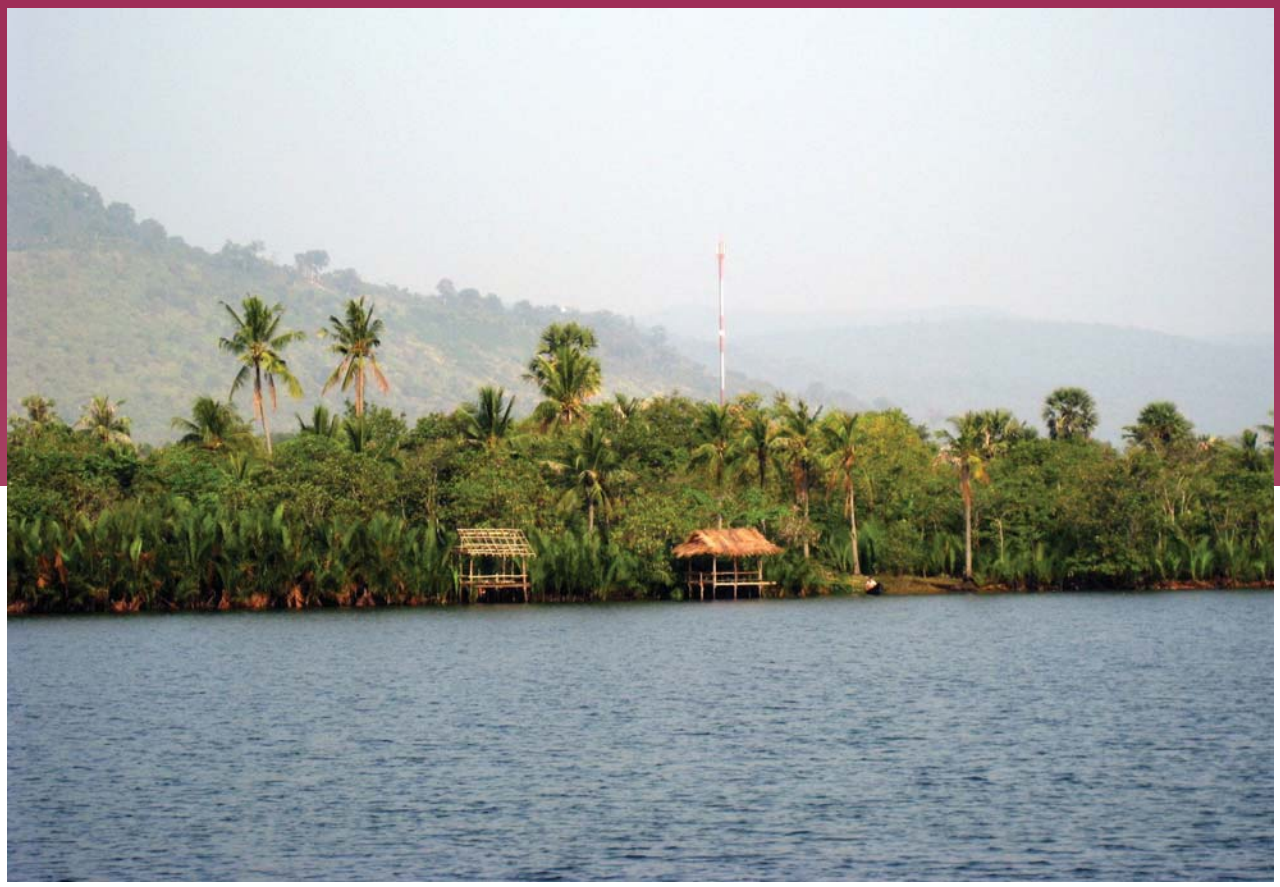
- 3 international freshwater treaties or major strategic alliance
- 11 non-military economic, technological, or industrial agreements
- 6 cultural or scientific agreements or support
- 3 official verbal supports of goals, value, or regime
- 12 minor official exchanges, talks, or policy expressions–mild verbal support
- 1 neutral or non-significant act for inter-nation situation
- 8 mild verbal expressions displaying discord in interaction
- 14 strong verbal expressions displaying hostility interaction
- 2 diplomatic-economic hostile actions.

An elaboration of the process leading to the signing of treaties and agreements is provided in Section 2.2.

As mentioned above, the Baglihar Dam dispute proved the resilience of the Indus Waters Treaty. Although a dispute occurred and had the potential to escalate into other realms of relations between India and Pakistan, the dispute resolution mechanisms that were in place in the Indus Waters Treaty prevented this from happening. While the treaty has been criticized as not being as fair and equitable as it could potentially be, it has served its purpose by preventing a dispute over water from escalating into conflict.

2.3.2.2 Inferences

- Shifting borders and partition exacerbated what was, initially, an intra-national Indian issue. After partition, political tensions, particularly over Kashmir territory, contributed to tensions of this newly international conflict.
- Power inequities may have delayed pace of negotiations. India had both a superior riparian position, as well as a relatively stronger central government, than Pakistan. The combination may



Mekong River near Kampot, Cambodia. Photo credit: Stephanie Garvey.

have acted as disincentive to reach agreement.

- The active participation of Eugene Black and the World Bank were crucial to the success of the Indus Water Treaty. The Bank offered not only their good offices, but a strong leadership role as well. The Bank provided support staff, funding, and, perhaps most important, its own proposals when negotiations reached a stalemate.

- Coming to the table with financial assistance can provide sufficient incentive for a breakthrough in agreement. The Bank helped raise almost $900 million from the international community, allowing for Pakistan's final objections to be addressed (Alam, 2002).

2.3.3 Mekong River Basin

The Mekong River originates from Himalayas in Tibet, passes through the deep and thinly populated gorges of Yunnan province in China, and enters the Lower Mekong Basin near the Burmese-Laotian border. It continues through Laos to stretch along the Thai-Lao border and at the Khone Waterfalls, the river enters Cambodia before it slows down and discharges into the South China Sea through the Mekong Delta in the southern part of Vietnam. From the origin at the Tibetan Plateau, the river maintains a southerly course for some 4,500 km to the South China Sea, draining a catchment area of 795,000 km^2 of six countries. The total population of the basin is over 70 million, with the lower Mekong Basin being home for some 60 million people. Almost 90% of the basin area lies inside Laos, Thailand, Yunnan Province of China, and Cambodia, whereas Vietnam and Myanmar share 8% and 3% of the basin area, respectively. However, due to the regional variation of rainfall and hydrological characteristics, the contribution of flow (runoff) is not shared proportionally to the basin area. Twenty-five percent of the basin area inside Laos produces 35% of annual runoff, whereas 21% and 23% of the basin area in the Yunnan province of China and in Thailand contribute only 16% and 18% of the annual runoff, respectively. Runoff contribution from the remaining portions of the basin is more or less proportional to their share of the basin area.

Although Mekong riparians enjoys abundant water resources, availability varies widely by country, by region within countries, and by season. Water availability in Laos and Cambodia depends almost entirely on the Mekong. In Thailand and Vietnam, large regions are fully dependent on the Mekong River Basin resources. The Mekong is a major water source in Yunnan Province, China. Only Myanmar is not strongly dependent on Mekong waters. Agriculture is a predominant economic sector in the Mekong River Basin. The large portion of water use in the basin is for irrigation, with rice as the main crop under irrigation. Although not a consumptive use, fisheries are a significant water user in the Mekong basin. The four riparian countries of the Lower Mekong Basin (LMB) have cooperated in the management of the basin water resources through the institutional arrangement of the Mekong River Commission (MRC).

2.3.3.1 Issues and Efforts for Conflict Management

The countries sharing the Mekong River Basin have different long-term major national uses for the river. China, the most upstream state, sees the upper Mekong primarily as a source of hydropower and as a trade route. One reservoir has already been constructed, a second one has just been finished, and six more are proposed in a cascade of eight dams. Also, a channel improvement project for navigation by removing obstructions is contemplated to allow transit of ships. If such a project is to proceed, it will have profound ecological, social, and economic consequences for the river and the people. Myanmar, the next downstream state, shares a relatively small part of the basin within its territorial boundaries and its use of water mainly for irrigation would have insignificant impact in the context of the basin-wide usage pattern. Laos also sees the Mekong primarily as a source of hydropower. Hydro-generated electricity is seen as an export product, which the government of the Lao PDR believes to have a major growth potential, with markets, primarily

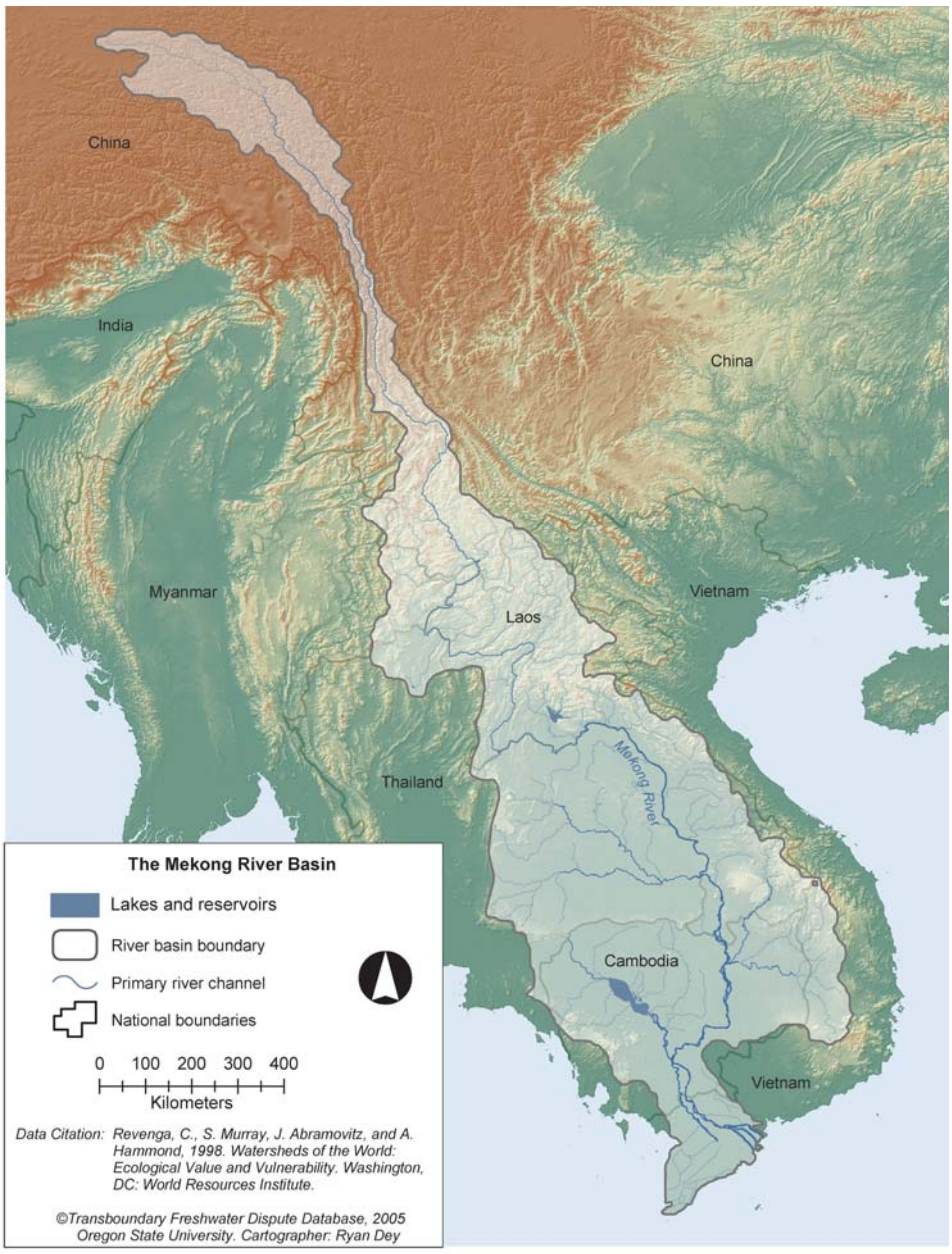


Figure 2.3 Mekong River Basin.

Rice planting, Vietnam. Photo credit: Philippe Berry, IFPRI (International Food Policy Research Institute), courtesy of USAID.

in Thailand and Vietnam. Thailand is primarily interested in Mekong River as a water source. There is likely to be increased pressure to use the Mekong and its tributaries for irrigation in northeast Thailand. For Cambodia, the main value of the Mekong is the fishery. Vietnam relies on the Mekong for water to support the rice crop in the Mekong Delta.

Country differences arise due to different levels of economic development, geographical position with respect to the river and its basin, and the relative significance of the basin in each country. The MRC is charged with coordinating management and development of the basin's resources. There have been numerous conflicts between neighbouring countries in the Mekong River Basin. Some use the Mekong for drug trafficking, illegal migration, and the exploitation of children and women. Others have harmed the Mekong's complex ecosystem through a number of recent development projects, which have resulted in deforestation and depletion of wildlife habitats. These problems have caused pain, suffering, and losses to whole communities, individual citizens, young and old, and to the nations in the area. During the early decades of Mekong cooperation, the focus was largely on economic development activities. Considerations for social and environmental aspects were minimal. Work was undertaken on a project and national basis and the transboundary impacts of development (social and environmental) were not

Visitors learn about rice-planting practices among hill tribes near Chiang Mai, Thailand, as part of a promotional event to introduce the concept of "edutainment." Photo credit: KIAsia/Paul Wedel, courtesy of USAID.

Produce boat at Cai Rang, Mekong River, Vietnam. Photo credit: Gene Molander.

considered. In the early 1990s, the need for regional development that is sustainable and holistic in nature gained prominence, and this concept is at the core of the 1995 Agreement. With the signing of the 1995 Agreement, increased importance has been put on ensuring the delicate balance between socioeconomic development and the need for environmental protection and maintenance of the ecological balance of the river basin. The MRC also coordinates sustainable development, utilization, management, and conservation of water and related resources of the basin.

A number of official exchanges and discussions were held that led to treaties and agreements to address the issue of sustainable development of the basin. A brief summary of the number of events of cooperation and conflict by relating them to the BAR Scale is provided below:

- 3 events involving strong verbal expressions display hostility in interaction
- 91 events involve minor official exchanges, talks, or policy expressions–mild verbal support
- 29 events involve cultural or scientific agreement or support (non-strategic)
- 60 events involve non-military economic, technological, or industrial agreement.

A listing of treaties and agreements among the basin countries reached at different times is provided in Table 2.2. An elaboration of the process leading to the signing of treaties and agreements is provided in Section 2.2.

The proactive and adaptive management approach, and the "Mekong Spirit of Cooperation" has so far helped MRC member states in preventing and turning the potential conflicts to a mutually beneficial cooperation and sustainable development of the river basin. The political commitment to collaboration will be further put to test when the policy level agreements have to be adopted in practice.

2.3.3.2 Inferences

- An international framework for integrated watershed management established well before any major

Mekong River, Laos. Photo credit: Alison Jarrett.

change taking place in the basin makes the task easier and more likely to succeed during later times of stress. The riparian countries of LMB have maintained a mechanism for collaboration since 1957, which is now widely praised as the "Mekong Spirit." Even though the region passed through difficult times in 1970s with political changes in basin countries and a number of conflicts among member states, the spirit of cooperation persisted.

Table 2.2 Agreements in Water Sector for Mekong Basin

No	Date	Treaty Basin	Countries	Treaty Name
1	10/31/57	Mekong	Cambodia, Laos, Thailand, Vietnam	Statute of the Committee for Co-ordination of Investigations of the Lower Mekong Basin established by the governments of Cambodia, Laos, Thailand and the Republic of Viet-Nam in response to the decisions taken by the United Nations Economic Commission for Asia and the Far East. Phnom-Penh Cambodia), on 31 October 1957
2	01/31/75	Mekong	Khmer, Republic of, Laos, Thailand, Vietnam	Joint declaration of principles for utilization of the waters of the lower Mekong Basin, signed by the representatives of the governments of Cambodia, Laos and Vietnam to the committee for coordination of investigations of the lower Mekong Basin, signed at Vientiane on 31 January 1975
3	05/04/95	Mekong	Cambodia, Laos, Thailand, Vietnam	Agreement on the cooperation for the sustainable development of the Mekong River Basin

Merchants on Tonlé Sap, Cambodia. Photo credit: Stephanie Garvey.

- The emphasis on data in advance of any construction projects sets the hydrographical stage for more efficient planning and also may establish a pattern of cooperation through relatively emotion-free issues. The MRC has been instrumental in setting up a knowledge base of data and information and a set of analysis tools in the decision support framework, which is now used in assessment works and analysis of basin development plan and integrated basin flow management.

- The MRC has embarked on a process of basin-wide development planning, taking into consideration the national programs of development using the resources from Mekong, to solve the water-related issues involving both technical and social aspects of development. The process is fully on a participatory basis, with input from the local, provincial, and national level agencies, and includes screening of national development proposals to identify those that have transboundary significance and are consistent with the sustainable development objectives of the member countries.

2.3.4 Salween River Basin

The Salween River, originating in the Tibetan Plateau, has a catchment area of 320,000 km^2 spread over China, Myanmar, and Thailand. It flows along a stretch of 2,400 km before it drains into the Gulf of Martaban. Of the total catchment area of 320,000 km^2, 53% is in China, 42% in Myanmar, and only 5% in Thailand. The basin is comparatively less developed, with a relatively small population within the basin. The topography is mountainous, and opportunities for sizeable settlements and agricultural activities are quite limited, especially along upstream and midstream reaches. Significant economic activities are limited to the production of and trade in rice and rice products, and wood and wood products. Ethnic minorities inhabit areas in and around the Salween River Basin and many of them are still engaged in shifting cultivation. These areas have been considered socio-politically unstable.

The Salween Basin is a case where ample opportunities exist for river basin development planning in advance of conflict. Effective realization of these opportunities would call for a broad regional perspective. Preliminary meetings were and are being held between Myanmar and

Thailand; some project feasibility studies were implemented, but to date, no basin-wide plan or any mainstream project has been implemented. Despite the fact that studies since the 1950s have identified tremendous hydropower potential, the Salween is a relatively undeveloped basin, with only one major hydroelectric project at Baluchaung. The power companies of Thailand and Myanmar, as well as private Japanese concerns, have pursued individual feasibility studies, but it is only since the 1970s that the potential of the basin as a whole has been investigated. Feasibility studies were also carried out on the possible diversion of water from the Salween and its tributary, the Moei, to river basins in Thailand.

2.3.4.1 Issues and Opportunities

The possibility of the out-of-basin water transfer to Thailand and the promotion and coordination for the joint development of hydropower projects within the Salween Basin are major water-related issues involved. The non-water related issues include the flow of river through regions of ethnic unrest and drug trade. In June 1989, following a visit of a Thai government delegation to Rangoon, a joint technical committee was established between Thailand and Myanmar, made up primarily of representatives from the power companies of the two countries. Since that time, the committee has continued to meet and to pursue feasibility studies, but no project or management body has been implemented. China has not been included in discussions to date.

By considering the countries sharing the Salween River Basin—Myanmar, Thailand, and China (Yunnan province)—and by taking account of possibilities for trans-basin water diversion and other relationships with immediate neighbouring basins, jurisdictional conditions for the development of the Salween River Basin appear to be complex. The situation may appear simple if Myanmar and Thailand are taken together and the development issues of the resources then become a typical upstream and downstream issue, with China in the upstream and Myanmar/Thailand in the mid- and downstream. This could

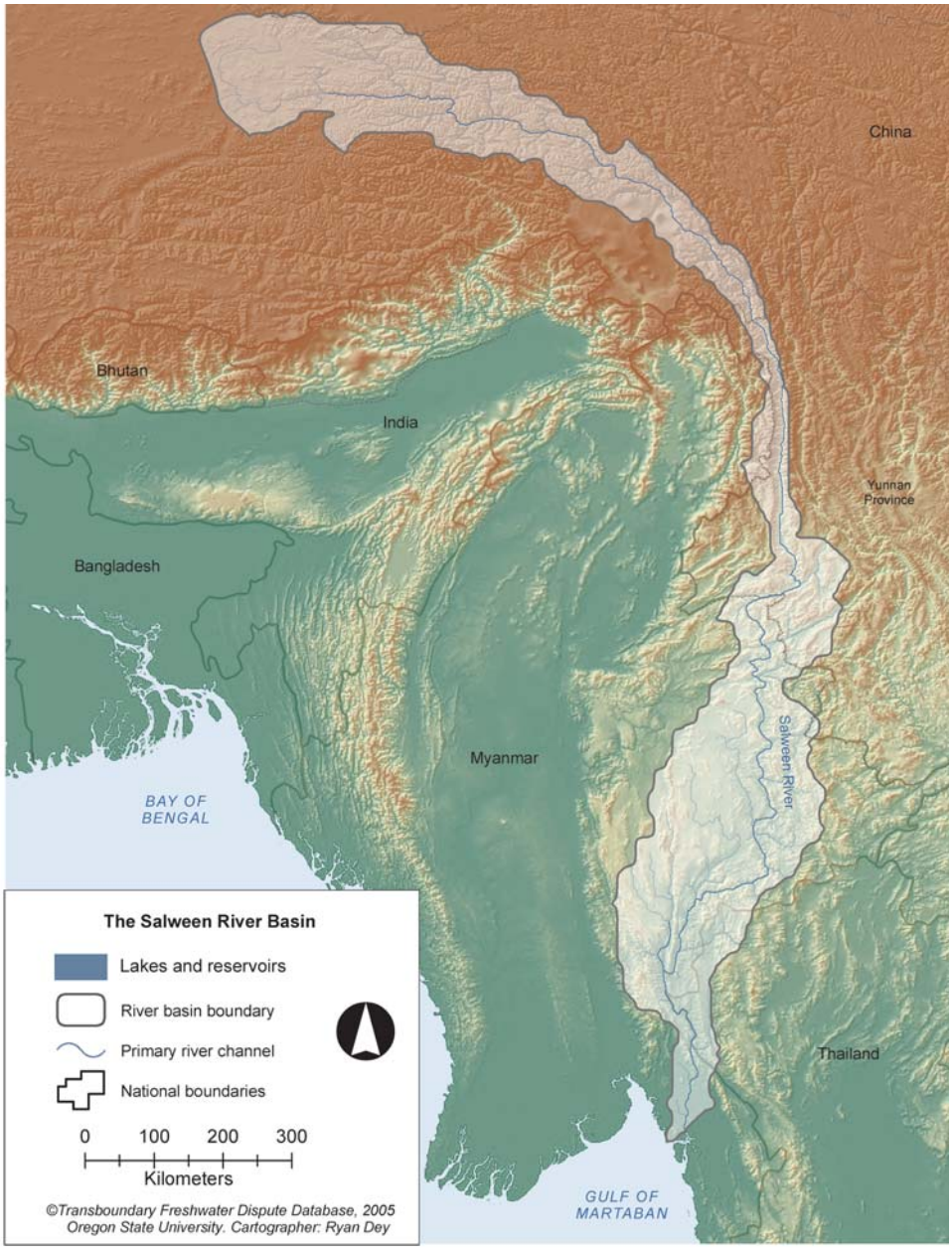
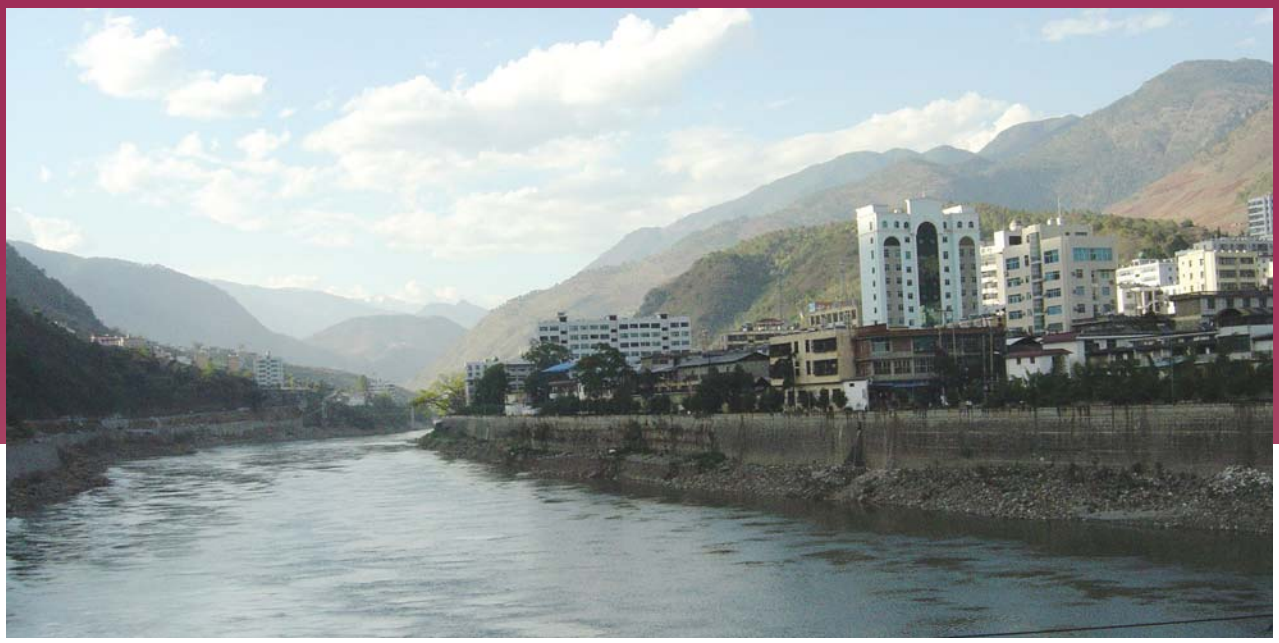


Figure 2.4 Salween River Basin.



Nu-Salween River, China. Photo credit: He Daming.

be a realistic way to look at the situation, as Thailand occupies only a small portion of the basin downstream and has a strong incentive to work closely with Myanmar. A major upstream-downstream conflict will arise when China will move ahead with the plan of developing a 13-dam cascade on the upper Salween River.

The Myanmar government attaches priority to the development schemes that fall entirely within its territory, for socio-political and security reasons. Opportunities exist for joint hydropower development by Myanmar and Thailand, with an option to divert water from the Salween River to internal river basins in Thailand. From a technical point of view, the trans-basin water diversion seems most feasible from the midstream, where a proposed dam site is close to the border with Thailand and the river flow can be most effectively regulated. This also provides opportunities for benefit sharing. A prerequisite for any joint development is that it should benefit all the participants. In the case of joint development of the Salween River for hydropower generation and trans-basin water diversion, benefits to Thailand are clear. However, the challenge would be how to internalize the notion of cost and benefit sharing in the process of development.

2.3.4.2 Inferences

Ad-hoc meetings and forums will continue without many concrete outcomes unless a proper institutional structure is set up in the form of a committee of the three riparian countries for discussion and resolution of the guiding principles of development of the Salween River Basin. It is noteworthy that the technical and economic viability of major development projects have been established by preliminary studies, but the socio-cultural and environmental aspects need to be examined before a basin-level development project is initiated, thus allowing for integrated management almost from the beginning.

Planning for the basin development should be conducted within a broad regional framework for increased economic interactions, trans-basin water diversion as well as sharing of hydroelectric energy. Joint development by countries requires prior agreement on cost allocation and benefit sharing. Any development in the upper catchment that could change the flow regime should be planned and discussed by three countries, considering complementary operation with downstream developments.

Planning for specific development activities should be conducted using a participatory approach. Participatory development is an idea that has become increasingly popular among donors, development consultants, and others. Existing ethnic problems should be considered as an advantage rather than obstacles for the joint development of Salween. Ethnicity does not observe national boundaries. It is essential for the

successful implementation of any development project that local communities in general, and ethnic groups in particular, are involved in the planning at the early stage.

2.4 Conclusion

International river basins in South and Southeast Asia are at different stages of development, ranging from basins at a fully developed state by the riparian countries to basins having opportunities for further development. Most of the existing treaties and agreements do not deal with the problems and programs of development from the perspective of a comprehensive, basin-wide approach, but rather relate in general context to specific river sections and project areas and to boundary water reaches. To cite an example, all of the treaties and agreements in the GBM basin are of this category. These agreements may address specific issues between riparian countries at a certain point in time, develop initial mutual trust, and offer the possibility of the development of water resources in a basin, albeit not in a comprehensive manner. In the long run, this approach could easily result in non-adherence to the agreed principle, develop creeping socio-economic problems in downstream countries, and create an atmosphere of disrespect and mistrust that is the sign of hydropolitical vulnerability. On the other hand, if the agreement process is associated with an institutional system involving agencies of respective countries entrusted to maintain active communication on technical matters on common interest, then the cooperative environment could still persist. Communication initiates a basis for trust, understanding, and cooperation in exchanging data and information, planning, and implementing projects that develop a sense of hydropolitical resilience. A bilateral process is the predominant state of affairs in most of the river basins in South Asia, although there have been signs of movement toward multilateral terms and conditions.

The role of MRC is to coordinate and promote cooperation in all fields of sustainable development, utilization, management and conservation of water and related resources of the basin. The establishment of the MRC, following the signing of the Agreement on Cooperation for the Sustainable Development of the Mekong River Basin in 1995 by the governments of the four riparian countries, is a major step in broadening the scope of cooperation in all fields of basin development and resource management, river navigation, flood control, fisheries, agriculture, power production, and environmental protection. The legal and institutional structure for regional

Rafting the Sun Kosi, Nepal. Photo credit: Heidi Powell.

Construction project on Lancang/Upper Mekong, China. Photo credit: He Daming.

cooperation in the lower Mekong Basin is basically in place. The success of MRC in meeting its mission and goals depends on the cooperation of the four riparian countries and the extent to which they can engage the upper basin countries, mainly China, whose development activities in the upper reaches of Mekong can greatly impact the whole downstream region. The 1995 Agreement allows the admission of new riparian nations to become party to the agreement, and in recent years, both China and Myanmar have been actively participating as dialogue members at meetings of the Joint Committee of MRC.

Drain for irrigation water drawn from wells near Bhaun, Pakistan, Indus River basin. Photo credit: Syed Usman Ali, via Wikimedia Commons.

China's initiative of developing a cascade of eight dams in the upper Mekong River raises concern about the negative social and ecological impacts downstream and that the projects are being implemented without much consultation with the downstream riparian countries. This action has mostly been seen as China's unilateral behavior in avoiding multilateral negotiations with the downstream countries for the cooperative management of the Mekong River. However, the water-related issues related to the dynamics of hydropolitics need to be addressed within the broader framework of regional development rather than river basin development. China is the most upstream country and a political and economic superpower in the region. It is to be noted that China is a major collaborative partner in many regional development programs. For example, the Greater Mekong Sub-region (GMS) Program, launched by the Asian Development Bank, promotes regional and sectoral planning in transportation, telecommunication, energy, environment, natural resources management, human resources development, trade, and tourism. Through these programs, China is collaborating and negotiating with downstream countries on various transboundary projects. Even though China is not a member of MRC, other regional programs like GMS program provide the

Along the Mekong River near Phnom Penh, Cambodia. Photo credit: Stephanie Garvey.

opportunity for MRC to initiate in a formal way cooperative actions on water-related issues.

Countries sharing a river basin are normally reluctant to sign an international agreement, since any agreement could be perceived tantamount to limiting a nation's flexibility and sovereignty to some extent. Concerns of national sovereignty are perhaps the major obstacle in the way of achieving integrated international river development. The Indus Water Treaty postulates the sharing of water of tributaries of the Indus River between India and Pakistan. The major motivation for agreement can be interpreted as the desire of both India and Pakistan to reduce the interdependence between them. This is a clear example of the influence of sovereignty concerns. The Salween River Basin possesses vast potential for development. Strong incentive for development rests in particular with the two lower riparians: Thailand and Myanmar. Thailand and Myanmar have established a Joint Committee for undertaking studies, investigations, and discussions pertaining to hydropower development. However, there are a number of obstacles to development of the basin. International relations and national political stability play a vital role in the implementation of transboundary river infrastructure projects. As the scale of these projects is large, international cooperation will be required for their implementation.

An external party, often an international agency, is found to facilitate the effective development of a process of engagement and discussion among the riparian countries. Once the institutional system is in place and functional, the long-term support for this process should come from the riparian countries. Where this is not the case, over reliance on donor support can arise, undermining long-term ownership. Along with the formation and development of transboundary institutions, national institutions should be strengthened, and collaborative links among the national institutions and transboundary institutions should be established. In order to ensure long-term ownership from riparian countries, one of the key process issues is promoting the benefits of effective transboundary management within national states. This has a political dimension sensitive to the different upstream-downstream perspectives of riparian countries and their political economies. Therefore, careful consideration has to be given to the meaning of equitable allocation of water, particularly in economically highly uneven river basins like the Mekong River Basin.

This USAID-funded water plant in Jordan is bringing 100,000 cubic meters of water daily to 700,000 people in the Greater Amman area by capturing water from brackish streams to increase the supply. Photo credit: Black and Veatch, via USAID.

Chapter 3. Hydrovulnerability of West Asia

Geoffrey T. Klise, Alyssa M. Neir, Michael E. Campana, Amy Ewing, Berrin Basak Vener, and Alistair Rieu-Clarke

3.1 Background on the Concepts of Vulnerability and Resilience as Applied to West Asia

3.1.1 Definition of Vulnerability and Resilience

The institutions involved in managing, administering, controlling, and/or monitoring the transboundary water resources are some of the elements within international river- and groundwater basins that factor into an assessment of the hydropolitical vulnerability and resilience of transboundary basins. Resilience is a characteristic that is based on a positive response to change—the institutional capacity of the basin to digest disturbance. Vulnerability is a gauge of the risk of conflict *if* a change occurs. This can be measured by analyzing the institutional capacity of the basin as well as by assessing whether historical events in the basin indicate a capacity for resilience. Therefore, in order to evaluate the hydropolitical vulnerability of individual transboundary river basins, aquifers, and the region of West Asia as a whole, it is necessary to look at international agreements, international institutions, the history of the development projects, political relations between countries, the level of economic development, and the speed of the environmental changes that are taking place (i.e., the physical side of the water—quantity, quality, and location).

The institutional framework that deals with transboundary water resources in West Asia[1] is very limited in its basin-wide comprehensiveness. The institutions that manage water resources and promote resilience in basins are not mutually exclusive from the political tensions of the countries involved. For example, the 1994 Peace Agreement between Israel and Jordan included provisions that dealt with apportioning water (Soffer, 1999). However, water was not the main focus of the agreement; it was one issue among many that was addressed as a prerequisite to attaining peace between the countries. The following quotation indicates that water in West Asia needs to be analyzed in the context of the political realm outside of the basin of interest:

> It is possible that the water shortage of the Jordanian kingdom was a major catalyst in its alacrity in signing the peace treaty with Israel. Water issues continue to be a serious obstacle to the attainment of full peace between Israel and Syria and the Palestinians (Soffer, 1999: 201).

The institutional capacity of a basin can include active institutions as well as apportionment and sharing agreements that can create institutions or serve as a formal check on the actions of each of the countries. Active institutions, such as committees, can be created whereby their primary function is to study and address disagreements over the use and management of water resources within a basin. An

[1] In this report, the Basins in West Asia include An Nahr Al Kabir, Aral Sea, Asi/Orontes, Coruh, Jordan, Kura-Araks, Nahr El Kebir, Samur, Sulak, Terek, Tigris-Euphrates/Shatt al Arab, and Wadi Al Izziyah.

Crossing the Sirwan/Diyala River, tributary of the Tigris, Kurdistan, Iran. Photo credit: Babak Sedighi.

example of this is the Joint Technical Committee on Regional Waters that covers the Tigris-Euphrates/Shatt al Arab River Basin and is comprised of Turkey, Syria, and Iraq (Food and Agricultural Organization of the United Nations (FAO), 1997d; Republic of Turkey Ministry of Foreign Affairs, 2004; Economic and Social Commission for Western Asia (ESCWA), 2002). Apportionment and sharing agreements can promote resilience in a basin when they are used as a legal resolution to disagreements between the countries. An example of an agreement in West Asia includes the 1994 Peace Agreement between Israel and Jordan that addressed water rights in the Jordan Basin (Rantawi, 2004). This type of document can provide resilience in the basin if the tensions concern the two parties that signed it. However, if the tension extends to the countries that are not party to agreement, vulnerability arises from the lack of consensus among all of the interested countries and territories.

3.2 General Description of West Asia

3.2.1 Climate and Water Resources in West Asia

The climatic regions in West Asia are cold, temperate, and dry; not tropical (Map 1 (A)). The cold and temperate climates are found in the northern part of the area, with the dry climate covering the southern third, primarily in Iraq, Syria, and Jordan. The amount of runoff attributed to each area follows the climatic patterns, with more runoff in the cold and temperate climates than in the dry climates (Map 1 (B)). In addition, the majority of rainfall is received in the winter months, not in the summer when it is needed most (FAO, 1997a; Ministry of National Infrastructures, 2001). Furthermore, a significant amount of rainfall in this region is lost to evaporation—90% in Jordan (FAO 1991;

Table 3.1 International River Basins in Asia

River Basin	Total Area (km^2)	Area Division (%)	
Amur	2,085,900	Russia	48.23
		China	42.62
		Mongolia	9.14
		Korea, Democratic People's Republic of (North)	0.01
An Nahr Al Kabir	1,300	Syria	67.60
		Lebanon	31.70
Aral Sea	1,231,400	Kazakhstan	34.46
		Uzbekistan	31.07
		Tajikistan	11.02
		Kyrgyzstan	9.07
		Afghanistan	8.52
		Turkmenistan	5.68
		China	0.15
		Pakistan	0.01
Asi/Orontes	37,900	Turkey	49.94
		Syria	44.32
		Lebanon	5.74
Atrak	34,200	Iran	68.86
		Turkenistan	31.14
Chu	199,400	Kazakhstan	92.95
		Kyrgyzstan	7.05
Fenney	2,800	India	65.83
		Bangladesh	34.17
Fly	64,600	Papua New Guinea	93.40
		Indonesia	6.60
Ganges-Brahmaputra-Meghna	1,634,900	India	58.01
		China	19.65
		Nepal	9.01
		Bangladesh	6.55
		India, claimed by China	4.11
		Bhutan	2.44
		Indian control, claimed by China	0.07
		Myanmar (Burma)	0.00
Golok	1,800	Thailand	56.62
		Malaysia	43.38
Har Us Nur	185,300	Mongolia	96.81
		Russia	3.04
		China	0.15
Helmand	353,500	Afghanistan	81.53
		Iran	15.52
		Pakistan	2.95
Ili/Kunes He	161,200	Kazakhstan	60.24
		China	34.32
		Kyrgyzstan	5.44
Indus	1,138,800	Pakistan	52.48
		India	33.51
		China	6.69
		Afghanistan	6.33
		Chinese control, claimed by India	0.84
		India control, claimed by China	0.14
		Nepal	0.00
Jenisej/Yehisey	2,557,800	Russia	87.17
		Mongolia	12.82
Jordan	42,800	Jordan	48.13
		Israel	21.26
		Syria	11.45
		West Bank	7.48
		Egypt	6.31
		Golan Heights	3.50
		Lebanon	1.33

River Basin	Total Area (km²)	Area Division (%)	
Karnaphuli	12,500	Bangladesh	58.78
		India	41.14
		Myanmar (Burma)	0.09
Kura-Araks	193,200	Azerbaijan	29.28
		Iran	20.55
		Armenia	18.03
		Georgia	17.77
		Turkey	14.32
		Russia	0.03
Lake Ubsa-Hur	62,800	Mongolia	75.78
		Russia	24.22
Mekong	787,800	Laos, People's Democratic Republic of	25.14
		Thailand	24.62
		China	21.79
		Cambodia (Kampuchea)	20.10
		Vietnam	4.84
		Myanmar (Burma)	3.51
Nahr El Kebir	1,500	Syria	85.61
		Turkey	13.87
Ob	2,950,800	Russia	74.31
		Kazakhstan	25.21
		China	0.47
		Mongolia	0.01
Oral/Ural	311,000	Kazakhstan	56.43
		Russia	43.57
Pu Lun T'o	89,000	China	87.39
		Mongolia	12.48
		Russia	0.09
		Kazakhstan	0.04
Sepik	73,400	Papua New Guinea	96.81
		Indonesia	3.19
Talas	49,000	Kazakhstan	79.31
		Kyrgyzstan	20.69
Tigris-Euphrates/ Shatt al Arab	789,000	Iraq	40.48
		Turkey	24.80
		Iran	19.70
		Syria	14.73
		Jordan	0.25
		Saudi Arabia	0.01
Tumen	29,100	China	69.75
		Korea, Democratic People's Republic of (North)	28.59
		Russia	1.66
Yalu	50,900	China	52.65
		Korea, Democratic People's Republic of (North)	46.82

Source: Wolf et al., 1999.

Hashemite Kingdom of Jordan Department of Statistics, 2002). Table 3.1 lists the transboundary river basins in the region and the countries that they traverse.

The Tigris-Euphrates/Shatt al Arab River Basin has the largest amount of annual runoff, followed by the Kura-Araks River Basin, the Asi/Orontes River Basin, and then the Jordan River Basin (Map 1 (B)). Combined, the Tigris and Euphrates Rivers account for about 19% of Turkey's flowing surface water (Tomanbay, 2000). In addition, the Euphrates River brings about 30,000 MCM/yr (million cubic meters/year) of water into Iraq; the Tigris River brings 21,200 MCM/yr (FAO, 1997e). The Yarmuk River in the Jordan River Basin supplies 40% of Jordan's surface water (FAO, 1997a). The groundwater resources in the region (Map 2

(A)) consist of some important aquifers that are not filled with fossil water (i.e., renewable supplies) in the north, and major aquifers with fossil water (i.e., non-renewable supplies) in the south.

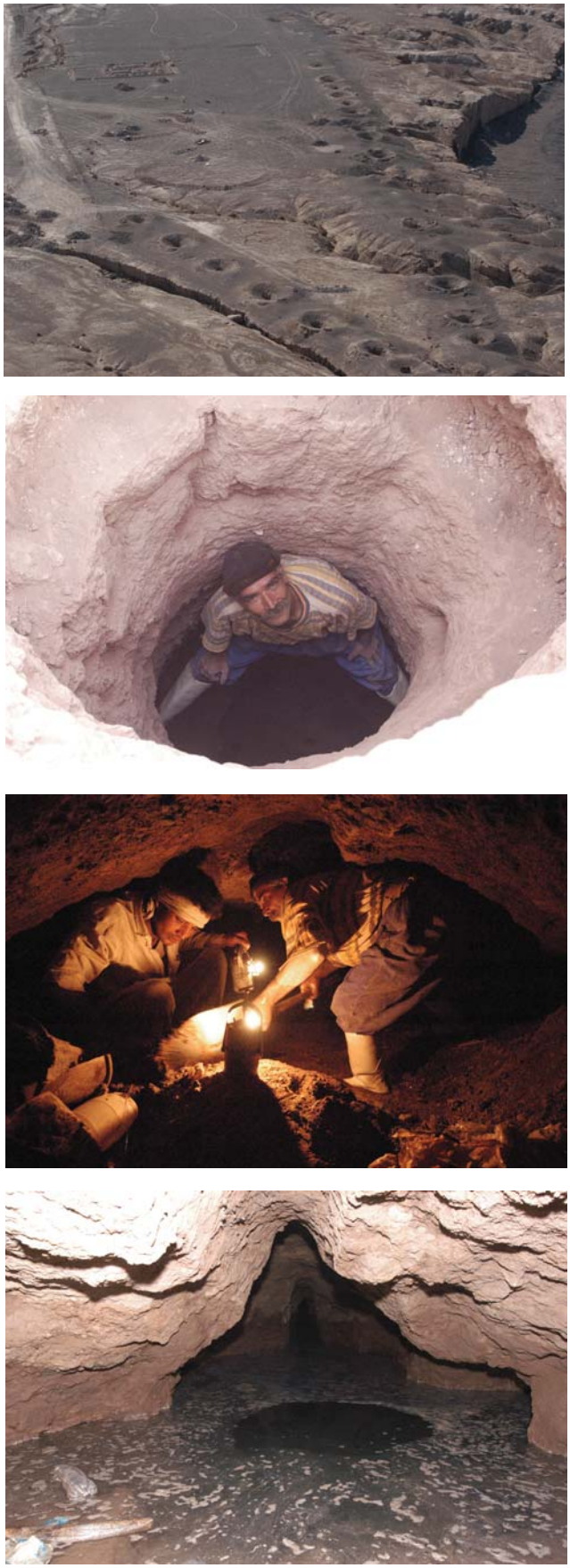
Turkey clearly has the largest amount of precipitation and internally produced water. It is followed by Iraq, which has less than 25% and16% of Turkey's levels of precipitation and internally produced water, respectively. The amount of water available to each country compared to its size and population bring the numbers into perspective.

Major water quality issues in the region include numerous water quality parameters (FAO, 1997e; Bou-Zeid and El-Fadel, 2002; METAP, 2001a; Ministry of National Infrastructures, 2001). For example, the lower Jordan River has problems with salinity levels, total dissolved solids, biological contamination (fecal coliform), nitrate, phosphorus, and pesticides (Howari and Banat, 2001; METAP, 2002). The Syrian portion of the Yarmuk River Basin is contaminated by sewage (METAP, 2001b). The arid climate exacerbates the water quality problems due to evaporation, which concentrates pollutants.

There are three primary uses of water in the region: agriculture, domestic, and industrial. Agriculture uses the largest amount of withdrawn water (Map 5(B)), typically followed by domestic and industrial uses.

3.2.2 Water Distribution and Infrastructure

It is possible for demand to exceed supply in some West Asian countries. When this happens in Israel, the agricultural sector feels the shortage, not the urban or industrial sectors (Ministry of National Infrastructures, 2001). In that case, the difference between supply and demand typically amounts to 200–300 MCM/yr, but can be met by exploiting groundwater resources, which has long-term consequences. It can also be met by increasing the use of treated wastewater (Soffer, 1999; Ministry of National Infrastructures, 2001). Jordan is another country that faces this supply and demand problem and exploits non-renewable fossil water to meet the demand when shortages arise (Soffer, 1999). In 1990, the shortage



(from top) Aerial view of qanat system of Bam, Iran; descending into qanat to perform maintenance; cleaning out the qanat; view of inside the qanat. This ancient form of water infrastructure is still widely used in arid and semi-arid regions to provide irrigation water and water for household usage. Water from aquifers or rivers is channeled through gently sloping subterranean canals. Photo credits: Babak Sedighi.

Kurdish farmer irrigating his fields near Erbil, Iraq. Photo credit: Ben Barber, USAID.

amounted to 264 MCM, which is similar to the level of Israel's water shortage (Soffer, 1999).

A number of dams in the region store and regulate the water supply. The Asi/Orontes River Basin has the greatest number of dams per 1 million km^2, above 100, in the region[2]. However, density is influenced by the size of the basin (37,900 km^2 for the Asi/Orontes Basin). Therefore, even though there is a high density, 100 dams/million km^2 equals only about four dams in the Basin, which is a small number of dams.[3] The high density of dams in this basin is followed by the Kura-Araks and the Jordan River Basins with a dam density of 51–100 dams and the Tigris-Euphrates/Shatt al Arab River Basin with 31–50 dams per million km^2. The Coruh and Nahr El Kabir River Basins do not have any dams.

Other large-scale infrastructure exists in Israel that artificially links the water resources and population. This occurred with the construction of the National Water Carrier in 1964 (Ministry of National Infrastructures, 2001). The water is taken from the north (80% of the water supply) and delivered to the south (20% of the water supply; Ministry of National Infrastructures, 2001).

[2] The density of dams in a Basin is only one gauge of activity in developing the resource.

[3] This rough calculation can be done for the other Basins using the Basin sizes given in Table 3.1.

3.2.3 Water Stress and Dependency

Water stress in basins is a major factor in transboundary water issues due to the increased demand on limited supply. Projected water stress in 2025 (Map 4 (B)) calculated on a basin-by-basin scale in West Asia shows that the Jordan and Kura-Araks Basins are water scarce; the Tigris-Euphrates/Shatt al Arab and Asi/Orontes Basins are water stressed; and the An Nahr Al Kabir, Nahr El Kabir, Coruh, Samur, Sulak, and Terek Basins are water abundant based on Falkenmark's (1989) thresholds. While this index has many problems, as Gardner-Outlaw and Engelman (1997) describe, it is used in this context as a way of demonstrating the limitations of the internal water supply. It also shows the importance of water in West Asian countries, especially for water that flows across borders that can be used to decrease population-induced, internal stress to each country's water supply. These numbers do not account for the spatial disconnect of population and the water resources, thereby potentially overestimating the per capita water availability in the basin, but they do indicate rough, comparative values of each basin's water situation.

The water dependency ratio (Map 6 (A)) for each country demonstrates the importance of

A team of Iraqi farm workers heads out to the fields. Photo credit: USAID.

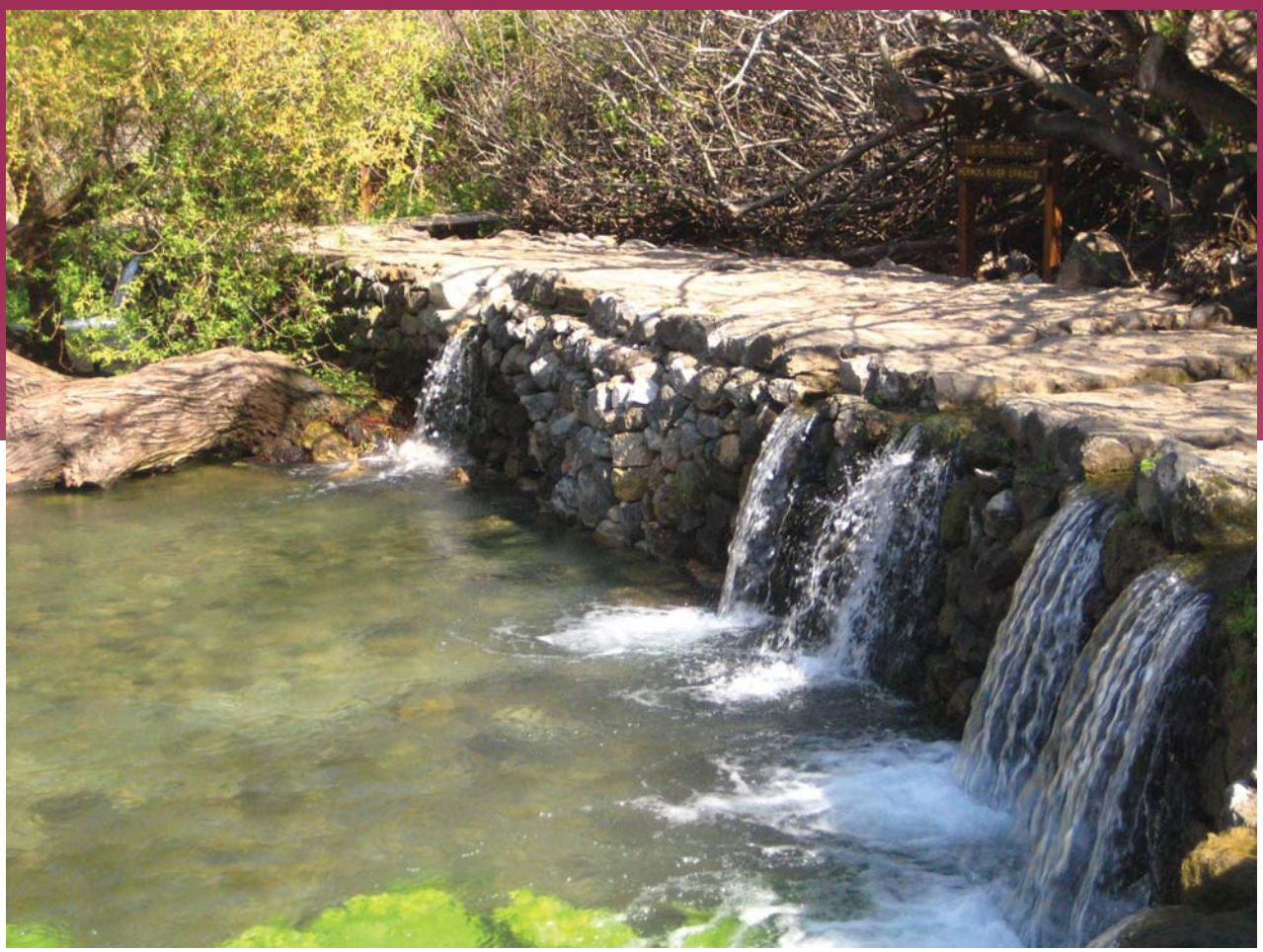
outside sources of water to that country. Syria has the highest dependence on outside sources (76–100%), followed by Iraq (51–75%), Jordan and Israel (11–25%), and then by Lebanon and Turkey (1–10%). A greater reliance on transboundary water resources translates into the potential for large-scale conflicts because changes in the amount of water that a country is receiving can significantly impact the viability of that country's economy, especially when the largest user of the country's water is agriculture.

3.2.4 Presence or Absence of Institutional Agreements

Many countries in West Asia are experiencing protracted water conflicts with water either central to the conflict or as an exacerbating factor with other issues (i.e., territorial disputes or concerns of sovereignty). Much of the conflict in West Asian basins is inter-state in nature, where one country is in dispute with another country. These conflicts can be large-scale and involve other countries or basins not central to the one in dispute by using the external basin as a bargaining chip.

Despite conflict, many agreements have been reached in the region, ranging from formal treaties that include water allocations, down to "unofficial" agreements made by local municipalities to help deal with internal conflicts. It is likely that the formal state agreements will be more resilient and help relationships between states over the long term. The informal agreements (i.e., between local governments) are more fragile due to the lack of official state support. Since they are not officially sanctioned by the state, they may not have the financial or political backing to remain in force.

Institutional arrangements between countries in West Asia span a large spectrum. The institutional arrangements might be the result of past relations between countries; their relative status in the stream system, such as upstream, downstream or riparian location; or even due to the addition or disregard of an additional party to an agreement. Examples of these agreements include (1) bilateral plans between two countries; (2) bilateral plans that exclude a potential third party that could benefit if included in the agreement; and (3) multilateral cooperation between more than two countries. The situation is further complicated due to the fact that the region is rife with visceral land disputes and contested borders, like the case of Israel and the Palestinian



Springs at Banias in the Golan Heights, source of the Jordan River. Photo credit: OSU Geo Club.

Authority (West Bank and Gaza Strip), Israel and Syria (Golan Heights) and Azerbaijan and Armenia. These issues make formal, long-lasting water agreements even more complex; as a result, not many have been created. In the cases of occupation and disputed territory, the group under occupation is not able to come to the table as a sovereign and negotiate on the same level as the occupying power.

3.3 Issues of Scale, Conflict, and Cooperation

3.3.1 Jordan River Basin

The Jordan River Basin is a unique case in West Asia due to the many transboundary water issues between states as well as the internal conflict within those states (Figure 3.1). Making the situation even more complicated is the presence of disputed lands and occupied territories. Since boundaries between sovereign nations are not completely resolved, water-sharing agreements are relatively non-existent. Despite the uncertainty over borders, some attempts have been made to foster cooperation amidst the conflict, both externally and internally. Amidst national conflict between two countries there are examples of cooperation at smaller scales as local citizens decide not to wait for their representative governments to solve their water resource problems. For example, as discussed below with the Alexander River Basin, local Israelis and Palestinians worked together to improve water quality without formal commitments from their national governments who appear to be at war with each other.

3.3.1.1 Issues of Conflict

Wazzani Spring

In 2002, tensions between Israel and Lebanon were heightened due to a conflict over the Wazzani Spring (Saoud, 2002). This spring originates in Lebanon, flows into the Hasbani

River, and eventually into the Jordan River where it empties into the Sea of Galilee.

The history of developing water use around the headwaters of the Jordan River shows that there has been a great deal of conflict between Israel and Lebanon. It is argued that the conflict did not start because of water, although some of the ensuing engagements had to do with acquiring land that contained the headwaters (Medzini and Wolf, 2004). The conflict over the Wazzani had its origins in 1964 when Israel took action to move water from the Sea of Galilee out of the Basin to the coastal plain. This caused the Arab League (Lebanon and Syria) to attempt to divert the headwaters of the Jordan River that would in turn have reduced the flow into Israel (Blanford, 2002). In response, Israel destroyed diversion infrastructure, which contributed to the tensions leading up to the 1967 war. Subsequently, claiming security needs, Israel invaded southern Lebanon in 1978 and again in 1982, remaining in the area until 2000 when it withdrew to international boundaries, allowing Lebanon to reclaim the land (Blanford, 2002).

Since Israel withdrew from the territory unilaterally, no agreements over the use of waters that originate in Lebanon and flow into Israel were made (Amery, 2002; ICG, 2002). Soon after Israel's retreat, Lebanon gave notice to Israel that it would pump a small volume of water from the Wazzani Spring for the few returning residents. This prompted no public reaction from the government or military other than an understanding that it was going to occur. The media picked up on it a short time after and according to Amery (2002), many different groups inside Israel did not agree with the government's decision not to stop the pumping. This happened during a time of drought, which likely exacerbated Israel's fears and reminded them of similar circumstances that led to the 1967 Arab-Israeli war (Amery, 2002). Two years later in 2002, a plan to pump a larger amount of water into a reservoir for 60 villages for domestic and irrigation purposes was met with even more resistance by Israel because they said reduced

Figure 3.1 Jordan River Basin.

water flows would increase salinity in the Sea of Galilee (Blanford, 2002). This led to statements by the Israeli government that the action was "a pretext for war" (Luft, 2002). Eventually, Lebanon decided not to develop the larger irrigation project due to influence from outside sources such as the United Nations and the United States. Lebanon decided to use water for domestic consumption instead (Ede, 2004).

While this conflict could be defused for a short amount of time thanks to international pressures, no formal water sharing agreement between these countries exists. An attempt was made in 1953 to apportion waters between Israel and Lebanon in this area, but the countries never ratified the agreement (Blanford, 2002). The Wazzani Spring conflict illustrates the vulnerability of the downstream state (Israel) to the use of water by the upstream state (Lebanon). Yet in this situation, it was uncertain whether Lebanon's consumption would have had any significant impact on Israel. Since Israel is more water stressed than Lebanon, any unilateral action by this upstream entity will prompt a reaction from Israel to ensure that its water supply is not diminished.

3.3.1.2 Issues of Cooperation

Yarmuk River

The Yarmuk River's headwaters originate in both Jordan and Syria. The Yarmuk initially forms a border between Syria and Jordan and then Jordan and the Golan Heights, before flowing into the Jordan River just south of the Sea of Galilee. Since the 1950s, plans have been drawn up but not ratified to apportion the Yarmuk's waters between Syria, Jordan, and Israel through bilateral and multilateral actions (Beach et al., 2000). One of such agreements, the Bunger Plan, was drafted in 1953 and supported by Syria, Jordan, and Palestinian refugees but opposed by Israel. The other such action, the Johnston Plan of 1955, included apportioning the Yarmuk but was not ratified by the "Arab League" that was made up of Syria, Lebanon, Jordan, and Egypt.

The first conflict regarding the Yarmuk River occurred in 1951 when Jordan decided to unilaterally use water to irrigate the East Gohr. Israel reacted and drained a swamp that went into Syria, which brought Syria into the conflict. Other oppositions emerged in the process of building dams. One of the first joint projects, proposed in 1953, was for two dams: the Wahidya[4] and Adasiya. These dams were put on hold due to opposition by Israel, the downstream state, because it was not a party to the agreement (UN, 2002). Jordan's later application to the World Bank was unsuccessful because the World Bank would not fund the project unless all riparians were in agreement; Israel was not cooperative (Salmi, 1997; Beach et al., 2000).

In the midst of these attempts, in 1997, both Syria and Jordan signed the bilateral Wahidya Dam Agreement that had provisions about apportioning benefits from the project (Hudes, 1998; Jordan Times, 1998). Since that agreement, Syria built more dams and is holding back more water than was outlined in the agreement (Mahadin, 2003). Within the midst of potential bilateral cooperation, the consequence of Syria's unilateral actions is less water flowing into the Jordan River, which could mean less water available for Jordan. Therefore, despite the water sharing agreement Israel and Jordon already have on the Yarmuk, the possibility that Jordan receives less water could lead to potential conflict (Mahadin, 2003).

When funding for the Wahidya Dam was secured from other sources (UN, 2002), Israel acquiesced because a more stable flow benefits it as well. However, Jordan will be the primary user of water stored behind the dam and Syria will be the primary user of hydroelectric power generated by the dam (AFP, 2004). Recent developments include the following press statement:

> At the beginning of 2004, allies Syria and Jordan launched a long-awaited dam project on the two countries' Yarmuk River, which is scheduled to be completed at the end of this year. The dam will provide Jordan—92 percent of which is desert and one of the world's 10 poorest countries in water resources—with desperately needed water for both human consumption and

[4] Wahidya is also known as Al Wahdah, which means "one" or "unity."

Dead Sea. Photo credit: Aaron T. Wolf.

> agriculture. Officials said its projected 110 MCM storage capacity would enable 81 MCM of water per year to be supplied to the Hashemite kingdom (AFP, 2004).

Another attempt in making an agreement regarding water resources occurred in 1996 when Syria mentioned that it would let Israel have water in the Golan Heights if Turkey agreed to release more water in the Euphrates. However, Turkey was not receptive to the idea (Kohen, 1996) and it does not appear that any such exchange is on the table. This example shows how interrelated these conflicts can become when water is used as a bargaining chip from an entirely different basin.

Red-Dead Canal

For many years, both Israel and Jordan contemplated schemes for diverting water into the Dead Sea. The primary justification for the plan is for hydropower generation and, more recently, for desalination. In addition, diversions from the Jordan River have reduced freshwater influx into the Dead Sea, causing a drop in the lake level (Berke, 1997; Pinto, 2005). In the proposed diversion, water would flow from a canal that would originate in either the Mediterranean Sea ("Med-Dead Canal") or the Red Sea ("Red-Dead Canal"). One plan outlined in 1996 would take water from the Red Sea and move it north towards the Dead Sea. This water would undergo a total elevation drop of about 400 m, allowing for the generation of hydropower. It is also suggested that electricity from hydropower facilities could be used to desalinate some of the water and use it for agriculture, recreation, and other purposes within the Jordan Rift Valley (Berke, 1997).

Sink hole caused by low water levels in the Dead Sea. Photo credit: OSU Geo Club.

Recently, Israel, Jordan, and the Palestinians came to an agreement to launch a multi-million dollar feasibility study of the canal (Pinto, 2005; AFP, 2005a; World Bank, 2005). All three entities believe it is urgent to complete this project as it will promote tourism, facilitate potash mining, and help alleviate water demand (Berke, 1997). This agreement follows the conditions set forth in the 1994 Israel-Jordan Peace Treaty. Specifically, in Annex II – Water and Related Matters Article VI: Co-operation, it says:

> Israel and Jordan shall co-operate in developing plans for purposes of increasing water supplies and improving water use efficiency, within the context of bilateral, regional or international cooperation (Israel MFA, 1999a).

The World Bank is supervising the funding of this project, which includes a two-year feasibility study and a 5-year development timeline. When complete, it is estimated that there will be a 50-year water supply for the Israelis, Jordanians, and Palestinians (World Bank, 2005). Furthermore, the recent multilateral agreement between Israel, Jordan, and the Palestinian Authority over the Red-Dead Canal has the potential to increase cooperation between the three countries because it seeks to provide water for all groups within the Jordan Basin. Another source of water that can help Israel, Jordan and the Palestinians is from the Managvat Project in Turkey. Water stored in a dam is transferred to tankers that deliver it to Israel. According to Pamukcu (2003), this water could be used by Israel to help stabilize water related conflicts with the Palestinians and meet water specific treaty obligations that Israel has with Jordan.

Jordan River, Golan Heights. Photo credit: Anthony Novak.

Separation wall, West Bank. Photo credit: Anthony Novak.

3.3.2 The West Bank

3.3.2.1 Issues of Conflict

The Separation Wall

Conflict between Israel and the Palestinians over construction of a separating wall on the West Bank involves groundwater use in this region as a peripheral issue. According to the Israeli government, the wall is being constructed to keep terrorists out of Israel (Israel MOD, 2004). According to others, it represents the de facto annexation of Israeli territory within the West Bank as the line does not follow the 1949 Armistice Line, or "Green Line" that is the unofficial "border" dividing the West Bank from the rest of Israel (MidEastWeb, 2005).

One controversial portion of the original route was that it would split lands around the Town of Qalqiliya, and some of the wells used by Palestinians would then be on the other side of the wall. Since Israel does not allow additional

water wells in this basin, the Palestinians would lose their water supply (Pengon, 2002). However, international pressure forced Israel to re-route a portion of the wall and not separate this town (MidEastWeb, 2005). Nonetheless, the location of the wall may end up destroying existing wells because they are either in the path of the wall or the buffer zone surrounded by the wall (Pengon, 2003). Other complications of the wall identified by Palestinians are that some remote communities rely on well water that is shipped to them by a tanker truck. The wall may make it difficult to get water to those communities (Pengon, 2003).

The wall is not complete and it remains to be seen whether other portions will be re-routed in response to Palestinian water issues, as was done recently for the town of Qalqiliya. The Israeli Supreme Court handed down two rulings on the wall in 2004 and determined that other alternatives to the initial wall route should be considered due to potential impacts to local communities (*Mara'abe v. the Prime Minister of Israel*). Despite the court rulings, Israel's decision to build the separating wall and its continued denial of new wells for Palestinians have created a situation of water scarcity for many Palestinians in the West Bank. This water scarcity is a result of the conflict between the Israelis and Palestinians, with the former wielding authority over this region. The Israelis' continued control allows them the power to determine water supplies for Palestinians in the West Bank.

Kedumim Quarry Landfill

A recent conflict over the Kedumim quarry landfill in the West Bank created tensions between Palestinians living near the area and Israel, who is developing the landfill. It appears that Israel is taking unilateral action to create the landfill as the West Bank is an occupied territory captured by Israel from Jordan in the 1967 War. Due to that designation, some believe that international law should dictate whether or not the landfill can be sited in the West Bank (Haaertz, 2005; SignOnSanDiego, 2005). Israel maintains that the landfill can be used by Palestinians (SignOnSanDiego, 2005). However, Palestinians believe that it can only be used for garbage from Israel (Palestinian IPC, 2005). One of the concerns about the location of the landfill is its proximity to the Cenomanian Aquifer, which is primarily used by Palestinians.

Tel Aviv fountain. Photo credit: Anthony Nokak.

Currently, Palestinians are limited in their capacity to construct their own landfills. This has led to many illegal Palestinian garbage dumps in the West Bank that threaten their own water supply (Haaertz, 2005; Palestinian IPC, 2005). This example of conflict rises from the tenuous situation between both Israelis and the Palestinian Authority over the status of the West Bank. Israel is taking unilateral action to create the dump in the occupied West Bank. Since it is the occupying power, Israel may be able to proceed without consulting the Palestinian Authority. Yet some argue that international law should be followed in this situation. Nevertheless, Palestinian interests are in a vulnerable position because they do not have a choice about where the landfill is sited; its location may ultimately threaten their water supply.

3.3.2.2 Issues of Scale

Alexander River/Wadi Al Izziyah

Amidst the continued conflict between Israelis and the Palestinian Authority in the West Bank, an example of local cooperation between residents to improve water quality in the Alexander River/ Wadi Al Izziyah exists. This stream originates in the mountainous areas of the West Bank and heads west for 44 km before flowing into the Mediterranean Sea (OMEWR, 1998).

Many Palestinian and Israeli towns dump raw sewage into the Alexander River and its tributaries, which leads to the contamination of the underlying Mountain Aquifer. The initial agreement in 1996 between local Israelis and

Abandoned ship in the former Aral Sea, near Aral, Kazakhstan. Photo credit: Staecker, via Wikimedia Commons.

Palestinian citizens called for a joint wastewater treatment plant (Israel MOE, 2005a), with the first project initiated in 2002 as a water treatment plant in Yad Hannah to treat wastewater from the Palestinian side (Rosenberg, 2004). This treatment plant intercepts water from the Alexander and diverts tributary water to the treatment plant. Some of the water leaves the facility and returns to the river, and some is reused to irrigate crops (Rosenberg, 2004). The most recent developments include treating all sources of wastewater, including tributary streams to the Alexander, which should significantly improve water quality (Israel MOE, 2005a).

This cooperation did not occur through an official agreement between the Palestinian Authority and the Israeli Ministry of the Environment. Rather, it was done through cooperation at the local level despite continued conflicts between the two countries. Both sides realized the positive aspects of treating wastewater and worked together to achieve that goal.

3.4 West Asia's Vulnerability

3.4.1 The Aral Sea Basin

The Aral Sea Basin covers an area of 1,231,400 km^2: the entire territory of Tajikistan, Turkmenistan, Uzbekistan, the southern part of the Kyrgyzstan, and the southern part of Kazakhstan. It also covers small parts of Afghanistan, China, Iran, and Pakistan (Figure 3.2). The basin is divided into three main parts: the upper part to the southeast mountainous part, the central part, and the delta region to the northwest (Dukhovny, 2003). Two main rivers cross the Aral Sea Basin: the Amu Darya and the Syr Darya. The climate within the region is mostly arid or semi-arid, with the average precipitation concentrated in the spring and winter amounting to about 270 mm, and total available surface water resources estimated at 116.5 km^3. Groundwater resources equate to a total reserve of 43.49 $km.^3$ The total population reliant on the Aral Sea Basin was 41.8 million in 2000, of which around 63.6 percent is rural.

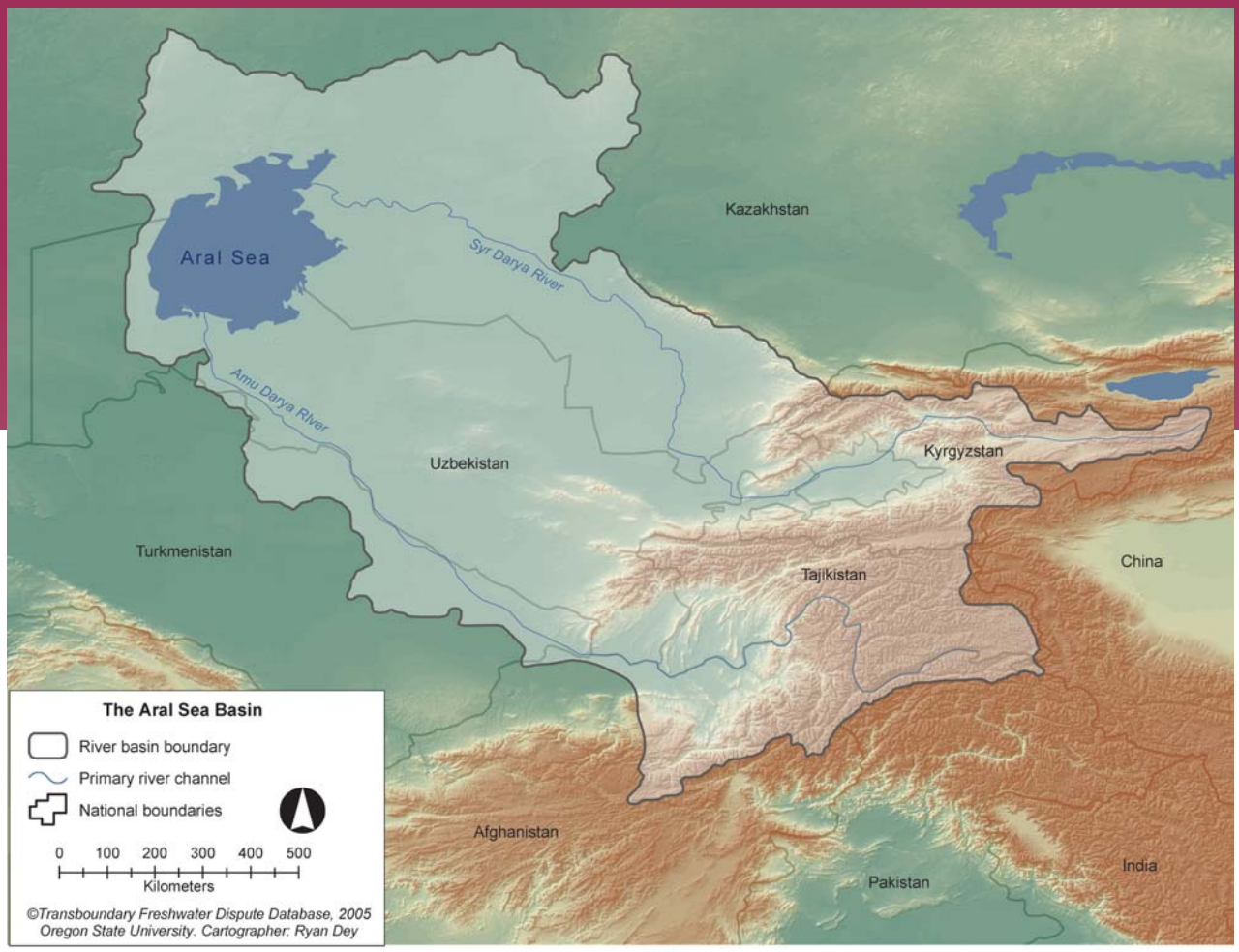


Figure 3.2 The Aral Sea Basin.

The Aral Sea, once the world's fourth largest lake in terms of surface area, has declined significantly in the last fifty years. Irrigation from the Amu Darya and Syr Darya Rivers during the 1960s to late 1980s sought to transform the region into the cotton belt of USSR, but in turn resulted in severe environmental degradation (TFDD, 2005). Negative impacts include the shrinking of the Aral Sea and related disruption to its ecosystem; losses of biological productivity due to salinity and toxic contamination; degradation of river deltas; deforestation; transfer of dust and salts from the dried-out seabed; the lowering of groundwater levels; soil degradation due to waterlogging and salinization of irrigated land; crop diseases and insect infestations due to cotton development; adverse health impacts due to poor water quality; the erosion of land in the upper watershed; and the desertification of the Aral Sea shores (Dukhovny, 2003). By 1987, the Aral Sea was two seas: a small northern part (North Aral Sea) and a larger southern part (South Aral Sea).

The population in the basin is heavily dependent on extensive irrigation for agricultural purposes on a daily basis, which requires large quantities of water (Micklin, 2000). In addition, a shift in water use to hydropower, especially during winter has increased tensions amongst the newly independent Aral Sea Basin States. Finding an equitable solution proves to be problematic. While Uzbekistan and Turkmenistan seek to hold on to existing water use levels, other Basin States are vying for an increase in their water share. Kyrgyzstan, an upstream state in Syr Darya, seeks to release water from its dam in the winter in order to generate electricity, but such a use conflicts with Uzbekistan and Kazakhstan's uses. The latter states want Kyrgyzstan to curtail its water release primarily until the spring and summer months.

Bilateral bartering agreements have been adopted between Kyrgyzstan and Tajikistan and their downstream neighbours since 1994. In order to limit water releases until the growing seasons, downstream neighbours trade cotton, natural gas,

Rehabilitated irrigation systems in Kyrgyzstan (top) and Tajikistan (bottom), enable farmers to grow crops on land that had not been productive for many years or increase productivity and profitability of existing crops such as these grapes. Photo credits (from top): Winrock Intr., courtesy of USAID; and USAID/CAR.

oil, and coal (Heltzer, 2003). For example, a 1996 agreement divides the water in Amu Darya below Karshi equally between Uzbekistan and Turkmenistan. An agreement signed by Kyrgyzstan, Uzbekistan, and Kazakhstan in 1998 created a trilateral exchange of water from Kyrgyzstan for goods such as gas, coal, and mazut, to which Tajikistan later acceded in 1999 (International Crisis Group, 2002). However, the agreements tend to be informal and are poorly enforced. In 2001, Kyrgyzstan raised the stakes by adopting a law that recognizes water as a commodity, and thus calling for the selling of water to its downstream neighbours.

At the regional level, a range of international agreements exists. In 1992 Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, and Turkmenistan signed an agreement on cooperation in the field of joint water resources management and conservation. The treaty recognized "the community and unity of the region's water resources" and that "the Parties have equal rights for their use and responsibility for ensuring their rational use and protection." In essence, the 1992 Agreement provided a formal recognition of the existing situation. However, it failed to stipulate how water flows to the Aral Sea

New water system provides clean drinking water and improved irrigation for the Yassy community, southern Kazakhstan. Photo credit: USAID.

would be secured, how emergency situations would be handled, or how water would be utilized more equitably and sustainably.

The 1992 agreement also established a number of organizations, including the Interstate Commission for Water Coordination (ICWC) and the Basin Management Authorities for the Amu Darya and the Syr Darya.

In 1993, the "Agreement on Joint Actions for Addressing the Problems of the Aral Sea and its Coastal Area, Improving of the Environment and Ensuring the Social and Economic Development of the Aral Sea Region" was signed by the five Central Asian States that focused directly on the Aral Sea Basin. This sought to improve the environmental conditions as well as generate funds for a solution. Under the 1993 Agreement, an Interstate Council for the Aral Sea (ICAS) was established along with the International Fund for Saving the Aral Sea (IFAS) in order to raise and utilize funds for the protection of the Aral Sea. Following a restructuring effort in 1997, the latter two organizations were combined into a new IFAS under biennial rotating chairmanship of the president of one of the five states. An executive committee of the IFAS was also established with the general remit of coordinating projects and programs related to the Aral Sea Basin. In 1997, ICAS was incorporated into IFAS in a bid to improve coordination and coherency. These organizations are responsible for deciding water allocation amounts amongst the Aral Sea states, overseeing the regulation of waters, and acting

An Uzbek boy fills up on fresh water from the Kyrgyz well in Jar-Kyshtak, a village of 2,400 people bordering Uzbekistan in southern Kyrgyzstan. Photo credit: Mahabat Alymkulova, USAID.

Fishing boats on the Amu Darya, Khiva, Uzbekistan. Photo credit: Gene Molander

as a forum for the discussion of future projects (Heltzer, 2003). However, weak legal foundations and erratic support from the Aral Sea Basin means that these organizations cannot always function effectively (Vinogradov, 1996).

Fisherman at the Amu Darya, Khiva, Uzbekistan. Photo credit: Gene Molander.

Political changes in Afghanistan have also raised concerns about increases in water use that are allowed under the 1946 agreement between Afghanistan and the Soviet Union on Afghanistan's portion of the Amu Darya. The latter agreement gives Afghanistan 9 km^3, of which it uses 2 km^3. Conversely, estimates of Afghanistan's runoff to the Amu Darya range from 6.18 to 24 km^3 (Dukhovny, 2002; Transboundary Water Issues, 2007). However, uncertainty regarding Afghanistan's agricultural sector exists: "Since the fall of the Taliban in November 2001, there has been concern about the implications of efforts to rebuild agriculture in Afghanistan" (ICG, 2002) … However, as Afghanistan continues to develop, so will its withdrawals from the Amu Darya increase, putting the stream at further risk (Pala, 2006).

A significant number of international projects focus on addressing the problems of the Aral Sea Basin. In 1994, the World Bank established the "Aral Sea Basin Programme" (ASBP) at a cost of $250 million. The project, scheduled to run for twenty years, focuses on the rehabilitation and development of the Aral Sea disaster zone, the strategic planning and

The confuence of the Kura (Mtkvari) and Aragvi rivers at Mtskheta, Georgia. Photo credit: Kober, via Wikimedia Commons.

comprehensive management of the water resources of the Amu Darya and Syr Darya, and building institutions for planning and implementing the latter two programs. The Program of concrete Actions on improvement of ecological, social and economic conditions in Aral Sea Basin for the period 2003-2010 (ASBP-2), was also authorised by heads of the Central Asia countries in 2003 (International Fund for the Aral Sea, 2003).

In 1999, the World Bank decided to support the diking of the North Aral Sea in an effort to raise its level 3 m, covering 800 km^2 of dry seabed, a process that would take 10 years. Surprisingly, the target elevation was achieved in just 7 months (Pala, 2006). The sea has now crept from 80 km to within 15 km of the former port city of Aralsk, Kazakhstan, and commercial fishing has resumed (Pala, 2006). Kazakhstan President Nursultan Nazarbayev has pledged to raise the North Aral Sea's level another 4 to 6 m, which would cover an additional 925 km^2 of now-dry seabed and bring the shoreline to within a few kilometers of Aralsk (Pala, 2006).

3.4.2 Kura-Araks River Basin

The Kura-Araks (sometimes spelled "Aras") River Basin is an international basin located in the South Caucasus with five separate countries contributing to the area of the watershed (Figure 3.3). These countries are Turkey, Iran, Armenia, Georgia, and Azerbaijan. The total area of the watershed is approximately 188,500 km^2. The total watershed area percentage for each of the countries is as follows: 18%, Georgia; 16%, Armenia; 31%, Azerbaijan; and 35% for Iran and Turkey combined (USAID, 2002). The Kura River originates in Turkey, and flows southeast through Georgia into Azerbaijan (USAID, 2002). Its length is approximately 1,364 km, with an average discharge of 575 m^3/second (CEO, 2002). The headwaters of the Araks River are also in Turkey. The river flows east through Turkey to the border with Armenia, then flows through Iran and Armenia, before flowing into Azerbaijan. The length of the Araks is approximately 1,072 km, with an average discharge of 210 m^3/second (CEO, 2002).

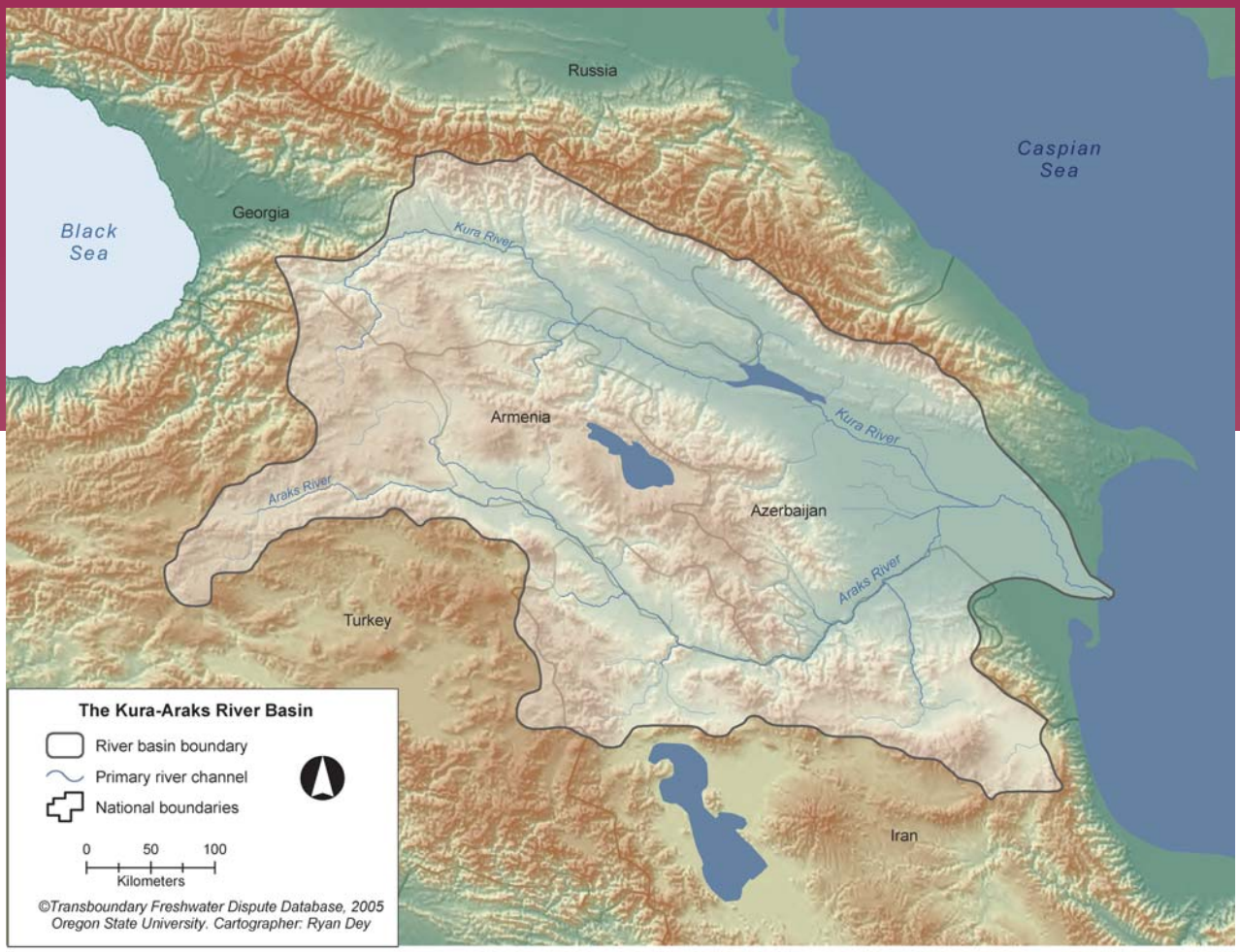


Figure 3.3 Kura-Araks River Basin.

Pollution in the Kura River includes organic pollution from untreated sewage, heavy metals from mining, hydrocarbons and PCBs from industry, organochlorine pesticides and nutrients from agriculture, as well as a high sediment load from deforestation and flood irrigation practices (TACIS, 2002). Many water quality monitoring projects either exist or are planned, and the involvement of international organizations in the basin is quite high. However, the current programs focus on the collection of data and do not seek to limit contaminant exposure.

When Armenia, Georgia, and Azerbaijan became independent states, these three countries lacked water resources management regulations or water codes. Each country adopted new water codes within the last 17 years: Armenia in 1992 and revised in 2002 by the European Union (EU) Water Directives; Georgia and Azerbaijan in 1997 (UNECE, 2000; Hovsepyan and Eduard, 2004; UNECE, 2003a; UNECE, 2003). There are currently no treaties among these countries concerning water rights or water quality in the basin (Wolf, 2003).

An overarching influence in transboundary water issues is the political context that prohibits the creation of multilateral agreements (UNECE, 2003). The political controversies between the countries include ownership of the Nagorno-Karabakh area[5] (Azerbaijan and Armenia) and the ethnic autonomy of the Armenians living in Javakheti region of Georgia (Cornell et al., 2002; CIA, 2005). Although there are no institutions governing the apportionment, quality, or management of the water in the Kura-Araks Basin, there are examples of cooperation between the three countries (mentioned above)

[5] This area is predominantly an Armenian-populated region in the west of Azerbaijan. Armenia supports ethnic Armenian secessionist in Nagorno-Karabakh and militarily occupies 16% of Azerbaijan with a massive ethnic cleansing of over 800,000 refugees and IDPs (USDS, 2003; CIA, 2005). A cease-fire was signed in May 1994, which has held without major violations ever since. The Organization for Security and Co-operation in Europe (OSCE) "Minsk Group" continues to mediate dispute.

on conducting technical studies concerning water quantity and quality. The Kura-Araks Basin also draws international organizations; several projects related to the management of the basin exist. Major regional perspective projects related to transboundary water resources management are the EU TACIS Joint River Management Project (TACIS JRMP) in cooperation with UNDP, the NATO/OSCE South Caucasus River Monitoring Project (Campana et al., 2008), and USAID's South Caucasus Water Management Project (UNECE, 2003; UNECE, 2003a; NATO, 2002).

An example of how projects of international organizations foster cooperation between the three countries (Armenia, Georgia, and Azerbaijan) is the European Union's Programme on Joint River Management for the Kura River Basin (TACIS). Since 2002, the TACIS Programme has created a country-to-country interaction that emphasizes consistency in gathering data in order to promote trust in another country's data (UNECE, 2003a; UNECE, 2003). The existence of accepted water quantity and quality data is expected to provide the basis for future trans-boundary water management (UNECE, 2003a).

In November 2002, the South Caucasus River Monitoring Project was funded by NATO's (North Atlantic Treaty Organization) Science for Peace Programme and OSCE (Organization for Security and Co-operation in Europe). This project is not a top-down project managed by NATO and OSCE, but was conceived, developed, and is managed jointly by individuals from the three countries. These individuals, whose personal relationships have overcome any intergovernmental animosity, come from scientific organizations and are led by Professor Nodar Kekelidze of Tbilisi State University in Georgia. Assistance is provided by NATO experts from Belgium, Norway, and the USA. The project's overall objective is to establish the social and technical infrastructure for international, cooperative, transboundary river water quality and quantity monitoring, data sharing, and watershed management among the Republics of Armenia, Azerbaijan, and Georgia. Its specific objectives are to (Campana et al., 2008)

- increase technical capabilities (analytical chemistry and its application to water resources sampling and monitoring, database management, and communications) among the partner countries
- establish standardized common sampling, analytical, and data management techniques for all partner countries and implement standards for good laboratory practice (GLP), quality assurance (QA) and quality control (QC) cooperatively
- establish database management, GIS, and model-sharing systems accessible to all partners via the WWW
- establish a social framework (i.e., annual international meetings) for integrated water resources management
- involve stakeholders.

The water quality data collected by the three riparians are generally considered the best in the South Caucasus (Campana et al., 2008).

A final report is in preparation.

3.4.3 Tigris-Euphrates/Shatt Al Arab River Basin

The Tigris-Euphrates/Shatt Al Arab River Basin covers approximately 789,000 km^2 and includes portions of Turkey, Syria, Iraq, and Iran, as well as small portions of Saudi Arabia and Jordan (Wolf et al., 1999) (Figure 3.4). The Euphrates River originates in Turkey from snowmelt and flows through Syria for 680 km before reaching Iraq. The Tigris River also starts in Turkey but instead of flowing through Syria, it flows along the Turkish-Syrian border for 32 km before reaching Iraq. The Euphrates and Tigris Rivers are the two longest rivers in West Asia. The snowmelt contribution to the water in the river basin results in seasonal flooding in the spring (Altinbilek, 2004). The use of these rivers for irrigation therefore requires infrastructure to create regular flows and certainty in supply in the irrigation season.

Continuous uncertainty and disagreement concerning the apportionment of the Tigris and Euphrates Rivers exists among Turkey, Iraq, and Syria. Although other issues have emerged over

Great Zab River, tribuatry of the Tigris, Turkey. Photo credit: Gene Molander.

the years, such as proposed and built dams by Turkey[6] or Iraq, and Syria requesting more water, the source of the disputes and disagreements stems from the lack of a formal, basin-wide agreement that apportions the water of each river between the three countries[7] (ESCWA, 2002; Gruen, 2000; Republic of Turkey Ministry of Foreign Affairs, 2004).

Fish farm on the Euphrates River, Iraq. Photo credit: USAID

Syria and Iraq entered into a bilateral agreement in 1990 that apportioned the flow of the Euphrates River, giving Syria 42% and Iraq 58% of the water measured at the Turkish-Syrian border (Altinbilek, 2004). Outside of a basin-wide agreement, the Joint Technical Committee on Regional Waters does exist to deal with transboundary water research and issues. The committee was created by Turkey and Iraq in 1980, with Syria joining in 1983 (FAO, 1997d; Republic of Turkey Ministry of Foreign Affairs, 2004; ESCWA, 2002; Gruen, 2000). ESCWA describes the purpose of this committee as being "established to negotiate water issues" (2002:17).

[6] Proposed and built dams by Turkey include the current Illisu Dam on the Tigris River which is part of the GAP Project, the Atatürk (GAP Project) and the Keban (1960s) Dams on the Euphrates, and the Karakaya (Dam (1970s) (Beaumont, 1998; Republic of Turkey, 2003; Gruen, 2000),

[7] For an historical account and description of all the agreements between any of the countries concerning the Tigris or Euphrates River Basins, see ESCWA, 2002.

However, the use of the committee is voluntary and seems to be more of a way to share information about proposed projects than to settle disputes (Republic of Turkey Ministry of Foreign Affairs, 2004; ESCWA, 2002). In addition, the last multilateral meeting was in 1992; attempts to revive the use of the committee since 1996 have been unsuccessful (ESCWA, 2002; Gruen, 2000).

Political changes in Syria and Iraq have stalled water conflict within the basin since 2003 (Altinbilek, 2004). These political changes include a new Syrian president and "the occupation of Iraq by the Coalition Forces which ended the rule of the Baath regime" (Altinbilek, 2004: 16). The focus of the United States via the Coalition Forces is on rebuilding Iraq. In the long term, this necessarily includes water that can be used to promote economic development through agriculture (Hnoush, 2004). To secure this water, there is the potential for the United States to attempt to bring the three countries (Turkey, Syria, and Iraq) together to create a permanent agreement concerning the apportionment of the water in the Tigris-Euphrates/Shatt al Arab Basin.

Turkey's desire to be in the European Union adds water quality and international cooperation requirements that it must follow, which may provide an incentive for cooperation in designing a multilateral agreement (SIWI, 2004).

Turkey's admission into the European Union would place it under the Water Framework Directive (WFD), which was adopted by the European Union in December 2000. The WFD requires member countries to cooperate with all of the countries and interested parties in managing transboundary water resources (SIWI, 2004). Taken to the extreme, this could mean that Turkey would have to initiate discussion on an agreement for the Tigris-Euphrates/Shatt al Arab Basin. At the very least, Turkey would have to entertain Syria's and Iraq's concerns about the Southeast Anatolia Project (GAP). In addition, Turkey would have to meet specific water quality standards, which would benefit Syria and Iraq as the downstream states (SIWI, 2004). This is

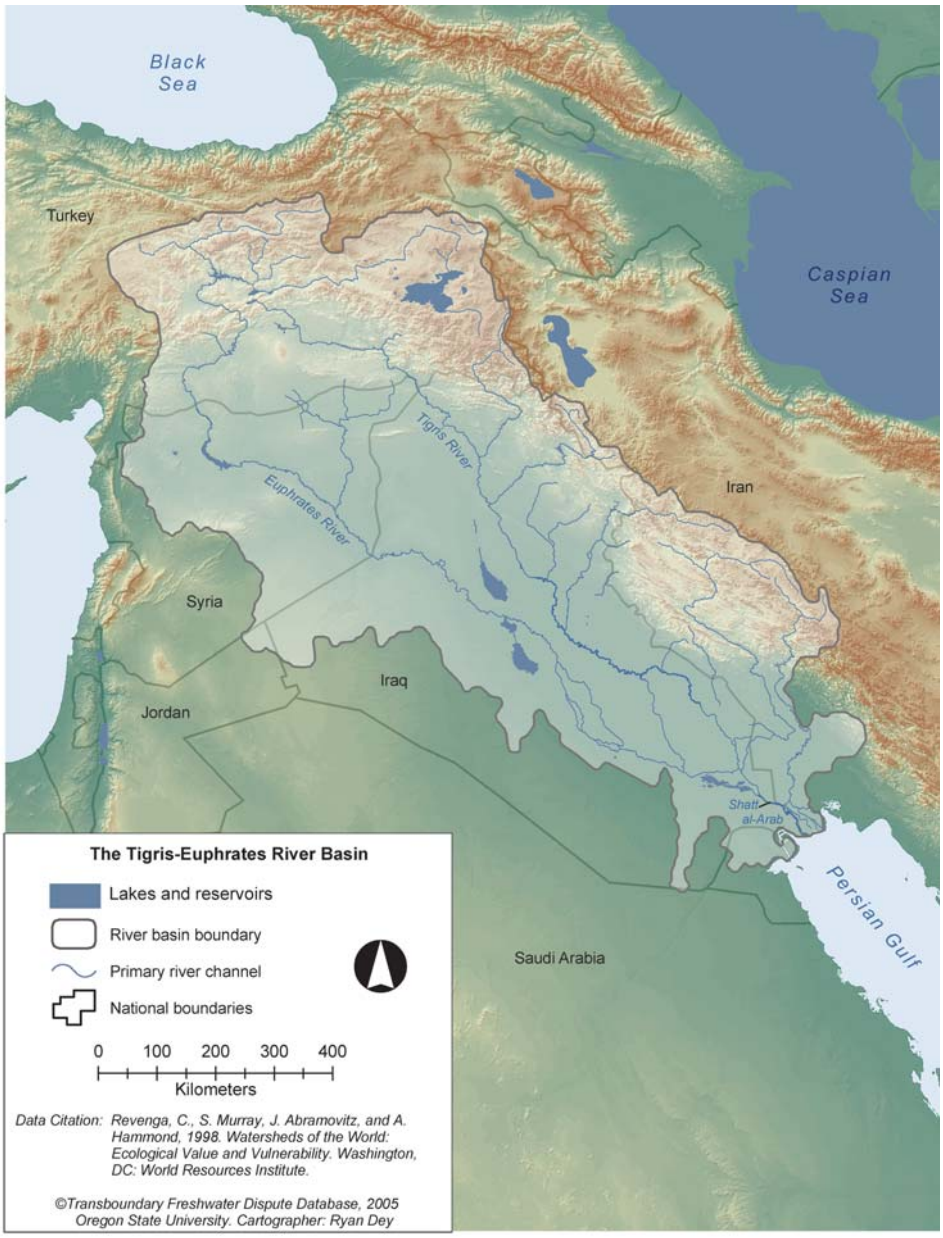


Figure 3.4 Tigris-Euphrates/Shatt Al Arab River Basin.

Men using boats to restore the marshlands of the Shatt al Arab, Iraq. Photo credit: USAID.

especially important in the context of the GAP Project which Syria and Iraq claim will degrade the water quality of the Tigris and Euphrates Rivers (Guner, 1997).

The basic disagreement in how the Tigris and Euphrates Rivers should be divided among the three countries is the result of the absence of consensus on how to define the apportionment.

Suspension bridge over the Euphrates at at Deir ez-Zor, Syria. Photo credit: Gene Molander.

Girls carrying wool cross the Sirwan/Diyala River, a tributary of the Tigris, in Kurdistan, Iran. Photo credit: Babak Sedighi.

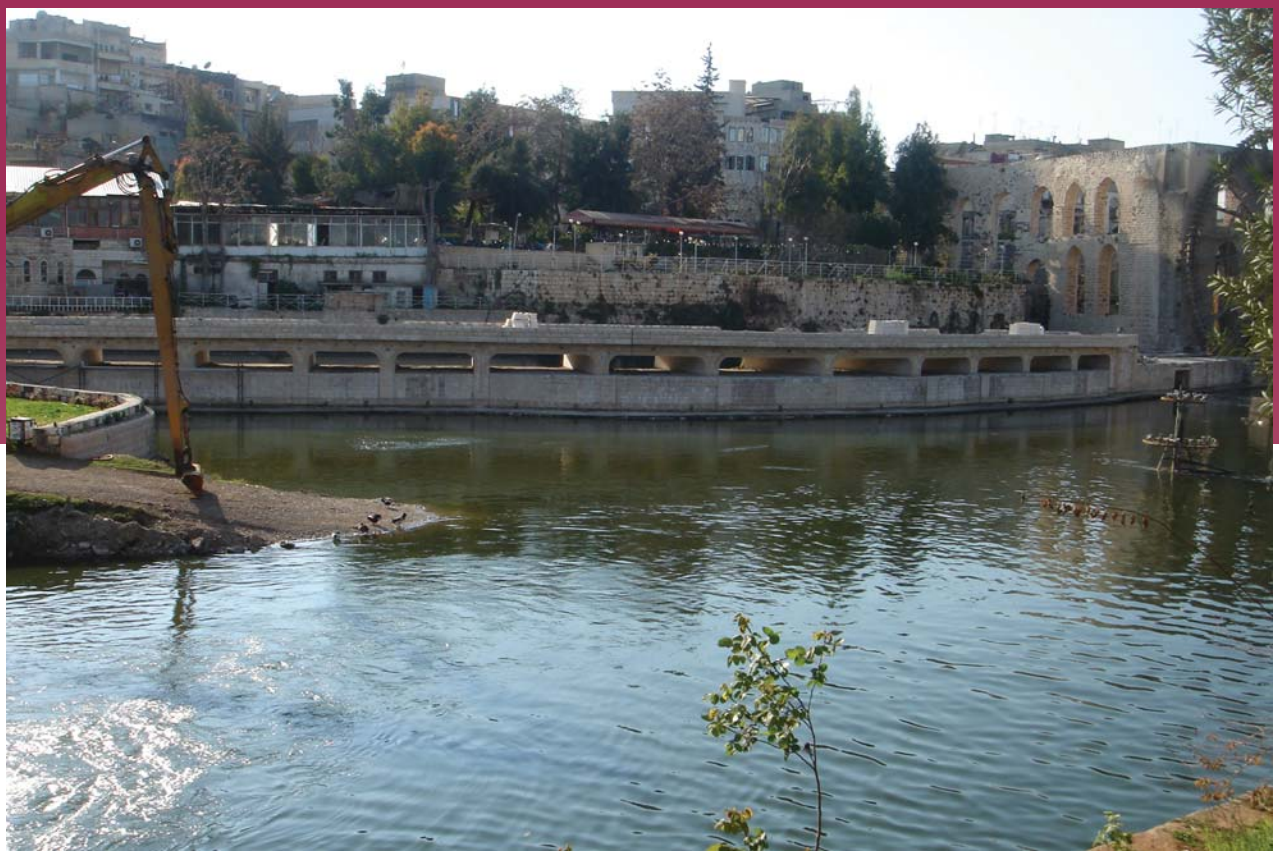
Turkey wants to use international water apportionment principles such as equitable apportionment and characterize the Tigris-Euphrates Rivers, as explained by Gruen (2000), in the following way:

> [Turkey] regards the Euphrates as a transboundary river, under Turkey's exclusive sovereignty until it flows across the border into Syria. It is only after the Euphrates joins the Tigris in lower Iraq to form the Shatt al-Arab, which serves as the border between Iraq and Iran that it becomes an international river.

In contrast, Iraq and Syria want to apportion the water based on historical use and the demands of each country (Guner, 1997; Gruen, 2000; Altinbilek, 2004). In addition, they treat the two rivers as a whole, without regard for boundaries—the fact that the rivers cross a boundary automatically makes them a transboundary, international river basin where water must be apportioned (Republic of Turkey Ministry of Foreign Affairs, 2004; Guner, 1997; Gruen, 2000). The different definitions used to determine the "reasonable and appropriate amount of water for each country" (ESCWA, 2002:17) will result in different amounts of water being allocated to each country.

Turkey's preferred definition is explained in its proposed three-stage plan entitled "Three-Staged Plan for Optimum, Equitable and Reasonable Utilization of the Transboundary Watercourses of the Euphrates-Tigris Basin" (Republic of Turkey Ministry of Foreign Affairs, 2004; ESCWA, 2002). This plan was first

Washing clothes, rural Iran. Photo credit: Babak Sedighi.



Orontes River at Hama, Syria. Photo credit: syriapath.com, via Wikimedia Commons.

introduced in 1984, then again in 1990 and 1993, but not accepted by either Iraq or Syria (Republic of Turkey Ministry of Foreign Affairs, 2004; ESCWA, 2002). The need to finalize the apportionment of the two rivers has not yet reached a critical stage as Turkey has not fully utilized the water resources available to it as the upstream country. In spite of the rejection of this plan, Turkey unilaterally created a new plan and began construction of the infrastructure necessary to complete the GAP (ESCWA, 2002). The ramifications of the GAP on Syria's water supply is that its "water allotment will fall from 500 m^3/s to, at most, 300 m^3/s [around 2030]. In addition, the quality of water will diminish, due to increased salinization and the use of pesticides and fertilizers further upstream" (Guner, 1997). The changes in water quality will also affect Iraq, as it is downstream from both Turkey and Syria (Gruen, 2000; Republic of Turkey Ministry of Foreign Affairs, 2004). However, the completion of the GAP (2010 at the earliest) and an increase in Turkey's population will raise its demand on the existing waters. Furthermore, without a basin-wide agreement, less water will be reaching Iraq and Syria and tensions will rise (ESCWA, 2002; USDA Foreign Agricultural Service, 2003; Gruen, 2000). This is just one example of a project on a transboundary river that provides benefits and costs to certain countries but is not governed by a comprehensive, multilateral agreement or body that can address the concerns of the interested countries.

3.4.4 Asi/Orontes River Basin

The Asi/Orontes River Basin covers Lebanon, Syria and Turkey and covers approximately 37,900 km^2 (Wolf et al., 1999) (Figure 3.5). The Orontes River[8] originates in northern Lebanon and flows south through Syria, then into Turkey where it empties into the Mediterranean Sea. Syria is the greatest user of this water and dams over 90% of its flow before it enters Turkey (Dolatyar and Gray, 2000). A bilateral treaty between Lebanon and Syria was signed in 1994 that allocates water between the two countries based on an initial annual water projection in Lebanon. If the projection is below a certain

[8] Also known as the Asi Nehri in Turkish and the Al-Asi in Arabic.

amount, Lebanon's use is reduced by 20% (TFDD, 2003a). An agreement between Syria and Turkey was finalized in 2001 that calls for co-operation on technical issues and identifies the potential for cooperation on future projects (TFDD, 2003b); however, it does not address sharing of a specific quantity.

Past conflict over the Orontes, which was mostly between Syria and Turkey, stemmed from the amount of water used by Syria. Attempts at trilateral negotiations over the Orontes and the Euphrates Rivers among Syria, Turkey, and Iraq are frustrated by a land conflict over the Hatay Province, which Turkey controls, but Syria believes is a part of its own territory (Çarkoğlu et al., 1998; El-Berr and Houdret, 2004). On more than one occasion, Turkey said it would discuss issues on the Tigris and Euphrates if the Orontes was included, yet every time, Syria refused. If Syria regained control over the Hatay province, then the Orontes would be within Syria's control and not flow into Turkey. This is likely the reason that Turkey has not agreed to include the Orontes, as it would legitimize Syria's claim to the Hatay Province (Dolatyar and Gray, 2000).

The Orontes River is an interesting case because Syria, as the upstream state, has control over what flows into Turkey. On the other hand, Turkey is the upstream state on the Euphrates and controls the flow into Syria. Iraq and Syria raise many objections about Turkey's actions to store water from the Euphrates, yet Syria is behaving similarly to Turkey (Turkish Embassy, 1999). However, due to the land dispute over the Hatay Province, Syria likely has a different viewpoint than does Turkey.

Any attempt at a basin-wide water sharing agreement is likely to be linked to activities on the Tigris and Euphrates that also bring Iraq into the discussion. Because Syria and Turkey are both the upstream and downstream states, they are each at an advantage and disadvantage in negotiations. In addition, because Syria retains

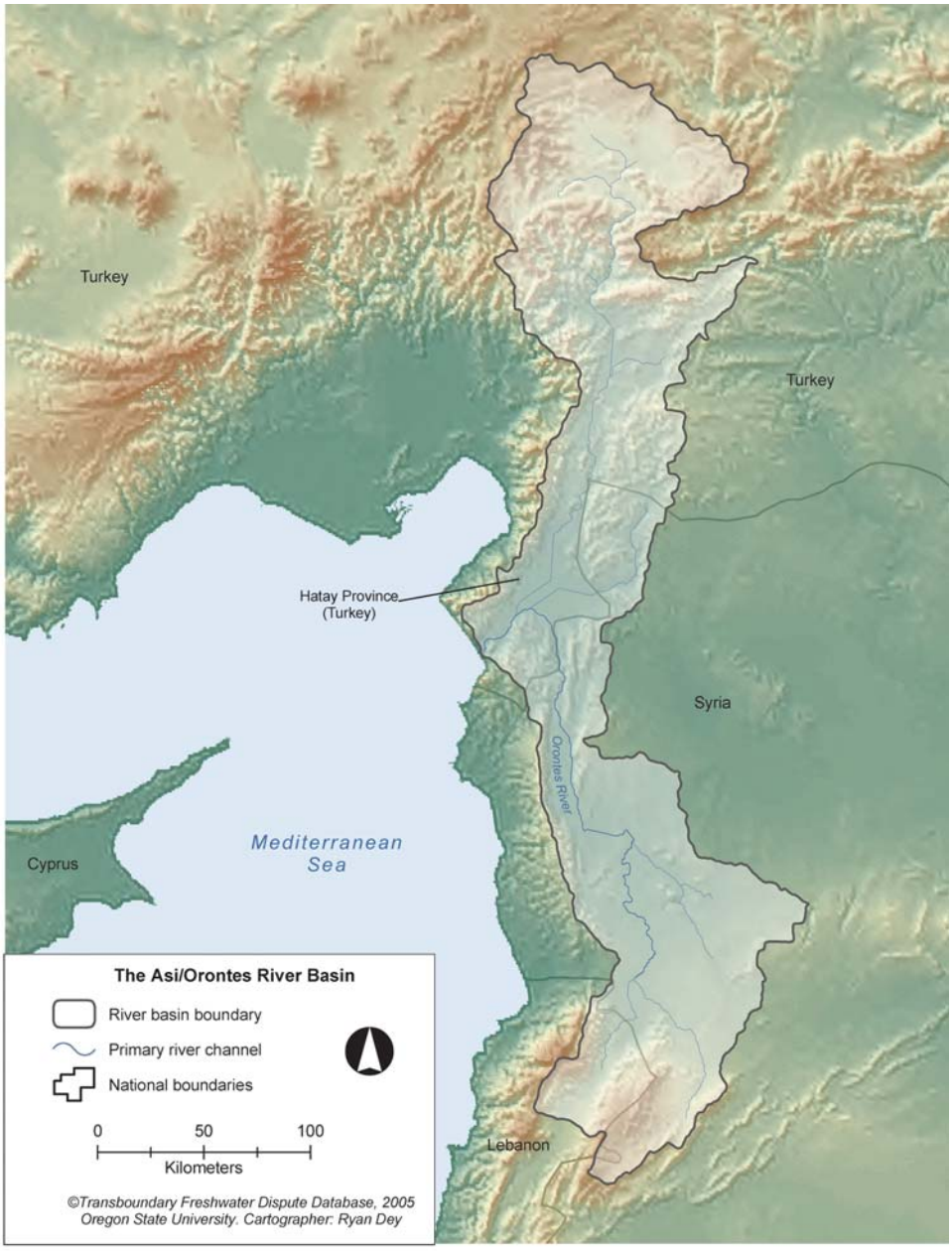


Figure 3.5 Asi/Orontes River Basin.

the Hatay conflict as a bargaining chip, Turkey will likely remain at a disadvantage regarding the Orontes River.

Despite the recent agreement over technical cooperation between Syria and Turkey, the Orontes River Basin can be seen as a "basin at risk" due to the lack of resolution over the Hatay Province. If Syria accepts Turkey's control over the province, the river remains a transboundary resource to be shared between the two countries. On the other hand, if Turkey relinquishes control over this province, then Syria would have total control of the river, as it would no longer be a transboundary resource.

3.4.5 An Nahr Al Kabir River Basin

The An Nahr al Kabir, or "Great Southern River," has a drainage area of 1,300 km^2 (TFDD, 2003d) and includes both Syria and Lebanon, creating the northern portion of the boundary between these two countries before flowing into the Mediterranean Sea (Figure 3.6). Both countries entered into a bilateral treaty in 2002, apportioning 60% of the water to Syria and 40% to Lebanon. This agreement also has stipulations for a dam that is to be constructed by both countries (TFDD, 2003c). Syria has occupied portions of Lebanon since the 1970s (Cole, 2005), hence wielding a great deal of control over what happens in Lebanon. This could be a possible reason for the greater amount of water apportioned to Syria on the An Nahr al Kabir. The United Nations Economic and Social Commission for Western Asia (ESCWA) is working as an outside facilitator to ensure this agreement remains intact by offering training to water policy managers in both Syria and Lebanon (MENA Business Reports, 2003).

Figure 3.6 An Nahr Al Kabir River Basin.

Syria's withdrawal from Lebanon changed the relationship between both countries and tested the resiliency of the water-sharing agreement. What still needs to be resolved is the status of the "Shebaa Farms" territory

occupied by Israel that belongs to Lebanon, as stated by the Lebanese or Syrians (Hatoum, 2005). This territory is also the area disputed with Israel due to the issue of using the Wazzani Spring (a tributary of the Jordan River).

Although the water sharing agreement between Lebanon and Syria was seen as a bilateral agreement, it was done under Syrian occupation. Bou-Zeid and El-Fadel (2002) point out that despite the perception that Lebanon is water rich, it is possible that by 2025, demand will be greater than supply due to the effects of climate change and increased agricultural demand. At the current stage of agreement between Syria and Lebanon over the An Nahr al Kabir, the presence of a bilateral treaty signals that both countries are entering into cooperative management of the shared resources.

3.4.6 Jordan River Basin

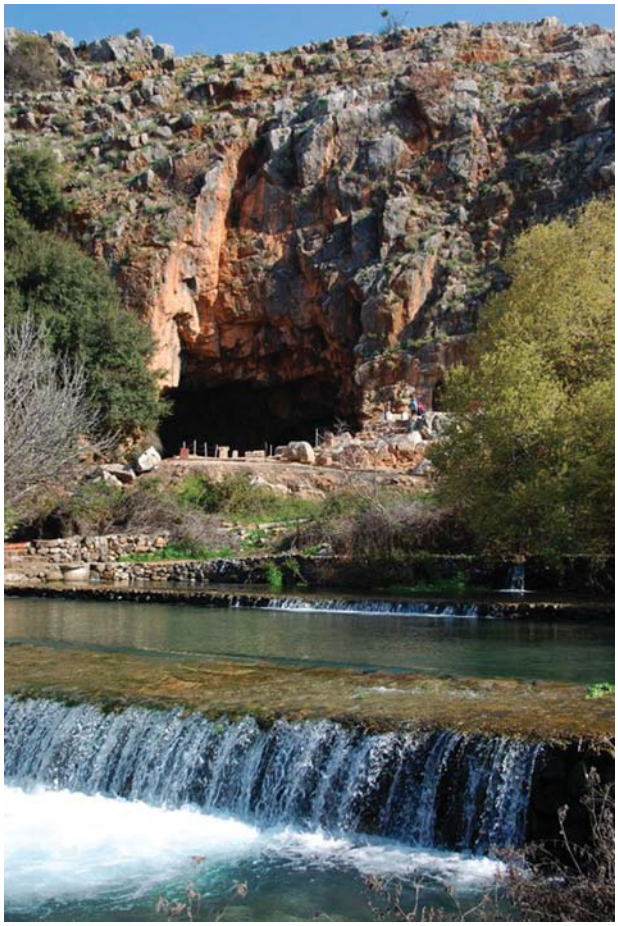
The Jordan River Basin has a total drainage area of 42,800 km^2 and includes Jordan, Israel, Syria, the West Bank, Egypt, Golan Heights, and Lebanon (TFDD, 2003d) (Figure 3.1). This basin has endured many years of conflict over water resource issues. However, the conflict seems to be transitioning towards eventual cooperation, since an institution such as the Israel-Jordan Peace Treaty demonstrates some resiliency.

It appears that Israel and Jordan are already on the path towards peace with the continued existence of the 1994 Israel-Jordan Peace Treaty. Furthermore, examples discussed earlier show that both countries are attempting to utilize the treaty provisions to deal with water-quality issues in the Jordan River and water-quantity issues in the Sea of Galilee. Including Palestinians in these agreements, such as the World Bank did in the recent Red-Dead canal study, would further strengthen the treaty, as their geographic location between Israel and Jordan will give them a strategic position in dealing with both the sharing of surface- and groundwater in the Jordan Basin.

Overall, countries within the Jordan Basin seem to be working towards peace amidst the protracted land conflicts that flare up within the region. The treaty between Israel and Jordan appears promising and has the potential to be a model between other countries in the basin. The conflict between Israelis and the Palestinians in the occupied territories has potential for resolution if the pullout from Gaza leads to cooperation between Israel and a sovereign Palestinian State. In addition, the conflict over the Wazzani Spring between Lebanon and Israel could potentially be resolved now that Israel has pulled out of that disputed territory and Lebanon is asserting its independence from Syria. In order to establish lasting peace, any future water-sharing agreement must include every party that uses the transboundary resource. This should help foster cooperation between all countries because it shows that each country is willing to share and recognize the needs of other countries.

3.5 Conclusion

The transboundary basins in West Asia show signs of both resiliency and vulnerability, but most basins are currently vulnerable. Beginning with the northern basins, the Kura-Araks Basin is



Source of the Jordan River at Banias Springs, Golan Heights. Photo credit: Anthony Novak.

Euphrates tractor wash, Turkey. Photo credit: Gene Molander.

vulnerable because of water quality problems that are overshadowed by politics and the long history of low investment in infrastructure and resources to prevent pollution of water resources. The existing form of cooperation is based mainly on the presence of international organizations that provide resources and attempt to open dialogues between countries.

Reflection in the debris-filled water of a birkeh; this ancient form of infrastructure is *used to collect and store water for community use in southern Iran and other arid regions. Photo credit: Babak Sedighi.*

Politics also play a role in the vulnerability of the Tigris-Euphrates/Shatt al Arab Basin. Due to the conflicting political agendas, short history of technical cooperation between the countries via the Joint Committee, the current infrastructure problems faced by Iraq after 2001, and the major construction of infrastructure by Turkey, the Tigris-Euphrates/Shatt al Arab Basin remains vulnerable. However, there are outside forces at work in the basin (i.e., the European Union in Turkey and the United States in Iraq) with the potential to influence greater cooperation between the three countries.

The Orontes River is considered vulnerable despite the 1994 bilateral agreement between Syria and Lebanon on water-sharing and the 2001 discussion of cooperating on technical issues between Syria and Turkey. Land conflict between Turkey and Syria remains a barrier to any formal water-sharing agreement. Furthermore, the pullout of Syria from Lebanon may test the resiliency of their 1994 agreement. In addition, Syria's insistence on bringing the Tigris and Euphrates Rivers into the discussion may make it complicated to reach a multilateral agreement between Lebanon, Syria, and Turkey (the three countries that share the Orontes River), especially since the Tigris and Euphrates do not flow through Lebanon.

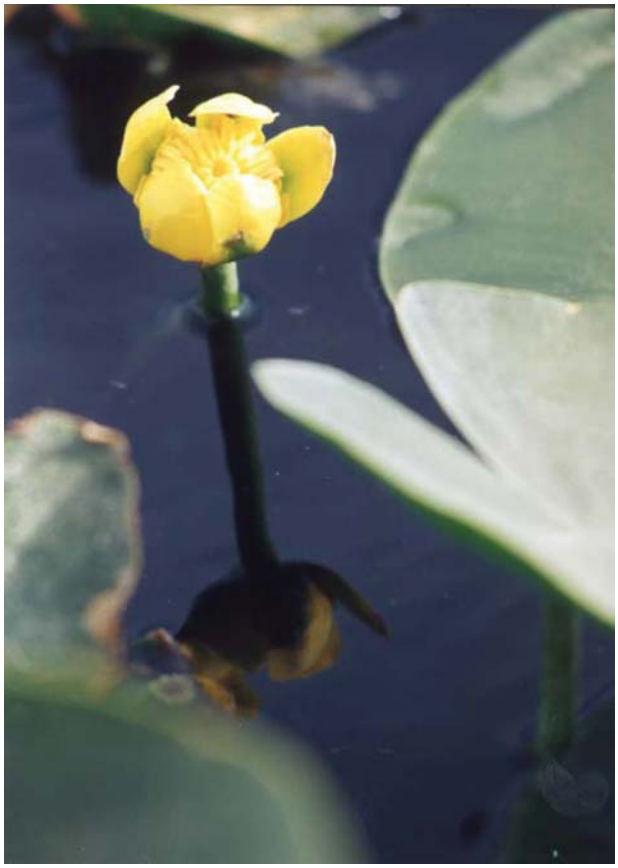
The Aral Basin also displays vulnerability due to the political history of the region. The former Soviet Union states rely heavily on water resources and want to change the existing agreements. However, they have not found a way to divide the water equitably. There is a heavy international presence in this basin that has the potential to increase the resources available to the states and entice them to cooperate. The Amu Darya Basin will become even more vulnerable as Afghanistan begins to withdraw more water from it.

Continued conflict between Israel and the Palestinian Authority in the West Bank displays the lack of institutional agreements between these two groups and keeps this region vulnerable. This is evidenced by the conflict over the "separation wall," where Israel acts unilaterally in a way that may impact the availability of water to Palestinian people. The Kedumim Quarry Landfill is another example where Israel acts unilaterally to site a landfill on land in the disputed West Bank territory. The unilateral pullout of Israel from the Gaza Strip undoubtedly affects how both Israel and the Palestinian Authority handle water resource issues in the West Bank. Inclusion of the Palestinian Authority in decisions that impact those living in the West Bank has the potential to reduce the level of conflict between both groups. Amidst the conflict, the local agreement over improving water quality in the Alexander River is a good example that shows how Israelis and Palestinians at the local level are trying to improve their situation without the consent or help from their representative national governments.

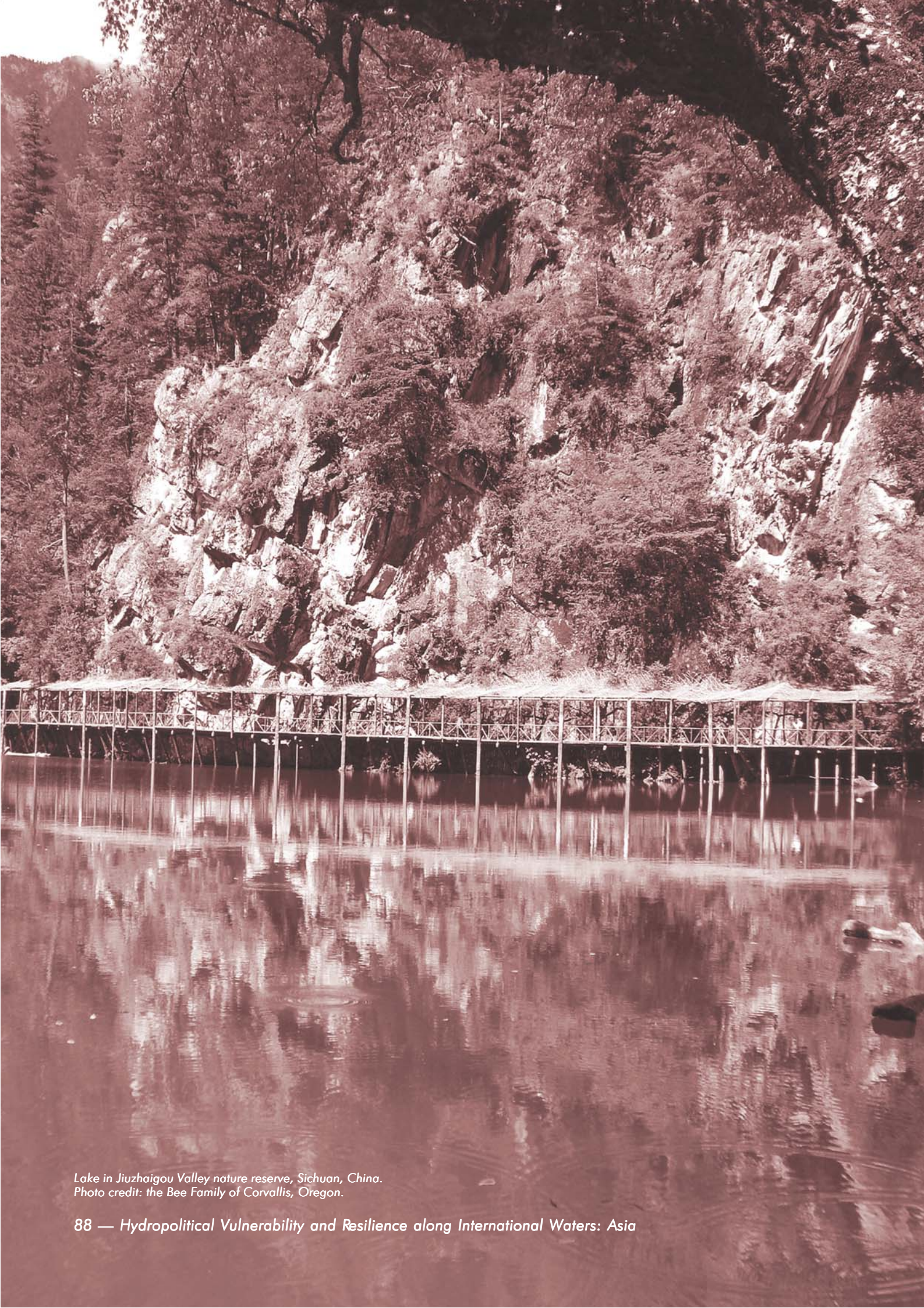
The Jordan Basin is the best example of resiliency due to the fact that the Israel-Jordan Peace Treaty has held up for almost 15 years through times of drought and political changes in the region. The inclusion of the Palestinian Authority for the study over water availability and quality has the potential to be a positive example of how the three entities (Israel, Jordan, and the Palestinian Authority) can work together to solve water resource issues that affect them all. In addition, the recent agreement with Jordan and Syria over the Wahda Dam shows efforts by these countries to work collaboratively to come up with solutions to their water resource problems.

The conflict between Israel and Lebanon is yet to be resolved, especially with the 2002 flare-up over water use of the Wazzani Spring. A report by the European Union describes the situation as unresolved, though tensions have decreased as a result of international attention and intervention in the conflict (EU, 2004). An explicit agreement between both countries would hopefully end the dispute over the use of water in this territory. With the withdrawal of Syria from Lebanon, an agreement may be easier to reach between Israel and Lebanon.

Around 60 years ago, the Johnston Accord set up a framework to resolve many of these water disputes by providing a model for water-sharing agreements. In order to maintain resiliency in this region, these recent agreements and treaties need to survive continued climatic variation and political change. This can be achieved by learning from past experience and building on the examples that appear to offer long-lasting solutions in a region that has been plagued by many years of conflict.



Water lily, Iran. Photo credit: Babak Sedighi.



Lake in Jiuzhaigou Valley nature reserve, Sichuan, China.
Photo credit: the Bee Family of Corvallis, Oregon.

Chapter 4. Hydropolitical Vulnerability and Resilience in International River Basins in China

Feng Yan and Darrin Magee

This chapter focuses on the international river basins of China (Figure 4.1), which, due to its location, serves as a water tower for the Asian continent. China's unique location and the breadth and diversity of ecosystems spanned by its international rivers basins also make it a vital locus for global biodiversity protection. Given the country's importance as an upper riparian to so many of Asia's waterways, patterns of development and utilization of international rivers in China can have implications for communities and countries far downstream.

China is a riparian to eighteen international river basins, eight of which it shares with South and Southeast Asia (see chapter 2) and ten of which it shares with West, East and Central Asia (see chapter 3). In comparison with many countries, China is rich in water resources. River runoff in China ranks sixth among all countries in the world, following Brazil, the former Soviet Union, Canada, the United States of America, and India, and accounts for about 5.8% of the global volume. River runoff is the main composition of water resources in China, accounting for 94.4% of the total. Based on investigations conducted by the Chinese Ministry of Water Resources in 1986, the sum of the average annual surface runoff in China is $27287 \times 10^8 m^3$, of which 99% is produced within China's borders. Despite the apparent abundance of water in the country, its geographic and temporal distribution is highly uneven, and only 10% is consumed. Among the outflow water, some 26.8% flows to downstream countries, while the rest (63.2%) flows into oceans from intra-national rivers. China contributes much more water supply than it gains from others.

China's 18 international basins are responsible for 26.8% of the country's total annual discharge and are concentrated in three regions: the northeast, the northwest, and the southwest. The international rivers and lakes in the northeast are largely components of borders. Problems of pollution and soil erosion on the international rivers in that region are especially significant due to the widespread development of heavy industries there since the 1950s. The international rivers in the southwest region cross from within China to downstream riparians—and include many major rivers important to large populations living in multiple countries. They are mainly conjunctive watercourses (watercourses that conjoin two countries rather than forming a border between them) and mostly outflow rivers. Major development objectives such as hydropower and channel modification, along with soil erosion problems, are becoming focal points for concern on the part of downstream countries because of cultivation on steep slopes, significant hydropower potential, and shortage of farmlands in the upstream areas. Finally, the international rivers in the northwest include rivers that both come into China from outside its borders, as well as rivers that start in China and flow out. The primary areas of concern in this region are water allocation, utilization, and future water resources development models. The latter is an extremely sensitive topic among riparian states due to shortages of water within the international river basins, coupled with the greater average per capita water consumption due to sparse population distribution and comparative richness of the per capita volume of water resource.

Economic conditions in the regions of China where most of the international river basins are located are depressed relative to other regions of the country. In addition, China's neighbours are mostly developing countries, countries facing water shortage, or remote regions of more developed countries

Figure 4.1 The major international rivers of China. Border issues between China and India are presently unresolved, as such this map does not represent the political boundaries. We regret any errors or omissions that may have been unwittingly made in the drafting of this map.

(Russia), and quite a number of them are the poorest countries in the world. Through exploitation of international rivers and shared water resources, these countries expect to promote basin-wide and/or nation-wide economic development, while introducing and absorbing foreign investment and technology. Such a model may cause the development and management of the international water resources to exceed the level of water resources development within the river basin countries themselves, and could have positive or negative impacts on diplomatic and economic cooperation. It also involves careful negotiation of complex international relations problem, such as jockeying among regional powers, in which international water resources development becomes inevitably entangled.

In order to fully explain the situation of hydropolitical vulnerability and resilience on international river basins in China, this chapter first provides a general introduction to China's waters and institutions, then analyzes the regional drivers affecting hydropolitical vulnerability (climate change, population change, status of water quality, capacity building). We discuss hydropolitical vulnerability and resilience through the lenses of water development, potential problems in water use objectives, and cooperation among the relevant countries. The chapter concludes with a discussion of specific cooperative endeavours in the Lancang-Mekong basin that might serve as a model for cooperation within other transboundary basins.

4.1 General Description of China's Waters and Institutions

4.1.1 Climate and Water Resources

China's surface water is divided into four river basin zones, three of which are exorheic (i.e.,

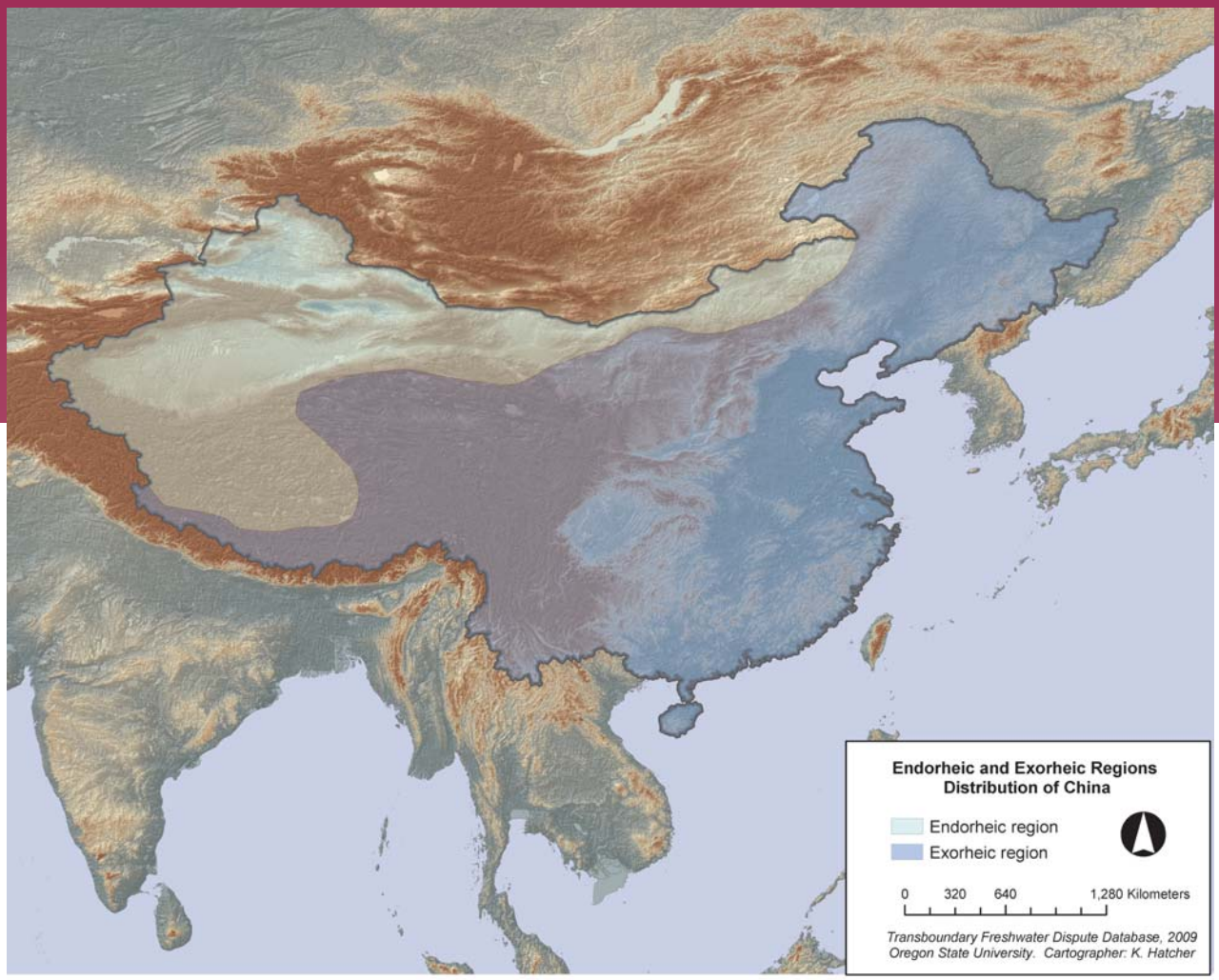


Figure 4.2 Endorheic and exorheic regions distribution of China. Border issues between China and India are presently unresolved, as such this map does not represent the political boundaries. We regret any errors or omissions that may have been unwittingly made in the drafting of this map.

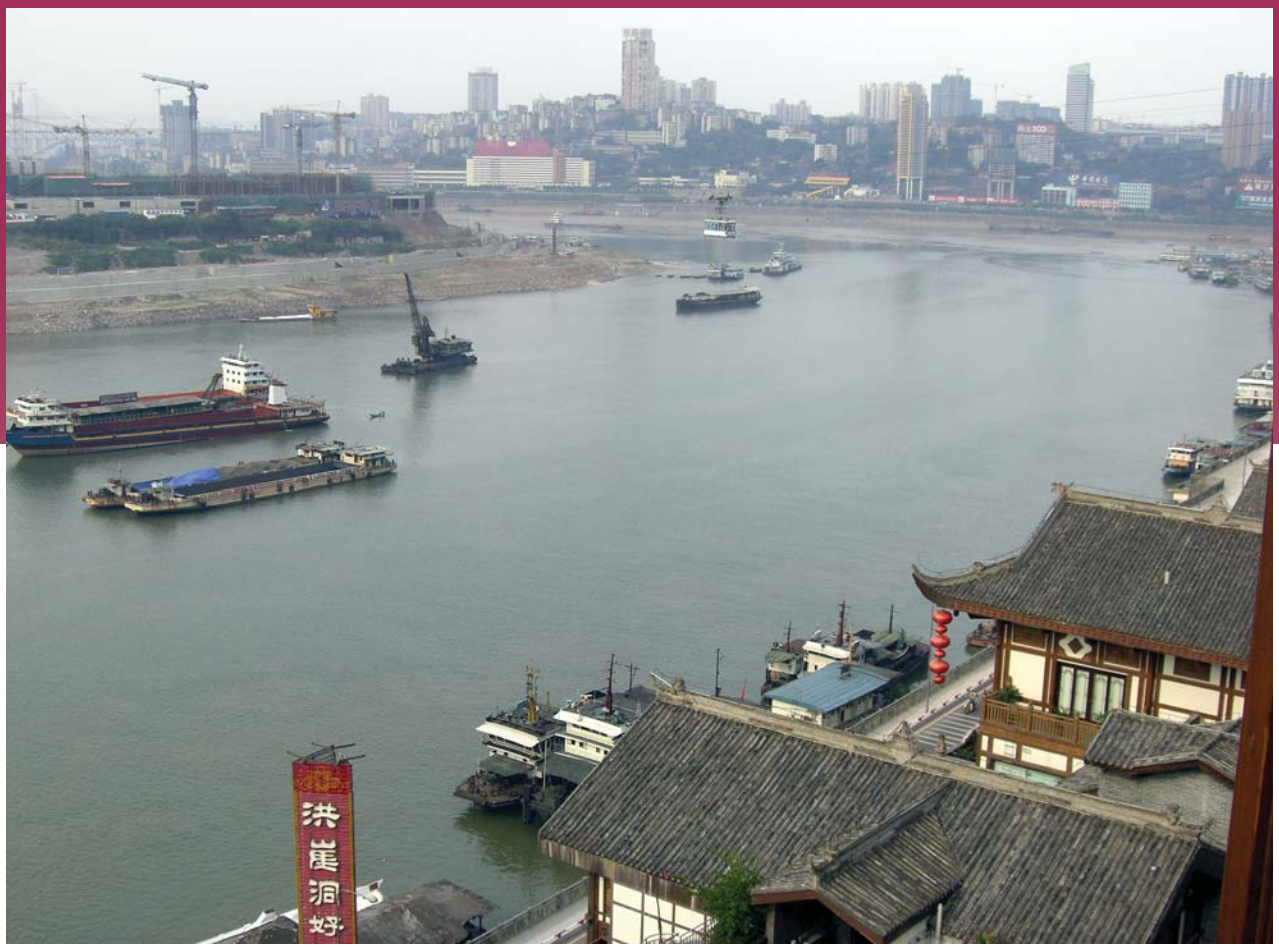
flowing to the sea) and one of which is endorheic (i.e., without a connection to the sea; Figure 4.2). Rivers in the three exoreic zones empty into the Pacific Ocean, Indian Ocean, and Arctic Ocean. Basins emptying into the Pacific Ocean account for more than half the country's total drainage area (58.3%) and include the Yangtze River, Yellow River, Heilongjiang, Pearl River, Liaohe, Haihe, Huaihe, Qiantangjiang, and Lancang (upper Mekong) River. Basins emptying into the Indian Ocean account for much less of China's drainage area (6.4%); these include the Nujiang (upper Salween) and the Yarlung Tsangpo-Brahmaputra-Ganges. Finally, those basins emptying into the Arctic Ocean account for the smallest drainage area (0.6%), with the Irtysh[1]-Ob as the sole river system in this category.

The inland river basin (endorheic) zone accounts for 34.7% of China's drainage area and can be roughly divided into several sub-regions. Inner Mongolia inland river basins are mostly seasonal rivers that are mainly recharged by snowmelt in spring and summer. They have large non-runoff areas and short flow due to their gently sloping terrain, high rates of evaporation, and groundwater infiltration. The inland river basins of Gansu Province, Zhungeer[2] (Inner Mongolia), and Tarim (Xinjiang Uyghur Autonomous Region) have developed some longer interior rivers such as the Tarim River and Yili River as a result of broken terrain and relatively copious recharge by snowmelt and precipitation.

The total volume of water produced at the country level masks the inequitable distribution across this huge country. In general water supplies are poor in the arid steppe and desert

[1] Occasionally Romanized as Ertix. The Irtysh joins the Ob after flowing out of China and through Lake Zaysan.

[2] Also Romanized as Zhunkeer.



Cable car crosses above ship traffic on the Yangtze River, Chongqing, China. Photo credit: the Bee Family of Corvallis, Oregon.

regions of the north and rich in the temperate regions of the south (see Maps 1 (A) and (B)). This phenomenon is evident when the water volume produced per surface area of major rivers in the south is compared to that of the north. The south of China, including the Yangtze and the drainages to the south of it, makes up 36.5% of China's surface area, and produces an overwhelming proportion (80.9%) of the country's water supplies. In contrast, basins in the northwest region, including the Irtysh-Ob, Tarim, Kunes, and Pu-Lun-To basins north of the Tibetan plateau comprise 63.5% of the national land area, but only contribute 4.6% of the nation's water supplies. The southern provinces of Xizang (Tibet), Sichuan, Yunnan, and Guangxi collectively hold the greatest volumes of water resources, with the annual volume of each exceeding 1.8×10^{11} m^3.

4.1.2 International Waters

Of the 22 major rivers in China, 12 are international rivers. The international rivers in China are distributed in three regions: the northeast, northwest, and southwest. The natural, socioeconomic, and environmental conditions as well as the international relations situation of these are all quite different. The major international rivers in China and the available water resources (including surface water and groundwater) are shown in Figures 4.1 and Map 2 (A).

Before the 1990s, economic cooperation in the border regions involving China was limited due to long-term regional economic development patterns and concerns about national economic security and industrial allocation. As a result, most of the international rivers are at present close to their natural state with very low degrees of exploitation. Most of the larger international rivers in China are situated in cold plateaus, high mountains and deep valleys. Though rich with water volume and hydropower potential, the development of these water resources is constrained by the soaring terrain, high mountains with steep slopes, high land with low rivers, scarce farmland, sparse habitation, limited markets and costly construction.

As of 2004, there were around 18 large- and medium-scale hydropower stations planned, under construction, or already operational on China's international rivers.[3] The increased demands for electric power (both within China and in neighbouring countries), combined with the deleterious effects of fossil fuel-based generation options, make large-scale hydropower development increasingly attractive in East Asia. Yet when such development occurs on international rivers, there often arises considerable concern among downstream users about the potential impacts on the river's flow regime. Much of this concern, however, could likely be eliminated or reduced through increased transboundary data sharing and cooperative basin-wide impact assessments.

4.1.3 Potential Impacts of Global Climate Change

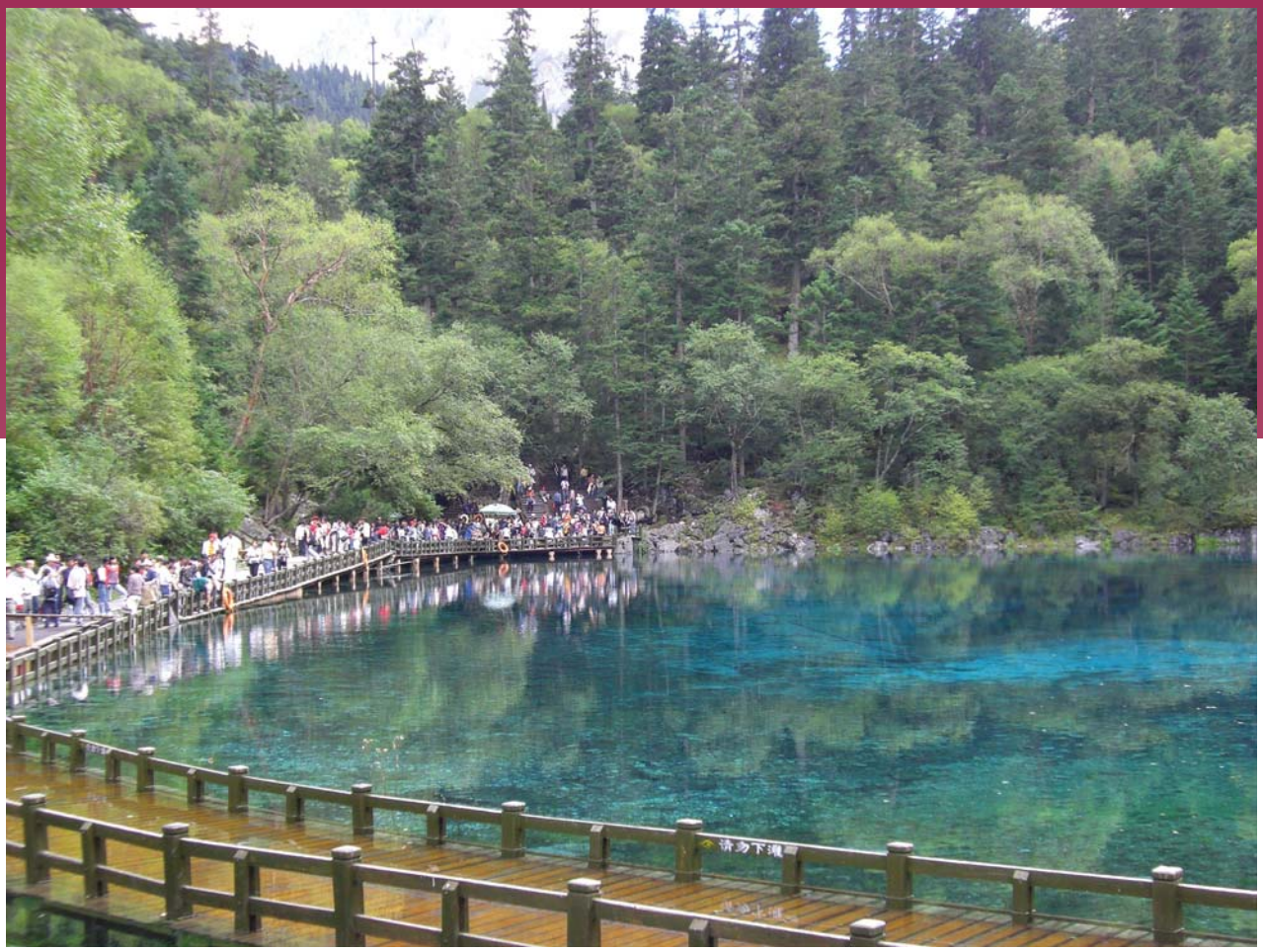
Though slightly lower than the global average, temperatures in China rose 0.4–0.5°C during the twentieth century, compared to the world average of 0.6° C. China's topography is such that the areas exhibiting the greatest evidence of climate warming are the northwest, east, and northeast regions. Among these, the extent of warming in the northwest is greater than elsewhere in the country.

Global warming will affect the whole process of water cycling. Water stored in glaciers, frozen earth, and snow may decrease, while evaporation will increase, thus changing regional precipitation and precipitation distribution patterns. These changes will likely give rise to extreme rainfall incidents; increase the frequency and intensity of flooding, drought and water-logging; and change surface runoff, water supply and demand status, and water quality. The following are some examples of specific changes:

1. *The differences in inter-year and seasonal precipitation may expand, causing increasingly uneven distribution of water resources in space and time.* Meanwhile, the likelihood of extreme hydrological phenomena increases, with frequent occurrence of flooding and severe drought around the world. As an example, the total water resources in the international river basins in the northeastern region of China changed greatly in the period from 1998 to 2002, when compared to the average water resources of the normal years. This caused flooding to a degree unrecorded in a century, followed by severe drought in four consecutive years, all of which greatly affected regional social and economic development.
2. *An increase in the uncertainty of available water resources, coupled with a decrease in their predictability, reliability, and safety, will make existing and proposed water resources utilization plans and aquatic environment regulation plans very hard to implement and verify.*
3. *Unstable changes in the interval of floods and drought may threaten regional socioeconomic activities and riparian*

Looking northeast across the South Inylchek Glacier below Chapaev peak, seen from near Inylchek basecamp, Kyrgyzstan (near the border with China). Photo credit: Simon Garbutt, via Wikimedia Commons.

[3] Medium-scale hydropower stations have 25MW to 250MW installed capacity, while stations having more than 250MW installed capacity are considered large-scale.



Crowds of visitors at Jiuzhaigou Valley nature reserve, Sichuan, China. Photo credit: the Bee Family of Corvallis, Oregon.

ecology and make water conservancy work hard to conduct. In the spring of 2004, the Manwan Power Station on the mainstream of the Lancang (upper Mekong) River, intended to capture floodwaters in the rainy season in order to reduce their impact on downstream areas and provide power generation potential, suffered from an empty reservoir. A spring drought had occurred in the river basin, causing record low water levels downriver, affecting socioeconomic activities and natural water use, and leading to heightened international tensions in the region.

4. *Instability and uncertainty regarding water resources reduces the rationality and operability of existing water resource distribution schemes for international rivers.*

4.1.4 Population Change

China's neighbours in international river basins are mostly developing countries, or relatively under-developed areas of developed countries (e.g., the far east region of Russia in the Heilong River basin[4]). Among these countries, east Asian and southeast Asian countries in particular are also countries with booming populations, which places further demands on water. As a result, water resource sharing will likely become a common concern, with international cooperation on shared water resources development an important factor in international relations among riparian countries. In recent years, under the Chinese population control policy, population growth has been slowed on the whole. The majority of the population in China is of Han Chinese ethnicity, whereas some 8% of the population belongs to the other 55 officially recognized ethnic minority nationalities. There remain differences in rates of population increase among minority communities when compared to that of China's overall population.[5] Since many

[4] Heilongjiang, in northeastern China.

[5] This is because China's one-child policy does not apply to ethnic minorities.

of China's ethnic minority populations are concentrated in border areas, increased population growth rates are often geographically localized, a phenomenon likely to contribute to higher-than-average population growth rates in China's international river basins. Figures 4.3 and 4.4 show the population growth trends between 1983 and 2000 in the major areas (administrative regions) of the international rivers. According to fourth and fifth national census statistics, population grew by 11.6% from July 1990 to September 2000, equivalent to an annual growth rate of 1.07%.

4.1.5 China's Internal Institutions for Managing Water Resources

In China, there is no single specialized agency in charge of transboundary water issues. According to the traditional division of official responsibilities, transboundary water issues fall under the jurisdiction of the Ministry of Foreign Affairs due to the fact that they are inextricably linked to relations among the relevant riparian countries. The Ministry of Foreign Affairs is charged with the diplomatic negotiation of affairs pertaining to international rivers; yet few diplomats are familiar with hydrology, water management, or resource development strategies for river basins, and therefore they rely on the expertise of internal water bureaucracies, in particular the Ministry of Water Resources (MWR) and a number of Water Management Agencies (WMA). Other technical bureaucracies that frequently provide input into decisions about international waterways include (1) the Ministry of Environmental Protection (WEP); (2) the Ministry of Construction; (3) the Ministry of Agriculture; (4) the State Forest Bureau; (5) the National Development and Reform Commission; (6) China Guodian Corporation; (7) the Ministry of Communication; and (8) the Ministry of Health.

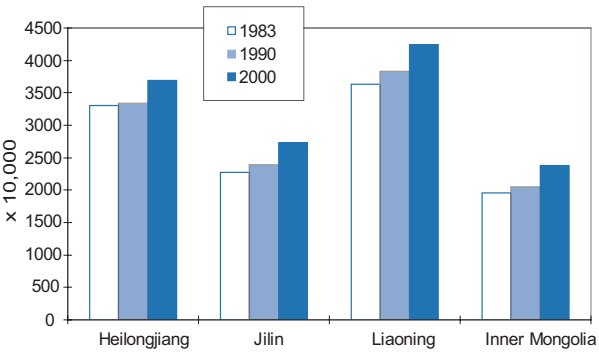


Figure 4.3 Population growth of Northeast international rivers of China. Figure provided by Feng Yan and Darrin Magee, 2009.

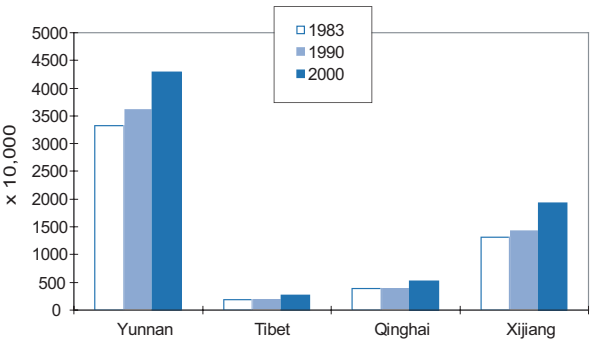


Figure 4.4 Population growth of the provinces in Northwest and Southwest international rivers of China. Figure provided by Feng Yan and Darrin Magee, 2009.

In this section on China's domestic institutional capacity, water administration agencies and their functions are introduced at first as the focal point, then the relative WMAs in charge of the different international rivers are clearly discussed. This background provides context for subsequent sections that specifically address institutional capacity for China's transboundary waters.

Under the MWR, several Watershed Management Agencies[6] in important watersheds have been established and charged with water management and supervisory duties within their watersheds as authorized by the Water Law and relevant administrative regulations enacted by the MWR itself. The following WMAs are involved in the management of China's international rivers:

1. *Yellow River Conservancy Commission (YRCC):* charged with water resource development planning, water permit issuance and management, and other affairs in the international river basins located in the northwestern region

2. *Pearl River Water Resources Commission:* charged with water resource development planning, water permit issuance and management, and other affairs in the international river basins in southern China located to the east of (but not including) the Lancang River

[6] Also commonly referred to as basin commissions.

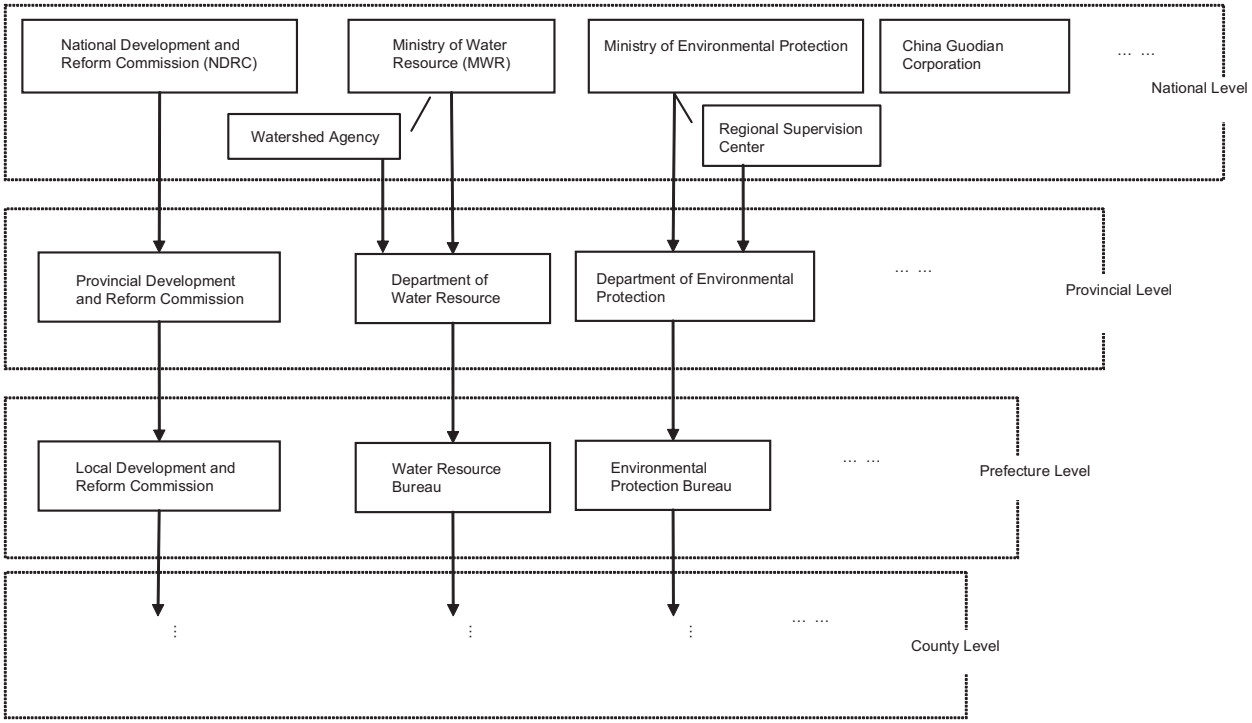


Figure 4.5 Institutional arrangement of water resource management. Figure provided by Feng Yan, June 2009.

3. *Yangtze River Water Resources Commission:* charged with water resource development planning, water permit issuance and management, and other affairs in the international river basins located to the west of (and including) the Lancang River

4. *Songliao River Water Resources Commission:* charged with water resource development planning, water permit issuance and management, and other affairs in the international rivers located in the Songhua and Liao River basins and the international boundary rivers and lakes of the northeastern region.

The basic organizational structure of China's water resources management bureaucracy is replicated from the national level (ministry) on down through the provincial (bureau), prefectural/municipal (department), county (agency) and township (station) levels of government (Figure 4.5). In China, however, vertical administrative alignments, and their ability to transmit central government priorities downward through multiple levels, are sometimes at odds with horizontal allegiances *within* each level between various units of the Chinese administration. Thus what appears at first to be a fairly straightforward top-down institutional hierarchy responsible for water resources governance is, in fact, complicated many times over through these two sets of overlaid institutional (and personal) relations.[7]

4.2 Drivers Affecting Hydropolitical Vulnerability

In the three regions where the international rivers in China are distributed, boundaries are generally stable, regional international cooperation has been promoted and is well developed, and geopolitical, economic, and social conditions are on the whole rather stable. Tensions between China and India, however, over disputed borders in the southwestern part of the Tibetan Autonomous Region have a long history; violent border clashes between China and India occurred in the 1960s, resulting in a standstill in cooperation and communication between the two countries. In recent years, increased precipitation in Tibet has caused cycles of landslides, blocked rivers, and transboundary flooding in the upper areas of transboundary rivers. For example, a huge landslide in the Yarlung Tsangpo-Brahmaputra River Basin

[7] This is referred to as "tiao kuai guanxi" in Chinese, and has been the object of much scholarship on the domestic political workings of China.

The river Irtysh near Pavlodar (Kazakhstan). Photo credit: Loris Romito, via Wikimedia Commons.

occurred in the spring of 2000, blocking the Yigong River for two months until the dam burst. The subsequent flooding caused by the outpouring of Yigong Lake created a series of national security issues for both countries. The most important and outstanding issues, then, on transboundary security and stability within China's international river basins are centered on resolving the boundary problem between China and India; establishing a system and standards for timely notification and action in urgent situations, especially those involving significant loss of life and/or property; and identifying the direction of water resources development in the southwestern region.

Drivers affecting hydropolitical vulnerability have both natural and socioeconomic elements. The natural elements include such things as changes in the hydrological system caused by climate change, and changes in the watershed landscape. The socioeconomic elements include the institutional capacity to absorb those changes, as well as other changes such as population growth, rearrangement national and/or regional economic structures, and economic development patterns. Below, we analyze the following key issues causing vulnerability to change in China.

4.2.1 Northwest Region

The major international rivers in this region are mainly located in western China's Xinjiang Autonomous Region, a dry area with a large distribution of ethnic minority populations and vast, arid (desert) area. Most of the population is concentrated around oases. Due to the difference in population growth policy regarding minorities, along with other policies designed to encourage resettlement of Chinese from eastern parts of the country to Xinjiang, population growth in the area is higher than the national average. Water resources are abundant on a per capita basis, with per capita volume exceeding 5,000 m^3, but water use in the region at present has exceeded 50% of the surface water resources. Given that China's northwest is an arid region, water demand for the natural environment is quite high, and per capita volume of water resources consumption is higher. In addition, regional population growth will place increasing stress on water resources and will have certain impacts on the oases economy, on the water resources demand for oasis development, and on outflow volume of the international rivers.

As climate change has brought warming in the region, rates of snow melting have quickened,

resulting in an increasing trend in surface and underground water resources. Over the long term, however, water recharge will decrease and water resources volume will drop. Despite the growing population, there are currently no effective water-saving measures in place and the demand for water for ecosystem services is increasing. Because the related areas and countries in the region are situated in arid areas, water resources protection, and socio-economic and environmental security become key issues. The northwest region, then, faces the challenge of ensuring economic development and environmental protection around the oases and cooperating with neighbouring countries on water resources development. Water quality has largely been preserved, with the worst river sections being those in or around the residential quarters in the towns.

Of primary concern in China's northwest are four large international rivers in Xinjiang: the Aksu[8]/Tarim, Ili, Irtysh-Ob, and Emin River-Alakol Lake,[9] which have boundary rivers and transboundary rivers with frequent inflow and outflow. Within China, this region is arid with minimal precipitation, yet an average annual inflow of $9.08\times10^9 m^3$ of water into China from the international rivers in the region yields a theoretical hydropower potential of about 2.3×10^8 kW. Outside China, the basins lie mostly within countries facing water shortages. The main courses of the Ili River, the largest of these, and the Irtysh-Ob River both flow outward from China, but some major tributaries originate in countries outside China and later flow into China, only to flow out again when mingled into the main courses. The Emin River, from its Chinese source, flows to Kazakhstan and ends at Lake Alakol.

The development and utilization of water resources in the transboundary rivers is of particular concern for all the neighbouring states. In June 2001, a total of 24 rivers were considered by China and Kazakhstan to be transboundary rivers between the two countries. In order to ensure equitable and rational development and use of the waters, vital to the long-term friendly relationship of the two countries, the governments of both signed the "Agreement between the Government of the People's Republic of China and the Government of the Republic of Kazakhstan on the Cooperation on Using and Protecting the Trans-Boundary Rivers" in September 2001. This was the first intergovernmental treaty regarding water management signed by the Chinese government with another national government.

A number of projects designed to increase annual stores of water in this region have been quite controversial. Construction in the Ili River and Irtysh-Ob River basins has become a cause for concern in the region, and China is also carefully monitoring the exploitation of the Aksu River in neighbouring countries, where the principal transboundary issue is volume. In 1970, the Kapchagai Dam on the middle section of the Ili River was completed in Kazakhstan. The dam, with its multi-year regulating capacity, total storage capacity of 2.8×10^{10} m^3, and runoff regulating factor of up to 56%, is able to control all the outflow volume from China on the Ili. Several other major water conservancy projects have also been built outside China on the Irtysh River, including the Bukhtarma Dam, whose reservoir's runoff regulating factor of 170% makes it capable of totally controlling the outflow from China. In this region, water resources exploitation and consumption volume in the river basins outside China are higher than that within China, and there are also water utilization through transferring. With the increase of water demand within the Chinese territory for irrigation, power generation, animal husbandry, urban expansion and domestic consumption, and natural consumption, the principal water problem among the neighbouring countries in this region is how to distribute the water volume reasonably.

From 2000 to 2002, water resources in the northwestern region were abundant. Yearly water volume in the autonomous region in 2002 was 25% above average, while water resources of the various rivers were on average 10% greater than their average yearly values. In Xinjiang, surface water utilization volume accounts for 90% of the total volume of water resources utilization. Water

[8] Also Romanized as Arkesu.

[9] Also Romanized as Ala Kul.

Nu-Salween River, China. Photo credit: He Daming.

resources utilization volume has reached 50% of the total surface runoff and total local water resources, and per capita volume of water consumed is near 2500 m^3 yearly, which is almost six times that of the national average level. Therefore, there is much potential for water saving in this region in the future. In addition, outflow volume through the boundary depends primarily on natural variations in the abundance or shortage of water resources. As suggested earlier in this section, though, human factors stand to play an increasingly important role.

As a whole, despite relatively high levels of utilization of comparatively scarce water resources in China's northwest, the condition of the aquatic environment is fairly sound. However, as China moves forward with its western development goals, increasing demands will be placed on those resources. The most likely points of contention in transboundary water resources utilization and development in the future will focus on changes to the outflow aquatic environment caused by increased water resources utilization within China, which could then affect foreign demands for both quantity and quality of the water leaving China. In addition, as awareness grows of the importance of these resources for sustaining ecological systems, and as increasing emphasis is placed on environmental construction, there will likely be some increase in the amount of water used for ecosystem services. This, too, could influence volumes discharged across China's borders, which might conflict with the water utilization priorities of neighbouring countries.

4.2.2 Southwest Region

China's southwest is the source of many major rivers in China and Asia, and is frequently referred to as the "water tower" of China and the Asian continent. Six major international rivers in southwest China rise in the Qinghai-Tibet Plateau: the Lancang-Mekong, Nu-Salween, Yarlung Tsangpo-Brahmaputra, Dulong-Irrawaddy, and Senge-Tsangpo-Indus. Most flow from north to south along the Hengduan Mountains. Many glaciers and snow-capped mountains are distributed in the region, and 40 mountains in the upper areas of the rivers rise to more than 6,000 m. The water storage capacity of those mountains is about $1 \times 10^{11}\ m^3$; their storage and glacial melting greatly affect water resources exploitation and utilization and aquatic ecological environment protection in the west. China lies in the upper drainage areas of these rivers, where water volumes and hydrological

Lancang River (upper Mekong), China. Photo credit: He Daming.

energy are rich. The region is generally agricultural with little industrial development, and has vast land area with sparse population. Thus, river water resources and their ecological environment are generally well preserved, except for point-source industrial pollution and raw sewage pollution in some small towns on the main courses and tributaries. These pollutants are diluted in the main streams, however, leaving water quality in the rivers as they cross the Chinese border generally high.

Qinghai Province, the source of the Lancang-Mekong, contributes very little to the southwestern region's water resources and has relatively low per capita volume. In Yunnan Province and Tibet, per capita volumes are much higher at 5329 m^3 and 158,932 m^3, respectively. Water resource utilization across the southwest is fairly low, so the increase in water resources demand brought about by population growth will not significantly affect water resources. Considering that Yunnan and Tibet are both highland areas, population growth will have a certain impact on the fragile mountain environment in some areas. Likewise, increases in farmland and irrigation will have indirect influence on the water resources to certain degree.

Current exploitation of these international rivers is mostly non-consumptive and centered on the Lancang (upper Mekong) River. The first dam on the main stem of the Lancang-Mekong, the Manwan Power Station, has an installed capacity of 1250 MW and was completed in 1993.[10] A second, Dachaoshan Power Station, with installed capacity 1350 MW, was completed in 2001. Xiaowan Power Station is currently under construction; at 4200 MW, it is nicknamed the "dragon head" station due to its multi-season regulating capacity, designed to enhance generation capabilities at downstream dams. Farther south, Jinghong (1750 MW) and Nuozhadu (5850 MW) are also under construction and are expected to come online sometime after 2010. Remaining water resources exploitation in the Lancang watershed is mostly due to small-scale industrial, agricultural, and urban domestic consumption, accounting for relatively little volume. Outflow volumes are

[10] This is the completion date for the first phase. A second phase was completed in 1995.

Fish farm near Chau Doc, Mekong Delta, Vietnam. Photo credit: Gene Molander

greatest in this region, and outflows on the Lancang and other international rivers in this region are generally stable and of high quality.

Water resources in the region over the period 2000–2002 were abundant, and water volume in the region and its basins increased by over 5%, while water utilization in the area remained basically unchanged. Per capita volume of water resources utilization in Yunnan Province is 20% less than the national average, and Yunnan's total utilization volume accounts for 6% of the southwest regional total. Meanwhile, per capita volume of water resources, utilization in Tibet is more than twice the national average, with total utilization by volume accounting for about 25% of the southwest regional total. Surface runoff contributes 97% to total runoff, and of the water consumption, the volume is less than 2% surface water. Annual outflow volume changes with abundance and shortage of water resources, and is minimally affected by human activities.

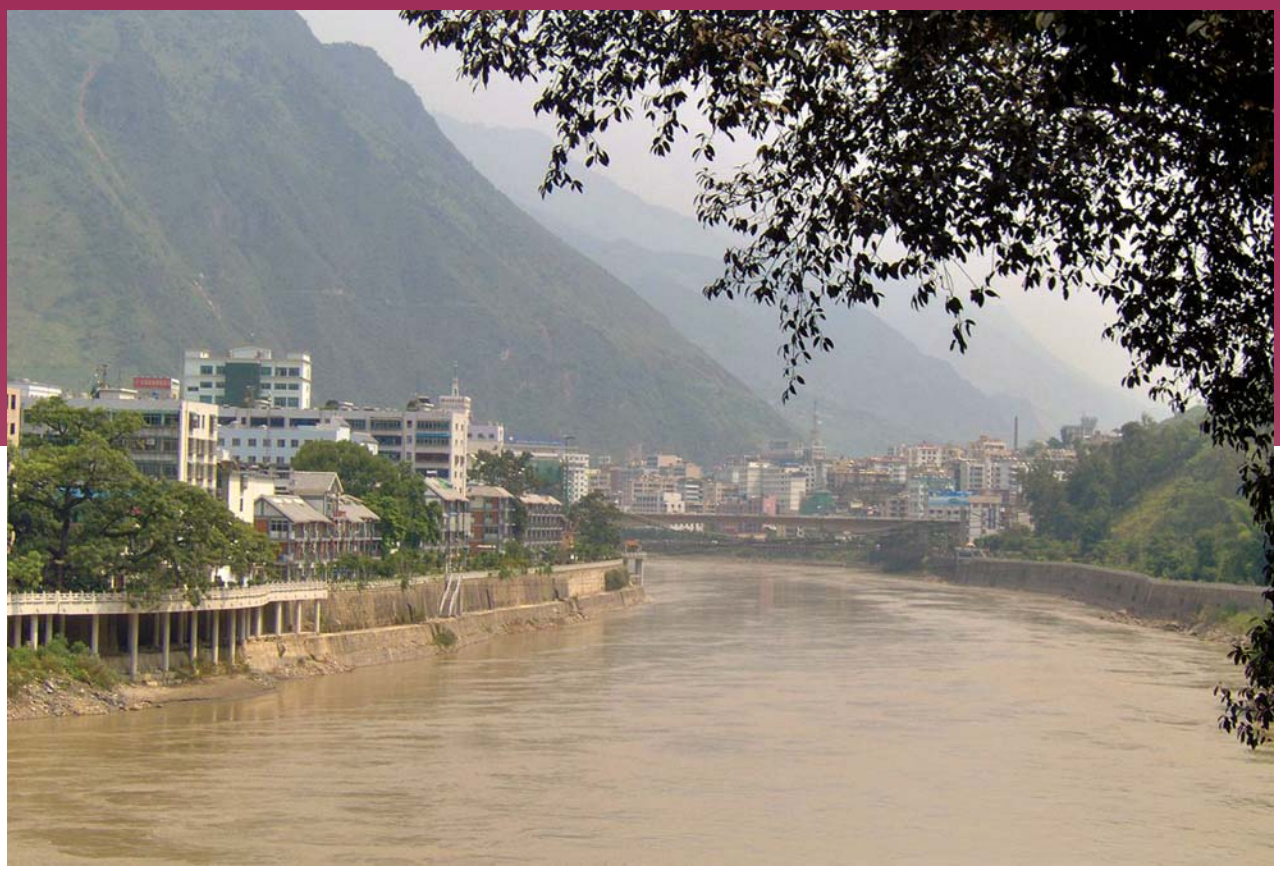
Although water quality is generally high in this region due to low population density and low levels of industrialization, water quality worsened slightly during the wetter-than-normal flows in 2000). Flooding brought increased surface runoff, which washed large amounts of sand into the river courses, adding to the amount of river sediment and worsening water quality. The sharp rise of water levels in the areas surrounding some town washed untreated raw sewage into waterways, thus further deteriorating water quality around the towns. In addition, even though the state of water resources in the southwest region is generally good, the complex natural conditions and physical geography, combined with a lack of environmental monitoring, results in a relatively high number of water-related accidents, such as floods, debris flow, blockages of river course by landslides and bank collapses, all of which threaten social and economic wellbeing in downriver areas. Moreover, sedimentation patterns can transform boundary rivers in some border areas, causing boundary disputes.

The southwest region has seen numerous international cooperative activities surrounding the Lancang-Mekong River basin relating to such sectors as transportation (railway and highway construction), navigation, tourism, trade, poverty alleviation, and environmental protection (details provided below). These activities resulted from

Buying fish, Mekong River, Laos. Photo credit: Alison Jarrett.

regional agreements and related international organizations that have been established by the riparian states. First among these, the "Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin" was signed by the lower basin states of Thailand, Laos, Cambodia, and Vietnam in April 1995. The objectives of the agreement are to promote the sustainable development of water resources in the Mekong River and the economic development and cooperation among the riparian states. The agreement established the Mekong River Commission (MRC), with the four lower Mekong countries (Thailand, Laos, Cambodia, and Vietnam) as members. The two upstream countries (China and Myanmar) have been invited to join the organization, and since 1996 have regularly participated in dialogue, though do not hold member status. Second is the Commercial Navigation Agreement signed by the Ministries of Communication of China, Laos, Myanmar, and Thailand in April 2000. Six other rule documents for ensuring navigational security have subsequently been signed. This agreement set the navigational reach of the river as stretching from Simao Port in China to Luang Prabang Port in Laos. Finally, the "Agreement on the Provision of Hydrological Information of the Lancang/Mekong River in Flood Season by the People's Republic of China to the MRC" was signed in 2002 in Phnom Penh. According to this agreement, China agreed to provide hydrologic data, including water level and precipitation over eight time periods in each day, during the summer monsoon season (June 15 to October 15) from 2002 to 2006 for two hydrologic stations (Jinghong and Man'an) on the Lancang River (Addison, 2006). Data are sent daily to the MRC Secretary via e-mail from the Yunnan Hydrology and Water Resource Bureau.

Other basins to the east and west have seen similar agreements. The "Memorandum on Provision of Hydrologic Data on Yuan-Red River" was signed by the Ministry of Water Resource of China and the International Cooperation Division of the State Hydrologic and Climatic Bureau of Vietnam in 2000. Based on the memorandum, with the Yunnan Hydrology and Water Resource Bureau as the implementing agency of Chinese side, a subsequent "Implementation Scheme on Providing Flood Forecast Service in Flood Season of Yuan-Red River to Vietnam by China" was



Salween River at Liuku, Yunnan, China. Photo credit: Florent Simonet, via Wikimedia Commons.

signed, and forecasting work began on June 15, 2001. The premiers of China and India signed a similar agreement in February 2002 in New Delhi regarding provision of flood season hydrologic data on the Yarlung Tsangpo-Brahmaputra River, which was followed by a more concrete implementation scheme signed by the Ministries of Water Resources of the two countries. The implementation scheme stipulates the scope and types of the hydrologic data—including flow regime forecast, time, route, and other information—to be provided from three hydrologic stations at Nu Gesha, Yang Cun, and Nu Xia in Tibet. China provides data from the three stations to India during the summer flooding season (June 1 to October 15).

The countries in the southwestern region are all developing countries, and demand for water resources is increasing due to population increase and economic development. The potential for future transboundary conflict lies mainly in the development of non-consumptive uses that could affect the spatial distribution of natural runoff, which in turn might conflict with planned water uses and/or the ecological balance in the related basins. Since the various basin countries have different goals for water utilization and targets for protection of basin ecology, tensions may arise when water resources utilization goals conflict. Under the impacts of the southwestern and southeastern monsoons climate, precipitation is centralized in the southwestern highland area, which can easily give rise to such natural disasters as flash floods, debris flows, and landslides. Such disasters are difficult to predict, and the magnitude of losses may vary spatially throughout the transboundary basins. it is important that basin states acknowledge and understand their international responsibilities when such events take place.

4.2.3 Northeast Region

There are ten large and small boundary rivers and three boundary lakes in the region, including the Erguna, Usuli, Heilong, Tumen, and Yalu. Major basins in the region include the Songhua and Liao, with the Songhua basin including the Heilong basin, and the Liao basin including two international rivers, the Yalu and Tumen. Most of the rivers in the northeast region are boundary rivers, responsible for some 5,000 km of international boundaries. Current exploitation of

The Heilongjiang (Amur) shore, Russia is on the left, China is on the right, and in the center is China's Dahei River Island. Photo credit: Refrain, via Wikimedia Commons.

these rivers within China is for industry, agriculture, and urban domestic consumption. Rivers in this region are seriously polluted because of the heavy industrial zone built after the founding of the People's Republic of China. According to China's National Water Quality Standards of China (GB3838-88), fewer than 40% of river reaches in this region meet or exceed the Type III standard (can be used as collective potable water supply), although this situation has been improving due to increased efforts by the country to regulate the environment. For this reason, future international cooperation on water resources and water protection should focus on tackling problems such as transboundary pollution; aquatic ecological environment protection and recovery; severe land loss caused by water eroding the banks, due to long period of ecological destruction; and serious soil erosion and lagging bank protection, resulting in boundary problems caused by the moving of the centerline.

The northeastern region saw three consecutive drought years from 2000–2002, during which water resources volume in provinces within the region dropped on average 20% from their usual volumes (the maximum drop was 60%). During that period, however, the levels of water resources utilization in the various provinces varied widely. In Inner Mongolia Autonomous Region, utilization volumes increased yearly, in contrast to overall general 26% drop in water resources across Inner Mongolia. Water consumption in Jilin Province remained steady, in contrast to a slight drop in the province's water resources (over 10% drop in 2001), but showed a general decrease over the period. Liaoning Province exhibited the greatest drop in water in these three years, with volumes reduced by 60% compared to their multi-year levels. Meanwhile, Liaoning's volume of water resources utilization remained steady with a slight decline, especially in 2000. Total water consumption, therefore, approximated total water resources volume in Liaoning, implying that consumption volume in the province has reached 40% of its multi-year average volume. Water utilization in the northeastern region as a whole remained basically steady, with slight decrease, from 2000 to 2002. The striking feature is that utilization of surface water has reached or exceeded 50% of the surface runoff in the region; under such conditions, attention to ecological

systems and aquatic environments will be a primary concern in the area, especially in light of international river development goals in the future. In addition, outflow volumes into the international rivers from Chinese territory depend on the fluctuations of available water resources in the entire basin, and are minimally affected by human activities.

Population growth in the northeast has been moderate, with the average annual growth rate lower than the national average. But per capita volume of water resources in the four provinces in the region is below 1,700 m^3, making the northeast region a water shortage area. Given the relative shortage, even mild growth in population presents a strain on the region's water resources. Longstanding and intensive industrial and agricultural development, coupled with the effects of climate change, further exacerbate the stress on water resources in the region. Aside from creating negative impacts on social and economic development, such stresses have led to significant deterioration in the aquatic environment. For instance, China has paid much attention to the impact of degraded waterways on salmon migration for reproduction along the main course of Heilong River.

There have been numerous agreements involving international waterways in this region, several of which have centered around boundary demarcations. In 1990, China and the Democratic People's Republic of Korea (DPRK) established cooperation and communication mechanisms regarding hydrological issues on transboundary rivers. The following year, China and Russia signed an agreement regarding the eastern section of the Sino-Russian boundary, using the centerline of the boundary rivers to demarcate national boundaries. The 1991 agreement failed to encompass two islands, Heixiazi and Abagaitu, but boundaries on those were provisionally settled in 1994. Also in 1994, China and Mongolia signed an agreement on the use and protection of transboundary waters, leading to the establishment of a joint committee on use and protection in 1998. In 2002, Russia and China undertook complex water resources development planning on the Argun[11] River and the boundary reach of the Heilong River. The foreign ministers of China and Russia signed "The Complementary Agreement between the People's Republic of the China and the Russian Federation on the Eastern Section of the China-Russia Boundary" in Beijing on October 14, 2004, which resolved 4,300 km of disputed boundary between China and Russia. Finally, the "Cooperation Agreement on the hydrological issues of the boundary rivers" was signed in September 2004 by the Ministry of Water Resource of China and the State Climate Centre of the DPRK.

The only international agreement pertaining to actual management of shared water resources in this region involves navigation. In 1858, China and Russia signed the Aihui Treaty, stipulating that only Russian and Chinese vessels were permitted to sail on the Heilong River and Usuli River; all foreign vessels were prohibited from navigation. Much more recently, the UNDP has promoted a regional economic and technical development zone in the region. In December 1995, China, Russia, and the DPRK signed the "Agreement on the Establishment of the Tumen River Area Development Coordination Committee" in New York.[12] Subsequent agreements involving the DPRK, Mongolia, China, Republic of Korea (ROK), and Russia include a memorandum on the environmental rules on Tumen River Economic Development Zone and Northeast Asia, and an agreement on establishing the development and negotiation commission related to the transboundary economic development zone.

The long history of intensive water resources development within Chinese territory in the northeast region has resulted in striking ecological problems in the area's river basins. As a result, there are numerous points of potential conflict or differences in future water resources development schemes, centered primarily around aquatic environment pollution, soil erosion, bank scouring and regulation, possible shifts in boundary demarcation (where rivers form the boundary), and flooding problems on boundary-forming or transboundary rivers caused by land cultivation.

[11] Also Romanized as Ergun River.

[12] See http://www.tumenprogramme.org/news.php?id=498.

River boats on the Mekong, Laos. Photo credit: Alison Jarrett.

4.3 Case Study: The Lancang-Mekong Basin

The Lancang-Mekong River is a famous international river in Southeast Asia (see Figure 2.3). Rising from its source at an elevation of 5,167 m in the Qinghai-Tibet Plateau of China, it then crosses through Qinghai, Tibet, and Yunnan before leaving China and flowing through Myanmar, Laos, Cambodia, Thailand, and Vietnam. The length of the mainstream from the source to the mouth is 4,800 km, and the river drains a watershed area of 800,000 km^2 according to Chinese surveys[13]. The average annual flow is 475 billion m^3, and the multi-year average discharge is 15,060 m^3/s.

The key characteristics of water distribution in the Lancang-Mekong are as follows. First, the river is fed by rainfall, groundwater, and snow- and ice-melt water. Second, the runoff yield per area is greater in the downstream portion than in the upstream portion of the river, and greater on the left side than on the right. Third, upstream water levels rise annually in April and May at the beginning of the rainy season, while peak volumes in the middle and lower reaches of the Lancang and Lower Mekong occur somewhat later due to time lag effects of the southwestern monsoon. The delay between peak volumes in the upper reaches and the lower reaches ranges from one to two months.

4.3.1 Water Utilization Objectives in the Lancang-Mekong River

The major problem of water allocation in the Lancang-Mekong is the water uses and allocation during the dry season. Each riparian country has different water use objectives, as detailed below.

4.3.1.1 China

Irrigation needs are limited because the reach of Lancang-Mekong in China is mostly a gorge-type river with few arable fields. Hydropower potential on this stretch of the river is very abundant, and the advantages and conditions for cascade hydropower development are very good, because the development of hydropower is in-basin use and the flow will increase about 1,000 m^3/s in the dry season.

[13] The Mekong River Commission estimated the drainage area as 795,000 km^2 in its 1993 annual report.

The Tonlé Sap, Cambodia. Photo credit: Gene Molander.

4.3.1.2 Laos

Laos contributes the greatest runoff of all Lancang-Mekong riparian countries, approximately 35% of the total flow. In the dry season, some withdrawals are made for irrigating the Vientiane Plain. Because Laos is a landlocked country, it hopes to develop international navigation in Mekong River. In addition, Lao authorities aim to develop hydropower on the tributaries of the Mekong in order to promote domestic economic development, as well as establish an electrical energy trade with Thailand.

4.3.1.3 Cambodia

Cambodia is home to the Tonlé Sap, the largest freshwater lake in Southeast Asia, and the most important natural regulating feature of the Mekong River. Every year, the lake absorbs about 46 billion m^3 of floodwaters in the rainy season, which it then returns to the mainstream Mekong in the dry season. Agricultural production and ecological needs in this area depend heavily on flooding and silt deposition from upstream in order to maintain a sufficient flooded area for raising soil fertility and providing nutrients for aquaculture.

4.3.1.4 Thailand

Northeastern Thailand is the largest dry area needing irrigation in the Mekong basin. At present, only 6% of the total 8.5 million ha of arable land is irrigated. A diversion of 400–500 m^3/s of flow of the Mekong mainstream in the dry season would play a key role in regional agricultural development and poverty alleviation.

4.3.1.5 Vietnam

Water consumption in the Mekong Delta during the dry season represents the greatest single demand in the entire basin. This is especially true in Vietnam, where approximately 3,900,000 ha are used for agriculture and fisheries. At present only 500,000 ha of those fields are irrigated. In April and May of every year, the flow from upstream is about 2,000 m^3/s. Approximately 1,500 m^3/s is required for preventing saltwater intrusion, leaving 500 m^3/s for irrigation. This is far less, however, than the 1,600-2,000 m^3/s needed for dry-season irrigation. So, in order to develop abundantly the potential of land, to effectively prevent saltwater intrusion, dry-season flows would need to increase by some 2,000 m^3/s over natural flows.

In short, satisfying the irrigation needs of each riparian country, ensuring adequate flooding around the Tonlé Sap, and preventing saltwater intrusion would require increasing the discharge by about 3,000 m^3/s during the dry season.

4.3.2 Regional Cooperation

Institutional arrangements for basin-wide co-operation have existed in the Mekong region for more than a half century. In 1957, the Committee for Coordination of Investigations of the Lower Mekong Basin ("Mekong Committee") was established, with Laos, Cambodia, Thailand, and South Vietnam as the member states. In 1977, the governments of Laos, Thailand, and Vietnam sought to establish the Interim Committee for Coordination of investigations of the Lower Mekong Basin in light of regional political instability that prevented Cambodia from participating in the Committee. Finally, following Cambodia's request for readmission to the group in 1991, the four governments signed the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin (hereinafter referred to as the 1995 Agreement), which re-established the Committee as the Mekong River Commission (MRC), with Laos, Cambodia, Thailand, and Vietnam as the members.

The 1995 Agreement includes rules for water utilization, intra-basin diversions, and inter-basin diversions in Article 5 and Article 26. Article 6 stipulates maintenance of flows on the mainstream, given the river's vitally important role (especially in the dry season) in flood control, fisheries, navigation, irrigation, and control of saltwater intrusion. The challenge comes in implementing the 1995 Agreement, since China and Myanmar—the two upstream riparian countries—currently only participate in the MRC as dialogue partners, not as members, and have not signed the Agreement. Clearly, however, water utilization in the two countries will impact the effectiveness of the Agreement. Not surprisingly, then, hydropower development on the mainstream of the Lancang River in China has met with opposition in lower riparian states and international organizations. Opposition is primarily based on concerns that the upstream dams may

- decrease the lowest water levels in the dry season, thereby adversely affecting navigation
- impede sediment transportation from upstream to downstream, decreasing the nutrients available for fisheries, increasing downstream bank and bed erosion, and potentially changing the aquatic environment as far downstream as the Tonlé Sap
- impede fish migration, change aquatic habitat for flora and fauna, and may threaten biodiversity
- adversely affect livelihoods in downstream riparian communities that depend on the river system.

Dam proponents have countered that the storage capacity of the dams will provide for increased dry-season flows and reduce the threat of catastrophic flooding in the rainy season. They also argue that the dams are good for regional economic development due to their ability to produce large amounts of hydroelectric power, some of which is already being sold to downstream users.

4.3.3 Basin-Specific Arrangements

The Mekong River Commission is but one example of a regional institution whose aim, at least in part, is cooperative governance of shared water resources. As noted above, cooperative initiatives between the MRC and China include agreements on commercial navigation and the sharing of hydrological data. In order to strengthen cooperation among the riparian states and coordinate water development and utilization activities in the Mekong basin, several other types of cooperative action plans and institutions have been promoted over the past two decades.

4.3.3.1 Greater Mekong Sub-region Cooperation (GMS)

The GMS has been promoted by the Asian Development Bank (ADB) since 1992, when the Bank opened a GMS office. The sub-region encompasses Yunnan Province and Guangxi Autonomous Region of China, Laos, Myanmar, Cambodia, Thailand, and Vietnam, and aims to

Mekong River near near Kampot, Cambodia. Photo credit: Stephanie Garvey

promote cooperation in several areas; among them are transportation, energy, telecommunications, environment, tourism, human resource development, trade, and investment. The GMS framework is two-tiered: the upper tier involves annual ministerial sessions; the second tier involves summit sessions at head-of-department level, forums in various fields, and the work-group meetings, all of which report to the ministerial session.

4.3.3.2 ASEAN—Mekong Basin Development Cooperation (AMBDC)

The Association of South East Asian Nations (ASEAN) was established in 1967 with Indonesia, Malaysia, the Philippines, Singapore, and Thailand as the five original members. The first ministerial session of AMBDC was held in June 1996 in Malaysia by the core group of ASEAN states,[14] in cooperation with the riparian states along the Mekong River. According to the Framework Agreement passed in the meeting,[15] at least one regular ministerial session will be held every year. The agreement identifies eight fields for cooperation: infrastructure construction; investment and trade; agriculture; mineral resource development; industry and small-medium enterprise development; tourism; human resource development; and science and technology. Since then, and with the invitation to Japan and the Republic of Korea to join the cooperative institution, AMBDC has evolved to a regional cooperative arrangement of the 10 ASEAN states plus China, Japan, and Korea.

4.3.3.3 China-ASEAN Free Trade Area (CAFTA)

In November 2002, the Framework Agreement on Comprehensive Economic Cooperation between China and ASEAN was signed, thus initiating planning for CAFTA. The free trade area

[14] Current ASEAN member states are Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. In addition to these, China participated in the 1996 meeting.

[15] See http://www.aseansec.org/6353.htm.

Red River, China. Photo credit: He Daming.

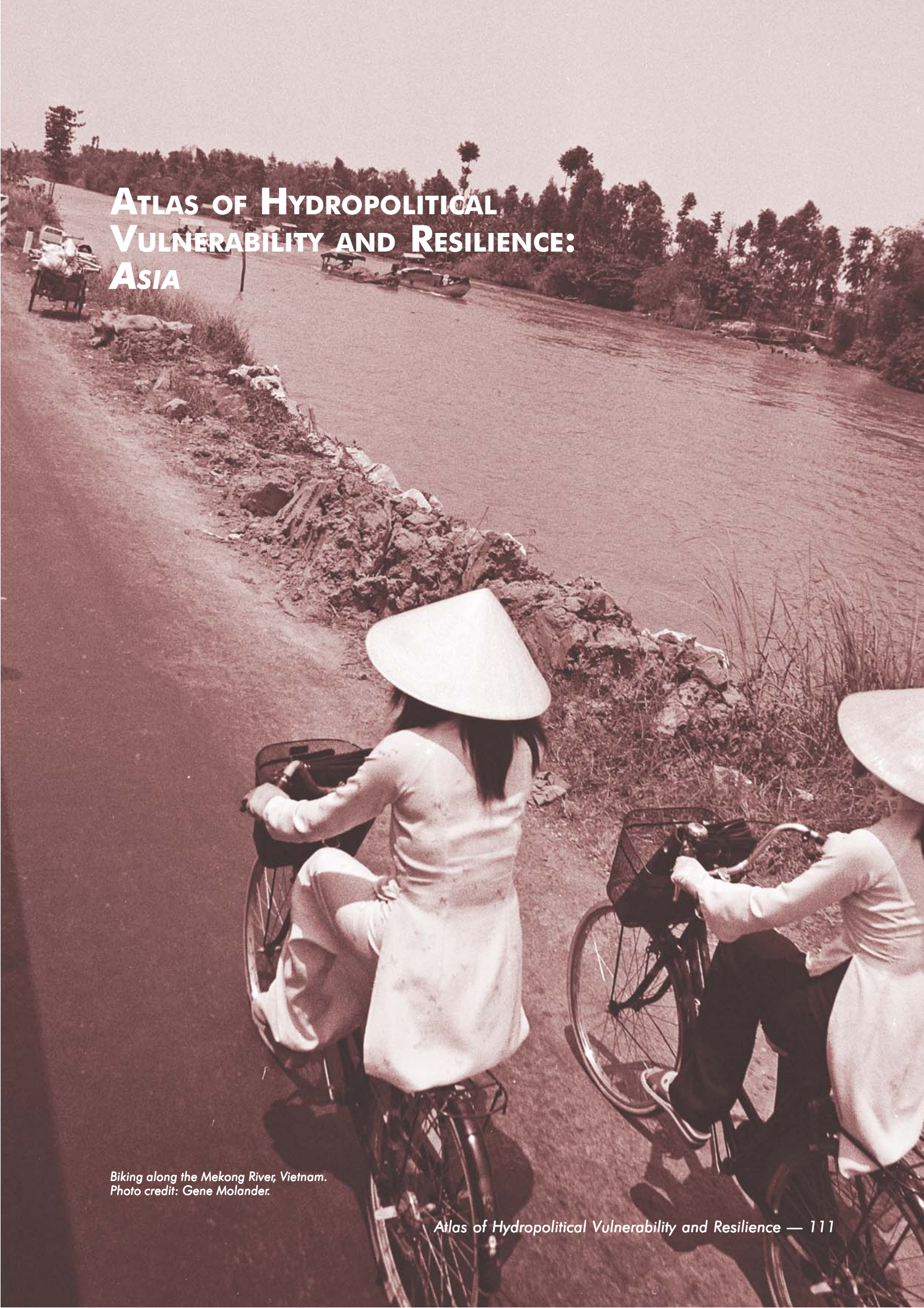
established by the agreement is expected to come into force from 2010 to 2015. Agreements areas such as trade in goods, dispute resolution, and trade in services have been completed. Because a significant portion of trade in goods will travel along the Mekong corridor (through both boat and truck traffic), the agreements will rely on and complement effective implementation of other cooperative management agreements in the region.

In summary, despite certain challenges, there are also many opportunities for basin-wide cooperation in the development of water and related resources in the Lancang-Mekong basin. International cooperation in various areas has gradually improved, likely because there is enough water to meet the objectives of each riparian country. The primary challenge lies in coordinating the objectives of the six riparian countries and regulating the spatial and temporal distribution of water resources throughout the region.

4.4 Conclusion

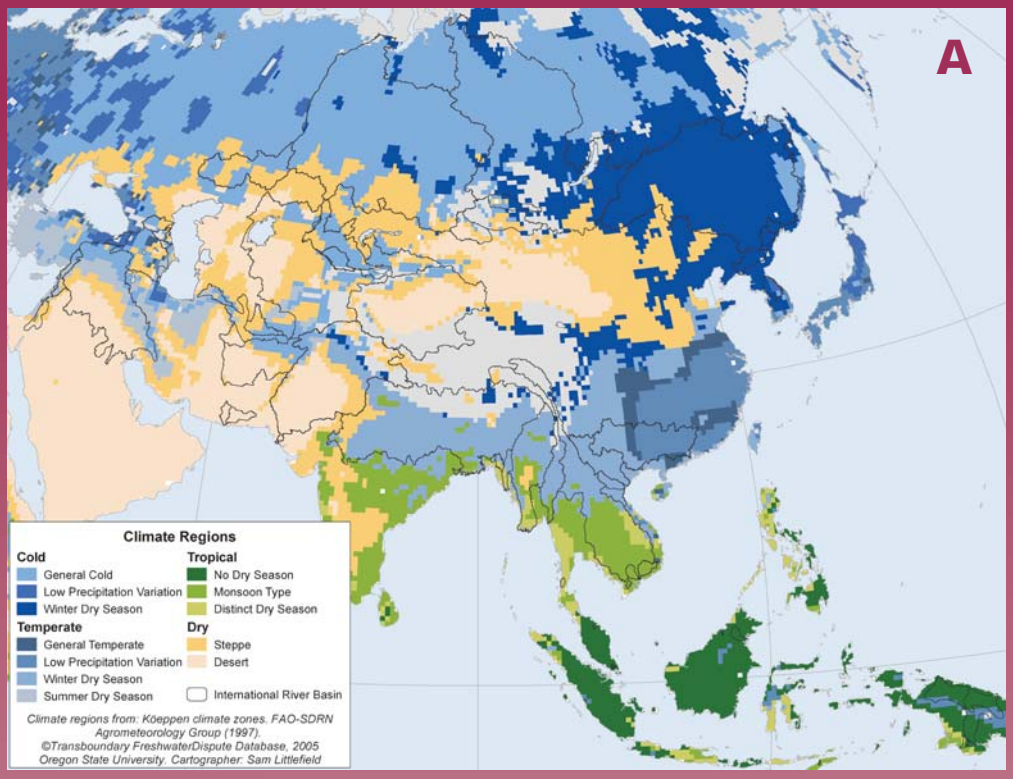
China is home to a large number of transboundary international rivers. As such, China's effective and meaningful participation in institutions governing those rivers is of vital importance to maintaining the integrity of aquatic environments, providing the best possible opportunities for socioeconomic development in their basins, and ensuring regional peace and stability through cooperative management of water resources. This chapter has summarized the overall situation of China's transboundary rivers, identified key water resources challenges in the various regions around the country, and outlined several ways in which China and its neighbours are attempting to address those challenges. Although China is a relative newcomer to inter-state institutions involved in water resources governance and management, there are promising trends in the depth and breadth of China's engagement in such institutions. At present, many of these arrangements involve technical cooperation on relatively depoliticized topics such as data sharing for flood forecasting and navigation. It is likely that with the ongoing success of such arrangements, China will increase its level of commitment to and participation in transboundary agreements and institutions for governing oft scarce, polluted, and threatened water resources, thereby reducing hydropolitical vulnerability for basin communities both within China and outside.

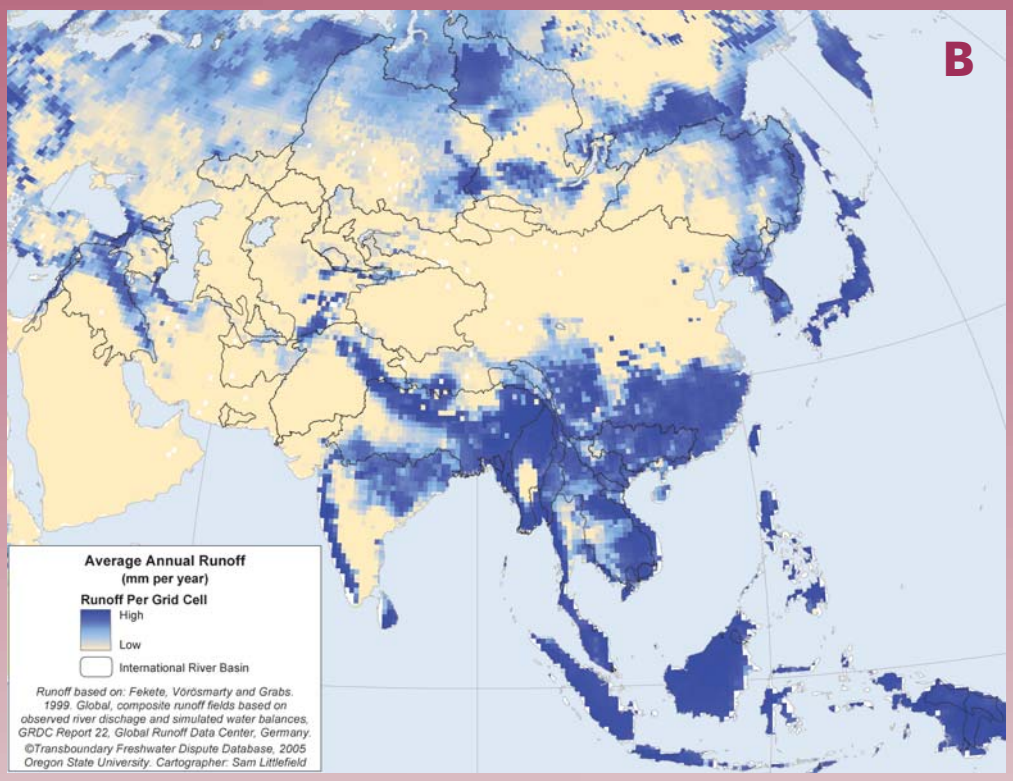
Atlas of Hydropolitical Vulnerability and Resilience: *Asia*



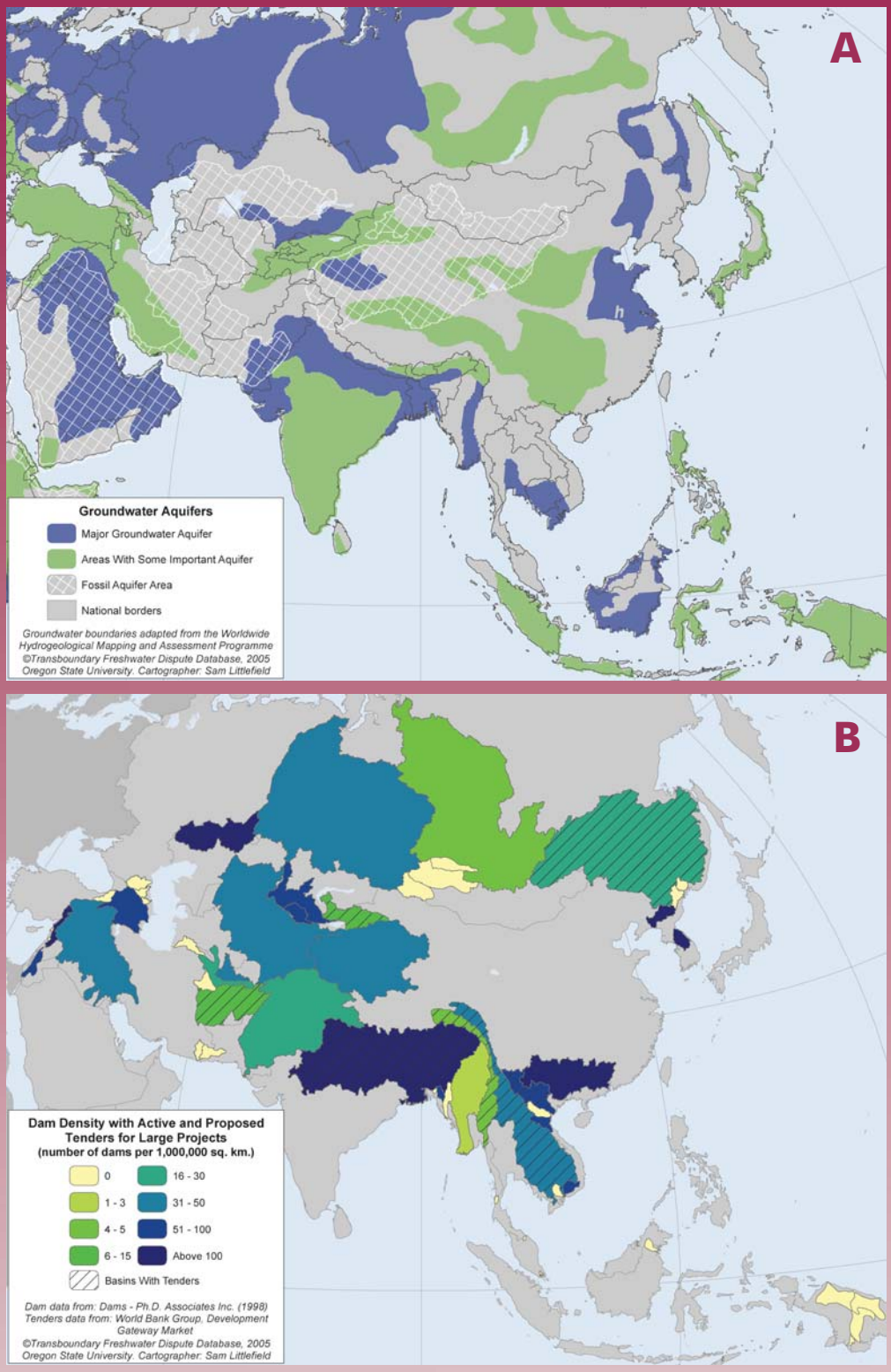
Biking along the Mekong River, Vietnam. Photo credit: Gene Molander.

Biophysical Parameters

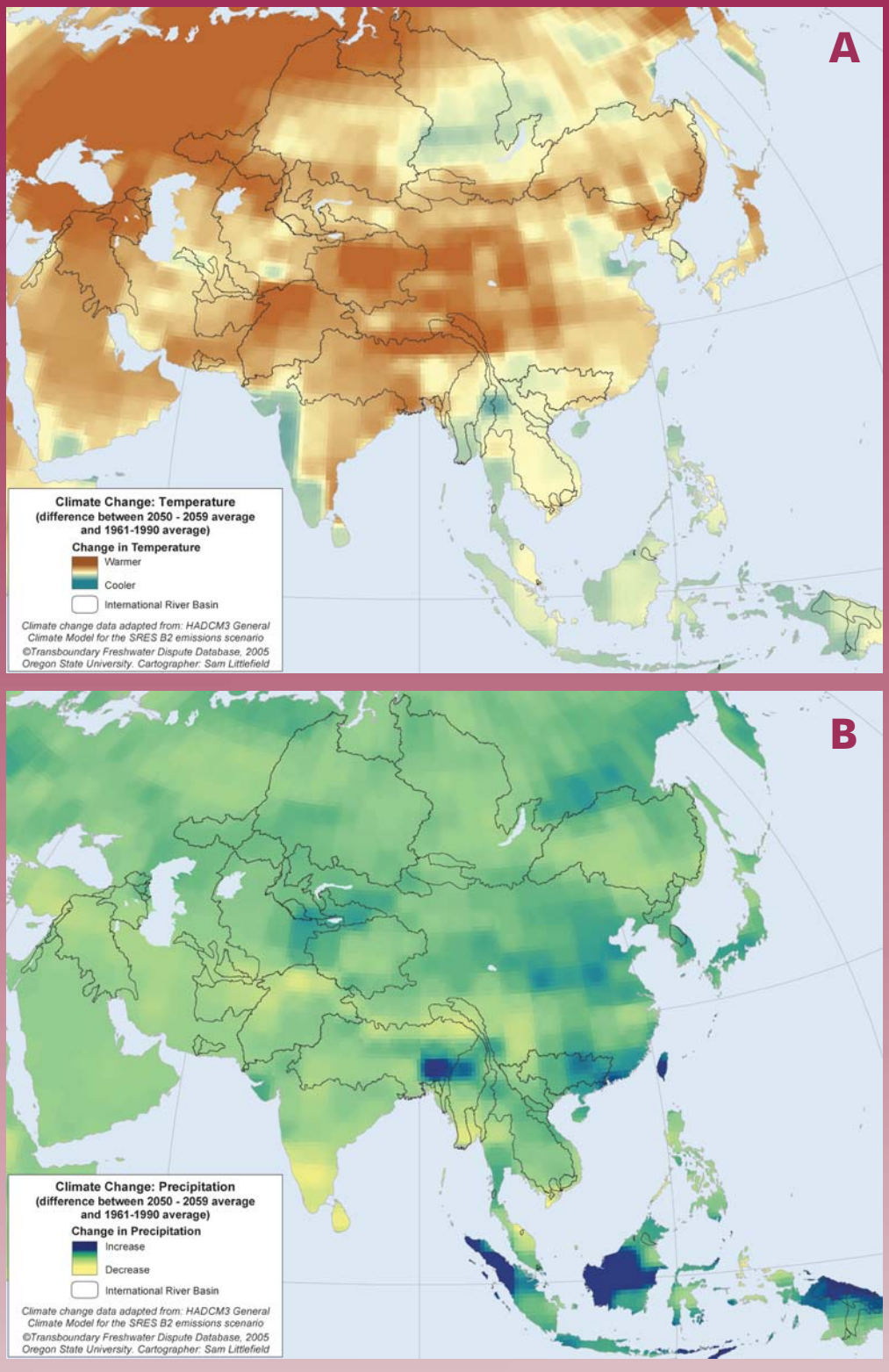




Map 1 (A) Climate Regions. *Köeppen climate zones based on a 0.5 decimal degree grid by Leemans and Cramer (1991) published by the International Institute for Applied Systems Analysis (IIASA). The Köeppen system integrates IIASA average monthly rainfall total and average monthly temperature, in most cases averaged from 1961–1990, to yield five base climate types: tropical, dry, temperate, cold, and polar. Each primary type is divided into sub-classes based mainly on the distribution of rainfall and temperature throughout the year. Not all classes may be represented at the continental level.* ***(B) Average Annual Runoff.*** *Fekete et al. (1999) produced composite runoff fields by accessing GRDC discharge data, selecting significant global gauging stations, and geo-registering the discharge information to locations on a simulated topological network. This dataset was deemed accurate for presentation with a 0.5 decimal degree grid. Summary statistics based on the runoff dataset, such as those used for projected water stress (human indicators), may not be considered accurate for basins with an area less than approximately 25,000 km^2.*

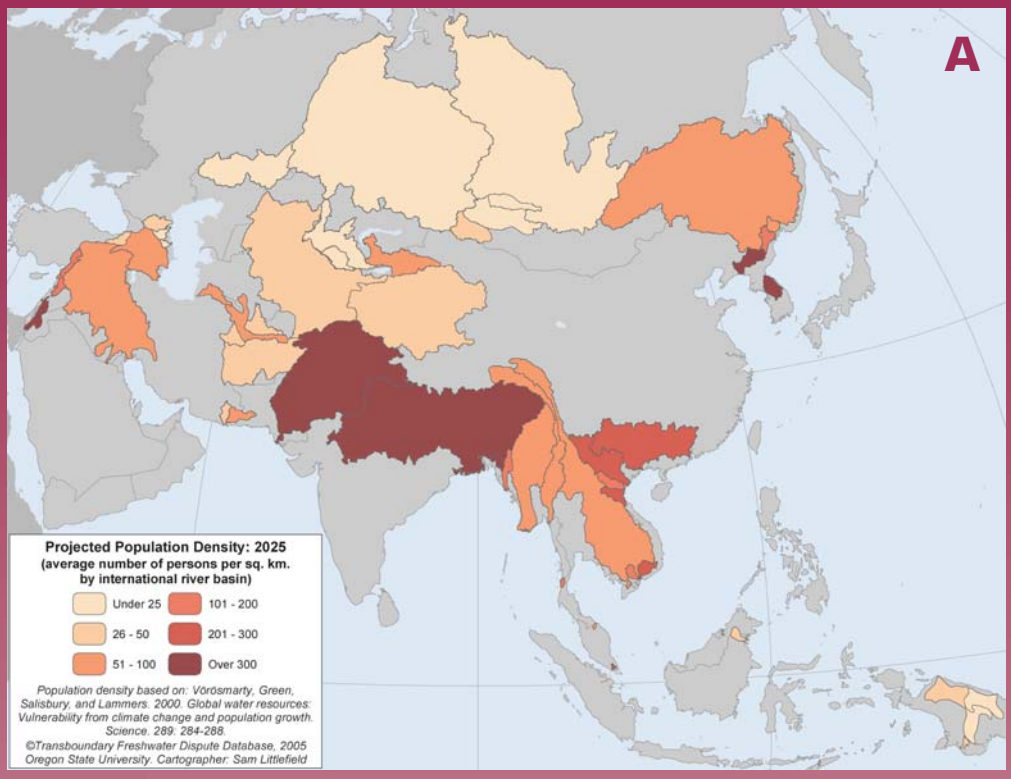


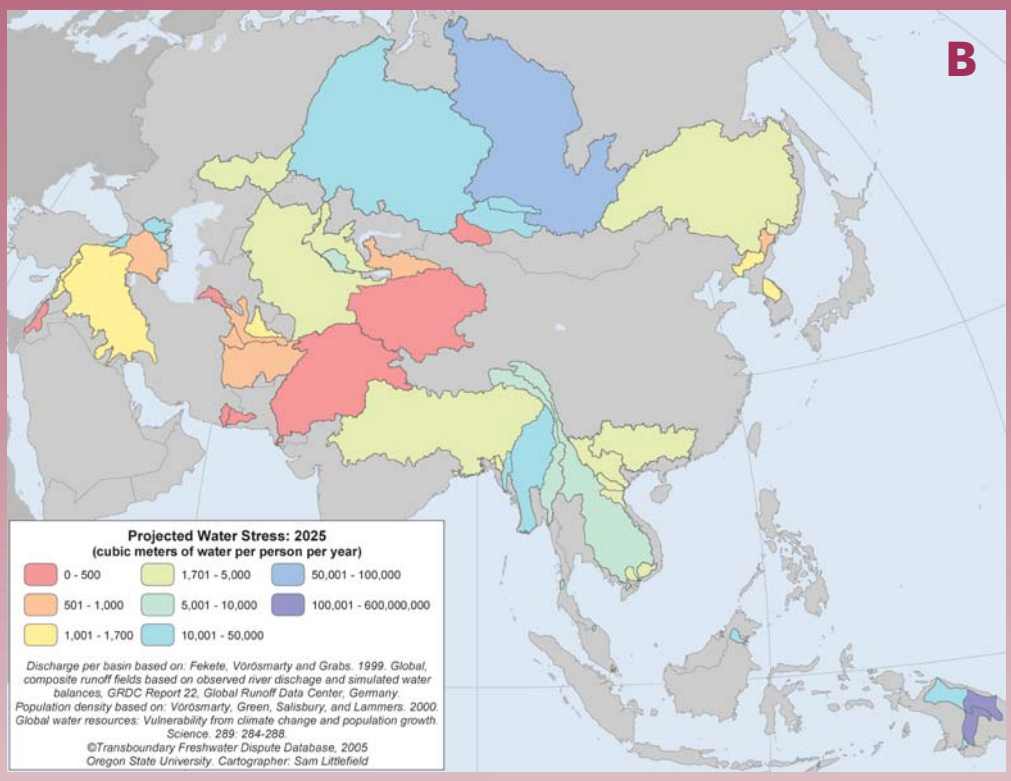
Map 2 (A) Groundwater Aquifers. *Adapted from a map developed by the World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP), August 2004. The most important groundwater basins are shown in blue. The green color symbolizes hydrogeological environments of complex structure. Unmarked regions are occupied by local and shallow aquifers in which relatively dense bedrock is exposed to the surface. Hatching has been applied in areas where "fossil" or non-renewable groundwater is stored. The boundaries of the various colored hydro-geologic regions are first order approximations using the best available information.* ***(B) Dam Density with Active and Proposed Tenders for Large Infrastructure.*** *Global Dams Data from: Ph.D. Associates Inc. 1998. DCW in ASCII version 3.0. 1998; Density Calculations from Fiske and Yoffee, 2001. Data on tenders is taken from the International Rivers Network "Dams In The Pipeline of Financial Institutions" database, which includes new projects in the lending pipeline from the World Bank, the Asian Development Bank, the African Development Bank and the Inter-American Development Bank, as well as links to ongoing and completed projects on the individual websites.*



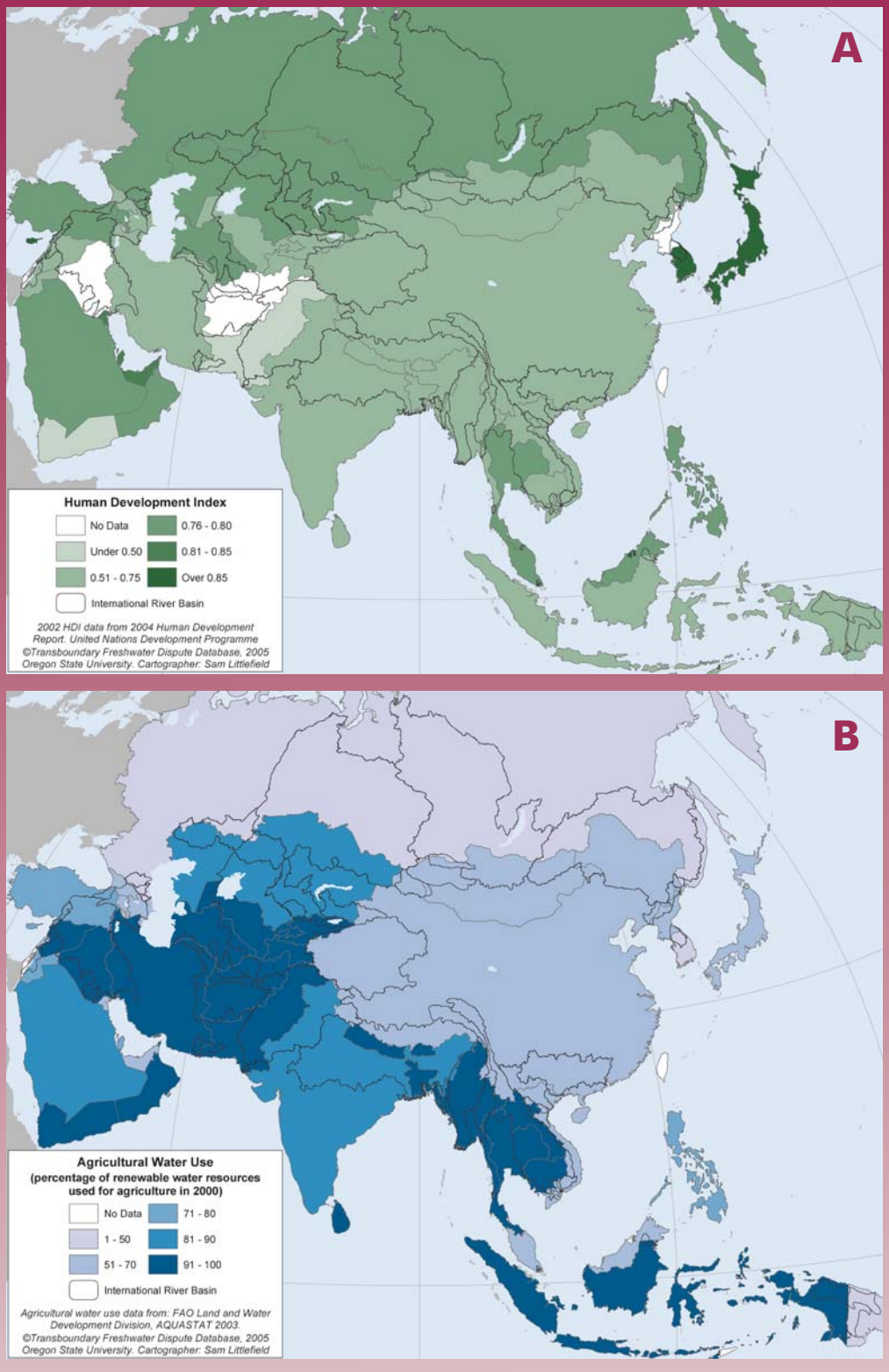
Map 3 (A) Climate Change, Temperature. (B) Climate Change, Precipitation. *Based on HADCM3 general climate model using the SRES B2 (moderate emissions, climate change, and technological advancement) emissions scenario. HADCM3 is distributed as 2.5 x 3.5 decimal degree data, which could not be properly projected in a GIS without square grid cells. Cell values were distributed to points at 2.5 x 3.5 decimal degree cell centroids, which were interpolated, using the inverse distance weighted method, at a resolution of 0.5 decimal degrees. The interpolated data used here should not be taken to exactly represent HADCM3 projections, but do provide a reasonable cartographic representation of current HADCM3 climate change predictions.*

Socioeconomic and Geopolitical Parameters



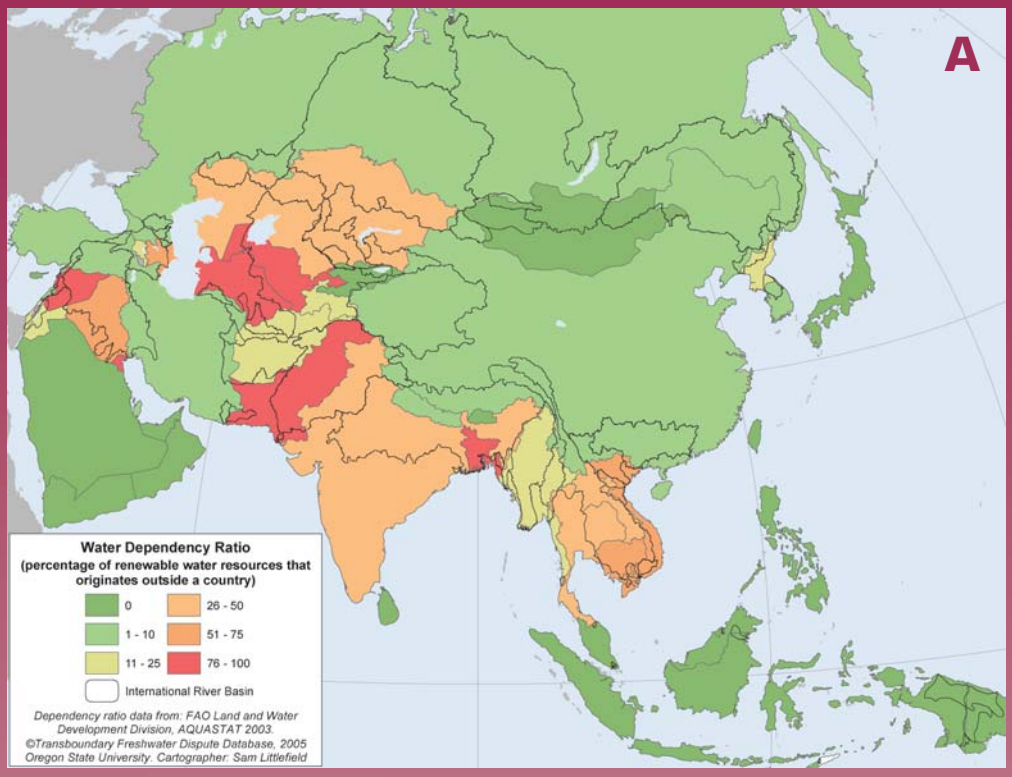


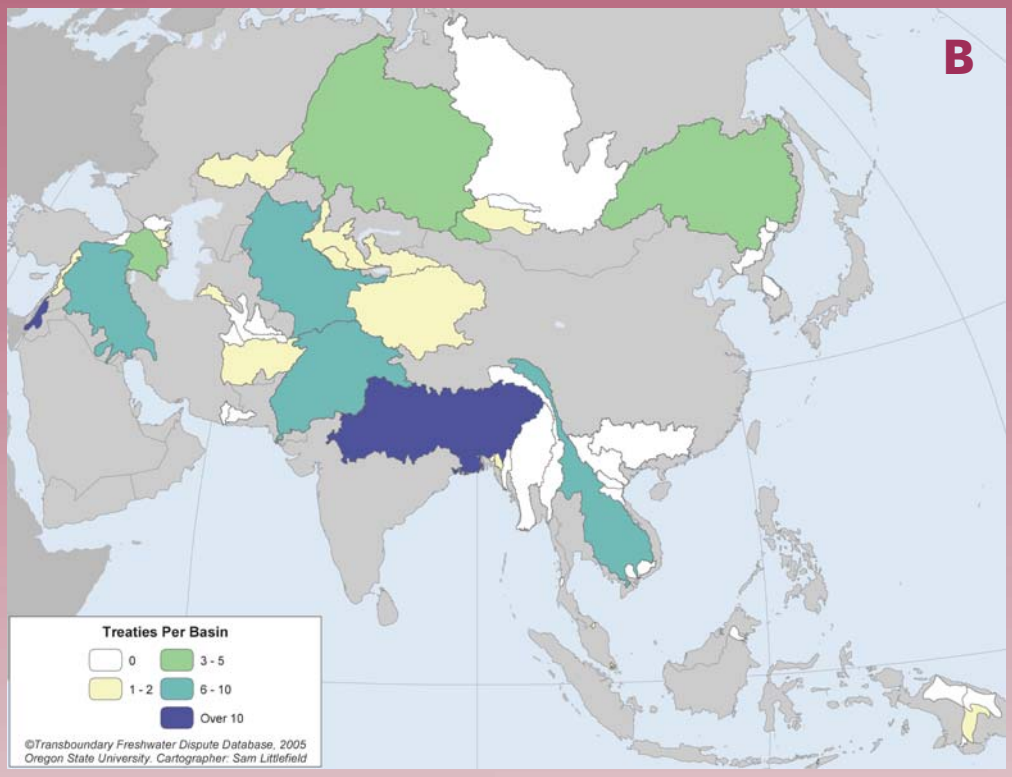
Map 4 (A) Projected Population Density: 2025. *The 2025 population dataset is published at a cell size of 0.5 decimal degrees (DD), which places a size constraint for small basin analysis. The raster was resampled at 0.01 DD to overcome the deficiency. This disregards some of the assumptions of the original 0.5 DD cell size, but affords a tentative estimate of predicted population in small basins. Because small basins maintain less area, there is less area to smooth out data errors. Therefore, some basins, especially those with a relatively small area (less than 25,000 km^2), may have projected populations significantly lower or higher than they should be.* ***(B) Projected Water Stress: 2025.*** *Water stress is the amount of water available per capita. Water stress estimates do not account for spatial variability of water resources, nor for technological or other adaptations affecting how a given population manages water scarcity. The map's calculation of water stress is based on renewable water supply defined by discharge, and does not consider groundwater extraction. Falkenmark's (1989) definition of water stress, calculates water supply based on renewable surface and groundwater flows. According to Falkenmark, a threshold value of 1000 cubic meters per person per year indicates a general point at which water shortages begin to chronically hamper economic development and human health and well-being in moderately developed nations.*



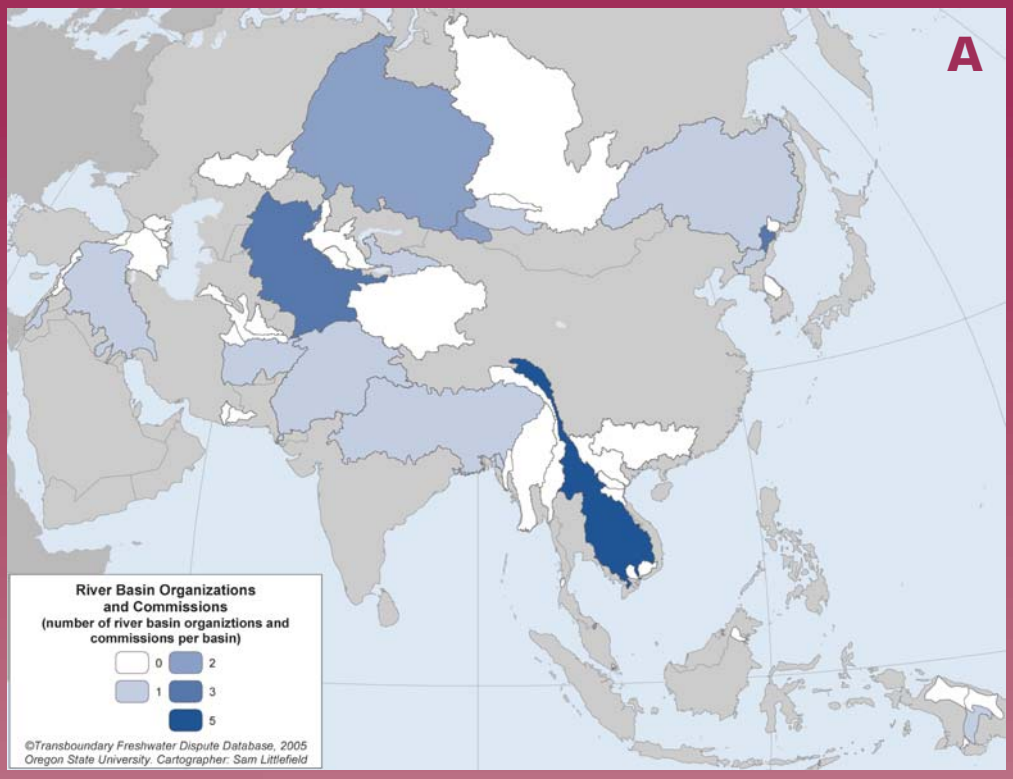
Map 5 (A) Human Development Index. *The human development index (HDI) is a composite index that measures the average achievements in a country in three basic dimensions of human development: a long and healthy life, as measured by life expectancy at birth; knowledge, as measured by the adult literacy rate and the combined gross enrolment ratio for primary, secondary and tertiary schools; and a decent standard of living, as measured by GDP per capita in purchasing power parity (PPP) US dollars. The formula to calculate the HDI, as well as specific data on the indicators, can be found at http://hdr.undp.org/reports/global/2004/.* ***(B) Agricultural Water Use.*** *Agricultural water use is based on a model of irrigation water requirements developed for AQUASTAT by the FAO Land and Water Development and incorporates crop, reference, and actual evapotranspiration, crop coefficient, area under irrigation as percentage of the total area under analysis, and cropping intensity. Renewable water resources available for agricultural use are defined as the sum of internal renewable water resources and incoming flow originating outside the country, taking into consideration the quantity of flows reserved to upstream and downstream countries through formal or informal agreements or treaties.*

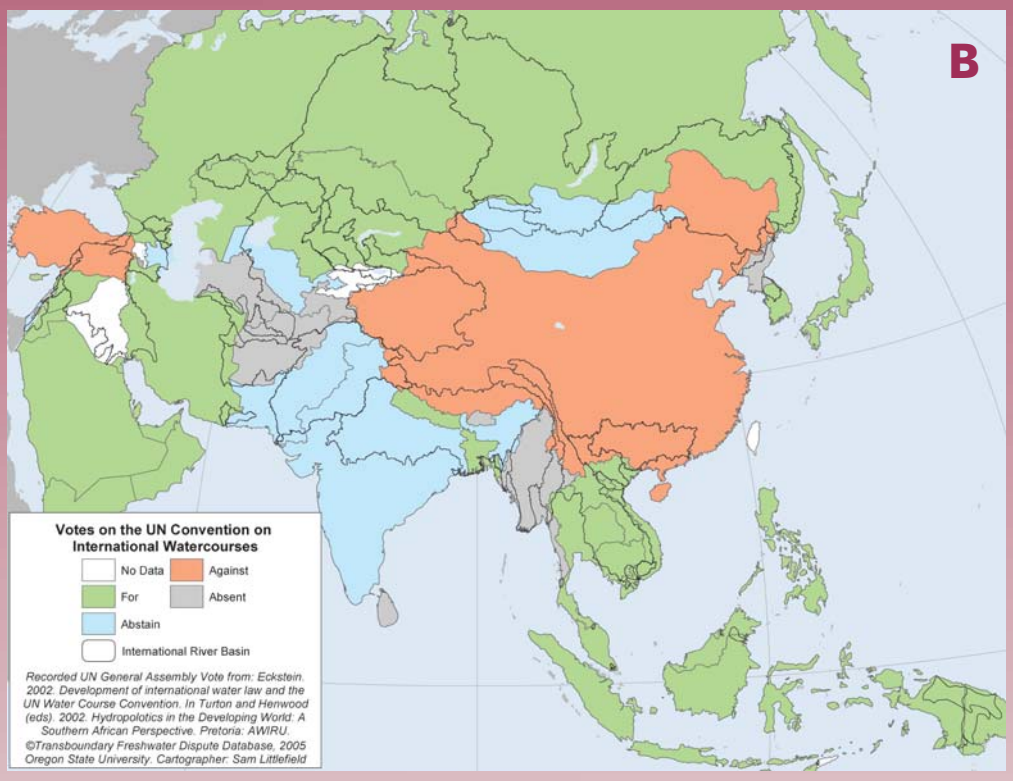
Institutional Capacity



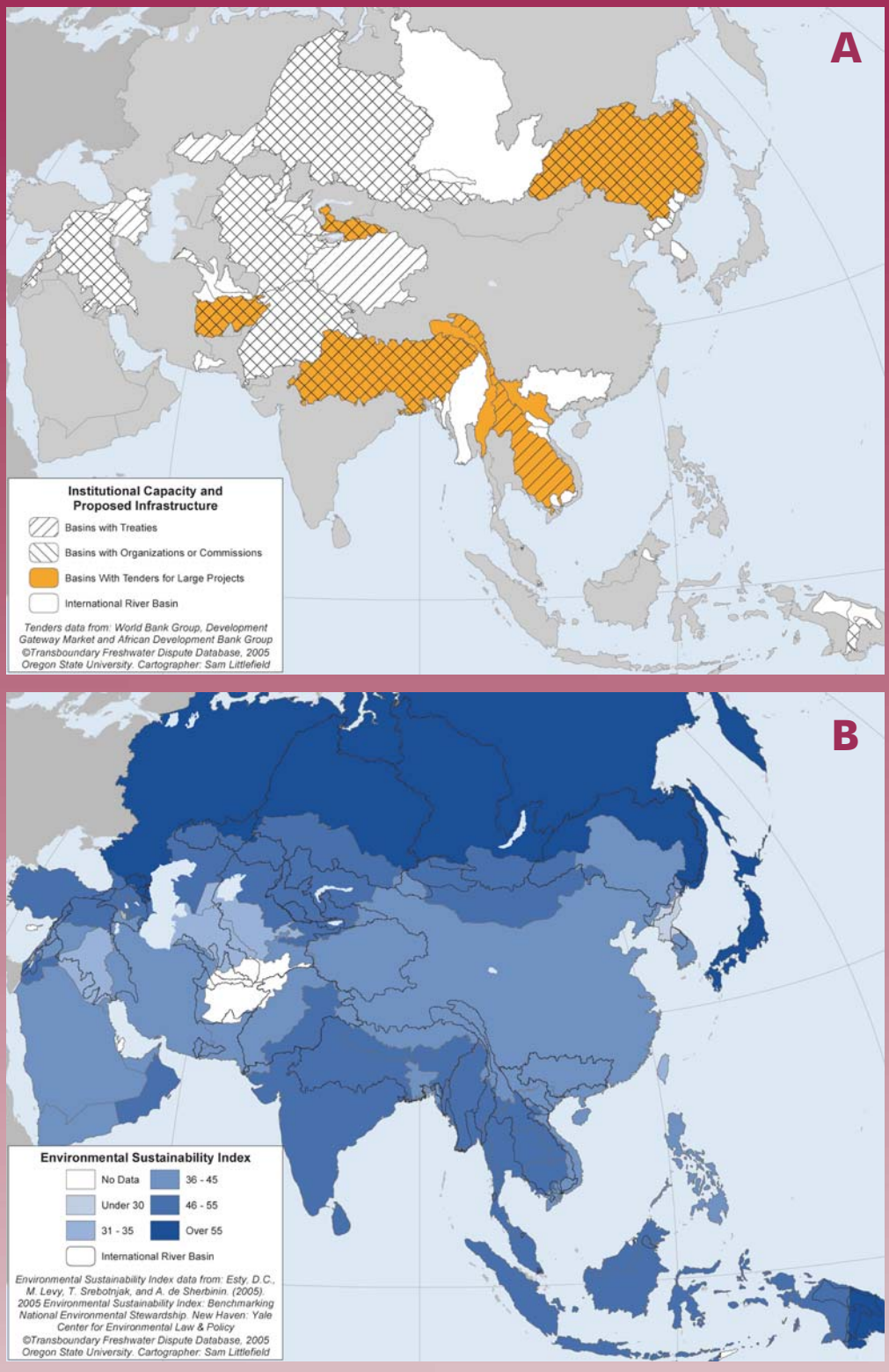


Map 6 (A) Water Dependency Ratio. *Water dependency ratio is calculated for AQUASTAT by the FAO Land and Water Development Division. It incorporates total country inflow and outflow of surface water and groundwater after accounting for flow submitted to and reserved by bilateral and multilateral treaties.* ***(B) International Freshwater Treaties Per Basin.*** *Number of treaties per basin is the sum of all agreements (historical, present, general) which have been signed by States governing water resources in the basin, either with one another or as part of a regional agreement, where the concern is water as a scarce or consumable resource, a quantity to be managed, or an ecosystem to be improved or maintained. Documents concerning navigation rights and tariffs, division of fishing rights, and delineation of rivers as borders or other territorial concerns are not included, unless freshwater as a resource is also mentioned in the document, or physical changes are being made that may impact the hydrology of the river system (e.g., dredging of river bed to improve navigation, straightening of a river's course.*

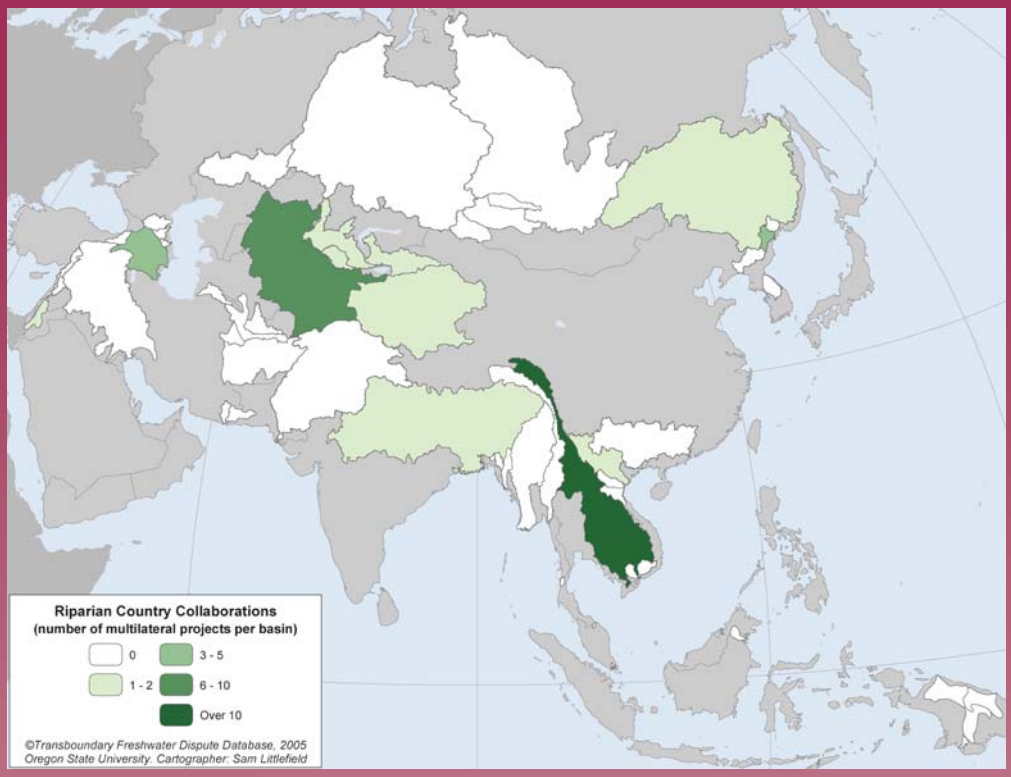




Map 7 (A) River Basin Organizations and Commissions. *Data for map was collected over a six month period from July to December 2004, drawing from: a compilation by Johannes Akiwumi at UNEP's Division of Environmental Information and Assessment (Nairobi); and internet searches and email interviews with international waters practitioners and scholars. (See SECTION 4 Tables for sources). We define an RBO/RBC as "a bilateral or multilateral body composed of representatives of national governments acting in an official capacity, created for the purpose of dialogue and/or coordinated management of an international water body." Presence of an RBO/RBC in an international river basin does not imply that all riparian countries are parties to the institution. Zero values do not necessarily reflect an absence of an RBO/RBC.* ***(B) Votes on the UN Convention on International Watercourses.*** *Vote records presented are based on data from the original convention voting period, which was open from May 1997 until May 2000. However, though the convention closed in 2000, member states may choose to become party to the convention at any time.*



Map 8 (A) Institutional Capacity and Proposed Infrastructure. *Treaties and River Basin Organizations and Commissions may serve to increase the hydropolitical resilience of a basin. This may be particularly important in basins with tenders for large projects, which can alter river functions and displace local inhabitants.* ***(B) Environmental Sustainability Index.*** *The 2005 Environmental Sustainability Index (ESI) measures the ability of a country to protect the environment over the next several decades. The ESI is an equally weighted average of 21 indicators, grouped into categories such as environmental systems, reducers of environmental stresses, reducers of human vulnerability, societal and institutional capacity and global stewardship. These data are combined from 76 separate data sets of natural resource endowments, pollution levels, environmental management efforts, etc. The ESI is useful for comparative analysis in identifying leading countries in environmental sustainability. The full ESI report is available at http://www.yale.edu/esi.*



Map 9 Riparian Country Collaborations. *Riparian Country Collaborations are defined as projects, programs, or partnerships with a river basin as a geographic focus, involving organizations or representatives (acting in an official or non-official capacity) from two or more countries that share the international water body. Data for the map was collected from internet searches, and compiled over a five-month period from July to December 2004. Due to the short time period in which the study took place, the number of projects represented on the map may not accurately reflect the number of collaborations actually occurring. Detailed information about each riparian country collaboration (including participating countries; principal issue area; level of collaboration; dates of collaboration; and source from which the information was gathered) is compiled in Appendix 2.*

Appendices

Men in fishing boat, marshlands of the Shatt al-Arab, Iraq.
Photo credit: Peter Reiss, DAI, courtesy of USAID.

Appendix 1. International Freshwater Agreements, River Basin Organizations, and River Basin Commissions of Asia

The treaties contained in this document were compiled as part of the Transboundary Freshwater Dispute Database (TFDD) project at Oregon State University in collaboration with the Food and Agriculture Organization (FAO) of the United Nations. The documents included are treaties or other international agreements relating to international freshwater resources, where the concern is water as a scarce or consumable resource, a quantity to be managed, or an ecosystem to be improved or maintained. Treaties concerning navigation rights and tariffs, division of fishing rights, and delineation of rivers as borders or other territorial concerns are not included, unless freshwater as a resource is also mentioned in the document, or physical changes are being made to the river system that might impact the hydrology of the river system (e.g., dredging of river bed to improve navigation, straightening of river course).

For ease of reference, the treaties are first categorized by continent, and then by international basin, as delineated in the TFDD Geographical Information System. The treaties listed under each international basin either refer directly to that international basin, or a sub-basin thereof. In cases of multiple spellings or names for the same river system of an international basin, a " / " separates the names (e.g., Asi/Orontes). Where the basin represents the confluence of a set of major rivers, a " - " is used to separate the names of the different river systems (e.g., Ganges-Brahmaputra-Meghna).

It is important to note that the following database of treaties is, by its very nature, a work in constant progress, and makes no claims to completeness. Those interested in updates should follow progress on the relevant sites, such as the Transboundary Freshwater Dispute Database Project (http://www.transboundarywaters.orst.edu/).

The area of each basin and its riparian countries' territorial share was calculated using a GIS at 1km spatial resolution (Wolf et al. 1999). We recognize the limitations of the data sources and process by reporting the size of basins, not as raw data as is common with digital data, but by rounding the last significant figure in basins 1–99 km^2 and the last two significant figures in basins 100 km^2 or larger. As a result of rounding the area values, the numbers for areas within each basin do not necessarily add up to the total area for that basin. The percentage areas were calculated based on raw data, and therefore do not reflect the rounding of the areas. An asterisk (*) following a TFDD basin's name indicates notes in Appendix 2 regarding caveats associated with the derivation of the area values. The following is a description of the terms used in the appendices.

Description of Terms

Commission—A bilateral or multilateral body, composed of officials appointed by national governments to participate in dialogue, discourse, and negotiations regarding the international water body for which it was created.

Date—The date usually indicates the date on which a treaty document was signed or a river basin commission was instituted. If such information was unavailable, the next choice was the date of entry into force, followed by the date of ratification. For agreements consisting of a series of letters or notes written on different dates, the latest date was used. Dates are represented in a month/day/year format.

Economic program—A bilateral or multilateral economic development project or program which aims to improve investment/trade/economic activities among countries sharing an international water body.

Environmental program—A bilateral or multilateral project or program which aims to improve/protect/conserve the quality and habitat of aquatic systems associated with an international water body.

International initiative—A bilateral or multilateral body, composed of non-official actors who serve a Track 2 function, bringing stakeholders together to dialogue and strategize about transboundary water issues. International initiatives involve stakeholders from multiple countries who are mainly functioning to enhance dialogue and improve stakeholder participation, but do not necessarily implement their own projects, as they do not have funding to do so.

Level of collaboration—Indication of level of international water collaboration form: official or non-official. Official collaboration is acknowledged by the national government while non-official collaboration has no governmental involvement.

Organization—A bilateral or multilateral body, composed of officials acting on behalf of their government (ministerial, technical or other) to conduct coordinated and/or informed management of the international water body. An organization differs from a commission in that it involves the implementation of bilateral or multilateral programs (information sharing, joint management, etc.).

Participating countries—The countries that are party to the international water collaboration form.

Principal issue—Issue area that international water collaboration form focuses on more than on other issues.

Riparian country collaborations—Projects, programs, or partnerships *with a river basin as a geographic focus*, involving organizations or representatives (acting in an official or non-official capacity) from two or more countries that share the international water body.

Signatories—Signatories to the agreement. The formal country names as delineated in the actual treaty are used if that information is readily apparent; otherwise, common country names are listed instead.

Social / health program—A bilateral or multilateral social and/or health project or program which aims to improve the social and/or health conditions of the people living in an international water body.

Treaty basin—Identifies the basin or sub-basins specifically mentioned in the document. If a document applies to all basins shared between the signatories, but no river or basin is mentioned specifically, the treaty basin is listed as "frontier or shared waters." For frontier or shared waters, a treaty is listed under all the TFDD basins shared between those signatories. A document may therefore appear listed under multiple basins.

Treaty or agreement—The full formal name of the document or best approximation thereof. The place of signature is often included as part of the agreement name. Agreement titles, regardless of the language of the source document, are listed in English. Not all titles are official.

Type of international water collaboration—Form of international water collaborations.

Amur

Total area: 2,085,900 km²

Countries	Area of Basin in Country km²	%
Russia	1,006,100	48.23
China	889,100	42.62
Mongolia	190,600	9.14
Korea, Democratic People's Republic of (North)	100	0.01

Sirwan/Diyala River, Kurdistan, Iran. Photo credit: Babak Sedighi

Treaties and Agreements

Agreement between the government of Mongolia and the government of the Russian Federation on the protection and use of transboundary waters

Treaty basin: Amur, Jenissei, Lake Baikal, Onon, Selenga, Har Us Nur, Lake Ubsa-Nur, Pu-Lun-T'o

Signatories: Mongolia; Russian Federation *Date:* February 11, 1995

Agreement between the government of the People's Republic of China and the government of Mongolia on the protection and utilization of transboundary waters

Treaty basin: Amur, Har Us Nur, Ob, Pu Lun T'o *Date:* April 29, 1994

Signatories: China, Mongolia

Agreement Between the Union of Soviet Socialist Republics and the People's Republic of China on Joint Research Operations to Determine the Natural Resources of the Amur River Basin and the Prospects for Development of its Productive Potentialities and on Planning and Survey Operations to Prepare a Scheme for the Multi-Purpose Exploitation of the Argun River and the Upper Amur River

Treaty basin: Amur *Date:* August 18, 1956

Signatories: China, Union of Soviet Socialist Republics

River Basin Organizations and Commissions

Amur River Coordination Committee

Treaty basin: Amur *Date:* 2004

Signatories: China, Mongolia, Russia

Source: http://www.panda.org/about_wwf/where_we_work/asia_pacific/news/successes/index.cfm?uNewsID=16173

The Joint Committee of Protection and Using the Transboundary Waters of China and Mongolia

In accordance with the agreement between China and Mongolia on "Using and Protecting the Transboundary Waters" (1994).

Treaty basin: Amur, Har Us Nur, Ob, Pu Lun T'o *Date:* 1998

Signatories: China, Mongolia

Source: http://www.ecdc.net.cn/newindex/chinese/page/tumen/tumen_jishi/01/3.htm [in Chinese]

An Nahr Al Kabir

Total area: 1,300 km²

Countries	Area of Basin in Country km²	%
Syria	900	67.60
Lebanon	400	31.70

Treaties and Agreements

An agreement between the Syrian Arab Republic and the Lebanese Republic for the sharing of the Great Southern River Basin water and building of joint dam on the maincourse of the river

Treaty basin: An Nahr Al Kabir *Date:* April 20, 2002

Signatories: Lebanon, Syria

Aral Sea*

Total area: 1,231,400 km²

Countries	Area of Basin in Country km²	%
Kazakhstan	424,400	34.46
Uzbekistan	382,600	31.07
Tajikistan	135,700	11.02
Kyrgyzstan	111,700	9.07
Afghanistan	104,900	8.52
Turkmenistan	70,000	5.68
China	1,900	0.15
Pakistan	200	0.01

Treaties and Agreements

Agreement between the Government of the People's Republic of China and the Government of the Republic of Kazakhstan on the Cooperation on Using and Protecting the Transboundary Rivers. The agreement aimed at facilitating cooperation on trans-boundary water management.

Treaty basin: Aral Sea, Ili/Kunes He, Ob, Pu Lun T'o *Date:* 2001

Signatories: Chinathe Republic of Kazakhstan

Protocol on inserting amendments and addenda in the agreement between the governments of the Republic of Kazakhstan, the Kyrgyz Republic, and the Republic of Uzbekistan on the use of water and energy resources of the Syr Darya Basin

Treaty basin: Syr Darya *Date:* May 07, 1999

Signatories: Kazakhstan; Kyrgz Republic; Tajikistan; Uzbekistan

Agreement between the government of the Republic of Kazakhstan, the government of the Kyrgyz Republic and the government of the Republic of Uzbekistan on cooperation in the area of environment and rational nature use

Treaty basin: Not specified *Date:* March 17, 1998

Signatories: Kazakhstan; Kyrgz Republic; Uzbekistan

Agreement between the governments of the Republic of Kazakhstan, the Kyrgyz Republic, and the Republic of Uzbekistan on joint and complex use water and energy resources of the Naryn Syr Darya cascade reservoirs

Treaty basin: Syr Darya *Date:* March 17, 1998

Signatories: Kazakhstan; Kyrgz Republic; Uzbekistan

Agreement between the government of the Republic of Kazakhstan, the government of the Kyrgyz Republic and the government of the Republic of Uzbekistan on the use of water and energy resources of the Sry Darya Basin

Treaty basin: Syr Darya *Date:* March 17, 1998

Signatories: Kazakhstan; Kyrgz Republic; Uzbekistan

Resolution of the heads of states of Central Asia on work of the EC of ICAS on implementation of action plan on improvement of ecological situation in the Aral Sea Basin for the 3-5 years to come with consideration for social and economic development of the region

Treaty basin: Aral Sea, Syr Darya, Amu Darya *Date:* March 3, 1995
Signatories: Kazakhstan; Kyrgz Republic; Tajikistan; Turkmenistan; Uzbekistan

Agreement on joint activities in addressing the Aral Sea and the zone around the Sea crisis, improving the environment, and ensuring the social and economic development of the Aral Sea region

Treaty basin: Aral Sea, Syr Darya, Amu Darya Date: March 26, 1993
Signatories: Kazakhstan; Kyrgyzstan; Tajikstan; Turkmenistan; Uzbekistan

Agreement on cooperation in the field of joint water resources management and conservation

Treaty basin: Aral Sea *Date:* February 18, 1992
Signatories: Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan

River Basin Organizations and Commissions

The Joint Committee of Protection and Using the Transboundary Rivers

Treaty basin: Aral Sea, Ili/Kunes He, Ob, Pu Lun T'o *Date:* 2001
Signatories: China, Kazakhstan

Interstate Coordination Water Commission (ICWC)

On February 18, 1992 the five Ministers of Water Resources of Central Asian states signed an "Agreement on cooperation in joint management, use and protection of interstate sources of water resources" and this agreement founded the ICWC. Executive bodies of ICWC are River Basin Authorities (BWOs) SyrDarya and AmuDarya. BWOs are in charge of planning and managing water flow schedules and water resources distribution, as well as direct implementation of the decisions made by ICWC relevant to water allocation, schedules of water flow and releases, water quality control.

Treaty basin: Aral Sea *Date:* February 18, 1995
Signatories: Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan
Source: http://www.icwc-aral.uz/index.htm

International Fund for saving the Aral Sea (IFAS)

An interstate organisation established in order to fund and credit joint regional environmental and research programmes and projects aimed at saving the Aral Sea and improving the environmental situation in the areas affected by the disaster as well as solving regional socio-economic problems. Primary goals include: stabilising and improving the environment of the Aral Sea Basin, rehabilitating the disaster zones, improving water resource management, and increasing the capacity of local and state institutions for planning and implementing programs.

Treaty basin: Aral Sea *Date:* 1994
Signatories: Kazakstan, the Kyrgyz Republic, the Republic of Tajikstan, Turkmenistan, and the Republic of Uzbekistan
Source: http://www.thewaterpage.com/aral.htm

Joint Water Committee (JWC)

Treaty basin: Aral Sea *Date:* 1994
Signatories: Israel, Jordan

A committee to jointly manage water resources of the West Bank for the purposes of monitoring, planning, study, information sharing, and dispute resolution. The Joint Water Committee is to manage mutual water resources, operate jointly established monitoring stations to monitor the quality of water along their boundary, and to develop plans to supply Jordan with an additional 50 mcm/yr. of drinking water.38 Article 6 of the Jordan Israel Peace Treaty provides for mutual assistance in the alleviation of water shortages. The JWC served as an institutional mechanism for the interim period, mainly to oversee the implementation of Article 40 (of the agreement deals with water allocation but refers to the immediate needs of the Palestinians without considering the principle of equitable and reasonable utilization of the water resources by both sides).

Source: http://www.wws.princeton.edu/~wws401c/aliya.pdf http://law.gonzaga.edu/borders/water.htm

Asi/Orontes

Total area: 37,900 km²

Countries	Area of Basin in Country km²	%
Turkey	18,900	49.94
Syria	16,800	44.32
Lebanon	2,200	5.74

Treaties and Agreements

The basins of Alyamouna, Marjahein, Jibab Alhumur and Arghash are to be considered closed and the exploitation of these basins shall be in the quantity of the annual renewable water resources for each basin. Concerning the basin of Allabwa, Lebanon may derive benefit and utilize water resources of Allabwa during the irrigation period, which extends from the end of April to the middle of October. Furthermore, the Lebanese villages (Allabwa, Amhaz, Attawfiqeyya, Al-Ayn, Annaby Othman, Saboogha, Alkhareeba, Halabta and Jaboola) may derive benefit and utilize these waters as drinking water

Treaty basin: Al-Asi River — *Date:* December 12, 2002
Signatories: Lebanon, Syria

Joint communiqué between Republic of Turkey Prime Ministry Southeastern Anatolia Project Regional Development Administration (GAP) and Arab Republic of Syria Ministry of Irrigation General Organization for Land Development (GOLD)

Treaty basin: Asi/Orontes, Nahr El Kebir, Tigris-Euphrates — *Date:* August 23, 2001
Signatories: Turkey, Syria

Bilateral agreement, Act No. 15 concerning the division of the water of Al-Asi River (Orontes) between the Syrian Arab Republic and the Lebanese Republic

Treaty basin: Asi/Orontes — *Date:* September 20, 1994
Signatories: Lebanon, Syria

Atrak*

Total area: 34,200 km²

Countries	Area of Basin in Country km²	%
Iran	23,600	68.86
Turkmenistan	10,700	31.14

Treaties and Agreements

Agreement between Iran and the Soviet Union for the joint utilisation of the frontier parts of the rivers Aras and Atrak for irrigation and power generation

Treaty basin: Araks, Atrak *Date:* August 11, 1957

Signatories: Iran; Union of Soviet Socialist Republics

Treaty between the government of the Union of Soviet Socialist Republics and the Imperial government of Iran concerning the regime of the Soviet-Iranian frontier and the procedure for the settlement of frontier disputes and incidents

Treaty basin: Tedzen, Atrak, Araks, Harirud *Date:* May 14, 1957

Signatories: Iran, Imperial Government of; Union of Soviet Socialist Republics

Chu

Total area: 199,400 km²

Countries	Area of Basin in Country km²	%
Kazakhstan	185,300	92.95
Kyrgyzstan	14,000	7.05

Treaties and Agreements

Agreement on Utilization of the Water Facilities of Interstate Use on the Chu and Talas rivers

Treaty basin: Chu, Talas — *Date:* January 21, 2000
Signatories: Kazakhstan and Kyrgyzstan

River Basin Organizations and Commissions

Article 5 of the international agreement between the Government of the Kazakh Republic and the Government of the Kyrgyz Republic on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas states that "in order to ensure safe and reliable work of water management facilities of intergovernmental status, the Parties shall create permanent commissions to determine the working regimes and the range of necessary expenses for exploitation and maintenance".

Treaty basin: Chu, Talas — *Date:* January 21, 2000
Signatories: Kazakstan, Kyrgyzstan

Source: http://www.talaschu.org/index.php?ID=basis,agree,en?

Fenney

Total area: 2,800 km²

Countries	Area of Basin in Country km²	%
India	1,800	65.83
Bangladesh	1,000	34.17

Treaties and Agreements

Summary record of discussions of the first meeting of the Joint Committee of Experts held in Dhaka between 16-18 January, 1986

Treaty basin: Frontier or shared waters *Date:* January 18, 1986

Signatories: India, Bangladesh

River Basin Organizations and Commissions

Joint Committee of Experts

Treaty basin: Fenney, Ganges-Brahmaputra-Meghna, Karnaphuli *Date:* November 22, 1985

Signatories: India, Bangladesh

Source: TFDD, http://ocid.nacse.org/qml/research/tfdd/toTFDDdocs/269ENG.pdf

Indo-Bangladesh Joint Rivers Commission. Mission: to develop the waters of the rivers common to the two countries on a cooperative basis (specifically excluding issues of Ganges development)

Treaty basin: Fenney, Ganges-Brahmaputra-Meghna, Karnaphuli *Date:* March 19, 1972

Signatories: India, Bangladesh

Source: http://www.transboundarywaters.orst.edu/projects/casestudies/ganges.html

Fly

Total area: 64,600 km²

Countries	Area of Basin in Country km²	%
Papua New Guinea	60,400	93.40
Indonesia	4,300	6.60

Treaties and Agreements

Agreement between the government of Australia (acting on its own behalf and on behalf of the government of Papua New Guinea) and the government of Indonesia concerning administrative border arrangements as to the border between Papua New Guinea and Indonesia

Treaty basins: Sepik, Fly *Date:* November 13, 1973

Signatories: Australia; Australia acting on the behalf of Papua New Guinea; Indonesia

River Basin Organizations and Commissions

Fly River Provincial Boundaries Commission.

Established in accordance with the Fly River Constituencies Act.

Treaty basins: Fly *Date:* 1978

Signatories: Indonesia, Papua New Guinea

Source: http://www.paclii.org/pg/cases/PNGLR/1980/140.html

GANGES-BRAHMAPUTRA-MEGHNA*

Total area: 1,634,900 km²

Countries	Area of Basin in Country km²	%
India	948,400	58.01
China	321,300	19.65
Nepal	147,400	9.01
Bangladesh	107,100	6.55
India, claimed by China	67,100	4.11
Bhutan	39,900	2.44
Indian control, claimed by China	1,200	0.07
Myanmar (Burma)	80	0.00

TREATIES AND AGREEMENTS

Treaty between the government of the Republic of India and the government of the People's Republic of Bangladesh on sharing of the Ganga/Ganges waters at Farakka

Treaty basin: Ganges — *Date:* December 12, 1996

Signatories: Bangladesh, People's Republic of; India

Treaty between His Majesty's government of Nepal and the government of India concerning the integrated development of the Mahakali River including Sarada Barrage, Tanakpur Barrage, and Pancheshwar Project

Treaty basin: Mahakali — *Date:* February 12, 1996

Signatories: India; Nepal

Summary record of discussions of the first meeting of the Joint Committee of Experts held in Dhaka between 16-18 January, 1986

Treaty basin: Ganges-Brahmaputra-Meghna — *Date:* January 18, 1986

Signatories: Bangladesh, India

Agreement on ad hoc sharing of the Teesta waters between India and Bangladesh reached during the 25th meeting of the Indo-Bangladesh Joint Rivers Commission held in July 1983, at Dhaka

Treaty basin: Teesta/Tista — *Date:* July 20, 1983

Signatories: Bangladesh, India

Meeting of the Joint Rivers Commission

Treaty basin: Ganges — *Date:* July 20, 1983

Signatories: Bangladesh; India

Indo-Bangladesh memorandum of understanding on the sharing of Ganga waters at Farakka

Treaty basin: Ganga/Ganges — *Date:* October 7, 1982

Signatories: Bangladesh, India

Agreement between Nepal and India on the renovation and extension of Chandra Canal, Pumped Canal, and distribution of the Western Kosi Canal

Treaty basin: Kosi *Date:* April 7, 1978

Signatories: India; Nepal

Agreement between the government of the People's Republic of Bangladesh and the government of the Republic of India on sharing of the Ganges waters at Farakka and on augmenting its flows

Treaty basin: Ganges *Date:* November 5, 1977

Signatories: Bangladesh, India

Provisional conclusion of the treaty of 18 April 1975 on the division of the waters of the Ganges

Treaty basin: Ganges-Brahmaputra-Meghna *Date:* April 18, 1975

Signatories: Bangladesh, India

Statute of the Indo-Bangladesh Joint Rivers Commission

Treaty basin: Ganges-Brahmaputra *Date:* November 24, 1972

Signatories: Bangladesh; India

Amended agreement between His Majesty's government of Nepal and the government of India concerning the Kosi Project

Treaty basins: Kosi *Date:* December 19, 1966

Signatories: India, Nepal

Agreement between His Majesty's government of Nepal and the government of India on the Gandak Irrigation and Power Project

Treaty basin: Ganges-Brahmaputra-Meghna *Date:* December 04, 1959

Signatories: India, Nepal

Agreement between the government of India and the government of Nepal on the Kosi project

Treaty basin: Ganges-Brahmaputra-Meghna *Date:* April 25, 1954

Signatories: India, Nepal

Agreement between Great Britain and the Panna state respecting the Ken Canal

Treaty basin: Ganges-Brahmaputra-Meghna *Date:* September 30, 1908

Signatories: Great Britain; Panna, State of

Agreement between the British government and the Patiala state regarding the Sirsa branch of the Western Jumna Canal

Treaty basin: Ganges-Brahmaputra-Meghna *Date:* August 29, 1893

Signatories: Great Britain, Panna, State of

River Basin Organizations and Commissions

Joint Committee to record at Farakka the daily flow below Farakka barrage, in the Feeder canal, at the Navigation Lock, as well as at the Hardinge Bridge

Treaty basin: Ganges-Brahmaputra-Meghna *Date:* December 12, 1996

Signatories: India, Bangladesh

Source: http://www.africanwater.org/farakka_water_treaty.htm

Mahakali River Commission, resulting from the Mahakali Treaty of 12 February 1996

The Commission has been directed to: (i) seek information on and, if necessary, inspect all structures included in the Mahakali Treaty; (ii) make recommendations for the conservation and utilization of the Mahakali River; (iii) provide expert evaluation of projects and make recommendations thereto; (iv) coordinate and monitor plans of action; and (v) examine any differences arising between the two countries concerning the Treaty's interpretation and application.

Treaty basin: Ganges-Brahmaputra-Meghna (Mahakali subbasin) *Date:* February 12, 1996

Signatories: India, Nepal

Source: http://hqweb.unep.org/dams/documents/ell.asp?story_id=123

Indo-Bangladesh Joint Rivers Commission

Mission: to develop the waters of the rivers common to the two countries on a cooperative basis (specifically excluding issues of Ganges development).

Treaty basin: Fenney, Ganges-Brahmaputra-Meghna, Karnaphuli *Date:* March 19, 1972

Signatories: India, Bangladesh

Source: http://www.transboundarywaters.orst.edu/projects/casestudies/ganges.html

Golok

Total area: 1,800 km²

Countries	Area of Basin in Country km²	%
Thailand	1,000	56.62
Malaysia	800	43.38

Treaties and Agreements

An inter-governmental agreement between Malaysia and Thailand was signed between the Ministers of Agriculture of both countries on 7th March 1997. This agreement outlines the commitment of both countries for the joint implementation of the Golok River Mouth Improvement Project, as well as the methodology for cost sharing, supervision, monitoring and maintenance.

Treaty basin: Golok *Date:* March 7, 1997

Signatories: Malaysia, Thailand

River Basin Organizations and Commissions

Joint Steering Committee

An inter-governmental agreement between Malaysia and Thailand was signed between the Ministers of Agriculture of both countries on 7th March 1997. This agreement outlines the commitment of both countries for the joint implementation of the Golok River Mouth Improvement Project, as well as the methodology for cost sharing, supervision, monitoring and maintenance. Therefore, the Joint Steering Committee was set up.

Treaty basin: Golok *Date:* March 7, 1997

Signatories: Malaysia, Thailand

Source: http://agrolink.moa.my/did/coast/sg_golok_web/00golokrivereng/main.html

Joint Technical Working Group

An inter-governmental agreement between between Malaysia and Thailand was signed between the Ministers of Agriculture of both countries on 7th March 1997. This agreement outlines the commitment of both countries for the joint implementation of the Golok River Mouth Improvement Project, as well as the methodology for cost sharing, supervision, monitoring and maintenance. Therefore, the Joint Technical Working group was set up.

Treaty basin: Golok *Date:* March 7, 1997

Signatories: Malaysia, Thailand

Source: http://agrolink.moa.my/did/coast/sg_golok_web/00golokrivereng/main.html

Har Us Nur

Total area: 185,300 km²

Countries	Area of Basin in Country km²	%
Mongolia	179,300	96.81
Russia	5,600	3.04
China	300	0.15

Treaties and Agreements

Agreement between the government of the People's Republic of China and the government of Mongolia on the protection and utilization of transboundary waters

Treaty basin: Amur, Har Us Nur, Ob, Pu Lun T'o *Date:* April 29, 1994

Signatories: China, Mongolia

Agreement between the government of Mongolia and the government of the Russian Federation on the protection and use of transboundary waters

Treaty basin: Amur, Jenissei, Lake Baikal, Onon, Selenga, Har Us Nur, Lake Ubsa-Nur, Pu-Lun-T'o

Signatories: Mongolia; Russian Federation *Date:* February 11, 1995

River Basin Organizations and Commissions

The Joint Committee of Protection and Using the Transboundary Waters of China and Mongolia.

In accordance with the agreement between China and Mongolia on "Using and Protecting the Transboundary Waters" (1994)

Treaty basins: Amur, Har Us Nur, Ob, Pu Lun T'o *Date:* 1998

Signatories: China, Mongolia

Source: http://www.ecdc.net.cn/newindex/chinese/page/tumen/tumen_jishi/01/3.htm [in Chinese]

Helmand

Total area: 353,500 km²

Countries	Area of Basin in Country km²	%
Afghanistan	288,200	81.53
Iran	54,900	15.52
Pakistan	10,400	2.95

Treaties and Agreements

Terms of reference of the Helmand River Delta Commission and an interpretive statement relative thereto, agreed by conferees of Afghanistan and Iran

Treaty basin: Helmand *Date:* September 7, 1950

Signatories: Afghanistan, Iran

River Basin Organizations and Commissions

Helmand River Delta Commission

Tasks: to elaborate the technical methods concerning the share of the water of the Helmand River for Iran (Seistan) and Afghanistan (Chakhansur), and measure and divide the river flows between the two signatories.

Treaty basin: Helmand *Date:* September 7, 1950

Signatories: Afghanistan, Iran

Source: http://www.transboundarywaters.orst.edu and ftp://ftp.fao.org/docrep/fao/005/w9549E/w9549E00.pdf

Ili/Kunes He

Total area: 161,200 km²

Countries	Area of Basin in Country km²	%
Kazakhstan	97,100	60.24
China	55,300	34.32
Kyrgyzstan	8,800	5.44

Treaties and Agreements

Agreement between the Government of the People's Republic of China and the Government of the Republic of Kazakhstan on the Cooperation on Using and Protecting the Transboundary Rivers. The agreement aimed at facilitating cooperation on trans-boundary water management.

Treaty basin: Aral Sea, Ili/Kunes He, Ob, Pu Lun T'o *Date:* 2001

Signatories: China, the Republic of Kazakhstan

Protocol between China and Russia for the delimitation of the frontier along the River Horgos

Treaty basin: Horgos, Ili *Date:* June 12, 1915

Signatories: China; Russia, Imperial Government of

River Basin Organizations and Commissions

The Joint Committee of Protection and Using the Transboundary Rivers

Treaty basin: Aral Sea, Ili/Kunes He, Ob, Pu Lun T'o *Date:* 2001

Signatories: China, Kazakhstan

INDUS*

Total area: 1,138,800 km²

Countries	Area of Basin in Country km²	%
Pakistan	597,700	52.48
India	381,600	33.51
China	76,200	6.69
Afghanistan	72,100	6.33
Chinese control, claimed by India	9,600	0.84
Indian control, claimed by China	1,600	0.14
Nepal	10	0.00

TREATIES AND AGREEMENTS

Indus waters treaty 1960 between the government of India, the government of Pakistan and the International Bank for Reconstruction and Development

Treaty basin: Indus *Date:* September 19, 1960

Signatories: India, International Bank for Reconstruction and Development, Pakistan

Agreement between Pakistan and India on West Pakistan-India border disputes

Treaty basin: Indus *Date:* January 11, 1960

Signatories: India, Pakistan

Indo-Pakistan agreement (with appendices) on East Pakistan border disputes

Treaty basin: Indus *Date:* October 23, 1959

Signatories: East Pakistan, India

Inter-dominion agreement between the government of India and the government of Pakistan on the canal water dispute between East and West Punjab

Treaty basin: Indus *Date:* May 4, 1948

Signatories: India, Pakistan

Treaty between the government of Afghanistan and His Britannic Majesty's Government for the establishment of neighbourly relations

Treaty basin: Kabul *Date:* November 22, 1921

Signatories: Afghanistan, Great Britain

Final working agreement relative to the Sirhind Canal between Great Britain and Patiala, Jind and Nabha

Treaty basin: Sirhind Canal *Date:* February 23, 1904

Signatories: Great Britain; Patiala, State of; Jind, State of; Nabha, State of

Articles of agreement between the Edur Durbar and the British government

Treaty basin: Hathmatee *Date:* July 20, 1874

Signatories: Edur, Great Britain

Terms of agreement between Great Britain and the States of Patiala, Jind, and Nabha regarding the Sirhind Canal

Treaty basin: Indus *Date:* February 18, 1873

Signatories: Great Britain, India/Pakistan

Amended terms of agreement between the British Government and the State of Jind, for regulating the supply of water for irrigation from the Western Jumana Canal

Treaty basin: Indus *Date:* September 16, 1892

Signatories: Great Britain; Jind, State of

River Basin Organizations and Commissions

Indus Water Commission or Permanent Indus Commission

Regulates the allocation of waters from the Indus River basin between India and Pakistan.

Treaty basin: Indus *Date:* 1960

Signatories: India, Pakistan

Source: http://wrmin.nic.in/international/industreaty.htm

JENISEJ/YENISEY

Total area: 2,557,800 km²

Countries	Area of Basin in Country km²	%
Russia	2,229,800	87.17
Mongolia	327,900	12.82

TREATIES AND AGREEMENTS

Agreement between the government of Mongolia and the government of the Russian Federation on the protection and use of transboundary waters

Treaty basin: Amur, Jenissei, Lake Baikal, Onon, Selenga, Har Us Nur, Lake Ubsa-Nur, Pu-Lun-T'o

Date: February 11, 1995

Signatories: Mongolia; Russian Federation

JORDAN*

Total area: 42,800 km²

Countries	Area of Basin in Country km²	%
Jordan	20,600	48.13
Israel	9,100	21.26
Syria	4,900	11.45
West Bank	3,200	7.48
Egypt	2,700	6.31
Golan Heights	1,500	3.50
Lebanon	600	1.33

TREATIES AND AGREEMENTS

Annex II to the Israeli-Palestinian interim agreement on the West Bank and the Gaza Strip: protocol concerning elections

Treaty basin: Jordan — *Date:* September 28, 1995

Signatories: Israel; Palestine Liberation Organization

Annexes IV, V, VI, and VII to the Israeli-Palestinian interim agreement on the West Bank and the Gaza Strip

Treaty basin: Jordan — *Date:* September 28, 1995

Signatories: Israel; Palestine Liberation Organization

Annex III to the Israeli-Palestinian interim agreement on the West Bank and the Gaza Strip: protocol concerning civil affairs

Treaty basin: Jordan — *Date:* September 28, 1995

Signatories: Israel; Palestine Liberation Organization

Annex I to the Israeli-Palestinian interim agreement on the West Bank and the Gaza Strip: protocol concerning redeployment and security arrangements

Treaty basin: Jordan — *Date:* September 28, 1995

Signatories: Israel; Palestine Liberation Organization

Israeli-Palestinian interim agreement on the West Bank and the Gaza Strip, with Annexes I to VII

Treaty basin: Jordan — *Date:* September 28, 1995

Signatories: Israel; Palestine Liberation Organization

Treaty of peace between the state of Israel and the Hashemite Kingdom of Jordan, done at Arava/Araba crossing point

Treaty basin: Jordan, Yarmuk, Araba/Arava groundwater — *Date:* October 26, 1994

Signatories: Israel, Jordan

Johnston Negotiations

Treaty basin: Jordan *Date:* December 31, 1955

Signatories: Israel, Jordan, Lebanon, Syria

Agreement between the Republic of Syria and the Hashemite Kingdom of Jordan concerning the utilization of the Yarmuk waters.

Treaty basin: Yarmuk *Date:* June 4, 1953

Signatories: Jordan, Syria

Agreement of good neighbourly relations concluded between the British and French governments on behalf of the territories of Palestine, on the one part, and on behalf of Syria and Great Lebanon, on the other part

Treaty basin: Jordan *Date:* February 2, 1926

Signatories: Great Britain, on behalf of Territories of Palestine; France, on behalf of Great Lebanon and Syria

Exchange of notes constituting an agreement between the British and French governments respecting the boundary line between Syria and Palestine from the Mediterranean to El Hamme

Treaty basin: Jordan, Yarmuk *Date:* March 7, 1923

Signatories: France, Great Britain

Franco-British convention on certain points connected with the mandates for Syria and the Lebanon, Palestine and Mesopotamia

Treaty basin: Jordan, Yarmuk, Tigris-Euphrates *Date:* December 23, 1920

Signatories: France, Great Britain

River Basin Organizations and Commissions

Joint Water Committee (JWC)

To jointly manage water resources of the West Bank; for the purposes of monitoring, planning, study, information sharing, and dispute resolution. Appendix I of Annex III Article 40 of the Interim Agreement (1995) deals with water allocation.The two parties agreed to establish the Joint Water Committee (JWC) as an institutional mechanism for the interim period. The main aim of the JWC is to undertake the implementation of Article 40.

Treaty basin: Jordan *Date:* 1996

Signatories: Israel, Jordan

Source: http://www.miftah.org/Doc/Factsheets/Miftah/English/PALESTINEWATER.pdf and http://www.wws.princeton.edu/~wws401c/aliya.pdf

Joint Syro-Jordanian Commission set up under the 'Agreement Between the Republic of Syria and the Hashemite Kingdom of Jordan Concerning the Utilization of the Yarmuk Waters' which entered into force on 8 July 1953.

It was established for the application of the provisions of this Agreement, the regulation and exercise of the rights and obligations which the two Governments have assumed thereunder and supervision over the settlement of all questions to which its application may give rise.

Treaty basin: Jordan (Yarmuk subbasin) *Date:* July 8, 1953

Signatories: Jordan, Syria

Source: http://www.internationalwaterlaw.org/regionaldocs/syria-jordan.html

KARNAPHULI

Total area: 12,500 km²

Countries	Area of Basin in Country km²	%
Bangladesh	7,400	58.78
India	5,100	41.14
Myanmar (Burma)	10	0.09

TREATIES AND AGREEMENTS

Summary record of discussions of the first meeting of the Joint Committee of Experts held in Dhaka between 16-18 January, 1986

Treaty basin: Frontier or shared waters *Date:* January 18, 1986

Signatories: Bangladesh, India

RIVER BASIN ORGANIZATIONS AND COMMISSIONS

Indo-Bangladesh Joint Rivers Commission

Mission: to develop the waters of the rivers common to the two countries on a cooperative basis (specifically excluding issues of Ganges development).

Treaty basin: Fenney, Ganges-Brahmaputra-Meghna, Karnaphuli *Date:* March 19, 1972

Signatories: India, Bangladesh

Source: http://www.transboundarywaters.orst.edu/projects/casestudies/ganges.html

Joint Committee of Experts

Treaty basin: Fenney, Ganges-Brahmaputra-Meghna, Karnaphuli *Date:* November 22, 1985

Signatories: India, Bangladesh

Source: http://www.transboundarywaters.orst.edu/http://ocid.nacse.org/qml/research/tfdd/toTFDDdocs/269ENG.pdf

KURA-ARAKS*

Total area: 193,200 km²

Countries	Area of Basin in Country km²	%
Azerbaijan	56,600	29.28
Iran	39,700	20.55
Armenia	34,800	18.03
Georgia	34,300	17.77
Turkey	27,700	14.32
Russia	60	0.03

TREATIES AND AGREEMENTS

Agreement between Iran and the Soviet Union for the joint utilisation of the frontier parts of the rivers Aras and Atrak for irrigation and power generation

Treaty basin: Araks, Atrak — *Date:* August 11, 1957

Signatories: Iran, Union of Soviet Socialist Republics

Treaty between the government of the Union of Soviet Socialist Republics and the Imperial government of Iran concerning the regime of the Soviet-Iranian frontier and the procedure for the settlement of frontier disputes and incidents

Treaty basin: Tedzen, Atrak, Araks, Harirud — *Date:* May 14, 1957

Signatories: Iran, Imperial Government of; Union of Soviet Socialist Republics

RIVER BASIN ORGANIZATIONS AND COMMISSIONS

Joint Commission

Treaty basin: Data not available — *Date:* is being set up

Signatories: Georgia, Turkey

Lake Ubsa-Nur

Total area: 62,800 km²

Countries	Area of Basin in Country km²	%
Mongolia	47,600	75.78
Russia	15,200	24.22

Treaties and Agreements

Agreement between the government of Mongolia and the government of the Russian Federation on the protection and use of transboundary waters

Treaty basin: Amur, Jenissei, Lake Baikal, Onon, Selenga, Har Us Nur, Lake Ubsa-Nur, Pu-Lun-T'o

Date: February 11, 1995

Signatories: Mongolia, Russian Federation

MEKONG*

Total area: 787,800 km²

Countries	Area of Basin in Country km²	%
Laos, People's Democratic Republic of	198,000	25.14
Thailand	193,900	24.62
China	171,700	21.79
Cambodia (Kampuchea)	158,400	20.10
Vietnam	38,200	4.84
Myanmar (Burma)	27,600	3.51

TREATIES AND AGREEMENTS

Commercial navigation on the Lancang-Mekong river

Treaty basin: Mekong — *Date:* June 26, 2001

Signatories: China, Laos, Myanmar, Thailand

Agreement on the cooperation for the sustainable development of the Mekong River Basin

Treaty basin: Mekong — *Date:* April 5, 1995

Signatories: Cambodia; Laos, People's Democratic Republic; Thailand; Vietnam, Socialist Republic of

Declaration concerning the Interim Committee for Coordination of Investigation of the Lower Mekong Basin

Treaty basin: Mekong — *Date:* January 5, 1978

Signatories: Laos, People's Democratic Republic; Thailand; Vietnam, Socialist Republic of

Joint declaration of principles for utilization of the waters of the lower Mekong Basin, signed by the representatives of the governments of Cambodia, Laos, Thailand, and Vietnam to the Committee for Coordination of Investigations of the Lower Mekong Basin

Treaty basin: Mekong — *Date:* January 31, 1975

Signatories: Khmer, Republic of; Laos; Thailand; Vietnam

Convention between Laos and Thailand for the supply of power

Treaty basin: Mekong, Nam Pong, Nam Ngum — *Date:* August 12, 1965

Signatories: Laos, Thailand

Statute of the Committee for Co-ordination of Investigations of the Lower Mekong Basin established by the governments of Cambodia, Laos, Thailand and the Republic of Viet-Nam in response to the decisions taken by the United Nations Economic Commission for Asia and the Far East

Treaty basin: Mekong — *Date:* October 31, 1957

Signatories: Cambodia, Laos, Thailand, Vietnam

Agreement on Providing the Hydrologic Data during Flood Season. According to the agreement, China will provide hydrological information to the other four downstream riparian countries

Treaty basin: Mekong *Date:* April 1, 2002

Signatories: Cambodia, China, Lao PDR, Thailand, Vietnam

River Basin Organizations and Commissions

ASEAN-Mekong Basin Development Cooperation (AMBDC)

The objectives of this cooperation are:(i) to enhance economically sound and sustainable development of the Mekong Basin; (ii) to encourage a process of dialogue and common project identification which can result in firm economic partnerships for mutual benefit; and (iii) to strengthen the interconnections and economic linkages between the ASEAN member countries and the Mekong riparian countries.

Treaty basin: Mekong *Date:* June 17, 1996

Signatories: Brunei Darussalam, Cambodia, China, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam

Source: http://www.aseansec.org/2474.htm

The ASEAN Mekong Basin Development Cooperation (AMBDC)

Set up to support and promote the economic development of the Mekong Basin countries and narrow the developmental gap between the countries in the South East Asia region

Treaty basin: Mekong *Date:* December 14, 1995

Signatories: Laos, Myanmar, Cambodia, China

Source: http://www.miti.gov.my/press-21-22dis04.html

Interim Committee for Coordination of Investigations of the Lower Mekong Basin

Treaty basin: Mekong *Date:* January 5, 1978

Signatories: Laos, Thailand, Vietnam

Source: http://www.transboundarywaters.orst.edu/

Committee for Coordination of Investigation of the Lower Mekong Basin

Treaty basin: Mekong *Date:* January 31, 1975

Signatories: Laos, Cambodia, Thailand, Vietnam

Source: http://www.transboundarywaters.orst.edu/

Mekong River Commission (formerly known as Mekong Committee; name change in 1995)

A coordinating mechanism between the four countries. Original aim was development of large scale water-resource developments, but this has never been realized. Now objections include hydropower, irrigation, flood control, collection and distribution of hydrological data. Also, the MRC serves as focal point for donor organizations and countries. MRC maintains regular dialogue with the two upper states of the Mekong River Basin, China and Myanmar.The MRC member countries agree to co-operate in all fields of sustainable development, utilisation, management and conservation of the water and related resources of the Mekong River Basin, such as navigation, flood control, fisheries, agriculture, hydropower and environmental protection. Note: the two upstream countries (China and Myanmar) were invited to join the organization and dialogue regurlarly since 1996.

Treaty basin: Mekong *Date:* 1957, reconstituted in 1995

Signatories: Cambodia, Lao PDR, Thailand, Vietnam

Source: http://www.mrcmekong.org/ and http://waterpartners.geo.orst.edu/news/OSU2003v3.ppt#9

Nahr El Kebir

Total area: 1,500 km²

Countries	Area of Basin in Country km²	%
Syria	1,300	85.61
Turkey	200	13.87

Treaties and Agreements

Joint communiqué between Republic of Turkey Prime Ministry Southeastern Anatolia Project Regional Development Administration (GAP) and Arab Republic of Syria Ministry of Irrigation General Organization for Land Development (GOLD)

Treaty basin: Asi/Orontes, Nahr El Kebir, Tigris-Euphrates *Date:* August 23, 2001

Signatories: Turkey, Syria

Ob*

Total area: 2,950,800 km²

Countries	Area of Basin in Country km²	%
Russia	2,192,700	74.31
Kazakhstan	743,800	25.21
China	13,900	0.47
Mongolia	200	0.01

Treaties and Agreements

Agreement between the Government of the People's Republic of China and the Government of the Republic of Kazakhstan on the Cooperation on Using and Protecting the Transboundary Rivers. The agreement aimed at facilitating cooperation on trans-boundary water management.

Treaty basin: Aral Sea, Ili/Kunes He, Ob, Pu Lun T'o *Date:* 2001

Signatories: China, Republic of Kazakhstan

Agreement on Using and Protecting the Transboundary waters (the waters relate to the tributaries of Heilong River and Ertrix River).

Treaty basin: Amur, Har Us Nur, Ob, Pu Lun T'o *Date:* April 29, 1994

Signatories: China, Mongolia

Agreement between the government of the Republic of Kazakhstan and the government of the Russian Federation concerning the joint use and protection of transboundary waters

Treaty basin: Ishim, Irtysh, Ural, Tobol *Date:* August 27, 1992

Signatories: Kazakhstan; Russian Federation

River Basin Organizations and Commissions

The Joint Committee of Protection and Using the Transboundary Waters of China and Mongolia

In accordance with the agreement between China and Mongolia on "Using and Protecting the Transboundary Waters" (1994).

Treaty basin: Amur, Har Us Nur, Ob, Pu Lun T'o *Date:* 1998

Signatories: China, Mongolia

Source: http://www.ecdc.net.cn/newindex/chinese/page/tumen/tumen_jishi/01/3.htm [in Chinese]

The Joint Committee of Protection and Using the Transboundary Rivers

Descriptive paragraph?

Treaty basin: Aral Sea, Ili/Kunes He, Ob, Pu Lun T'o *Date:* 2001

Signatories: China, the Republic of Kazakhstan

Oral/Ural*

Total area: 311,000 km²

Countries	Area of Basin in Country km²	%
Kazakhstan	175,500	56.43
Russia	135,500	43.57

Treaties and Agreements

Agreement between the government of the Republic of Kazakhstan and the government of the Russian Federation concerning the joint use and protection of transboundary waters

Treaty basin: Ishim, Irtysh, Ural, Tobol
Signatories: Kazakhstan; Russian Federation

Date: August 27, 1992

Pu Lun T'o

Total area: 89,000 km²

Countries	Area of Basin in Country km²	%
China	77,800	87.39
Mongolia	11,100	12.48
Russia	80	0.09
Kazakhstan	30	0.04

Treaties and Agreements

Agreement between the Government of the People's Republic of China and the Government of the Republic of Kazakhstan on the Cooperation on Using and Protecting the Transboundary Rivers. The agreement aimed at facilitating cooperation on trans-boundary water management.

Treaty basin: Aral Sea, Ili/Kunes He, Ob, Pu Lun T'o *Date:* 2001

Signatories: China, Republic of Kazakhstan

Agreement between the government of Mongolia and the government of the Russian Federation on the protection and use of transboundary waters

Treaty basin: Amur, Jenissei, Lake Baikal, Onon, Selenga, Har Us Nur, Lake Ubsa-Nur, Pu-Lun-T'o

Date: February 11, 1995

Signatories: Mongolia; Russian Federation

Agreement between the government of the People's Republic of China and the government of Mongolia on the protection and utilization of transboundary waters

Treaty basin: Amur, Har Us Nur, Jenissei, Lake Baikal, Lake Ubsa-Nur, Onon, Pu-Lun-T'o, Selenga

Signatories: China, Mongolia *Date:* April 29, 1994

Agreement between the government of the Republic of Kazakhstan and the government of the Russian Federation concerning the joint use and protection of transboundary waters

Treaty basin: Ishim, Irtysh, Ural, Tobol *Date:* August 27, 1992

Signatories: Kazakhstan; Russian Federation

River Basin Organizations and Commissions

The Joint Committee of Protection and Using the Transboundary Rivers

Treaty basin: Aral Sea, Ili/Kunes He, Ob, Pu Lun T'o *Date:* 2001

Signatories: China, Republic of Kazakhstan

The Joint Committee of Protection and Using the Transboundary Waters of China and Mongolia. In accordance with the agreement between China and Mongolia on "Using and Protecting the Transboundary Waters" (1994).

Treaty basin: Amur, Har Us Nur, Ob, Pu Lun T'o *Date:* 1998

Signatories: China, Mongolia

Source: http://www.ecdc.net.cn/newindex/chinese/page/tumen/tumen_jishi/01/3.htm [in Chinese]

Sepik

Total area: 73,400 km²

Countries	Area of Basin in Country km²	%
Papua New Guinea	71,000	96.81
Indonesia	2,300	3.19

Treaties and Agreements

Agreement between the government of Australia (acting on its own behalf and on behalf of the government of Papua New Guinea) and the government of Indonesia concerning administrative border arrangements as to the border between Papua New Guinea and Indonesia

Treaty basin: Sepik, Fly *Date:* November 13, 1973

Signatories: Australia; Australia acting on the behalf of Papua New Guinea; Indonesia

Talas

Total area: 49,000 km²

Countries	Area of Basin in Country km²	%
Kazakhstan	38,800	79.31
Kyrgyzstan	10,100	20.69

Treaties and Agreements

Agreement on Utilization of the Water Facilities of Interstate Use on the Chu and Talas rivers

Treaty basin: Chu, Talas *Date:* February 2002

Signatories: Kazakhstan and Kyrgyzstan

River Basin Organizations and Commissions

Article 5 of the international agreement between the Government of the Kazakh Republic and the Government of the Kyrgyz Republic on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas states that "in order to ensure safe and reliable work of water management facilities of intergovernmental status, the Parties shall create permanent commissions to determine the working regimes and the range of necessary expenses for exploitation and maintenance".

Treaty basin: Chu, Talas *Date:* January 21, 2000

Signatories: Kazakstan, Kyrgyzstan

Source: http://www.talaschu.org/index.php?ID=basis,agree,en

Tigris-Euphrates/ Shatt al Arab*

Total area: 789,000 km²

Countries	Area of Basin in Country km²	%
Iraq	319,400	40.48
Turkey	195,700	24.80
Iran	155,400	19.70
Syria	116,300	14.73
Jordan	2,000	0.25
Saudi Arabia	80	0.01

Treaties and Agreements

Joint communiqué between Republic of Turkey Prime Ministry Southeastern Anatolia Project Regional Development Administration (GAP) and Arab Republic of Syria Ministry of Irrigation General Organization for Land Development (GOLD)

Treaty basin: Asi/Orontes, Nahr El Kebir, Tigris-Euphrates *Date:* August 23, 2001

Signatories: Turkey, Syria

Minutes between Syria and Turkey on cooperation in fighting terrorism, signed at Adana, including Annex 2

Treaty basin: Not specified *Date:* October 20, 1998

Signatories: Syria, Turkey

Law No.14 of 1990, ratifying the Joint Minutes concerning the provisional division of the waters of the Euphrates River

Treaty basin: Euphrates *Date:* April 17, 1989

Signatories: Iraq, Syria

Agreement between Iran and Iraq concerning the use of frontier watercourses, and protocol

Treaty basin: Alvend, Bnava Suta, Cham, Duverij, Kanjan, Qurahtu, Tib, Gangir

Date: December 26, 1975

Signatories: Iran, Imperial Government of; Iraq

Treaty concerning the state frontier and neighbourly relations between Iran and Iraq and protocol

Treaty basin: Shatt al'Arab *Date:* June 13, 1975

Signatories: Iran, Iraq

Treaty of friendship and neighbourly relations, and six annexed protocols, signed at Ankara

Treaty basin: Euphrates, Tigris *Date:* March 29, 1946

Signatories: Iraq, Turkey

Franco-British convention on certain points connected with the mandates for Syria and the Lebanon, Palestine and Mesopotamia

Treaty basin: Jordan, Yarmuk, Tigris-Euphrates *Date:* December 23, 1920

Signatories: France, Great Britain

River Basin Organizations and Commissions

Joint Technical Committee on Regional Waters

Formed on the basis of a former protocol (1946) concerning the control and management of the Euphrates and the Tigris.

Treaty basin: Tigris-Euphrates *Date:* 1980

Signatories: Iraq, Turkey

Source: http://www.fao.org/ag/agl/aglw/aquastat/countries/turkey/index.stm

Tumen

Total area: 29,100 km²

Countries	Area of Basin in Country km²	%
China	20,300	69.75
Korea, Democratic People's Republic of (North)	8,300	28.59
Russia	500	1.66

Treaties and Agreements

The three parties signed the "Agreement on establishing the Development and Coordination Commission of Tumen River Area" in New York, December 1995.

Treaty basin: Tumen *Date:* December 1995

Signatories: China, Russian Federation, DPRK

The parties signed the "Agreement on establishing the development and negotiation commission of the Tumen River Economic Development Zone and Northeast Asia."

Treaty basin: Tumen *Date:* 1996

Signatories: DPRK, China, ROK, Mongolia, Russia

River Basin Organizations and Commissions

Coordination Commission of the Tumen River Area

The three parties signed the "Agreement on establishing the Development and Coordination Commission of Tumen River Area" in New York, December 1995.

Treaty basin: Tumen *Date:* 1996

Signatories: China, Russian Federation, DPRK

Source: http://www.ecdc.net.cn/newindex/chinese/page/tumen/tumen_jishi/01/3.htm [in Chinese]

The parties signed the "Agreement on establishing the development and negotiation commission of the Tumen River Economic Development Zone and Northeast Asia."

Treaty basin: Tumen *Date:* 1996

Signatories: DPRK, China, ROK, Mongolia, Russia

http://www.tumenprogramme.org/data/upload/download/tumen_prodoc3/tumen_prodoc3.pdf

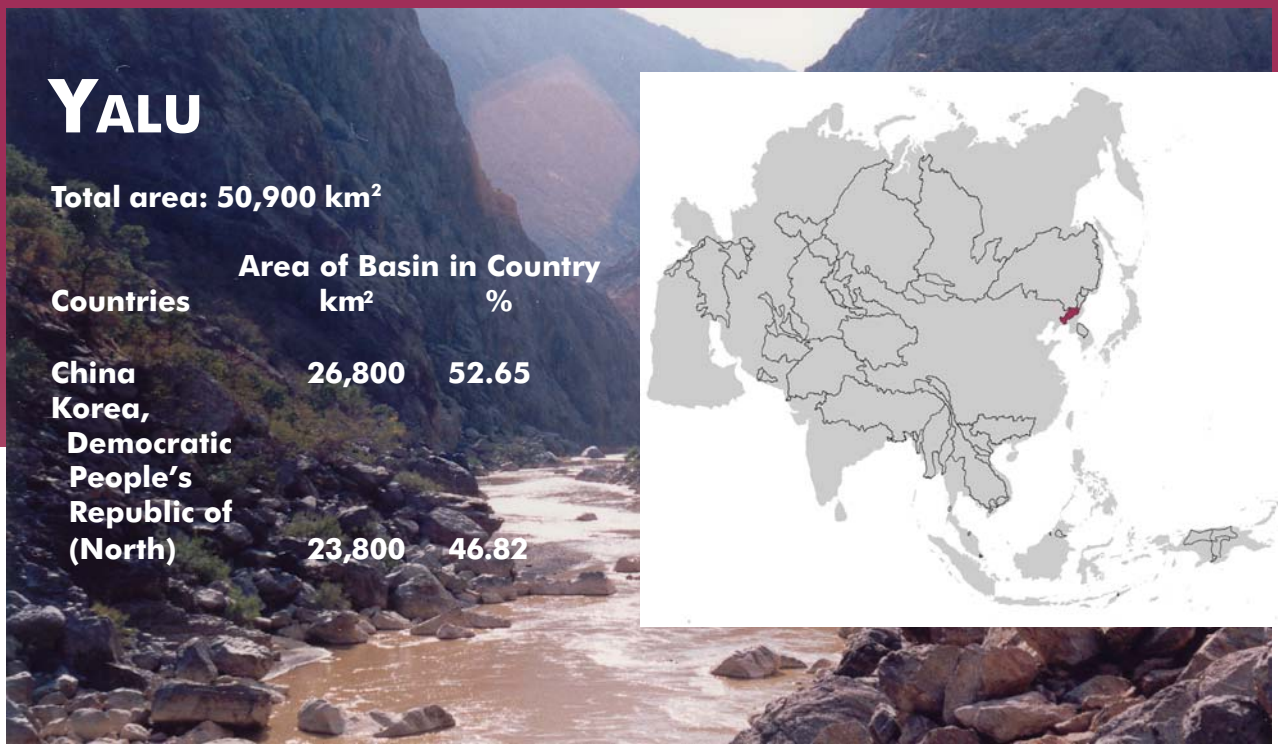
China-DPRK Border River Navigation Cooperation Committee

Goal: further cooperation and management over navigation in China-DPRK border rivers and the Yalu River.

Treaty basin: Yalu *Date:* 1961

Signatories: China, Korea, Democratic Peoples Republic

Source: http://www.moc.gov.cn/news/news/200207/2002-07-19-8175.htm [in Chinese]



YALU

Total area: 50,900 km²

Countries	Area of Basin in Country km²	%
China	26,800	52.65
Korea, Democratic People's Republic of (North)	23,800	46.82

RIVER BASIN ORGANIZATIONS AND COMMISSIONS

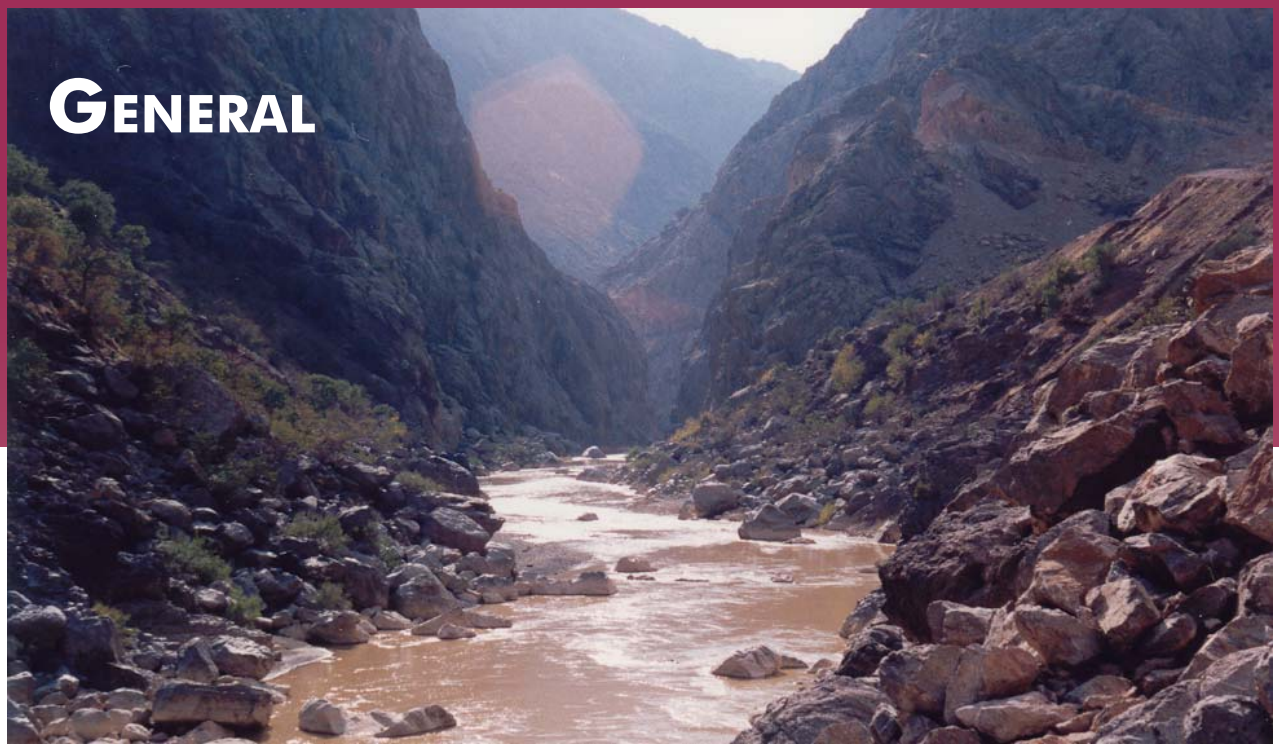
China-DPRK Border River Navigation Cooperation Committee

Goal: further cooperation and management over navigation in China-DPRK border rivers and the Yalu River.

Treaty basin: Yalu *Date:* 1961

Signatories: China, Korea, Democratic Peoples Republic

Source: http://www.moc.gov.cn/news/news/200207/2002-07-19-8175.htm [in Chinese]



General

Treaties and Agreements

Tashkent Declaration resulting in the UN Special Programme for the Economies of Central Asia (SPECA)

Treaty basins: Aral Sea, Ili/Kunes He, Tarim *Date:* March 26, 1998
Signatories: Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Republic of Uzbekistan, UN ECE, UN Economic and Social Commission for Asia and the Pacific

Agreed items between Malaysia Prime Minister Dr Mahathir Mohamed and Senior Minister Lee Kaun Yew at their 4-eye meeting at Putrajaya

Treaty basins: Johore *Date:* August 15, 2000
Signatories: Johore State Government, Singapore

Tashkent Declaration resulting in the UN Special Programme for the Economies of Central Asia (SPECA)

Treaty basins: Aral Sea, Ili/Kunes He, Tarim *Date:* March 26, 1998
Signatories: Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Republic of Uzbekistan, UN ECE, UN Economic and Social Commission for Asia and the Pacific

Agreement between the Government of the State of Johor and the Public Utilities Board of the Republic of Singapore

Treaty basins: Johore *Date:* November 24, 1990
Signatories: Johore State Government, Singapore

Johore River water agreement

Treaty basins: Johore *Date:* September 29, 1962
Signatories: Johore State Government, Singapore

Independence of Singapore agreement

Treaty basins: Not applicable *Date:* August 09, 1965
Signatories: Malaysia, Singapore

Tebrau and Scudai Rivers water agreement

Treaty basins: Tebrau, Scudai *Date:* September 01, 1961
Signatories: Johore State Government, Singapore

Appendix 2. Notes on Basins

Aral Sea

Most of the boundary shared between China and Tajikistan is in dispute, including in the Pamir mountain regiohowever, China and Tajikistan have pledged to demarcate (CIA World Factbook, 2007; IBRU, 1999).

Kyrgyzstan and Tajikistan have a territorial dispute regarding their boundary in the Isfara Valley area (CIA World Factbook, 2007).

Astara Chay

The boundaries of the Caspian Sea remain to be determined among Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan (CIA World Factbook, 2007).

Bilateral talks are commencing with Azerbaijan and Turkmenistan about separating the seabed and oil fields in the middle of the Caspian.

Atrak

Kyrgyzstan and Tajikistan have a territorial dispute regarding their boundary in the Isfara Valley area (CIA World Factbook, 2007).

Bangau

Brunei may wish to purchase the Malaysian salient that divides the country (CIA World Factbook, 2007).

Bei Jiang/His

Sections of the land boundary between China and Vietnam are indefinite (CIA World Factbook, 2007).

Beilun

Sections of the land boundary between China and Vietnam are indefinite (CIA World Factbook, 2007).

Coruh

The boundaries of the Caspian Sea remain to be determined among Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan (CIA World Factbook, 2007).

Ganges-Brahmaputra-Meghna

India and China dispute approximately 83,000 km^2, including three of the four political divisions of the Northeast Frontier Agency – the Sumdurong Cho sector. This region falls in the Ganges-Brahmaputra basin (Conflict and Border Disputes, 1993; Columbia Gazetteer, 1998; IBRU 1999).

Portions of the boundary between Bangladesh and India are indefinite. Much of the boundary between the two countries is based on administrative units that do not shift with the rivers as they change course or level over time. Alluvial or "char" land that is exposed as a river shifts often leads to dispute, as the land is highly valued for agriculture (CIA World Factbook, 2007; IBRU, 1999).

Han

A 33-km section of the boundary between China and North Korea in the Paektu-san (mountain) area is indefinite. North Korea claims territorial rights to two thirds of Chonji, the crater lake on Mount Paektu (CIA World Factbook, 2007; IBRU, 1999).

The Demarcation Line between North Korea and South Korea is in dispute (CIA World Factbook, 2007).

Indus

Disputed boundaries between China and India include approximately 25,900 km^2 in the regions of Sang, Demchok, and Aksai, China (Encyclopaedia of International Boundaries, 1995; Columbia Gazetteer, 1998).

India and Pakistan dispute the status of the Jammu and Kashmir region, an area of approximately 220,000 km^2 (Encyclopaedia of International Boundaries, 1995; CIA World Factbook, 2007).

Jordan

The West Bank and Gaza Strip are Israeli-occupied with the exception of territories under control of the Palestinian Authority, as delineated in the 1995 "Israeli-Palestinian Interim Agreement on the West Bank and the Gaza Strip," commonly referred to as "Oslo II", and in the 1998 agreement signed at Wye. Permanent status is to be determined during further negotiation (CIA World Factbook, 2007).

Israel and Syria dispute the Golan Heights, which is currently administered by Israel (CIA World Factbook, 2007).

Topographically, Egypt is riparian to the Jordan River basin, however Egyptian territory does not contribute water to the basin, except for the possibility of intermittent, seasonal wadis.

Kura-Araks

The boundaries of the Caspian Sea remain to be determined among Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan (CIA World Factbook, 2007).

Mekong

Parts of the boundary between Cambodia and Thailand are indefinite, including overlapping claims in the Gulf of Thailand, an area potentially containing oil and gas deposits, and an island located near the boundary between Cambodian Koh Kong and the Thai province of Trat (CIA World Factbook, 2007; IBRU, 1999).

Parts of the boundary between People's Democratic Republic of Laos and Thailand are indefinite. The two countries have an agreement to demarcate their boundary, but demarcation was suspended in February, 1998 (CIA World Factbook, 2007; IBRU, 1999).

Ob

The boundaries of the Caspian Sea remain to be determined among Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan (CIA World Factbook, 2007).

Oral/Ural

The boundaries of the Caspian Sea remain to be determined among Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan (CIA World Factbook, 2007).

Pandaruan

Brunei may wish to purchase the Malaysian salient that divides the country (CIA World Factbook, 2007).

Red/Song Hong

Sections of the land boundary between China and Vietnam are indefinite (CIA World Factbook, 2007).

Samur

The boundaries of the Caspian Sea remain to be determined among Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan (CIA World Factbook, 2007).

Sembakung

Brunei may wish to purchase the Malaysian salient that divides the country (CIA World Factbook, 2007).

Sulak

The boundaries of the Caspian Sea remain to be determined among Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan (CIA World Factbook, 2007).

Tarim

Kyrgyzstan and Tajikistan have a territorial dispute regarding their boundary in the Isfara Valley area (CIA World Factbook, 2007).

Disputed boundaries between China and India include approximately 25,900 km^2 in the regions of Sang, Demchok, and Aksai, China (Encyclopaedia of International Boundaries, 1995; Columbia Gazetteer, 1998).

India and Pakistan dispute the status of the Jammu and Kashmir region, an area of approximately 220,000 km^2 (Encyclopedia of International Boundaries, 1995; CIA World Factbook, 2007).

Terek

The boundaries of the Caspian Sea remain to be determined among Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan (CIA World Factbook, 2007).

Tigris-Euphrates/Shatt al Arab

Iran and Iraq restored diplomatic relations in 1990, but work continues on developing written agreements to settle outstanding disputes from their eight-year war, including boundary demarcation, prisoners-of-war, and freedom of navigation and sovereignty over the Shatt al Arab waterway (CIA World Factbook, 2007).

Appendix 3. Riparian Country Collaborations

Aral Sea

UN Special Programme for the Economies of Central Asia (SPECA) - a result from the Tashkent Declaration

SPECA assists the participating countries to strengthen their cooperation. SPECA addresses, amongst others, transport and border crossing and water management.

Participating countries: Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Republic of Uzbekistan

Date: March 26, 1998

Level/Type of Collaboration: Aral Sea, Ili/Kunes He, Tarim/Economic program

Principal Issue: Joint management

Source: http://www.unece.org/speca/

Chu

UNECE, UNESCAP and OSCE Project: Support for the creation of a transboundary water commission on Chu and Talas Rivers between Kazakhstan and Kyrgyzstan

The project is aimed to assist Kazakhstan and Kyrgyzstan in making the Agreement on Utilization of the Water Facilities of Interstate Use on the Chu and Talas Rivers between the Government of the Republic of Kazakhstan and the Government of the Kyrgyz Republic of 21 January 2000 operational. According to the Agreement, a permanent bilateral commission is to be established in order to operate the water facilities of interstate use and define and share the costs for their exploitation and maintenance.

Participating countries: Kazakhstan, Kyrgyzstan *Date:* 2003 - 2004

Level/Type of Collaboration: Official/Economic program

Principal Issue: Joint management

Source: http://www.talaschu.org/index.php

Ganges-Brahmaputra-Meghna

CGIAR Challenge Program: Water for Food

Benchmark basin: Indo-Gangetic basin. To improve the productivity of water (in crop, livestock and fisheries production systems and ecosystem services) within the basin, by generating and applying knowledge on how to manage trade-offs and promote synergies to enhance water productivity, while maintaining or improving food security and environmental sustainability.

Participating countries: Bangladesh, India, Nepal, Pakistan *Date:* November 2002 - 2012

Level/Type of Collaboration: Non-official/International initiative

Principal Issue: Other: research and education

Source: http://www.waterforfood.org/BB_Indo_Genatic.asp

Golok

Golok River Mouth Improvement Project

Identified through the Golok River Basin Study that was jointly undertaken by the Governments of Malaysia and Thailand in 1986. Subsequently, in 1992, the Governments of Malaysia and Thailand agreed to proceed with a joint detail study and design of the Golok River Mouth Improvement Project.

Participating countries: Malaysia, Thailand *Date:* 1992

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Other: research and education

Source: http://agrolink.moa.my/did/coast/sg_golok_web/00golokrivereng/topic03in.html

Golok River Mouth Improvement Project

An Inter Governmental Agreement between Malaysia and Thailand was signed between the Ministers of Agriculture of both countries on 7th March 1997. This agreement outlines the commitment of both countries for the joint implementation of the Golok River Mouth Improvement Project, as well as the methodology for cost sharing, supervision, monitoring and maintenance.

Participating countries: Malaysia, Thailand *Date:* March 7, 1997

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Water quality, other: research and education

Source: http://agrolink.moa.my/did/coast/sg_golok_web/00golokrivereng/main.html

Ili/Kunes He

UN Special Programme for the Economies of Central Asia (SPECA) - a result from the Tashkent Declaration

SPECA assists the participating countries to strengthen their cooperation. SPECA addresses, amongst others, transport and border crossing and water management.

Participating countries: Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Republic of Uzbekistan

Date: March 26, 1998

Level/Type of Collaboration: Aral Sea, Ili/Kunes He, Tarim/Economic program

Principal Issue: Joint management

Source: http://www.unece.org/speca/

Jordan

Green Cross International / PC—> CP project: Transboundary Basin Sub-Projects: The Jordan

Water for Peace in the Jordan River Basin. The broad objective of the proposed project is to prevent future water related conflicts from occurring in the region.

Participating countries: Israel, Jordan, Palestinia, Syria *Date:* 2001 - 2003

Level/Type of Collaboration: Non-official/International initiative, social / health program

Principal Issue: Joint management, other: research and education

Source: http://www.riob.org/ag2002/WaterForPeace.htm

EU Water Initiative - Water for Life project: GREM

Groundwater recharge in the Eastern Mediterranean (GREM)- A comparative study on integrated evaluation techniques for groundwater resources, including research institutions from Germany, Greece and Cyprus. Funded by the EC.

Participating countries: Israel, Jordan *Date:* 1997 - 2000

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Technical cooperation / assistance

Source: http://europa.eu.int/comm/research/water-initiative/projects/ic18_ct_1997_0143_en.htm

MEKONG

IUCN Water and Nature Initiative: Mekong. Where large and small meet. Demonstration site.

The programme is a combined venture between the UNDP, the World Conservation Union, and the intergovernmental Mekong River Commission to help preserve the biodiversity of wetlands in the lower Mekong Basin.Vietnam is expected to sign up to the agreement in coming months.The Mekong Programme therefore works at different levels. It works in four field sites to improve wetland planning and management - Stoeng Treng, Cambodia; Attapeu province, Lao PDR; Songkram river basin, Thailand; and the Plain of Reeds, Vietnam. It works with the four governments and the National Mekong River Committees to build capacity, encourage participation and coordinate various departments to better take local realities into account in policies and plans. And it works at the regional level with the governments and the Mekong River Commission to integrate local livelihoods and biodiversity conservation into basin-wide planning processes.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: July 2004 - July 2009

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Water quality, joint management

Source: http://www.iucn.org/themes/wani/1i.html

MRC project: the Basin Development Plan (BDP)

An Integrated Water Resources Management and Development Plan for the Mekong Basin. The plan aims at identification, active promotion and coordinated implementation of priority initiatives and investment opportunities, as agreed between the member countries.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: October 2001 - October 2007

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Water quality, joint management

Source: http://www.mrcmekong.org/

MRC project

The Water Utilization Programme (WUP) to develop "rules" for water use that are agreed upon by the four governments of the Lower Mekong Basin. WUP aims to improve water management and ensure mutual beneficial water utilization in the Lower Mekong River Basin while maintaining its ecological balance. In order to accomplish these objectives, the WUP will create an integrated knowledge base, providing data and decision support, as well as a comprehensive hydrological modelling package.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: Data not available

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Water quantity, joint management

Source: http://www.mrcmekong.org/

MRC project

The Environment Programme strengthens the framework for transboundary environmental management by the four Lower Mekong countries. The Environment Programme will generate data, information and knowledge for decision-making to balance economic development and environmental conservation that will benefit the Basin's inhabitants.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: Data not available

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Water quality, joint management

Source: http://www.mrcmekong.org/

MRC project

The Flood Management and Mitigation Programme focuses on three areas: providing technical products and services, addressing differences and facilitating solutions, and capacity building and technology transfer.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: Data not available

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Flood relief/control, joint management

Source: http://www.mrcmekong.org/

MRC project

The MRC supports an ongoing Integrated Capacity-Building Programme. This programme has provided support to the Secretariat and National Mekong Committees in each country for improved systems of administration, management and communications.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: Data not available

Level/Type of Collaboration: Official/Economic program

Principal Issue: Joint management

Source: http://www.mrcmekong.org/

MRC project: Agriculture, Irrigation and Forestry

The programme focuses on water-use efficiency, catchment management and capacity building. In 2002, watersheds in the Lower Mekong Basin were inventoried and key areas of transboundary significance were selected for activities.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: 2002

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Irrigation, water quantity, joint management

Source: http://www.mrcmekong.org/

MRC project: The Fisheries Programme

Aim: to manage the productive Mekong fisheries so as to sustain their high yield and economic output well into the future. The programme does research into capture fisheries, trains fisheries managers, promotes aquaculture of indigenous Mekong fish species and disseminates information to policy makers and planners in the four Lower Mekong countries.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: Data not available

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Fishing, joint management

Source: http://www.mrcmekong.org/

MRC project: The Navigation Programme

To promote freedom of navigation on the Mekong, and increase social development and international trade opportunities using the natural navigation potential of the river system.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: Data not available

Level/Type of Collaboration: Official/Economic program

Principal Issue: Navigation, joint management

Source: http://www.mrcmekong.org/

WWF project: Promoting International Cooperation on River Basin Management for the Amur and Mekong Rivers

This project will increase input from China into regional IRBM (integrated river basin management). The Objective is to establish partnerships with like-minded organizations (e.g., research/academic organizations, other NGOs, appropriate government agencies) in promoting IRBM approaches in China and to provide information and assistance to the Mekong and Amur river basin programmes that are run by the Indochina and Russian Far East offices of WWF, respectively. International cooperation on NGO-level.

Participating countries: China, Indochina, Russia, Thailand, Vietnam *Date:* Data not available

Level/Type of Collaboration: Non-official/Environmental program

Principal Issue: Other: research and education

Source: http://www.wwfchina.org/english/sub_loca.php?loca=21&sub=91

IBRD/WB project: Mekong River Basin Water Utilization Project

The Project's broad development objectives would be to assist the MRC to establish mechanisms to promote and improve coordinated and sustainable water management in the Basin, including reasonable and equitable water utilization and water quality management by the countries of the Basin and protection of sensitive ecological systems including wetlands, flooded forests and the estuary system that support globally significant bio-diversity. This would be achieved through preparation of "Rules" for water utilization (in particular, minimum in-stream flows on the Mekong River) and protocols for information exchange, notification/consultation in accordance with the Mekong Agreement.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: 7-year span. Approved 07 May 1999; effective March 2000.

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Water quantity, joint management

Source: http://www.gefonline.org/projectDetails.cfm?projID=615

WWF project: Living Mekong Programme (LMP)

A regional multi-disciplinary project aimed at marrying biodiversity conservation with sustainable development. Various WWF staff contribute to LMP planning, including the China, Indochina and Thailand Programme Offices, WWF country directors in Cambodia, Laos and Vietnam, the coordinator of the Asia/Pacific Climate Change Programme, the WWF International Asia/Pacific Programme and WWF International Living Waters Programme staff.

Participating countries: Cambodia, China, Indochina, Laos, People's Republic of, Thailand, Vietnam

Date: December 1, 2002 - December 31, 2004

Level/Type of Collaboration: Non-official/Economic, social and environmental program

Principal Issue: Water quality, joint management

Source: http://www.panda.org/about_wwf/where_we_work/asia_pacific/where/indochina/mekong_river/projects/project_details.cfm?sPrjId=9S0750

Website: MekongInfo

MekongInfo is a platform for sharing of information and experiences in natural resources management in the Mekong River Basin. MekongInfo is hosted by the Mekong River Commission. It is an interactive system for sharing information and knowledge about participatory natural resource management (NRM) in the Lower Mekong Basin. In addition to over 4,200 documents (full-text and abstract) in the Library, Reference and Case Studies MekongInfo provides: a Contacts database of individuals, projects and organisations, news and Announcements of events, relevant Web Links, a Gallery of useful resource materials, a Forum for online discussions, and a free Web hosting service.

Participating countries: Cambodia, Laos, People's Republic of, Thailand, Vietnam *Date:* 2001

Level/Type of Collaboration: Non-official/International initiative

Principal Issue: Other: research and education

Source: http://www.mekonginfo.org/mrc

CGIAR Challenge Program: Water for Food. Benchmark basin: the Mekong river.

To improve the productivity of water (in crop, livestock and fisheries production systems and ecosystem services) within the basin, by generating and applying knowledge on how to manage trade-offs and promote synergies to enhance water productivity, while maintaining or improving food security and environmental sustainability. The Benchmark Basins provide a geographical focus and the river basin is where the water problems and issues converge.

Participating countries: Cambodia, Laos, People's Democratic Republic of, Thailand, Vietnam

Date: November 2002 - 2012

Level/Type of Collaboration: Non-official/International initiative

Principal Issue: Water quality, water quantity, fishing, economic development, joint management, technical cooperation/assistance

Source: http://www.waterforfood.org/BB_Mekong_River_Basin.as

The Mekong-Ganga Cooperation (MGC)

A loose grouping that aims to focus attention on cooperation in the areas of tourism, culture, education and communications between India and the five Mekong river basin countries

Participating countries: India, Myanmar, Thailand, Laos, People's Democratic Republic of, Cambodia, Vietnam *Date:* November 10, 2000

Level/Type of Collaboration: Official/Economic program

Principal Issue: Economic development, other: research and education

Source: http://www.frontlineonnet.com/fl1724/17240490.htm

ADB project: the Great Mekong Sub region Cooperation

The Greater Mekong Sub region (GMS) comprises Cambodia, the People's Republic of China, Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam. These six countries entered into a program of sub regional economic cooperation, designed to enhance economic relations among the countries. The program has contributed to the development of infrastructure to enable the development and sharing of the resource base, and promote the freer flow of goods and people in the sub region. It has also led to the international recognition of the sub region as a growth area.

Participating countries: Cambodia, China, Laos, People's Democratic Republic of, Myanmar, Thailand, Vietnam *Date:* 1992

Level/Type of Collaboration: Official/Economic program

Principal Issue: Economic development

Source: http://www.adb.org/GMS/default.asp

Red / Song Hong

EU Water Initiative - Water for Life project: FLOCODS

Decision Support System for ecosystem upgrading and flood control of a sustainable development in the Red River System (China, Vietnam) Pilot Phase. Research project funded by the EC; includes research institutions from France, the Netherlands and Portugal.

Participating countries: China, Thailand, Vietnam *Date:* 2001 - 2004

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Technical cooperation / assistance

Source: http://europa.eu.int/comm/research/water-initiative/projects/ica4_ct_2001_10035_en.htm

Talas

UNECE, UNESCAP and OSCE Project: Support for the creation of a transboundary water commission on Chu and Talas Rivers between Kazakhstan and Kyrgyzstan

The project is aimed to assist Kazakhstan and Kyrgyzstan in making the Agreement on Utilization of the Water Facilities of Interstate Use on the Chu and Talas Rivers between the Government of the Republic of Kazakhstan and the Government of the Kyrgyz Republic of 21 January 2000 operational. According to the Agreement, a permanent bilateral commission is to be established in order to operate the water facilities of interstate use and define and share the costs for their exploitation and maintenance.

Participating countries: Kazakhstan, Kyrgyzstan *Date:* 2003-2004

Level/Type of Collaboration: Official/Economic program

Principal Issue: Joint management

Source: http://www.talaschu.org/index.php

Tarim

UN Special Programme for the Economies of Central Asia (SPECA) - a result from the Tashkent Declaration

SPECA assists the participating countries to strengthen their cooperation. SPECA addresses, amongst others, transport and border crossing and water management.

Participating countries: Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Republic of Uzbekistan

Date: March 26, 1998

Level/Type of Collaboration: Aral Sea, Ili/Kunes He, Tarim/Economic program

Principal Issue: Joint management

Source: http://www.unece.org/speca/

Tumen

UNDP/GEF project: Tumen River Area Development Program (TRADP)

A Northeast Asian Strategic Action Program to protect Transboundary Biodiversity and International Water Resources and to attract Green Investment. Part of this Program is: the Tumen River Strategic Action Program (TRSAP). The project comprises 5 major project components: (EIS) Environmental Information System; (TDA) Transboundary Diagnostic Analysis; (AWARE) Awareness Raising Program (provision of information about ecological problems to the residents of the area where the project is supposed to be implemented); (SAP) Strategic Action Program; (SURWEY) Regional Water Survey. TumenNET (http://www.tumennet.org/) is an initiative under the TRADP.

Participating countries: China, Mongolia, the Republic of Korea, Russia *Date:* 1991

Level/Type of Collaboration: Official/Economic and environmental program

Principal Issue: Water quality, economic development

Source: http://www.tumennet.org/, http://tumennet.febras.ru/eng/?findings_for_discussion, http://www.nautilus.org/archives/papers/enviro/hunter_tumen.html

IW Learn project

Preparation of a Strategic Action Programme (SAP) and Transboundary Diagnostic Analysis (TDA) for the Tumen River Area, its coastal regions and related Northeast Asian Environs.

Participating countries: Democratic People's Republic of Korea, Mongolia, People's Republic of China, Republic of Korea, Russia *Date:* 1997 - 1999

Level/Type of Collaboration: Official/Environmental program

Principal Issue: Water quality, joint management

Source: http://www.iwlearn.net/docs/tumen/trsap00e.pdf

Tumen Environmental Initiative under the China Biodiversity Network

The main objectives for the Tumen Environmental Initiative were to raise awareness of the ecological importance of the Tumen River region and advocate for its protection within relevant Russian and Chinese ministries and the international community.

Participating countries: China, Russia *Date:* 1996

Level/Type of Collaboration: Non-official/Environmental program

Principal Issue: Water quality

Source: http://www.earthisland.org/cbn/tumenreport.html

Appendix 4. Tenders for Large Projects

Ganges

Rural Electrification Development Project (formerly Small Hydropower and Rural Electrification Project)

Examine (i) the feasibility of developing a project on small-scale hydropower development to provide electricity to the poor and reduce environmental pollution created by alternative fuels, and (ii) policy options to improve the market-based policy environment to promote small-scale hydropower in rural areas. Two western provinces such as Yunnan, Guizhou, or Gansu will be selected as the project area. The TA aims to produce a feasibility study that will examine a sector project to address off-grid supply in remote areas rich in water resources. About 10 small-scale hydropower plants, each with not more than 25 MW installed capacity, will be selected in each province.

Country: China *Sector:* Energy/hydropower generation

Cost in millions (USD): 0.5 *Status:* Fact-finding mission scheduled for February of 2008

Source: http://www.adb.org/Documents/Profiles/PPTA/34499012.ASP

Heilong Jian-Amur

The Ni'erji water control Project

The objective of this large-scale multipurpose project is to control the drainage of the upper reaches of the Nenjiang River, in the Songnen Plain. The reservoir is designed to provide a total storage capacity of 8.152 billion m^3 and a flood control capacity of 2.368 m^3. The hydropower capacity is on the order of 250 MW. Other benefits include: irrigation, water supply and navigation channel improvement in the lower stream.

Country: China *Sector:* Flood control, water supply, power, navigation

Cost in millions (USD): Data not available *Status:* Construction schedule: 2001-2005

Source: http://www.chinagate.com.cn/english/1381.htm

Helmand

Small to Medium Hydropower Development Project

The objective of the project is to facilitate essential investments required for power sector development in Afghanistan and invest in underserved and off grid areas, mobilizing local resource (small to medium hydropower) for maximum community benefits. The fact-finding study will review existing hydropower assessment work and prepare a project suitable for external financing.

Country: Afghanistan *Sector:* Power

Cost in millions (USD): 0.8 *Status:* Approved October 3, 2005

Source: http://www.adb.org/Documents/Profiles/PPTA/39078012.ASP

Ili River

Jilingtai

Project objective: power, irrigation, flood control. Installed capacity: 460 MW.

Country: China *Sector:* Power, irrigation, flood control

Cost in millions (USD): Data not available *Status:* Construction schedule: 2002-2008

Source: http://www.chinawest.gov.cn/english/asp/showinfo.asp?name=200107270003

MEKONG

Da Chaoshan

Power. Installed capacity: 1350 MW

Country: China *Sector:* Power

Cost in millions (USD): Data not available *Status:* Construction schedule: 1997-2003

Source: http://us.tom.com/english/1446.htm

Jing Hong

Installed capacity: 1750 MW

Country: China *Sector:* Flood regulation, power, navigation

Cost in millions (USD): Data not available *Status:* Construction schedule: 2004-2009

Source: http://www.pnl.gov/china/thaihydro.htm

Nua Zhadu

Installed capacity: 5850 MW

Country: China *Sector:* Power

Cost in millions (USD): Data not available *Status:* Construction schedule: 2005-2017

Sponsors: Electricite de France (EDFI), Electricity Generating Public Company Ltd. (EGCO), Government of Laos (GOL), Italian Thai Development Public Company Limited (ITD)

Source: http://www.adb.org/Documents/Profiles/PS/37910014.ASP

Nam Theun 2 Hydroelectric Project

The NT2 hydropower facility would have an installed capacity of 1,070 MW, providing 995 megawatt (MW) of power for export to Thailand and an additional 75 MW for domestic use. The main features of the hydropower facility component include: a 48 meter high gravity dam on the Nam Theun river; a 450 square kilometer reservoir; a powerhouse (from which water would flow into the Xe Bang Fai river, also a tributary of the Mekong); a 130 kilometer long, double circuit 500 kV transmission line to the Thai grid; and a 70 kilometer long, single circuit 115 kV transmission line to Lao's domestic grid.

Country: Laos *Sector:* Water, sanitation and flood protection

Cost in millions (USD): 1,250 *Status:* Approved 2005

Source: http://pid.adb.org:8040/pid/LoanView.htm?projNo=37734&seqNo=01&typeCd=3

Thuong Kontum (Upper Kontum) Dam

Installed capacity is 210-MW. The proposed dam would be located 110 km upstream of the Yali Fall dam. It is the uppermost dam planned on the Se San River. The reservoir area: 14 km^2.

Country: Vietnam *Sector:* Power

Cost in millions (USD): 276 *Status:* Approved 2001

Source: http://www.vir.com.vn/Client/VIR/index.asp?url=content.asp&doc=4570

Nuozhadu Dam

Would generate 5,500 MW. This is one of the six dams China plans to put in operation between 2010 and 2015 to meet the growing demand for electricity in its southern and eastern provinces.

Country: China *Sector:* Power

Cost in millions (USD): 3,600 *Status:* Pre-construction, planning phase. Completion in 2015.

Source: http://internationalrivers.org/files/03.uppermekongfac.pdf

Xiaowan Dam

At 292 meters in height, Xiaowan would be one of the highest dams in the world. Impoundment of water during the wet season for Xiaowan would increase dry season flows by up to 70% as far as 1,000 km downstream in Vientiane, Laos. The dam would block 35 percent of the silt that nourishes the fertile floodplains downstream. Part of eight planned dams on the Lancang will supply power to southwest China and Thailand.

Country: China *Sector:* Power

Cost in millions (USD): 6.38

Status: Construction began in December of 2001; it will be completed in 2012.

Source: http://www.china.org.cn/english/environment/42990.htm

Se San 4 Dam

The dam is projected to generate 255-MW of electricity. It would be located 50 km downstream of the Se San 3 dam site. It is the furthest project downstream on the Se San River in Vietnam. The dam will be 60m high. The reservoir is 54 km2.

Country: Vietnam *Sector:* Power

Cost in millions (USD): US$252 million *Status:* Approved 2001

Source: http://www.ngoforum.org.kh/Environment/Docs/politics_of_the_se_san.htm

Longqingxia Hydropower Station Project

This project is expected to generate 2.5-MW of power. Located on the Beiqu River (main source of Lancang River), Qinghai Province (Tibet)

Country: China *Sector:* Power

Cost in millions (USD): US$6.3 million

Status: Feasibility studies have been completed. Construction contracts have not been awarded.

Source: http://www.rwesa.org/lancang/intro.html

Jinghong Dam

Part of eight planned dams on the Lancang will supply power to southwest China and Thailand.

Country: China *Sector:* Power

Cost in millions (USD): 1,200 *Status:* Pre-construction, planning phase. Completion in 2016

Source: http://groups.google.com/group/Lancang-Mekong/browse_thread/thread/8659d8773a9b0326

Se San 3 Dam

The project is projected to generate 273-MW of electricity. Storage capacity is 162 million m^3. Reservoir is 6.4 km^2. The dam will be 73 m high. Will be located on the Se San River, 20 km downstream from Yali Falls Dam. The dam would be located in Gia Lai and Kon Tum provinces.

Country: Vietnam *Sector:* Power

Cost in millions (USD): 273 *Status:* Approved in 2001, completion in 2007

Sponsors: Vietnam Government

Source: http://internationalrivers.org/en/southeast-asia/cambodia/villagers-voice-outrage-over-plans-build-sesan-3

Red

Son La Dam

This 3,600-MW hydropower project would flood an area of 44,043 hectares. The 177-m dam is being proposed to control floods and irrigate downstream areas, including midlands and the Red River delta. Located on the Da River, It Ong commune, Muong La district, Son La province (North Vietnam).

Country: Vietnam *Sector:* Power

Cost in millions (USD): US$3.55 billion*Status:* Construction has been delayed until 2005 and is expected to take 15 years.

Source: http://www.wrm.org.uy/bulletin/69/Vietnam.html

Salween

Ta Sang Dam

The Tasang Dam would be a hydroelectric dam with a likely generating capacity of at least 3,300 megawatts and a cost of at least US$3 billion. It would be the tallest dam in Southeast Asia, at least 188 m high. The flood area caused by the dam would cover at least 640 km2.

Country: Myanmar *Sector:* Power

Cost in millions (USD): US $3 Billion *Status:* Pre-construction, planning phase.

Source: http://www.burmalibrary.org/reg.burma/archives/199904/msg00416.html

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Index of Basin Names

Waterfall, Ganges River basin. Photo credit: Tom and Heidi Powell.

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International, regional, and local level conflicts regarding access to and use of freshwater pose a serious threat to both human security and the security of the countries in this region, especially so in those areas which are already severely affected by water scarcity. Issues of transboundary water resources are complex and sensitive, as these involve national sovereignty of riparian countries. The fragmented approach to water management is a major challenge which is likely to increase the potential for conflict and competition both at the local and international level if appropriate management approaches like Integrated Water Resource Management and ecosystem management system-based approaches are not applied. Despite these difficulties, progress has been made in adopting basin-wide approaches to resolve some issues.

This publication on hydropolitical vulnerability and resilience along international borders promotes a broader dissemination of assessed information and data for informed policy-making.

For further information

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