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Water is a unique and vital resource, for which there is no substitute. In Latin America and the Caribbean, major rivers, lakes, and aquifers are shared by two or more countries. The region is characterized by the greatest availability of freshwater resources. However, the distribution of water to all nations is heterogeneous, which increases the risk of being used or adapted inequitably. As a result, the likelihood of tension and conflict rises between nations in the region in the midst of competing use and requirements for the resource by its communities and its ecosystems.

It is estimated that three-quarters (75%) of the water in the region is used for agriculture, while 40% of the total population in Latin America and the Caribbean have access to only 10% of the region's water. Many parts of the region still lack access to good quality water and sanitation.

Sustainable management of this rich resource in the region is complex. Currently, several regional and sub-regional entities are working together to develop, manage, and share multiple-use of the water resource. In recent years the sustainability discourse has broadened to include human systems, at the same time work has increasingly been geared towards identifying indicators of hydropolitical resilience and vulnerability within this broader context. The purpose of this publication on hydropolitical vulnerability and resilience along international is to warrant broader promotion and dissemination of assessed information and data in order to support informed policy-making and provide a model for other regions that face similar water challenges.

Hydropolitical Vulnerability and Resilience along International Waters
LATIN AMERICA AND THE CARIBBEAN

# Hydropolitical Vulnerability and Resilience along International Waters

## LATIN AMERICA AND THE CARIBBEAN

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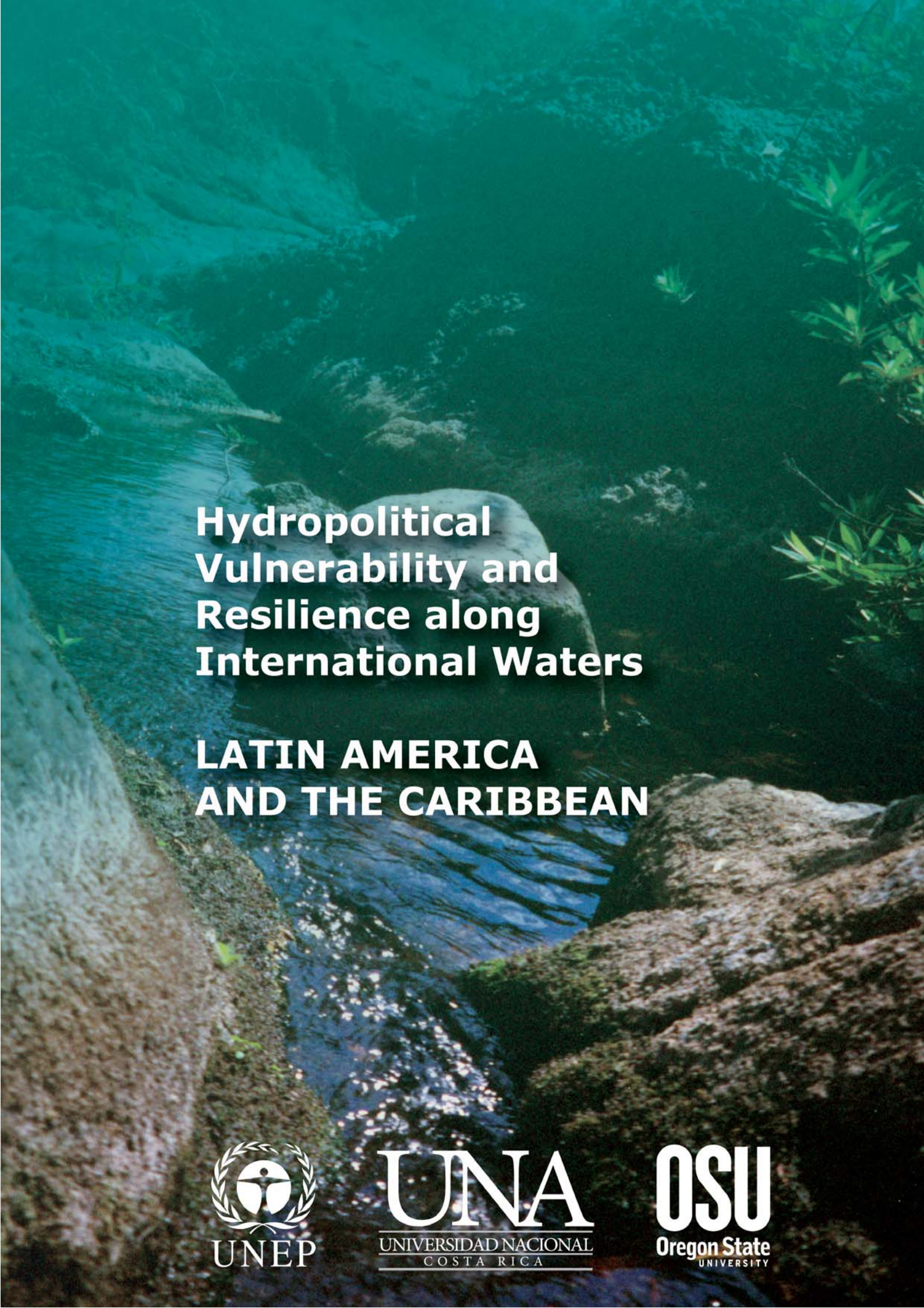

# Hydropolitical Vulnerability and Resilience along International Waters

## LATIN AMERICA AND THE CARIBBEAN

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*Hydropolitical Vulnerability and Resilience along International Waters: Latin America and the Caribbean* is the second of a five-part series of continental reports. This volume was compiled in collaboration between UNEP-DEWA, OSU's Transboundary Freshwater Dispute Database (TFDD) Research Group, and Universidad Nacional Costa Rica, Mesoamerican Center for Sustainable Development of the Dry Tropics (UNA-CEMEDE). "Hydropolitical Vulnerability and Resilience: Series Introduction (Chapter 1)" was authored by Aaron T. Wolf, Oegon State University, Department of Geosciences. "Hydropolitical Resilience and Vulnerability in Central America and the West Indies" (Chapter 2) was authored by Alexander López Ramírez, Universdad Nacional, Costa Rica. "Hydropolitical Resilience and Vulnerability in South America" (Chapter 3) was authored by Joshua T. Newton of OSU. Maps throughout the report and tables in the appendices were compiled by the Transboundary Freshwater Dispute Database (TFDD) Research Team (Department of Geosciences, OSU), which includes Marloes Bakker, Melissa Carper, Ryan Dey, Nathan Eidem, Barbara Geren, Samuel Littlefield, and Erick Stemmerman.

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# Contents


Preface ..... xi

Foreword ..... xiii

Acknowledgements ..... xv

Chapter 1. Hydropolitical Vulnerability and Resilience: Series Introduction, by Aaron T. Wolf ..... 1

1.1 Hydropolitical Vulnerability and Resilience ..... 1

1.2 Water and Security ..... 5

1.2.1 International Waters ..... 5

1.2.1.1 Examining the Record ..... 5

1.2.1.2 Tensions and Time Lags: Causes for Concern ..... 8

1.2.1.3 Institutional Capacity: The Heart of Conflict Management ..... 10

1.2.2 Intranational Waters ..... 12

1.3 Regional Instability: Political Dynamics of Loss of Irrigation Water ..... 14

Chapter 2. Hydropolitical Vulnerability and Resilience in Central America and the West Indies, by Alexander López Ramírez ..... 17

2.1 International River Basins of Central America and the West Indies ..... 18

2.1.1 Central America ..... 20

2.1.2 West Indies ..... 21

2.2 Environmental Factors, Population Dynamics, and Hydric Availability ..... 21

2.3 Groundwater Resources: Increasing Consumption and Overexploitation ..... 25

2.4 Water Dependency and Interdependency ..... 27

2.5 Triggers of Environmental Change and Conflict Potential in Central America ..... 28

2.5.1 Dam Construction as a Trigger of Socio-environmental Conflict ..... 29

2.5.2 The Negro River Basin: A Transboundary Basin at Risk in Central America ..... 31

2.6 Governance in International River Basins ..... 35

2.6.1 International Cooperation Agreements ..... 35

2.6.2 River Basin Committees: Big Goals, Small Organizations ..... 36

2.6.3 International Projects in Transboundary River Basins ..... 38

2.7 The Role of Institutions in Preventing Conflict and Fostering Cooperation: The Lempa River Basin ..... 38

2.7.1 Environmental Change and Transboundary Cooperation ..... 38

2.7.2 The Trifinio Plan as an Institutional Framework ..... 40

2.8 The Role of Institutions and the Dynamic of Conflict and Cooperation, Regional Integration, and Peace ..... 42

Chapter 3. Hydropolitical Vulnerability of South America's International Water Resources, by Joshua T. Newton ..... 45
3.1 South America's International River Basins ..... 45
3.2 Issues of Vulnerability: Where are the Gaps? ..... 49
3.2.1 Hydrological ..... 50
3.2.1.1 Distribution: The Amazon, La Plata, and Orinoco Effect ..... 50
3.2.1.2 Basic Services ..... 50
3.2.1.3 Groundwater Use ..... 52
3.2.1.4 Pollution ..... 53
3.2.1.5 Hydropower ..... 54
3.2.1.6 Climate variability ..... 56
3.2.2 Institutions ..... 57
3.2.2.1 Governance ..... 57
3.2.2.2 Treaties ..... 58
3.2.2.3 Regional Efforts – South American Technical Advisory Committee (SAMTAC) ..... 59
3.2.2.4 Public Participation ..... 60
3.2.3 Socioeconomic Factors ..... 62
3.2.3.1 Demographics and Development ..... 62
3.2.3.2 Poverty ..... 63
3.2.4 Hydropolitical Vulnerability: The Silala, a Small-Scale Example ..... 64
3.3 Mitigation of International Waters Conflict in South America ..... 66
3.3.1 La Plata River Basin ..... 66
3.3.2 Lake Titicaca ..... 70
3.4 Conclusions ..... 74
Atlas of Hydropolitical Vulnerability and Resilience ..... 79
Biophysical Parameters ..... 80
Socioeconomic and Geopolitical Parameters ..... 83
Institutional Capacity ..... 85
Appendices ..... 89
Appendix 1. International Freshwater Agreements, River Basin Organizations, and River Basin Commissions of Latin America ..... 91
Appendix 2. Notes on Basins ..... 114
Appendix 3. Riparian Country Collaborations ..... 116
Appendix 4. Tenders for Large Projects ..... 128
References ..... 131
Index of Basin Names ..... 135

# Lists of Tables, Figures, Maps, and Acronyms

## Tables


Table 1.1 Selected examples of water-related disputes ..... 6

Table 2.1 Number of river basins by country in Central America and the West Indies ..... 18

Table 2.2 International river basins of Central America and the West Indies ..... 19

Table 2.3 Percentage of country in international river basins in Central America and the West Indies ..... 20

Table 2.4 Main environmental problems for international river basins in Central America and the West Indies ..... 22

Table 2.5 International basins in protected areas on Hispaniola Island ..... 23

Table 2.6 Availability of water resources ..... 24

Table 2.7 Population and provinces affected by the 2000-2001 drought ..... 25

Table 2.8 International river basins: Cooperation and protection agreements ..... 36

Table 2.9 Central America and West Indies river sub-basin organizations ..... 37

Table 2.10 Major cooperative projects developed in international river basins ..... 37

Table 3.1 Basin statistics ..... 48

Table 3.2 South American international basin coverage ..... 55

Table 3.3 La Plata River Basin countries, basin area, and population ..... 68

Table 3.4 Lake Titicaca Basin information ..... 71

Table 3.5 Hydropolitical vulnerability in South America's international basins ..... 72


## Figures


Figure 1.1 International river basins in Latin America ..... 2

Figure 1.2 International river basins and countries, territories, and areas of Latin America ..... 3

Figure 2.1 Negro River Basin ..... 31

Figure 2.2 Lempa River Basin ..... 39

Figure 3.1 Silala Basin ..... 64

Figure 3.2 La Plata River Basin ..... 67

Figure 3.3 Lake Titicaca Basin ..... 71

# Maps


Map 1 (A) Climate regions ..... 80
(B) Average annual runoff ..... 80
Map 2 (A) Groundwater aquifers ..... 81
(B) Dam density with active and proposed tenders for large infrastructure ..... 81
Map 3 (A) Climate change: temperature ..... 82
(B) Climate change: precipitation ..... 82
Map 4 (A) Projected population density: 2025 ..... 83
(B) Projected water stress: 2025 ..... 83
Map 5 (A) Human development index ..... 84
(B) Agricultural water use ..... 84
Map 6 (A) Water dependency ratio ..... 85
(B) International freshwater treaties per basin ..... 85
Map 7 (A) River basin organizations and commissions ..... 86
(B) Votes on the UN Convention on International Watercourses ..... 86
Map 8 (A) Institutional capacity and proposed Infrastructure ..... 87
(B) Environmental sustainability index ..... 87
Map 9 Riparian country collaborations ..... 88

# Acronyms

| | |
|---|---|
| GEF | Global Environmental Fund |
| IHE | International Hydrological Programme |
| IUCN | International Union for the Conservation of Nature and Natural Resources |
| MW | Megawatt |
| OAS | Organization of American States |
| OTCA | Organización del Tratado de Cooperación Amazónica (Amazon Cooperation Treaty Organization) |
| SAMTAC | South American Technical Advisory Committee |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNEP IW | United Nations Environment Programme / International Waters |

# Preface

Wherever a major river, lake, or aquifer system is shared by two or more nations, decision makers and managers face a challenge of achieving equitable and sustainable use of the water resource. Faced with increasing freshwater demands for multiple societal and environmental needs, the nations sharing these international waters also become vulnerable to tensions and conflict. At the same time, historical evidence from around the world has shown that nations sharing water resources will often seek cooperative and resilient ways to develop, manage, and use them. Such 'hydropolitical cooperation' has become an increasingly critical arena for scientific enquiry and analysis within and between the regions of the world.

With only 15 percent of the world's total landmass, Latin America and the Caribbean enjoy the distinction of being the region with the greatest availability of freshwater resources. However, the sustainable management of this rich resource is complicated by several factors. Firstly, the distribution of the region's fresh water is highly heterogeneous; Brazil, for example, has 40 percent of the region's freshwater resources. While some zones receive over 9000 mm of rainfall each year, others receive virtually none. Then there are the skyrocketing demands imposed by a rapidly growing population of over 560 million inhabitants, with 40 percent of them living in areas holding only 10 percent of the region's water, and nearly 80 million still lacking access to potable water. Third, agricultural activities account for nearly three-quarters of all the water used in the region. Added to this already complex scenario is the fact that most of the major river basins in the region are shared between two or more countries. Meanwhile, the region in common with the rest of the world is facing the impacts and challenges of climate change with wide-ranging likely impacts on hydrological regime.

Today, there are several regional and sub-regional entities, often supported by the international community, working to develop, manage, and share the multiple-use potential of the region's shared water resources. These entities include the Forum of Ministers of Latin America and the Caribbean, the Action Plan for the Joint Management of Water in the Central American Isthmus, and the South American Advisory Committee—all of which are dedicated to the ratification and implementation of bilateral and multilateral water-related agreements. This 'hydropolitical resilience' warrants broader promotion and dissemination in order to support informed policy-making and provide a model for other regions facing similar transboundary water challenges.

Guided by the targets for safe water supply and improved sanitation set by the Millennium Summit and the World Summit on Sustainable Development, UNEP's present and future commitments and activities relating to fresh water are embodied in the UNEP Water Policy and Strategy, including the assessment, management and coordination of transboundary water resources. This report presents a

comprehensive assessment of the hydropolitical vulnerabilities and resiliencies of Latin America's international waters, including detailed information on existing and forthcoming cooperative agreements to develop more sustainable resilience and informed policies at regional, sub-regional, and national levels.

As a critical subject that has been undergoing rigorous scientific inquiry and analysis in recent years, this latest study on *Hydropolitical Vulnerability and Resilience* aims to support informed policymaking and greater cooperation across the diverse social, political and economic boundaries that characterise the Latin American and Caribbean region.

ACHIM STEINER

United Nations Under-Secretary General

Executive Director, United Nations Environment Programme

# Foreword

During the 2002 World Summit on Sustainable Development, the Forum of Ministers of Latin America and the Caribbean adopted the *Latin American and Caribbean Initiative for Sustainable Development (ILAC)*, which provides the basis for collective action for environmental conservation and sustainable development among Latin American and the Caribbean countries. The ILAC highlights the integrated management of water resources as one of eight priority issues to be addressed in the region. Recognising that "natural richness constitutes a potential source for sustainable development and poverty eradication … based upon the development of inner capacities and international cooperation," the Forum of Ministers at its XV Meeting in Caracas in November 2005 further cited regional cooperation on water as "a space for the integration and consolidation of peace among peoples of the region."

More recently, at the Latin American Parliamentarians Meeting on Water Resources in Panama in September 2006, the region's lawmakers adopted the *Panama Declaration on Water*, which confirms the sovereignty of each country over its water resources, and access to sufficient good quality water as a basic human right. The declaration specifies that there is a clear need in Latin America and the Caribbean to establish a permanent framework for the management of shared water basins and to develop common strategies for their sustainable management, including the protection of water catchments, groundwater aquifers, wetlands, and transitional waters.

It is in this context that I, as the Regional Director of the UNEP Regional Office for Latin America and the Caribbean, welcome the publication of *Hydropolitical Vulnerability and Resilience along International Waters: Latin America and the Caribbean*. The close collaboration among the governments of Latin America and the Caribbean, UN agencies, and the international community continues to generate increased awareness of the vulnerabilities affecting the region's shared water resources, as well as the resilience emerging from collective actions at national, sub-regional, and regional levels to confront these challenges. This publication should inspire the continuing development of intergovernmental dialogue and collective action to halt and reverse the water challenges facing this part of the world.

Ricardo Sánchez Sosa

Regional Director

Regional Office for Latin America and the Caribbean, UNEP

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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 Vörösmarty 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.

*Young woman works construction in Padre Nuestro in the Dominican Republic, a new housing development with running water and electricity, aimed at replacing a settlement without water and sewage infrastructure located above a critical aquifer. Photo: Henry Welhouse/USAID.*

# 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 in Latin America.*


*Figure 1.2 International river basins and countries, territories, and areas of Latin America.*

*Lake Titicaca, the largest freshwater lake in South America, located high in the Andes on the border of Bolivia and Peru. Photo credit: Joshua T. Newton.*

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 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:

[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).

## 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).

*Scientist conducting ecological research, La Plata estuary, Argentina. Photo credit: Rolando León.*

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 neighbors, 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 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.

[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.


*Flood rescue efforts along the Choluteca River, Honduras, following Hurricane Mitch, 1998. Photo credit: Debbie Larson, NWS, courtesy NOAA*

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 Viet Nam as an intergovernmental agency in 1957, exchanged data and information on water resources development throughout the Viet Nam 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 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

[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).

*The great waterfall of Iguazú, on the border of Argentina and Brazil. The Iguazú (Portuguese, Iguaçu) is a tributary of the Paraná River in the Triple Frontier of Paraguay, Brazil, and Argentina Photo credit: Rolando León.*

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 neighbors. 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 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

*Soil erosion on deforested river bank, Amazon. Photo credit: Gretchen Bracher.*

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 harbors: 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 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

*Canal of Artibonite River, Haiti. The canal is used for fishing, drinking, swimming, and washing. Photo credit: Sharon Nichols, Rochester Community & Technical College.*

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 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

*Loading sugar, Amazon, Peru. Photo credit: Iva Nafzinger.*

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 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,

*Jaribu storks, Pantanal (Brazil), Paraguay River basin. Photo credit: William M. Ciesla, Forest Health Management Intl., www.forestryimages.*

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 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.

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

[4] Giordano et al. 2002.

*Washing dishes in household without running water, Honduras. Photo credit: Michael Campana.*

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 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

*Ricefield with water buffalo and egret. Haitian rice cannot compete with less expensive imported rice. Photo credit: Sharon Nichols, Rochester Community & Technical College.*

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.

*Epera Indian boy with broken hand pump, La Chunga, Panama. Photo credit: Michael E. Campana.*

# Chapter 2. Hydropolitical Vulnerability and Resilience in Central America and the West Indies

Alexander López Ramírez

Despite their relatively modest land area, Central America and the West Indies contain 29 international river basins. The surface area of these international river basins covers approximately 37% of Central America, an area larger than any single country in the region. This prevalence of shared water resources has important implications for transboundary cooperation and conflict prevention, considering that such processes often require the appropriate management of international river basins.

As an examination of international river basins in Central America and the West Indies will show, there is no evidence to support widespread fears of water wars between states in Latin America. To the contrary, shared river basin management can foster cooperation and sometimes can be a pathway for confidence building and conflict prevention. It is important to recognize, however, that an international river basin does not provide a good foundation for regional cooperation simply by virtue of its crossing national borders. Normally, greater interdependence among riparians and the generation of externalities increases the necessity and possibility of international cooperation.

For transboundary cooperation to be effective, however, solid institutions should be developed. Institutions normally establish a set of rules of conduct which define practices and assign roles when grappling with collective problems. For the parties involved in the management of international river basins, this collective process implies sharing responsibility both for making decisions and for implementing them, as well as a fair opportunity to either prevent conflicts or manage them.

This study is divided into eight sections. The first section provides background information on the international river basins of Central America and the West Indies. Considering that institutions are not stand-alone arrangements, but that they operate within economic, political, and social boundaries that often affect the outcome, the second and third sections explain key factors for understanding conflict and cooperation in transboundary river basins in the two regions analyzed. The fourth section explains the dependency and interdependency generated by the sharing of 29 river basins in these two regions. The fifth section deals with the factors triggering water conflicts in the area; it also presents the case of the Negro River Basin as a river basin at risk, therefore requiring attention from the research and policy side. This section is balanced by the cooperation side presented in the sixth section, where the different categories of institutional frameworks developed in Central America and the West Indies are examined in detail. In the seventh section, the Lempa River basin is presented as case study for exploring the two sides of the dispute setting: the rate of change in the system and the institutional capacity present in an international basin. Some final thoughts on conflict, cooperation, institutions, peace, development, and regional integration are presented in the eighth section.

*Suchiate River, photo credit: Alexander López Ramírez.*

## 2.1 International River Basins of Central America and the West Indies

Central America and the West Indies have a wide variety of climates and a grand capacity for hydric production due to their tropical location, various altitudes, geophysical setting, and insular conditions. Water has shaped and defined this region's landscapes and there are a great variety of river basins (Table 2.1). There are 189 river basins of first order in the 544,751 $km^2$ that comprise the land area of Central America. In the Dominican Republic, there are 14 river basins of first order transporting 15,204 to 20,000 million cubic meters of water annually. Four are considered great basins: the Artibonite, Yuna, Yaque del Norte, and Yaque del Sur rivers. The largest of these basins are the Usumacinta-Grijalva, San Juan, and Coco River basins (Table 2.2).

Guatemala and Honduras are the countries with the most international river basins: in Guatemala, 13 international river basins occupy 64.6% of the country, and in Honduras, 7 basins occupy 18.5%. Other countries with important possession of basins are Belize, with 65.1%, and El Salvador, with almost 62% (Table 2.3).

**Table 2.1 Number of river basins by country in Central America and the West Indies.**

| Country | Number of Basins |
|---|---|
| Panamá | 51 |
| Guatemala | 38 |
| Costa Rica | 34 |
| Belize | 32 |
| Nicaragua | 21 |
| Honduras | 18 |
| El Salvador | 10 |
| Total Central América | 205 |
| Dominican Republic | 14 |
| Haití | No data |
| Total West Indies | — |

*Source:* The Mesoamerican Center for Sustainable Development of the Dry Tropics (CEMEDE) 2004.

## Table 2.2 International river basins of Central America and the West Indies.

| River basins | Countries | Area (km²) |
|---|---|---|
| Usumacinta-Grijalva | Guatemala, México, Belize | 106,000.0 |
| San Juan | Nicaragua, Costa Rica | 38,569.0 |
| Coco o Segovia Wangki | Nicaragua, Honduras | 24,866.6 |
| Lempa | El Salvador, Honduras, Guatemala | 18,234.7 |
| Motagua | Guatemala, Honduras | 15,963.8 |
| Belize | Belize, Guatemala | 12,153.9 |
| Choluteca | Honduras, Nicaragua | 8,132.6 |
| Hondo* | Guatemala, Belize, México | 7,189.0 |
| Chamelecón | Honduras, Guatemala | 5,154.9 |
| Changuinola | Panamá, Costa Rica | 3,387.8 |
| Sixaola | Costa Rica, Panamá | 2,839.6 |
| Goascorán | Honduras, El Salvador | 2,745.3 |
| Negro | Nicaragua, Honduras | 2,371.2 |
| Paz[c] | Guatemala, El Salvador | 2,647.0 |
| Sarstún | Guatemala, Belize | 2,009.5 |
| Suchiate | Guatemala, México | 1,499.5 |
| Coatán Achute | México, Guatemala, | 1,283.9 |
| Corredores-Colorado | Costa Rica, Panamá | 1,281.8 |
| Moho | Belize, Guatemala | 911.9 |
| Temash | Belize, Guatemala | 476.4 |
| Jurado | Panamá, Colombia | 234.3 |
| Chiriqui | | |
| Candelaria | Guatemala, México | 12,800.0 |
| Total for Central America | 25 international river basins | 219,451.9 |
| Artibonite | Dominican Republic, Haití | 9,013.0 |
| La Hoya del Lago Herniquillo** | Dominican Republic, Haití | 3,048.0 |
| Pedernales (Zona de la Sierra del Bahoruco)** | Dominican Republic, Haití | 2,814.0 |
| Dajabón-Massacre** | Dominican Republic, Haití | 858.0 |
| Total for the West Indies | 4 international river basins | 15,733.0 |

* Does not include the Mexican part.

**Includes only the territory of the Dominican Republic.

*Sources:* UIFC-Funpadem 2000; Cabrera y Cuc 2002; Cuenca de los ríos Grijalva y Usumacinta, S.f., Procuenca, San Juan 2004; Plan Maestro y para el Desarrollo Integrado y Sostenible de la Cuenca Binacional del río Paz. Sf.; CEMEDE 2004; TFDD.

*Staff from the Ministry of Natural Resources and Environment measure water levels on the Choluteca River, Honduras. Photo credit: U.S. Geological*

## 2.1.1 Central America

The following are some important aspects of international river basin distribution in Central America:

- Almost all river basins are divided between only two countries, except the Usumacinta-Grijalva, Lempa, and Hondo, which are shared by three countries (Table 2.2). This is significant, since one might think that cooperation is easier when fewer states are involved.
- Some basins are divided nearly equally, such as the Goascoran River basin (48.1% in El Salvador and 51.9% in Honduras) and the Paz River (47.4% in El Salvador and 52.6% in Guatemala).
- The opposite occurs with other basins, that is when one single country possesses the basin almost entirely. This is the case for the Chamelocon River (98% in Honduras and 2% in Guatemala) and the Choluteca River 96.7% in Honduras and 3.3% in Nicaragua). Although these are international basins, they function nearly as domestic basins because of the overwhelming presence of one country in the basin. This is an interesting consideration: one might expect that where the countries' participation is more homogeneous, the necessity of and the possibility for cooperation are greater.

**Table 2.3 Percentage of country in international river basins in Central America and West Indies.**

| Country | Area within basin (%) |
|---|---|
| Belize | 65.1 |
| Guatemala | 64.6 |
| El Salvador | 61.9 |
| Nicaragua | 34.7 |
| Costa Rica | 34.3 |
| Dominican Republic | 19.2 |
| Honduras | 18.5 |
| Panamá | 5.2 |
| Haití* | 0.0 |

*Haití = 0.003%

*Source:* UIFC 2000 and CEMEDE 2004.

To know the dimensions of a river basin and the countries with sovereignty over it does not provide enough information to draw conclusions. The more important factor is not simply *how much* one country possesses—but *how* a basin is divided and the level of dependency. For example, where

*Haitian people who live in the hills may walk 4-6 hours to carry products to/from market. Background: irrigation canal of the Artibonite River. Photo credit: Sharon Nichols, Rochester Community & Technical College.*

one country possesses the upper basin and the lower part belongs to another, one might expect the latter country to have a greater role in the management of the basin, since it also has more at risk concerning deterioration. In the same way, if one of the countries depends heavily on the river basin in question (such as El Salvador on the Lempa), one can expect a higher level of involvement by that country in the management of the basin.

Some countries with international basins show a low interdependency in comparison to their neighbors. This is the case for Panama: Panama shares the small basin of the Jurado River with Colombia. With Costa Rica, Panama shares two larger basins, the Changuinola and Sixaola, which belong in great part to one of the two countries. Likewise, Guatemala and Honduras, with the Motagua and Chamalecon basins, demonstrate very little bilateral participation. On the other hand, countries such as Guatemala and Belize, Honduras and El Salvador, and Mexico and Guatemala, are highly interdependent.

### 2.1.2 West Indies

Except for Hispaniola Island, the individual islands of the West Indies have no political divisions due to their insular condition. Hispaniola Island, the second largest island in the West Indies at 76,430 km$^2$, is shared by two nations: Haiti (36.3%) and the Dominican Republic (63.7%). The 360-km border separates the basins of El Lago Herniquillo and the Pedernales, Dajabón-Massacre, and Artibonite rivers. The Artibonite River is the longest on the island.

## 2.2 Environmental Factors, Population Dynamics, and Hydric Availability

During the final decades of the last century, natural areas of Central America and Hispaniola Island have been marked by many social and economic transformations, provoking big changes in the environment. These changes included the conversion of additional lands to agriculture and other changes in land use, the expansion of farming activities, and increased urban development.

Many river basins are currently suffering the effects of these changes (Table 2.4). Most of the rivers in Central America and the West Indies have high levels of contamination. In many cases, the problems have not been addressed

## Table 2.4 Main environmental problems for international river basins in Central America and the West Indies.

| River basin | Environmental problems | | | |
|---|---|---|---|---|
| | Deforestation | Erosion | Sedimentation | Pollution |
| Usumacinta-Grijalva | ✓ | ✓ | ✓ | ✓ |
| San Juan | ✓ | ✓ | ✓ | ✓ |
| Coco o Segovia Wangki | | ✓ | | |
| Lempa | ✓ | ✓ | ✓ | ✓ |
| Motagua | ✓ | ✓ | ✓ | ✓ |
| Belice | ✓ | ✓ | | |
| Choluteca | ✓ | ✓ | ✓ | ✓ |
| Hondo | | | | |
| Grijalba | | | | |
| Chamelecón | ✓ | ✓ | ✓ | ✓ |
| Changuinola | | | | |
| Sixaola | ✓ | ✓ | ✓ | ✓ |
| Goascorán | ✓ | ✓ | ✓ | ✓ |
| Negro-Guasaule | ✓ | ✓ | ✓ | |
| Paz | ✓ | ✓ | | ✓ |
| Sarstún | | | | |
| Nentón | ✓ | ✓ | | |
| Suchiate | | ✓ | ✓ | |
| Coatán-Achute | | | | |
| Corredores-Colorado | ✓ | ✓ | | ✓ |
| Moho | | | | |
| Temash | | | | |
| Jurado | | | | |
| El Naranjo | | | | |
| Conventillos | | | | |
| Pedernales (Zona de la Sierra del Bahoruco) | | | | ✓ |
| Dajabón-Massacre | ✓ | ✓ | | ✓ |
| Artibonite | ✓ | ✓ | ✓ | ✓ |
| La Hoya del Lago Enriquillo | | | | |
| % occurrence of environmental problems in international basins | **50** | **50** | **25** | **75** |

*Source:* The Mesoamerican Center for Sustainable Development of the Dry Tropics (CEMEDE) with data from: Cabrera y Cuc 2002; Hernández y Rodríguez 2002; Procuenca San Juan 2004; De León 2003; Progolfo 1998; Pasos et al. 1994; Proyecto Gestión ambiental para el manejo integrado de cuencas hidrográficas y áreas costeras en pequeños estados insulares del caribe. Sf, Plan maestro y para el desarrollo integrado y sostenible de la cuenca bionacional del río Paz. S.f.

*Río Goascorán en el puesto fronterizo. Photo credit: Alexander López Ramírez.*

### Table 2.5 International basins in protected areas on Hispaniola Island.

**Antibonito Basin: 82% protected**

*Protected areas*

Parques nacionales Nalga de Maco,
Sierra de Neiba, José del Carmen
Ramírez y Armando Bermúdez

**Dajabón-Massacre Basin: 21.8% protected**

*Protected areas*

Parque Nacional Montecristi

**Pedernales Basin (Zona de la Sierra del Bahoruco): 72.9% protected**

*Protected areas*

Parques nacionales Jaragua y Sierra del Bahoruco
Reserva Biológica Miguel Domingo Fuertes
Monumento Nacional Las Caobas
Vías panorámicas Aceitillar, Mirador del Paraíso y Cabral-Polo

**La Hoya del Lago Enriquillo: 36.5% protected**

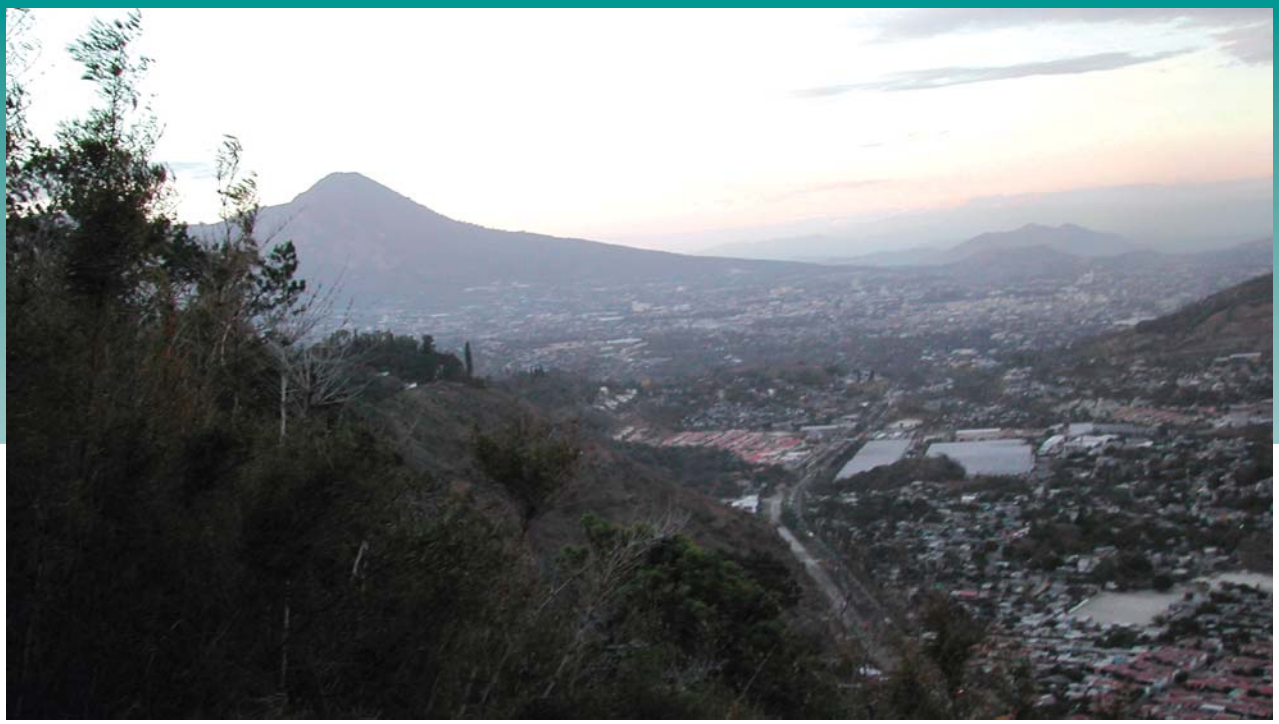
*Protected areas*

Parques nacionales Lago Herniquillo, Sierra de Neiba,
Sierra Bahoruco, Isla Los Cabritos y Donald Dod

*Source:* Proyecto Gestión ambiental para el manejo integrado de cuencas hidrográficas y áreas costeras en pequeños estados insulares del caribe. Sf

and the deterioration continues, even as population levels and water demands increase. There have been some efforts toward environmental protection, however. For example, in Central America, there are two biosphere reserves in the Usumacinta-Grijalva and Sixaola River basins, while on Hispaniola Island, there are protected natural areas in all four international basins (Table 2.5).

The most densely populated international river basins are the Lempa, Choluteca, and Belize. The Lempa River Basin holds 66% of the Salvadorian



*San Salvador, El Salvador. Photo credit: Katherine Hayden.*

population and the Belize River Basin has 45% of the country's inhabitants (Hernandez y Rodriguez 2002; Ministry of Natural Resources, Environment, and Industry 2002). The capital cities of El Salvador (San Salvador), Nicaragua (Managua), Honduras (Tegucigalpa), and Belize (Belmopan) are located in these international basins. Although each of these major cities places a great demand on the water resource, San Salvador, in the lower basin of the Lempa River, is most dependent and has the greatest concern over the proper management of the resource.

With the exception of El Salvador, where conditions are more critical (SG-SIGA 200), water scarcity is not a problem for most

**Table 2.6 Availability of water resources in Central America and the West Indies.**

| Country | Average annual precipitation (mm) | Annual per capita availability ($m^3$) | Total extraction of water (% in 1999) | Urban access to improved sources (% in 2000) | Water used in hydro-energy (%) |
|---|---|---|---|---|---|
| Belize | 1300–4450 | 64,817 | 0.6 | 83 | Sd |
| Costa Rica | 1300–7500 | 31,318 | 5.1 | 98 | 4.7 |
| El Salvador | 1500–2300 | 2,876 | 4.1 | 88 | 18.9 |
| Guatemala | 500–6000 | 12,121 | 2.6 | 97 | 9.2 |
| Haiti | | | | | |
| Honduras | 1500–3000 | 15,211 | 1.6 | 97 | 15.8 |
| Nicaragua | 400–6300 | 38,668 | 0.7 | 95 | 2.3 |
| Panamá | 1500–5500 | 52,437 | 1.1 | 88 | 10.7 |
| Dominican Republic | 500–2700 | 2,551 | 80 | | |

*Source:* CCAD 1998, quoted in SG-SICA. 2000; Campos and Lücke 2003; Proyecto Gestión ambiental para el manejo integrado de cuencas hidrográficas y áreas costeras en pequeños estados insulares del caribe. Sf.

*El lago cerce de Tehscall, El Salvador, in February during dry season, note low lake level. Photo credit: David Huskins.*

Central American countries (Table 2.6). Yet the available information for Central America indicates that the isthmus has a shortage of drinking water, and with an annual growth index rate of 3.5%, the situation will continue to worsen (SG-SICA 200). The aqueduct systems do not satisfy the demand of the population in each state and rainfall distribution is not even. For example, in El Salvador in 1997, 53% of the population was supplied with water from community systems, in contrast with Costa Rica, where 90% of the population was supplied that same year (FAO 2002c; FAO 2002b).

**Table 2.7 Population and provinces and affected by the 2000-2001 drought.**

| Country | Number of provinces | Population |
|---|---|---|
| Guatemala | 16 | 2,500,000 |
| Honduras | 10 | 2,200,000 |
| El Salvador | 4 | 1,200,000 |
| Nicaragua | 16 | 2,600,000 |
| Costa Rica | 1 | No data |

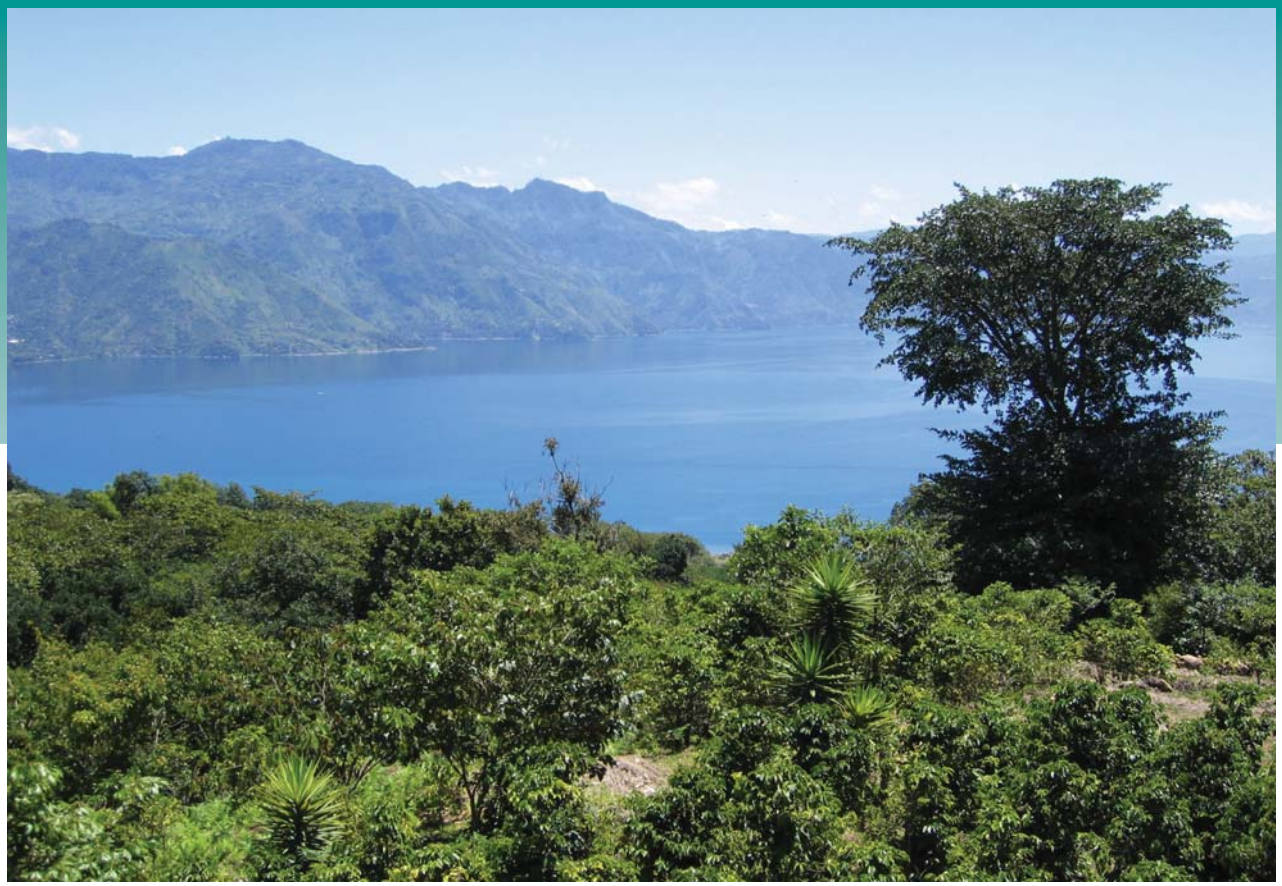
*Source:* Vega 2004.

The situation in El Salvador has improved only slightly since 1997, with 63.7% of the population having access to water supply (PROCEDAMO 2002). The uneven distribution of rain can cause significant problems as well. For example, the drought during 2000–2001 caused agricultural losses and water supply shortages in some areas (Table 2.7). The international river basins affected were the La Paz, Lempa, Goascorán, Choluteca, San Juan, El Naranjo, and Coventillos (Vega 2004).

## 2.3 Groundwater Resources: Increasing Consumption and Overexploitation

Due to the high demand for water resources and the contamination of surface waters, the use of groundwater resources is increasing in Central America. In the upper basins, these groundwater resources are primarily volcanic aquifers. The volcanic aquifers are more important in the isthmus because they provide water to some of the largest cities, such as Ciudad Guatemala, Tegucigalpa, San Salvador, and Managua (Losilla et al. 2001). The major concern for these aquifers is the risk of contamination through use.

In the mid-basins, the aquifers are a mix of alluvial and volcanic materials; in the lower



*Chuwanimajuyu Municipal Park, Lake Atitlán, Guatemala, was established with support from the local government and USAID. Photo credit: TNC/Christa Mehard/USAID.*

basins, the aquifers are made of alluvial land and sedimentary materials (Losilla et al. 2001). These latter aquifers are significant for Honduras, Guatemala, and Belize.

The main aquifers in international river basins in Central America are the following:

*Negro, Chixoy, and Motagua Rivers.* The volcanic aquifers most significant for Guatemala's water supply are found in the Altiplano Central, which covers one tenth of the country of Guatemala. These aquifers are found in nine intermountain basins, which include the Negro and Chixoy Rivers. This is a tributary of the Usumacinta River (Losilla et al. 2001).

In addition, in El Valle de Guatemala, the area occupied by La Vaca River, a tributary of the Motagua, one can find an aquifer that flows almost entirely into this river.

*Choluteca River.* The Honduran city of Tegucigalpa is located in the Choluteca River basin, where there is an important aquifer that provides 5% of the water demands of this urban area.

*Lempa River.* In El Salvador, groundwater resources make up an estimated 34.25% of the total water supply. The Central Depression of El Salvador contains highly permeable volcanic materials. The porous soils and natural drainage feed aquifers, which are an important water source for rivers. This is the case of the Sucio River, a tributary of the Lempa River. The San Salvador aquifer extends 185 $km^2$ and supplies 37% of the water for the larger metropolitan area of San Salvador (Losilla et al. 2001).

*Negro and San Juan Rivers.* In Nicaragua, the more important aquifers are located on the Carazo Plateau, in the León-Chinandega Plains, and the Nicaragua Depression. The León-Chinandega plains include part of the basins of the transboundary rivers Negro and San Juan. These rivers flow into the Managua and Nicaragua Lakes. In Nicaragua, the most important aquifer is the Managua, encompassing an area of approximately 600 $km^2$. It supplies water to 1,500,000 people (Losilla et al. 2001).

There has been little progress toward the management of Central American groundwater, and few advances have been made toward understanding the demand, availability, and direct and indirect effects of transboundary

*Verrettes waterfall, Haiti. Photo credit: Sharon Nichols, Rochester Community & Technical College.*

environmental interdependency. Nevertheless, there has been a marked increase in the exploitation of aquifers, many of which are located beneath the most important cities of the region. In El Salvador, for example, aquifers in metropolitan areas are being overexploited: 76% of the water supply now comes from underground resources, with only 24% from the Lempa River (PROCEDAMO 2002). Belize and Nicaragua are becoming more dependent on the extraction of underground water resources as well. It is therefore necessary to begin to work toward the management of Central American aquifers, especially those of volcanic origin, since they constitute a significant source of drinking water and irrigation water in the region.

## 2.4 Water Dependency and Interdependency

The water dependency and interdependency of each country in the region varies according to the number of countries in the basin and their locations (i.e., upper or lower basin or slope). Guatemala has the largest number of shared international basins in the region. Its surface waters flow into Mexico, El Salvador, Belize, and Honduras (Aragón, Roday, and Hurtado 2002). Furthermore, 42% of the land area of Guatemala falls into one international river basin, the Usumancita (Hamann and Ankersen 1996). With some exceptions, Guatemala is primarily an upper-basin riparian and its neighbors are greatly dependent on its water resources. To date, however, Guatemala does not yet have institutions in place for protecting water quality, including regulating and controlling polluting agents used in agriculture (FAO 2002a).

In the rest of Central America and on Hispaniola Island, the water dependency situation within international river basins is as follows (Map 6a):

In Honduras, it is estimated that 27,780.3 $km^2$ of national land corresponds to international basins. These basins represent 23.4% of shared waters providing 20 $km^3$ of water per year. The Motagua and Chamelecón Rivers send 53.36 $km^3$ to Guatemala; the Lempa and Goascorán Rivers send 5.07 $km^3$ to El Salvador; and Negro and Segovia Rivers provide 6.9 $km^3$ to Nicaragua (FAO 2002f).

*Rural latrine, Honduras. Photo credit: Michael Campana.*

Almost half of the land area of El Salvador is located in the lower basins of three international rivers (Campos and Lucke 2003): the Lempa and Paz Rivers, which flow into the Pacific Ocean, and the Goascorán River, which flows into the Fonseca Gulf. The basins represent 34.56% of the annual flow in the country (FAO 2002c). El Salvador is highly dependent on the Lempa River, particularly for hydropower generation; the Lempa is used to generate 41% of the country's annual energy supply. Furthermore, as noted above, the Lempa aquifer is the primary underground water source in El Salvador, and it is being heavily exploited.

In Nicaragua, it is estimated that the annual 6.9 $km^3$ of water flow to three international rivers: San Juan, Coco, and Negro Rivers. The upper basin of the San Juan River is heavily used, as 57% of the population is concentrated in the area. Lake Managua (or Lake Xolotlán) receives 57 million cubic meters of non-treated sewage waters and 153,650 tons of trash per year (FAO 2002).

Costa Rica provides 29.5 $km^3$ of water annually to international basins: an estimated 0.5 $km^3$ to the Sixaola River, 5.8 $km^3$ to Lake Nicaragua (or Lake Cocibolca, the second largest lake in Latin America after Lake Titicaca), and 23.2 $km^3$ to the San Juan River (FAO 2002g).

Panama possesses the mid and lower section of the Changuinola River. It is in the Panamanian section where agricultural use and urban growth intensifies. The other two shared basins are the Sixaola River, which is protected by La Amistad Biosphere Reserve in Panama and Costa Rica, and the Jurado River, which is part of Darién National Park in Panama.

Unlike in Central America, the water relationship between the two countries that share Hispaniola Island is not highly interdependent. This may be because the island's international river basins are not located in important population centers (FAO 2002e).

## 2.5 Triggers of Environmental Change and Conflict Potential in Central America

Watershed deterioration and water pollution are the most important factors of environmental change in transboundary river basins in Central America. Many Central American watersheds are

*Landslide damage in the aftermath of Hurricane Mitch. Over 9,000 deaths and 9,000 missing were attributed to Mitch, making it the second most deadly hurricane in history ranking only below a 1780 hurricane in the Lesser Antilles. Photo credit: Debbie Larson, NWS, International Activities, courtesy NOAA.*

characterized by very steep topography and occupy relatively little land area. Deforestation causes soil to erode rather easily from this sheer terrain, thereby contributing large amounts of sediment to most of the freshwater streams, rivers, and lakes of the region, as well as to coastal bays and estuaries (Leonard 1987). These sediment loads can hinder government efforts to regulate and harness stream flows for agricultural development, hydroelectric power generation, urban consumption, and other contributions to economic development.

In addition, most rural areas and many urban areas lack treatment facilities for domestic waste, posing major health problems for downstream populations who use streams and rivers for washing, bathing, and drinking. Thus, the major threats to Central America's water quality are the discharge of fecal matter from urban sewage, rural latrines, and septic tanks, and the high levels of suspended sediment loads from soil erosion. Moreover, Central America is also highly vulnerable to extreme weather events. The devastating consequences of recent atmospheric phenomena (such as Hurricane Mitch and El Niño and La Niña) have revealed severe environmental deterioration, as evidenced by the region's significantly reduced capacity to drain off extraordinary volumes of water (Map 3).

## 2.5.1 Dam Construction as a Trigger of Socio-environmental Conflict

Currently there are also other factors in Central America contributing to social and environmental stress in international river basins. One of these factors is the creation of hydroelectric generation plants, which presupposes significant environmental change in the zones where they are implemented. The major transformation is in the storage, use, and availability of the water resource. This specific issue usually creates tension between the community and the development company; furthermore, it involves additional potential elements of conflict related to floods, land expropriation, and the imminent pollution produced by the draining and dredging of dams. These issues are being considered as important elements in planning for future hydroelectric projects as well as for those that are already present in the international river basins of Central America.

*Dr. Stephen Pao, left, teaches microbiology testing techniques to Zorayda Villalta, a laboratory technician at the Laboratory of Integral Quality in San Salvador as part of a workshop on microbiological detection and investigation. Photo credit: Winrock International/USAID.*

Currently, possible sites for the installation of dams have been identified in several international basins in Central America. Five possible locations for the dams have been identified on the main stem of the Usumacinta River. These projects may produce an estimated 2.3 megawatts of electricity per year (Hamann and Ankersen 1996). The possible development of these projects has caused some tension between Mexico and Guatemala, however, due to the potential impact of reduced flows, the flooding of archeological sites, and the ecological effects of their implementation (Hamann and Ankersen 1996).

In Nicaragua, sites have been identified for the development of hydroelectric projects in the Coco River basin. In Panama, the Changuinola River basin seems to have great potential for electricity generation, with production estimates as high as 3600 Gwh considered possible (FAO 2000h). Tensions have not arisen over the potential Coco and Changuinola projects, however, because formal interest in building the hydroelectric plants has not yet materialized.

*Small dam, Corinto, El Salvador. Photo credit: USAID.*

In the Guatemalan section of the Motagua River, a dam was built with a production capacity of 20 megawatts. In 2002 and 2003, pollution in the river increased considerably due to the flow of accumulated solids into the Las Vacas hydroelectric dam. Although several communities feared that this increased pollution could affect human health, there were no registered relevant increases in gastrointestinal illness and skin infections. These solid flows did markedly affect aquatic life, however (De León 2003).

In the case of Honduras, there are two international river basins (Lempa and Motagua) that have hydroelectric plants, but not located in the territory of Honduras. Within Honduras, the expansion of hydroelectric plants is projected for the Ulúa, Patuca, Sico, Cangrejal, and Nacaome River basins, but as it was stated there are no proposed hydropower projects in international river basins (SERNA 2001).

In El Salvador, as noted above, an important portion of the country's energy consumption is produced by the hydroelectric plants in the transboundary Lempa River basin. This river already has four dams, all of them in El Salvador. In addition, the Hydroelectric Commission of the Lempa River (CEL, its abbreviation in Spanish) is planning to build a new dam, known as "El Cimarron," to satisfy future energy demands.

The Cimarron project has provoked some uncertainty and fears in the population about possible changes in water availability for both natural systems and human consumption, and over potential impacts on the economy, housing losses, and disruption of community linkages (Gómez and Kandel 2000).

El Tigre Dam, in El Salvador, is another example of a hydrological building project. However, its construction necessitates an agreement between Honduras and Guatemala, which has not been forthcoming. Thus, the development of this project is presumably not option in the short term (Gómez and Kandel 2000).

Other environmental changes provoking tensions in international river basins in Central America and on Hispaniola Island are oil exploitation, fishing activities, and riverbed fluctuations. For instance, in the Usumacinta River basin (Guatemala-México), there has been crude oil extraction since 1930. This region possesses three plants producing 7,000 oil wells (Hamman and Arkensen 1996). This kind of exploitation has produced considerable environmental impacts, such as flows of contaminants, the construction of plants, and deforestation produced by road construction in Laguna del Tigre National Park in Guatemala (Hamman and Arkensen 1996).

In the Dajabón River basin (Dominican Republic-Haiti), transboundary conflicts have arisen over Saladillo Lake. This lake has multiple uses in the Dominican Republic and is currently suffering an exploitation of the fishing resource by the Haitians.

One of the most interesting and most recent cases is the conflict arising in the lower Negro River basin (Nicaragua-Honduras) over the availability of water resources in the aftermath of natural phenomena such as floods and droughts.

## 2.5.2 The Negro River Basin: A Transboundary Basin at Risk in Central America

The transboundary Negro River Basin is currently one of the most critical scenarios deserving attention both from the policy and science side.

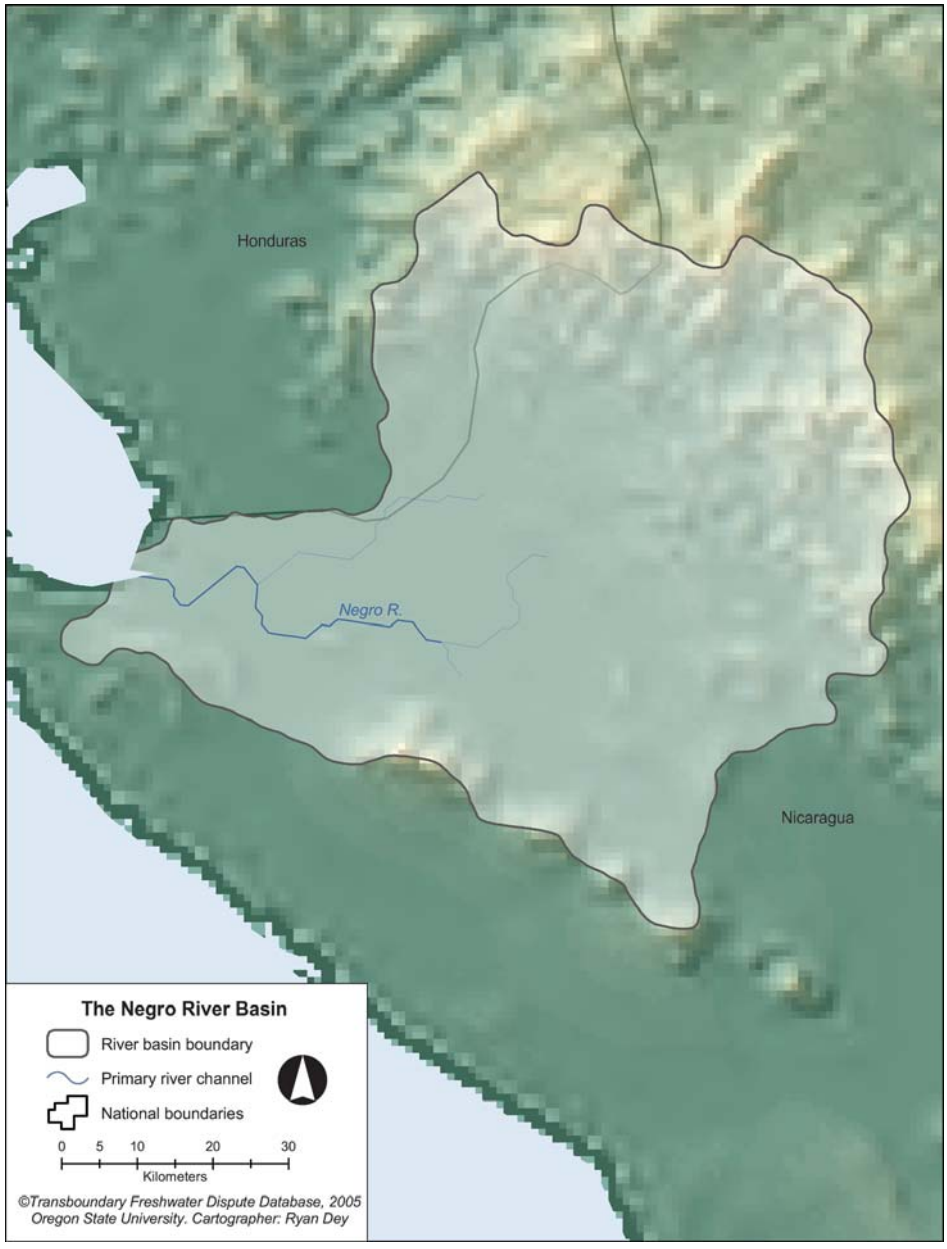



*Figure 2.1 Negro River Basin.*

*Kids, Honduras. Photo credit: Michael Campana.*

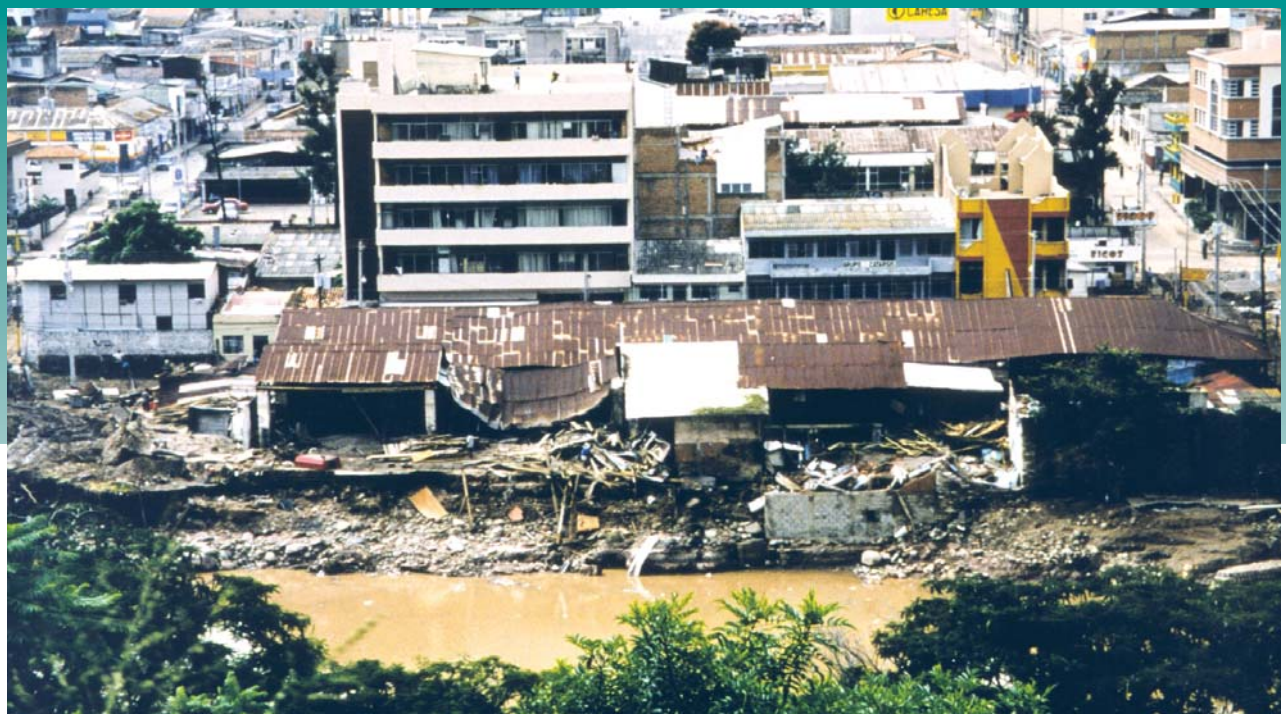
There are several factors explaining such a statement. In the first place, this river makes up a good part of the border between Nicaragua and Honduras (Figure 2.1). Thus, the border situation has been one of the hottest issues in the relation between these two countries, the situation worsened in 1998 after Hurricane Mitch changed the river flow. In the second place, this area should be of great priority since Honduras and Nicaragua are the poorest countries in the region (Map 5a), with the border area being one of the poorest areas within each country. Finally, this river basin is connected to one of the most important natural ecosystems of the region, the Fonseca Gulf. In addition, the area encompassed by the Negro River basin is a crucial part of the Mesoamerican Biological Corridor. Until now, this border area has been one of the least assisted zones in terms of international cooperation. All the above factors explain why it is important for the international community to pay attention to the area encompassed by the Negro River basin.

As previously noted, the Negro River is shared by Nicaragua and Honduras, is 154 km long, and flows into the Fonseca Gulf on the Central American Pacific Coast. Its main stream originates in southern Honduras and flows along 9 km (Rivera 2004). For 19 km, this river, along with the Guasaule tributary, are part of the international boundary between Nicaragua and Honduras. That is, only 12% of the total length of the river is part of the boundary. The remainder, 145 km, is in Nicaraguan territory. This river basin is 2,371.2 km$^2$, of which 60.3% belongs to Nicaragua and 39.7% to Honduras (UIFC 2000).

As stated above, one of factor explaining the urgency for international cooperation in this area is the poverty of the zone. Honduras and Nicaragua have the highest levels of poverty in Central America. Both countries report 60% of unsatisfied basic household needs, and in rural homes, the percentage rises to 80% (Proyecto Estado de la Región, PNUD 2003). This is particularly evident in the area around the Negro River basin, where growth rates in rural areas are high compared with urban areas in the same region. Thus, the socioeconomic scenario indicates a high demand for employment and goods and services, triggering concerns over increasing pressures on the region's natural resources.

The most important land use in the Negro River basin consists of farming and agricultural activities. As a result of the growth of commercial agriculture, extensive cattle raising, and aquaculture, the poorest populations have moved to very sensitive natural areas, such as slopes and coasts.

The importance of the Negro River basin in the economic activities in the region became



*Damage along Choluteca River in the aftermath of Hurricane Mitch, Tegucigalpa, Honduras. Photo credit: Debbie Larson, NWS, International Activities, courtesy NOAA.*

evident after the international boundary tensions over access and water use for crop irrigation in the Honduran portion of the basin. Geographically, water conflicts in this international hydrographic system are located in the lower portion of the basin, where communities face natural threats and hazards, such as dry season droughts and rainy season floods. Additionally, their socioeconomic characteristics make these communities highly vulnerable to environmental changes. Populations are dense and there is a high poverty rate, making them unable to respond efficiently to those natural changes. The tensions at the lower basin, in the coastal area, are greatly associated to the land uses decisions made in the mid and upper basin. In these upper areas, the land use is inappropriate and has deteriorated the natural resources and eroded the soil as well (Rivera 2004).

A general assessment of the potential for conflict in this river basin will show the following factors as the most relevant:

***Factor 1.*** *Disputes over the international boundary derived by the changes in the Negro River* — the situations related to the international boundary began during Hurricane Mitch in 1998 due to changes in the river flow. Before the hurricane, the Negro River would flow into the Honduran territory, Estero San Bernardo. Currently, this river flows into the Estero Real, in Nicaraguan territory. This flow change has encountered each country's governments and even "authorities have stated that works should be done to have the water river back into its natural flow" (Rivera 2004:3).

The negotiations over this boundary issue are also affected by the tension originating at the end of 1999, when Honduras ratified the boundary treaty with Colombia in the Caribbean Sea. This controversy about the sea limits between Nicaragua and Honduras arose when Honduras ratified the Maritime Delimitation Treaty between Honduras and Colombia in November 1999. Nicaragua argued that part of its maritime territory was taken. Nicaragua thus applies a 35% tax for products imported from Honduras and has filed a lawsuit at the International Justice Court (Rivera 2004).

***Factor 2.*** *Dispute over water use and access* — this mainly occurs in the dry season between the populations on both sides of the border. Water scarcity in the dry season mainly affects the Nicaraguan population. It is believed that this drought is due to two reasons: (a) the variation of the communities´ distance with the new flow and (b) water extraction works for irrigation done in the Honduran section of the basin.

The infrastructure for Honduran water extraction and its canalization provokes a great potential for conflict and it was originated by a treaty between both countries´ Foreign Affairs

*Farmer María Leisa Rodríguez convinced other women subsistence farmers in the Los Hules-Tinajones area of Panama to form an alliance to work the land together to produce more, using sustainable agricultural practices that help promote soil and water conservation. The alliance uses organic fertilizers and sustainable pest controls in growing a variety of crops such as cucumbers, tomatoes, green peppers, and green beans. Photo credit: Eliceda Melendez/USAID.*

Ministry allowing a construction to turn the river towards Honduras and use the water to maintain export crops such as melon and watermelon.

***Factor 3.*** *Disputes over water extraction for irrigation during the dry season* — when the river flow diminishes and becomes insufficient for the communities´ demand and for cattle on the Nicaraguan side (Rivera 2004).

In early 2003, the Honduran government dismantled the irrigation works due to the risk of confrontations between boundary populations. However, an alternative irrigation project is being built to harness one-fifth of the river during the rainy season. This project involves the construction of a 1.5 km channel that will join La Hormiga Lake with the Negro River (Rivera 2004).

***Factor 4.*** *Conflicts over the deterioration of Fonseca Gulf diversity* — this is a consequence of river water shortages during the dry season and inappropriate land management in the mid and upper basin.

The wetlands in the Fonseca Gulf in the Nicaragua sector are one of the most important natural resources in this area. Wetlands in the region, due to the natural dynamics of combining salt and fresh waters, have become important places for the protection of the mangroves and sea species, especially shrimp larvae. Nevertheless, the pressure provoked by the undiscriminating use of resources, lack of sufficient management of the natural resources at the upper basins, and economic activities is leading dangerously close to an environmental deterioration in the area.

In sum, the above-mentioned elements together explain why the transboundary Negro River basin is a scenario that deserves particular attention by Central American policy makers and the international community.

## 2.6 Governance in International river basins

One of the premises of this study is that the likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change (Wolf 2000); therefore, an understanding of institutions in international river basins is critical. Thus, this section describes in general terms the institutional frameworks dealing with international river basins in Central America and on Hispaniola Island, and later tests the above premise, using the Lempa River basin as case study.

In Central America, it is possible to identify a chain of efforts directed toward better management of river basins through the development of new legal frameworks for the water sector. In international river basins; however, the emergence of institutional frameworks is still very limited. There have been basically two main initiatives in the San Juan and Lempa Rivers, but the creation of transboundary river basin organizations has been slow.

In addition, at the regional level, the governance process has been promoted by the Action Plan for the Joint Management of Water in the Central American Isthmus (PACADIRH). The aim of PACADIRH is to constitute a guiding framework for states' efforts toward the management of water resources, as well as to add its own dynamics to individual states' actions in this regard. Thus, its main objective is as follows:

> *To promote and to get the aggregate value inherent to the regional initiatives concentrated in resolution of the main water resource conflicts, through an integral focus on conservation and sustainable management of this vital resource, articulating in complementary way, the actions being executed in the regional, national and local levels, considering the social, economic and environmental issues* (PACADIRH 2000:51).

Each country's experiences in Central America are unique in term of institutional frameworks. For instance, in Honduras, institutional frameworks have been emerging as part of decentralization strategies; however, these experiences are just in the process of consolidation, they do not work with all river basins yet, and they need to be integrated into the processes of land organization at the state level.

Guatemala's remarkable experience in the creation of domestic river basin institutions for the lakes Amatitlán, Atitlán, and Izabal offers both lessons and possibilities for international river basin initiatives. It is important to recognize these pioneering efforts and revitalize the elements of the process. Through legislative acts 64-96, 133-96, and 10-98, river basin authorities were created. However, there has not been a deeper advance in the creation of these types of entities in river basins in Guatemala (IDEADS 1999, quoted in Aragón, Rodas and Hurtado 2002).

In the case of Panama, the New River Basin Administration Law of Panama (August 5, 2002), was created with the objective of administrating, managing, and conserving the water resources, and it established the Hydrographical Basins Committees that must carry out the following tasks:

- To recommend the juridical and technical norms related to the river basins
- To get resources for environmental, social, and economical management
- To design mechanisms for civic participation (Martínez 2003).

### 2.6.1 International Cooperation Agreements

In Central America there are four agreements that have as their direct or indirect purpose attending to the management of environmental issues in international river basins. Those agreements involve the international river basins of the

*San Juan River. Photo credit: Alexander López Ramírez.*

Lempa, Usumacinta, Motagua, and Sixaola Rivers. The agreements from the Usumacinta, Motagua, and Lempa Rivers have as a common element that they just cover a section of the river basin, whereas the agreement of the Sixaola River possesses authority over the whole drainage of the river.

The Trifinio Plan has been the primary institutional framework for the Lempa River basin. Currently the Tri-national Development Program of the High Basin of the Lempa River is being implemented, with the direction of the Tri-national Commission Trifinio Plan, created by El Salvador, Honduras, and Guatemala.

Mexico and Guatemala signed an agreement for the creation of the Limits and Water Commission between Mexico and Guatemala, which was formally established in 1961. The commission works on the border between both countries near a section of the river basin of the Usumacinta River. Its work deals with advancing both States' authorities about border issues, development, research, and the implementation of the tasks previously approved for the countries (Hamman and Arkensen 1996). Furthermore, these countries ratified an agreement 15 years ago on the protection of environmental resources in the border area, the main objective of which was to strengthen cooperation and links between Guatemala and Mexico for the protection of natural resources and the reduction of pollution (Hamman and Ankersen 1996).

In short, the constitution of a strong base for the creation of institutions and organizations for the preservation of environmental resources in general and water in particular is as yet incipient in Central America. The establishment of river basin committees is not an intrinsic component of all international river basin projects. Although many consider environmental issues as of vital importance, few propose the creation of institutions for river basins. Moreover, the few river basin organizations that have been established in the region must fight to find space for the development of regional territorial management amid scenarios of unilateral state actions. This trend tends to encourage a particular preoccupation with the micro-river basin organization level.

### 2.6.2 River Basin Committees: Big Goals, Small Organizations

As previously noted, some form of institutional framework exists for some river basins. Most of these organizations have their origins in local and regional institutions aimed at creating mechanisms for producing better living conditions and conserving water and the environment. With international support, some of these organizations have grown from the micro-basin level.

The sub-basins that are part of international river basins with institutional frameworks in Central America and the West Indies are shown in Table 2.9, followed by some examples drawn from the region.

**TABLE 2.8 INTERNATIONAL RIVER BASINS: COOPERATION AND PROTECTION AGREEMENTS.**

***Environmental Protection and Improvement of frontier zones agreement between Guatemala and Mexico (1988)***
*Signatories:* Guatemala, Mexico

***Trifinio Plan (1987)***
*Signatories:* Guatemala, Honduras, El Salvador

***International Commission on Limits and water between Mexico and Guatemala (1961)***
*Signatories:* Guatemala, Mexico

***Improvement and regulation agreement of Sixaola River, as part of the National Park La Amistad (date not known)***
*Signatories:* Costa Rica, Panama

*Source:* CEMEDE 2004

## Table 2.9 Central America and the West Indies river sub-basin organizations.

***Municipalities Association for Development in the Macasías River Basin (AROMA)***
*International basin:* Artibonite River — *Scale:* Sub-basin of Macasias River
*Institutional consolidation:* Finished

***Coatán River Basin Committee***
*International basin:* Coatán River
*Institutional consolidation:* In process

***Managing Committee of the San Simón River Basin***
*International basin:* Lempa River — *Scale:* Sub-basin in lower Lempa basin
*Institutional consolidation:* In process

*Source:* CEMEDE 2004

The Coatán River Basin Committee currently is in the process of installation. In June, 2004, a meeting took place among the Municipal Council, the Mexican National Water Commission, and the World Conservation Union (IUCN) to generate awareness of the importance of this river basin and the necessary steps to consolidate a river basin organization (Agencia Gráfica del Sur 2004).

## Table 2.10 Major cooperative projects developed in international river basins in Central America and the West Indies since 1994.

| Countries | International Basin | Project |
|---|---|---|
| Costa Rica, Nicaragua | San Juan | *Procuenca San Juan* |
| Costa Rica, Panama | Sixaola | *Project of management of the river basin of Sixaola/Puebla-Panama River* |
| | Sixaola | *La Amistad Biosphere Project* |
| El Salvador, Honduras | Negro, Choluteca | *Regional program of river basins (Procuencas) Zamorano/USAID* |
| El Salvador, Guatemala, Honduras | Lempa | *Tri-national Program of the high basin of the Lempa River* |
| | Lempa | *XXI Century Lempa River Initiative/ Phase 1* |
| Guatemala | Suchiate, Nenton | *Project of Joint Management of Natural Resources in the Occidental High Plateau (MIRNA)* |
| | Chixoy, Usumacinta-Grijalva | *Chixoy Project* |
| | Motagua | *Rural Economy Recovering Program of the effects of Hurricane Mitch and for diminution of vulnerability to disasters* |
| | Motagua | *Early alert system in hydrographical river basins* |
| | Paz | *Management plan of Paz River* |
| Guatemala, Mexico | Coatan | *Joint Management of the river basins associated with Tacaná Volcano-UICN* |

*Source:* CEMEDE 2004

*Lempa River, El Salvador. Photo credit: Katherine Hayden.*

The Managing Committee of the San Simón River basin was officially created in 1999 and has concentrated its efforts in three municipalities of the province of Usulután. The Committee is composed of the municipal mayors, the community leaders, the local development council's representatives, the government and non-governmental organizations of the region and the Geotérmica Salvadoreña representatives (Alvarez 2001).

### 2.6.3 International Projects in Transboundary River Basins

In both Central America and Hispaniola Island over the last decade, a number of projects have been executed with the basic purpose of improving the quality of life and environmental conditions in transboundary river basins (see Table 2.10 for a synthesis of these recent projects; also see Appendix 3 for an extended list of current initiatives). In addition to this real progress, however, the countries of Central America and Hispaniola Island must continue to move forward in the process of consolidating frameworks in order to promote cooperation and avoid conflicts related to international waters.

## 2.7 The Role of Institutions in Preventing Conflict and Fostering Cooperation: The Lempa River Basin

The Lempa River Basin offers an excellent opportunity to test the basic premise of this study: that the likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change (Wolf 2000). There are four main issues that impact the potential for environmental conflict in transboundary river basins: the level of environmental deterioration, the level of foreign causation of pollution, the level of dependence of populations on transboundary waters, and the location of the countries in the basin (López 2002).

### 2.7.1 Environmental Change and Transboundary Cooperation

The Lempa River basin encompasses an area of about 18,246 km$^2$ and is divided by the international boundaries of Guatemala, Honduras, and El Salvador (Figure 2.2). Years of dense human settlement and intense land use have

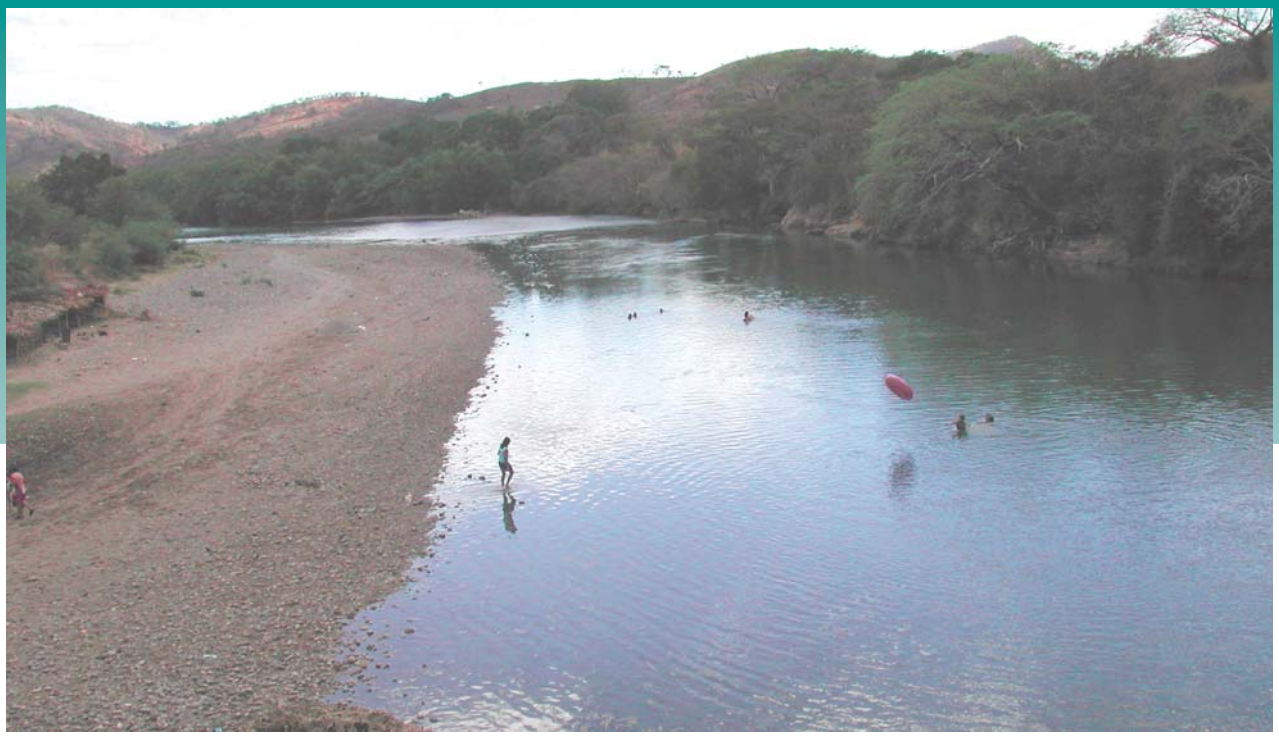

*Figure 2.2 Lempa River Basin.*

transformed the Lempa River into one of the most environmentally damaged basins in Central America. Major environmental problems are associated with dam building, deforestation, land overuse, increasing populations, urban construction processes, and industrial zones (López 2004).

One of the most significant sources of deterioration is the discrepancy between land-use capacity and its actual use. Research shows that more than half of the land in the watershed (almost 9500 km$^2$) is overused. Of the total land area classified as overused, 58.4% is in El Salvador, 23.3% is in Honduras, and 18.3% is in Guatemala (Granados 2002). The consequences of this are severe erosion upstream and sedimentation downstream. Almost half (48%) of the sedimentation deposited in the lower basin comes from Honduran territory, 39% is produced in El Salvador, and 13% is from Guatemala (Granados 2002).

As noted above, foreign causation can be considered another element promoting environmental conflict. The risk of environmental conflict is higher when one country is certain that environmental pollutants are coming across the border from a neighboring country. In the Lempa basin however, the level of foreign causation is not so high. This situation can be explained by the diversity of sources of environmental deterioration in the area, and by the geography of El Salvador, which, located in the lower basin, is responsible for most of the environmental deterioration in its own portion of the basin. Problems such as the Honduran production of sediments, which is the highest in the area, have a high potential for generating conflicts, if it is considered that an excess of sediment load in El Salvador dams could impair its power generation and that this country satisfies most of its energy supply with the energy generated in the Lempa's dam system.

The third issue is dependence. Out of the three countries involved, the one most highly dependent on the resources of the Lempa is El Salvador. Forty-nine percent of its territory falls in the Lempa River Basin, and the basin is home to 48% of its population. Three of the main



*Rio Lempa. Photo credit: Katherine Hayden.*

Salvadorian cities, including the capital city, are located in the basin (Hernández and Rodríguez 2002). There are four hydroelectric plants on the Lempa and two water treatment plants that supply San Salvador with potable water.

Because of El Salvador's location in the lower river basin, it suffers from the environmental mismanagement taking place upstream in the Honduran and Guatemalan catchment areas. The potential for conflict is attenuated, however, by the fact that El Salvador also is a significant contributor to the environmental degradation of the basin and therefore cannot protest against the contributions of its neighbors.

The circumstances in the Lempa River basin—with high levels of change in terms of environmental degradation and dam building—might be expected to yield a high potential for transboundary environmental conflict. Yet despite the potential, such conflict has not occurred. Significantly, the Lempa River basin is also the only international river basin in Central America in which a transboundary process of governance is taking place. The primary institutional framework for the Lempa River basin is called the "Trifinio Plan." Although the focus of this institutional framework extends beyond the Lempa Basin, it is fair to say that its current dynamic is determined to a large extent by concerns over the management of the Lempa River basin. Institutions are not stand-alone arrangements, however; they operate within economic, political, and social boundaries that often affect the outcome of an institution (IHDP 1999). Therefore, it is important to understand the context in which the Trifinio Plan is embedded. Furthermore, in order to examine the Trifinio Plan as an institution responsible for averting or avoiding conflict in the Lempa basin, its effectiveness must be evaluated against the likely outcomes that might have occurred in the absence of this institution.

### 2.7.2 The Trifinio Plan as an Institutional Framework

The Trifinio Plan was formulated to provide development in an ecologically diverse region that is critical to maintaining the health of the Lempa River watershed. The initiative required the participation of high-level authorities in each of the three countries before being ratified by the three legislative assemblies and signed by the heads of State. The Plan is administered by a Trinational Commission which was established by the three vice-presidents in 1997.

The significance of the Trifinio Plan in promoting peace and preventing conflict must be evaluated in the historical context in which it was conceived. The Trifinio Plan played a major role


*Lining up for water in the aftermath Hurricane Mitch, Tegucigalpa, Honduras. Photo credit: Debbie Larson, NWS, International Activities - NOAA.*

in facilitating post-conflict dialogue and building confidence between countries. The Plan provided a platform for high-level dialogue and strengthened cooperation among border communities.

The Trifinio region has become the main experimental laboratory for regional integration in Central America. It represents the only transboundary area where an institutional framework has been established. Since its inception, the Trifinio Plan has built on existing national development initiatives to reach its primary objective of increasing regional integration and collaboration (López 2004).

The Trifinio Plan has provided the means for El Salvador, Guatemala, and Honduras to begin to coordinate their efforts to ensure the integrated, harmonic, and balanced development of their border region (OEA-IICA 1992). The Plan is an effort to make the progression toward Central American integration more tangible. While its objectives are still somewhat modest, the Plan has provided a number of real solutions to specific problems that are of genuine concern to the people in the Trifinio region (OEA-IICA 1992).

Since institutions are not actors in their own rights, they must influence the behavior of those subject to their rules, decision-making procedures, and programs in order to become effective (IHDP, 1999). The Trifinio Plan clearly has influenced the behavior of its member states. The Plan's trinational public institutional framework has fostered genuine high-level cooperation without the posturing and turf wars that often characterize collaborative efforts among ministries.

The new management program for the upper Lempa River basin has the potential to generate mechanisms that are more capable of improving the river's water quality while simultaneously promoting sustainable development. However, the design and implementation of an integrated program will require powerful leadership —an order which could most naturally be filled by El Salvador, since it is the main beneficiary of any positive change in the upper river basin. With proper guidance, the new management program

*Cattle in a reservoir above a community water system, Lempa Basin, El Salvador. Photo credit: David R. Huskins, University of Akron.*

*New community water system, Honduras. Photo credit: USAID.*

has a good chance of reversing the damage to the river and creating a better life for the people who depend on it.

## 2.8 The Role of Institutions and the Dynamic of Conflict and Cooperation, Regional Integration, and Peace

In Central America, the constitution of borders among countries has been a long process derived from conflicts among states over differences in the demarcation of the boundaries. This is a highly relevant fact for understanding the complexity involved in the establishment of river basin organizations in transboundary waters.

The Sarstún, Lempa, and San Juan international river basins represent three cases where the creation of transboundary institutions have had to face the challenge of overcoming prevailing tensions. For instance, the Sarstún River is not officially recognized as frontier because of the territorial disagreement between Guatemala and Belize (FAO. 2000d). In the Lempa River basin, the war between Honduras and El Salvador in 1969 and the territorial tensions produced by the "Bolsones" may eventually represent a challenge that must be overcome. Finally, in the case of the San Juan River, the rights and conditions for navigation are still a factor of dispute between Costa Rica and Nicaragua.

*New well, Nicaragua. Photo credit: Michael Campana.*

Furthermore, in Central America, the international river basins governance process must face the remarkable challenge of accomplishing the effective promotion of the application of a legal framework directed to facilitate the efficient articulation of the institutions among them, with the objective of protecting the water resource, the user's interests, and the formulation of the necessary proposals for water management. As can be perceived, the homogenization of legal frameworks of institutional competences and the creation of strong institutional frameworks for the management of international river basins are the most important goals to reach. However, there are regional efforts, such as the one taking place in the Lempa River basin, which illustrate the possibility of change in the short and mid-term.

It is evident that there is a strong need for participation of local actors in the process of territorial management of international water

*In the aftermath of tropical storm Jeanne, a trainer in Haiti demonstrates how to properly filter water using PuR. Photo credit: PSI/USAID.*

resources. This represents a reality that must be recognized as an element to reinforce in Central America, Haiti, and the Dominican Republic in the management of these river basins.

It is recognized that water problems do not necessarily have to lead to conflict but instead can be solved cooperatively. As the Lempa River basin demonstrates, the development of institutional frameworks is a key aspect in establishing peace and environmental cooperation.

In addition, the Central American experience seems to confirm that in order to foster cooperation in the region it is necessary to focus more on qualitative issues. The quantity of water has brought many riparian states into disputes. The quantitative issue amounts to a zero-sum game; what country X gets is denied to country Y. Better water quality is something all may gain from, and qualitative control is comparatively easy to achieve. Such focus creates an important space for negotiation in Central America, due to the fact that problems in the region's international river basins are basically related to quality and not as much to quantity, with the exception of the Lempa River and the dependency of El Salvador on this basin. Regional integration mechanisms seem to be a very promising opportunity in this regard.

We have learned that to foster cooperation is possible even while points of disagreement remain. The strongest conflicts of interests are taking place in the San Juan and Lempa rivers, however and the case of the Lempa River shows there is an enormous opportunity for cooperation. Win-win projects such as the ones being developed in the Lempa River Basin can help to build confidence and a mutual language that in turn may help generate solutions to long-term points of contention.

It is important to point out that the political interests of the basin countries are important in deciding whether countries head towards cooperation. However, even more crucial is the fact that Central American governments are beginning to look at international river basins as elements for promoting regional integration in border areas rather than perceiving these areas merely as natural borders and security zones. This new interest is evident in the Lempa River basin.

Finally, it is clear that scarcity and/or pollution of transboundary freshwater resources impedes development, undercuts human health, and can potentially create some level of social unrest. The development of good institutional frameworks in transboundary river basins is urgently needed. These institutions can play a critical role in fostering cooperation among states and communities, thereby promoting development, peace, and regional integration.

*Fountain in public square, Chile. Photo credit: Keith Davis.*

# Chapter 3. Hydropolitical Vulnerability of South America's International Water Resources

Joshua T. Newton

The South American continent is the richest hydrological region of the world and contains some of its largest rivers. Yet even with an abundance of one of the earth's most precious natural resources, South America is extremely susceptible to hydropolitical vulnerability due to many factors that affect its political, social, ecological, and economic environments. With countries industrializing and modernizing, changes are influencing whole sectors and are impacting the way in which people utilize water resources in the region. The fact that most of the freshwater of the continent is shared between countries adds an additional dynamic to a situation that is potentially very conflictive.

An international approach to water resources is a relatively new concept for much of South America, as it is in many parts of the world. Although in some international basins, notably Lake Titicaca and the La Plata River, river basin organizations have been working together for decades, for most of the continent, international river basin management has come about only within the past five to ten years. Such institutional frameworks can aid in the mitigation of conflict and natural disasters; however, because these organizations are still relatively new, they may not be fully prepared to handle many of the issues contributing to hydropolitical vulnerability in South America.

The first section of this chapter will set the stage by looking at South America and its international river basins, examining the various cases that exist within the region. After this groundwork has been laid, the most important issues affecting the vulnerability of basins in South America will be addressed, attempting to pinpoint areas that are most at risk to conflict. There are several examples of basins where extensive work is being carried out and the next section will explore whether the institutions confronting the issues of these international basins are being effective in mitigating potential conflicts between stakeholders. Through this process, we will be able to identify weak points where efforts should be concentrated within South America in order to prevent future disputes over transboundary waters.

## 3.1 South America's International River Basins

South America, the world's fourth-largest continent, comprises 12% (over 17.8 million km$^2$) of the world's landmass (Rand McNally 1996) and is home to 365 million inhabitants, 6% of the world's population (PRB 2004). The region holds 12 countries, a British territory, and an overseas department of France.

The continent has a varied climate, ranging from the hot tropics of central and northern South America, where there are wet summers and dry winters, to the cool climates of the Andean region and from the arid region of northern Chile and southern coastal Peru to the temperate climes of Patagonia, which receives rain from the Pacific Ocean on its west side, but is dry on the east due to the adiabatic, or "east side" effect (See Map 1a). The distribution of rainfall also varies considerably from region to region and is one of the principal elements affecting the continent's water resources.

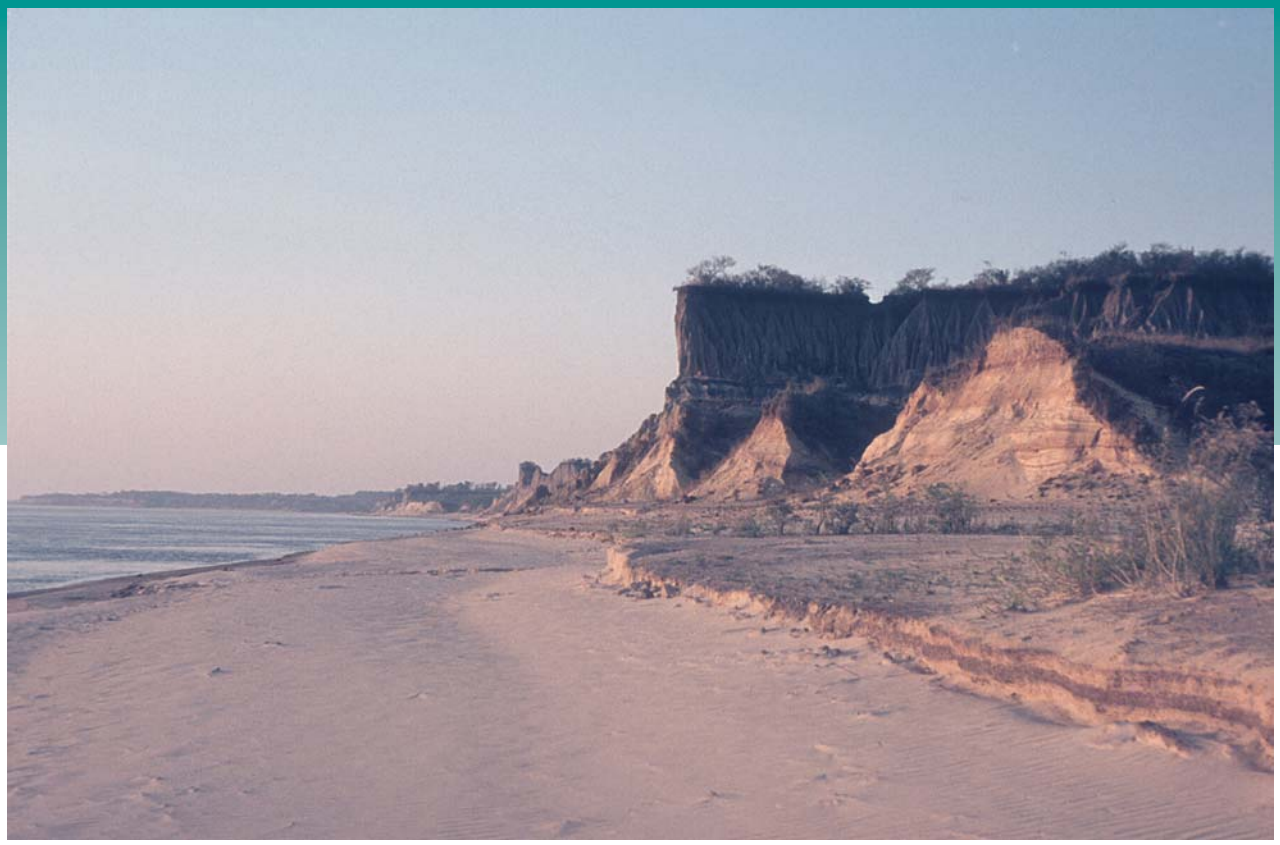
*Coast of Rio Paraguay in Asunción, Paraguay (on the northern Argentina, border with Paraguay). Photo credit: Rolando León.*

The per capita availability of water in South America averages 34,000 $m^3$ per year, which is much greater than the world average of 6,800 $m^3$ and is the highest of all the continents (UNEP 2000). These numbers can be deceiving, however. For example, the small country of Guyana, with not even a million inhabitants, possesses enough water for a country many dozens of times its size. Guyana, as well as Suriname, has annual water availability amounts of approximately 300,000 $m^3$ per capita; whereas Peru has a yearly average of approximately 1,641 $m^3$ per capita and is the only country below the world average in the region (GWP-SAMTAC 1999). And in Chile, which is far above the world average, there are areas such as the Atacama Desert in the north that are almost without any water at all.

South America possesses 38 international water basins that cover almost 60% of the continent and where over 29%—more than 100 million inhabitants—of the population resides (TFDD 2004). The amount of discharge from those basins is 68% of the continent's total freshwater flow. Of the 10,565,900 $km^2$ of land mass included in these international basins, the Amazon, La Plata, and Orinoco River Basins comprise over 92% of the territory within international basins and 55% of the entire continent. The other 8% is composed of the remaining 35 river basins. This disparity of having a few basins with the majority of the water is one of the main factors influencing the continent's water regime.

The majority of the international river basins in the region are not stressed in terms of availability of water for agricultural, industrial, and domestic consumption. With low population densities, the Orinoco and Amazon basins clearly have an overabundance of water for their rural populations. Most of the other shared river basins are above the 2000 $m^3$ per capita/year that is deemed necessary for a "good standard of living and sustainable economic growth" (Rebouças 1999). However, with various factors affecting the region, it is projected that some of the basins in the continent will face higher levels of water stress than they are currently experiencing (Map 4).

South America's international basins are highlighted by the Amazon River. Not only is the Amazon Basin the largest in South America, but it is the largest in the world. The basin covers



*Paraná River beach in Empedrado, Corrientes Province. Photo credit: Rolando León.*

more area and discharges more water than any other river system in the world (see Table 3.1). It is so large that it discharges five times the amount of water than that of its closest rivals, the Ganges and Congo Rivers (TFDD 2004). In many ways, this basin is not only the largest in the world, but one of the most important. Covering eight countries, the basin contains the largest rainforest in the world, one-fifth of all the world's water, and one-third of the world's plant and animal species (WWIC 2005).

Groundwater discharged into rivers comprises almost 30% of all available water resources in South America (Rebouças 1999). This also makes up over 32% of the world's groundwater resources and is greater than any other region of the world (WRI 2003). According to recent research by UNESCO's International Hydrological Programme (IHP) and the Organization of American States (OAS), there are 35 international aquifers on the continent of South America (UNESCO 2003a). The majority of these aquifers can be found in the northern and central areas of the continent. The OAS/UNESCO project will be developing more in-depth information on these aquifers in a study to be published in the future.

As a result of increasing costs in the storage and treatment of surface waters, groundwater has become a more economic alternative to the extraction of river water over the past 20 years in South America. Many cities use groundwater as the primary source for domestic consumption and industry, but in areas where there is little surface water, like southern Peru and the northern Atlantic coast, groundwater is also used for domestic supply and irrigation (Rebouças 1999).

One of the most significant aquifers of note in South America is that of the Guarani, which is located in the La Plata River basin system in the countries of Brazil, Paraguay, Argentina, and Uruguay. The Guarani Aquifer covers over 1.2 million $km^2$ and has an average annual discharge of 40 to 60 $km^3$. There are already more than 2,600 wells in the region, which provide water for more than 500 urban centers (Mejia et al. 2004). Due to its heavy use and the impact this has on the sustainability of the aquifer, the countries are now initiating joint management activities through the General Secretariat of the Guarani Aquifer System Project to look at the future of the aquifer. These include initiatives such as expanding the technical and

*Power and rail lines in Urabamba canyon, Peru. Photo credit: Keith M. Davis.*

scientific knowledge of the aquifer, promoting stakeholder participation, education, and communication, and the development of mitigation tactics for problem areas in the basin (SG-Guarani 2005).

The quality of the water in the international river basins of South America has been much like that of other developing areas of the world. With the modernization and industrialization of cities and nations, more chemicals are being used for both industry and agriculture, which, without the proper control mechanisms, can contaminate water resources. And, with only 79% of South America's population receiving basic sanitation

**TABLE 3.1 BASIN STATISTICS.**

| | LAND COVER | | POPULATION | | DISCHARGE | |
|---|---|---|---|---|---|---|
| BASIN | $KM^2$ | % | NUMBER | % | $KM^3$ | % |
| Amazon | 5,883,339 | 33 | 21,931,100 | 6 | 6,630 | 54 |
| La Plata | 2,954,187 | 17 | 59,143,000 | 16 | 736 | 6 |
| Orinoco | 927,431 | 5 | 10,201,300 | 3 | 986 | 8 |
| Total | 9,764,957 | 55 | 91,275,400 | 25 | 8,352 | 68 |
| Rest of S.A. | 8,053,043 | 45 | 273,716,600 | 75 | 3,894 | 32 |
| Total S.A. | 17,800,000 | 100 | 364,992,000 | 100 | 122,464 | 100 |

*Note:* S.A. = South America
*Sources:* TFDD 2004; Rand McNally 1996; PRB 2004; WRI 2003.

*Boat houses, Amazon. Photo credit: Iva Nafzinger.*

services, with countries such as Bolivia and Ecuador well under the average (WHO 2000), combined with just approximately 13% of all *collected* sewage treated in some way (PAHO 1998), this creates a large amount of untreated contaminants that are being introduced into water basins around the continent. Mining also plays a significant role in the pollution of water resources in the region, as most countries participate in mining activities (UNEP 2000).

In such a region, where climatic conditions vary markedly from area to area, where water resources are abundant, although not distributed equally, where water quality issues are a major concern as countries develop both economically and institutionally, and where institutions governing international basins are still in their nascent stages, there exists the potential for conflict over shared water resources. With its wealth of water resources, South America has a large capacity for development. But, there are many obstacles in and along the way that could pose serious threats to cooperation. The following section will address some of the key areas that influence hydropolitical vulnerability within the continent's shared water resources.

## 3.2 Issues of Vulnerability: Where are the Gaps?

Despite its water richness, there are millions of inhabitants without basic access to drinking water and sanitation services in South America. Its potential for hydropower is enormous, yet millions of people are without electricity. And although more than one quarter of the world's freshwater flows through the rivers of the

*Amazon village child, Peru. Photo credit: Iva Nafzinger.*

*Trekkers washing up with bottled water carried along the trail, Machu Picchu, Peru. Photo credit: Keith Davis.*

continent, economic development is often stymied by lack of sufficient water resources. These problems, and many others, abound throughout South America, as hydrological, institutional, and socioeconomic factors are strained.

## *3.2.1 Hydrological*

### 3.2.1.1 Distribution: The Amazon, La Plata, and Orinoco Effect

Because water resources are unequally distributed throughout the continent, the region may appear to be water abundant, although in reality, there are areas that suffer from lack of water. In examining the total quantity of water resources in South America, it is impossible not to notice the effect that the basins of the Amazon, La Plata, and Orinoco have on the figures. These three river basins cover 55% of the land area of the entire continent, but contain only 25% of the population. If one looks at the international river basins and countries of Latin America (Figures 1.1 and 1.2), one can note the extension of these three basins with respect to the size of the continent. The disparity between the percentage of water resources these basins hold compared with the rest of the continent is even greater: these three basins account for more than 68% of South America's freshwater (Table 3.1). The effect that the Amazon, La Plata and Orinoco rivers have on the numbers skews the reality for people living in other places where water resources are more limited. For example, the Cancoso/Lauca basin in northern Chile and southwestern Bolivia and the Silala River basin (an international body of water not considered an international river, because of a dispute between the two countries over whether it is a river or a transfer), in the same area, are two examples of transboundary waters that have seen much conflict—and may see more in the future—because of the dry region in which they reside.

### 3.2.1.2 Basic Services

According to the World Health Organization (WHO 2000), 85% of the population of South America's international basins has access to safe drinking water and 79% has adequate basic sanitation services. Even though these numbers appear to be high, both are above the world average; with such a large population, this

*Washing clothes, Amazon. Photo credit: Iva Nafzinger.*

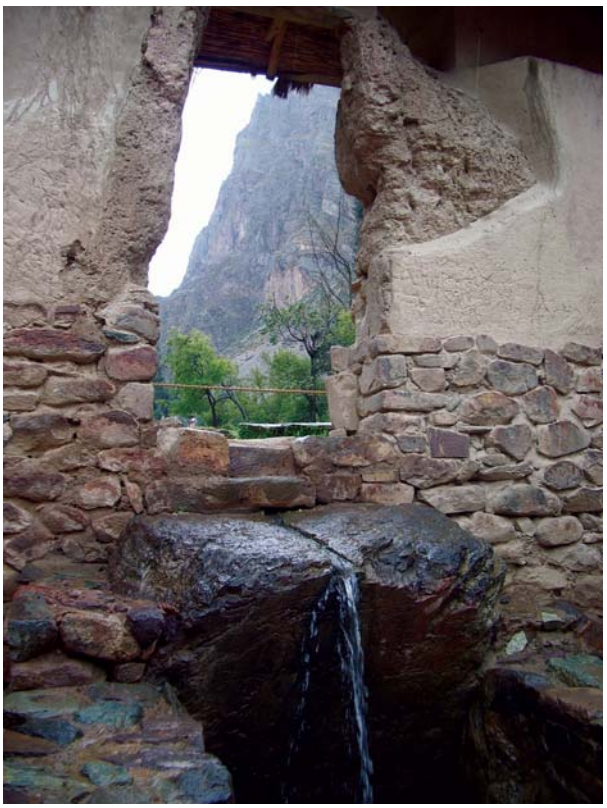
equates to over 51 million South Americans without potable water and over 72 million inhabitants without sanitation services. This is a considerable number of people who do not have access to basic services.

The international river basins of South America contain abundant amounts of water yet there are still many people who do not drink safe water or have clean sanitation. For example, countries such as Argentina, Bolivia, Brazil, Peru, and Ecuador all have less than 50% of their rural populations with the infrastructure for basic sanitation services (WHO 2000). By not having adequate access, people are living under stressed conditions, malnourishment becomes more prevalent (in Bolivia, Colombia, Guyana, Peru, Paraguay, and Venezuela, 12% to 21% of the population is malnourished; 9%, or almost 34 million people, for the entire continent; WFP 2004), their economic development is slowed and their general situation is not favorable. As a result, many layers of society are going to have more difficulties if their population is not living under good conditions. Governments, local and national, are more or less forced to confront the issue, NGOs spend time and money attempting to alleviate the situation, the economy does not

*Polluted stream behind residences, Peru. Photo credit: Keith M. Davis.*

*Fishing boats and merchants, Amazon. Photo credit: Iva nafzinger.*

reach its potential, and the people do not live free of constant worry regarding their water, thereby decreasing their human security. This has a large effect on causing disputes among stakeholders and increases the vulnerability of each basin.



*Spring water still flows from ancient Inca water systems, Peru. Photo credit: Keith M. Davis.*

### 3.2.1.3 Groundwater Use

Groundwater has been used in South America dating back to centuries before Columbus set foot in the Americas (Rebouças 1999). However, the amounts that were drawn from aquifers have significantly changed over the past 500 years and the ever-increasing amounts of extractions are beginning to adversely affect the underground resources. Contamination becomes easier, because there is not as much water to dilute the pollutants and saltwater intrusion occurs as pumping of freshwater out of aquifers causes saltwater to invade groundwater areas. As mentioned above, South America has grown more dependent on groundwater over the past 20 years due to the increasing costs of storage and treatment of surface waters. Groundwater acts as an almost-free storage facility, and, if not being polluted, a clean source of freshwater. On a continent where water resources are not equally distributed, aquifers have become a more secure source of water.

The principal problem stems from the lack of data and science around groundwater use to know how human use is affecting the aquifers (Rebouças 1999). We do know that we are polluting many of our aquifers through inadequate waste disposal of heavy metals, chemicals, and hazardous waste (UNEP 2000).

*Sawmill on Amazon, photo credit: Gretchen Bracher.*

The Guarani Aquifer is the most important international aquifer in South America. Over the past decade, several issues have emerged that provided an impetus for the countries within the basin to cooperate in the management of the aquifer (Mejia et al. 2004). These issues included pollution, over-extraction, and local conflicts over groundwater use, along with an increase in the demand for freshwater. The nations that shared the aquifer initiated the Guarani Aquifer System Project, financed by the Global Environment Facility of the United Nations. The project is leading to the reduction of the hydropolitcal vulnerability of the aquifer as the countries work together to mitigate disputes, sustainably manage the groundwater, and share information regarding the Guarani.

### 3.2.1.4 Pollution

Pollution has been and will be a trigger for both conflict and cooperation as long as humans continue to contaminate earth's waters. For example, water quality issues have caused disputes between India and Pakistan, Israel and Jordan, and Hungary and Slovakia, among others, while cooperative efforts have been even more prevalent (TFDD 2004), even within South America, as can be seen by treaties concerning water quality issues of the Amazon and Titicaca Basins as well as many joint initiatives between South American nations (See RBOs and RBCs Sheets). One of the principal problems with international watercourses is that there are usually upstream

*Schoolchildren walk home across the Mandiyupecuá bridge in Mbocayaty, in Villa Elisa, Paraguay. The bridge covers a ditch that was once polluted and dangerous but has been been cleaned up and filled. Photo credit: Chemonics International/Luis Rodriguez/USAID.*

*Ecuador's small farmers harvest broccoli to survive the country's agricultural trade problems. Photo: USAID.*

and downstream nations along the shared rivers. If one nation is polluting upstream and that damages the waters used by a country farther down the river, there is a potential for conflict.

With such large numbers of people without basic sanitation services and with only a small percentage of collected sewage actually treated, industrial and domestic waste is the primary cause of pollution of South America's international freshwater resources (UNEP 2000). Poignant examples of this can be seen in Lake Titicaca where, although the entire lake is not polluted, there are specific areas near the urban centers of Puno, Peru, and Copacabana, Bolivia, where the levels of contamination are very high (Revollo 2001).

Second to urban waste as a source of contamination is that of agriculture. With many of the upstream areas of international river basins such as the La Plata, Amazon, Orinoco, Essequibo being in large agricultural regions, this introduces the possibility of upstream agricultural runoff polluting the rivers as they flow towards other countries. With the increased use of chemical fertilizers in rural areas of the continent, rivers like the Orinoco and the Amazon have been found to have higher rates of nitrates (UNEP 2002). Eutrophication is becoming a problem for reservoirs in the La Plata and Amazon River basins because of the nutrient loading from soils being washed down the rivers (Tundisi et al. 1998).

### 3.2.1.5 Hydropower

Of all the non-consumptive uses for water within the international river basins of South America, hydropower is, by far, the most important. As the countries in South America become more developed, they will increasingly look towards how to provide their economies with enough energy to promote the development they require to sustain growth and meet the demand from the increasing population.

The South American continent has the second largest potential in the world for hydro-electricity behind Asia and 20% of the world's hydropower potential (Mendiondo 1999), but only about 20% of that is used (San Martin 2002). The La Plata River basin is the most widely used for hydropower of the international basins in South America. It is thought to have reached more than half its potential production, mostly for Brazil, which meets 93% of its energy needs from hydroelectricity (Tucci and Clarke 1998).

Somewhat surprisingly, there are only 55 dams in international river basins (TFDD 2004,

*Confluence of Iguazu and Paraná Rivers at the Triple Frontier of Paraguay, Brazil, and Argentina, near Itaipu Dam, one of the largest hydroelectric power plants in the world. Photo credit: Rolando León.*

Table 3.2), around 5% of the total for South America (Gleick 2002). These dams are located in the La Plata (46), Amazon (2), Orinoco (2), Essequibo (2), Titicaca (1), Chira (1) and Valdivia (1) basins (TFDD 2004). This shows why a significant amount of potential for hydropower is not being harnessed when 68% of the discharge in South America is used by only 5% of the dams. Or, another comparison would be that South America's international river basins have 19% of the world's water, but just 0.1% of the world's dams. Map 5b shows the dam density per 1,000,000 $km^2$ within the shared basins of the continent with proposed tenders for projects indicated for identified basins.

Large dams have caused conflict and at times promoted cooperation in all regions of the world. The Senegal River's Manantali Dam, jointly funded by Mali, Mauritania and Senegal, and the Mahakali River Project, a hydropower initiative between India and Nepal, have shown that cooperation is possible even when there are upstream and downstream riparians (Curtin 2000). This is no different in South America. The Itaipu Dam, in the La Plata Basin, initially provoked conflict between local communities and environment groups. Through a process of joint planning by the Brazilian and Paraguayan governments, however, the major environmental and social impacts of the dam were mitigated and monitoring and control processes were implemented to maintain minimal impact on the communities and environment near the dam (Baschek and Hegglin 2002). Two of the major programs that were initiated, the Mymba Kuera and Gralha Azul projects, were aimed at foresting

**TABLE 3.2 SOUTH AMERICAN INTERNATIONAL BASIN COVERAGE.**

| | Coverage (%) | Discharge (%) | Dams Number | Dams (%) |
|---|---|---|---|---|
| International Basins | 59 | 68 | 55 | 5 |
| Rest of South America | 41 | 32 | 1041 | 95 |
| Total | 100 | 100 | 1096 | 100 |

*Rainbow over the Amazon River, Iquitos region, Peru. Photo credit: Iva Naffziger.*

areas surrounding the Itaipu Dam and catching fauna from the dam area, and releasing them into conservation areas (TED 1996b).

The Itaipu Dam case not only caused friction on a local level, but on an international one as well. In 1973, when Paraguay and Brazil first signed the Treaty of Itaipu, consideration was not given, as was required under the 1969 La Plata Basin Treaty, to how the dam would affect the lower riparians. Argentina, at the time, was planning the Corpus Christi Dam 250 km downstream from Itaipu, and the flow that was to be affected by Itaipu would have influenced the performance of the Corpus Dam. Being the lower riparian, Argentina had always argued for projects of mutual benefit for all basin-states in order to maximize the utility of the La Plata Basin waters. After negotiations, in 1979, the three countries arrived at the Agreement on Paraná River Projects, whereby the levels of the river would be maintained and exchanges of information would take place (Malecek 2001).

*A nutria swimming in the La Plata. Photo credit: Rolando León.*

An opposite example is that of the Yacyretá Dam, also found in the La Plata Basin. Problems have plagued the project since construction began in 1973 and continue to do so. The impact on the local communities, in terms of resettlement, and on the environment, in terms of deforestation and destruction of habitat of endangered species, caused conflicts that had widespread effects on the development of the dam project. As each phase of the dam was completed, more and more contention grew as larger areas of land were flooded and people were forced to move (TED 1996a). If an institution is not in place or does not have the capacity to manage the situation, as in the Yacyretá case, conflicts like these can determine the outcome; whereas such a situation may have been avoided by joint planning for mutual benefit.

### 3.2.1.6 Climate variability

The "wet summers" and "dry winters" that occur on the majority of the continent play a large role in how governments manage the international

*Sudden storm sends tourists running for cover, Machu Picchu, Peru. Photo credit: Keith M. Davis,.*

water basins of South America and how the people are forced to live within them. This climatic phenomenon causes periods of an abundance of water and then a lack of water. Even though these variations in the climate are expected, as the region has been experiencing these patterns for thousands of years, slight variations from the normal rainfall trigger either floods or droughts, wreaking havoc with local populations' economies and general safety.

Several international basins in South America suffer natural hazards on a regular basis. Flood-prone areas are primarily found in many of the tributaries of the Amazon, in the La Plata and Orinoco Rivers (San Martin 2002), but are not exclusive to these basins. Even Lake Titicaca, with its large size, has been subjected to floods in the past two decades (Revollo et al. 2003).

With climate change influencing weather patterns all over the world, the extreme events that occur in South America are only going to make the international basins of the continent more vulnerable unless physical mitigation efforts, such as dams and floodways, and policy changes, such as prohibiting house construction in hazardous areas, are made by the governments and institutions that manage these shared bodies of water.

## 3.2.2 Institutions

### 3.2.2.1 Governance

Peter Rogers (2002) defines governance as "the capability of a social system to mobilize energies, in a coherent manner, for the sustainable development of water resources." This is difficult enough when dealing with issues on a national

*Water station, Colombia, photo credit: USAID.*

or even local level, but add to this the potential complexity of an international dynamic and the situation becomes even more challenging.

Governance of international water resources in South America is still nascent and has room for improving its effectiveness in order to combat the vulnerability issues that these basins face. If governance is considered to be a comprehensive system that includes all aspects of society—political, economic, social, administrative (Rogers 2002)—then the 38 international basins on the continent are missing many aspects of water governance. In this report's collection of international river basin collaborations (see Appendix 1), for example, very few in South America (only the Amazon, La Plata, and Titicaca) have multinational initiatives that address economic, environmental, social, and institutional concerns. Of the rest, many have one or two collaborations, but there are eleven that have little or nothing and another dozen that have only small international initiatives. This is especially worrisome in basins such as the Orinoco and the Essequibo, as they are the third and fourth largest rivers in South America.

*Waterfall, Parque Nacional Vincente Perez Rosales, Chile. Photo credit: William M. Ciesla, Forest Health Management International, Bugwood.org.*

In some areas, governance is difficult due to political tensions between the basin-states. In the Essequibo, for example, Venezuela and Guyana are at odds over the location of the border between the two nations (Hensel 1998). As a result, management efforts are crippled by a lack of political willingness. Other examples of this can be seen between Peru and Ecuador, which just ended wars over the delineation of their borders, and between Chile and Bolivia, concerning the Silala River (see below).

Without proper governance mechanisms in place, which are more difficult to achieve on an international level, transboundary river basins will be more vulnerable to disputes between stakeholders within those basins. Once a multifaceted management program can be established, the likelihood of conflict will be reduced.

### 3.2.2.2 Treaties

Of the 38 international water basins found in South America, only 4 have international treaties signed by the riparian nations (La Plata, Titicaca, Amazon and Lagoon Mirim, see Map 6). The third and fourth largest basins on the continent, the Orinoco and Essequibo, both do not have treaties. The treaties in the region have played an important role in the attempt at mitigation of conflict. In all four cases, after treaties have been signed by the nations, river basin organizations (RBOs) have followed (see Map 7 and Appendix 1). The only basins with RBOs without treaties are the relatively minor basins of Zapaleri, Cullen, San Martin and Lake Fagnano, the last three of which are found in the distant, almost unpopulated region of Tierra del Fuego in Patagonia. And, in looking at Map 8, it can be seen that those basins with treaties also have more collaborations between basin-states than those which do not. This shows the importance of treaties in the formation of RBOs within international river basins in South America.

The Amazon River Basin is an example of how this treaty-to-organization process has functioned. The Amazon Cooperation Treaty was signed in 1978 by all eight basin-states (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Surinam, and Venezuela). The treaty's main goals were to promote the development of the basin in a cooperative manner with an underlying theme

*In the semi-arid "backlands" of Brazil's northeast, severe droughts force farmers to relocate about once each decade. With his backyard mandala farming system, Senhor José Correa, 52, subsistence farmer and ranch hand in the settlement of Santo Antônio de Cajazeira, can produce a variety vegetables, herbs, fruit, poultry, and fish. Photo credit: CRS/Luiz Claudio Mattos/USAID.*

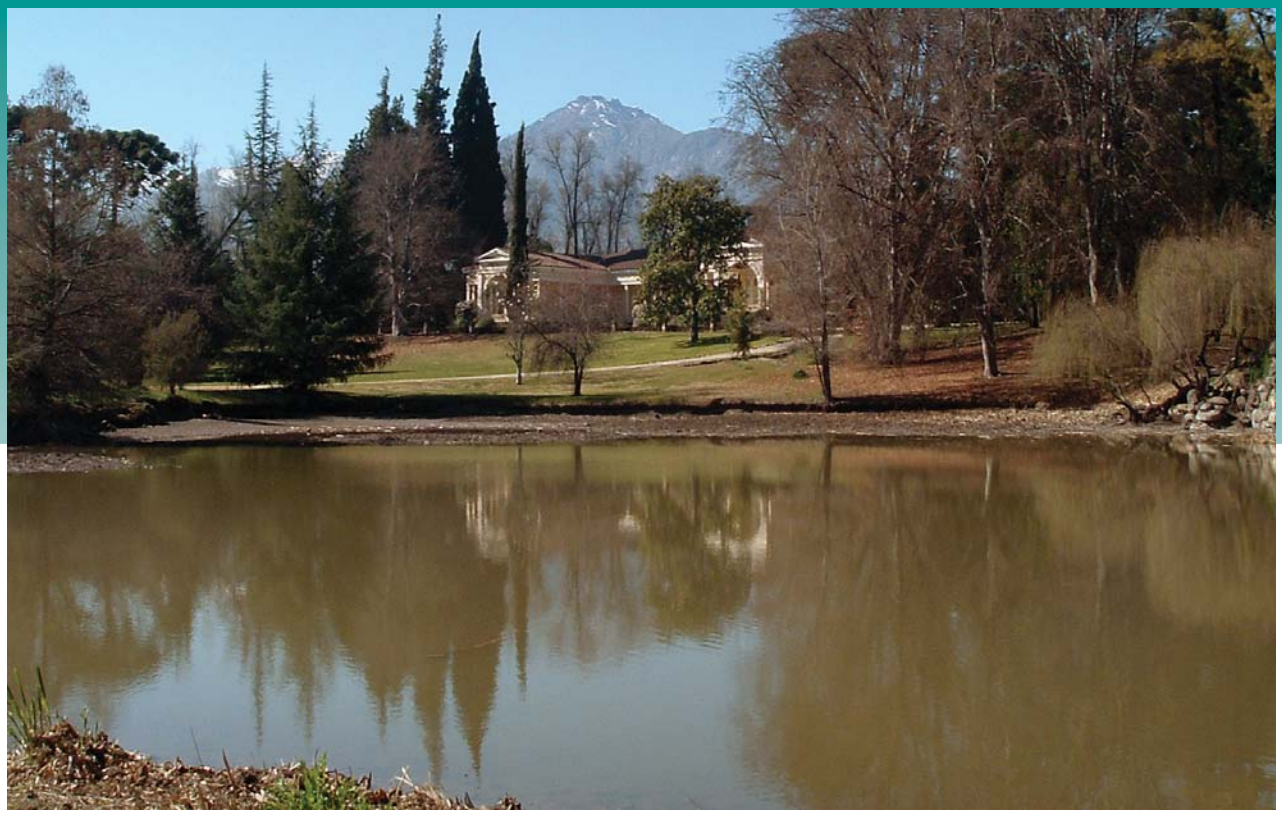
of conservation while respecting the sovereignty of each signatory nation (Ware 1980). The Treaty itself has not been considered a success, because there have been many difficulties in completing its mandate, due in large part to little cooperation between the basin-states (Samanez-Mercado 1990). With this in mind, in 2002, the Amazon Cooperation Treaty Organization was created in order to help implement the 1978 Treaty. Up to 2005, in its short existence, the organization has worked to sign agreements between countries and with the United Nations to address the sustainable development of the region (Elias 2004). It is hoped that the creation of the organization, using the underlying framework of the Treaty, will help move the nations forward in the goals of the original agreement.

Another aspect of the international treaty system is to examine the votes to the United Nations Convention on the Law of Non-navigational Uses of International Watercourses, which was voted upon by nations in a period between 1997 and 2000. Of the thirteen nations on the continent, no one voted against the Convention nor was anyone absent from the voting (see Map 7). Even though some nations depend on water originating from neighboring countries more than others do, they all depend on this type of water to some extent (see Map 6) and, as a result, would not vote against an international treaty based on "no significant harm" and "equitable utilization" (UN 1997).

### 3.2.2.3 Regional Efforts—South American Technical Advisory Committee (SAMTAC)

With such a high number of international river basins carrying the majority of the water on the continent, and all countries in South America sharing freshwater with one or more countries, a regional approach appears to be the most effective way to manage the transboundary waters. As regions share climatic, cultural, political, social, and environmental similarities, there is much to gain by working together. Basins can learn from one another and apply experiences from one basin to the next.

Regional approaches have been slow in developing worldwide, however, and this shows



*Mansion with private lake and manicured grounds, Chile. Photo credit: Keith M. Davis.*

in Latin America as well. Through the efforts of the Global Water Partnership (GWP), the South American Technical Advisory Committee (SAMTAC), an organization made up of ten countries (Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Paraguay, Perú, Uruguay, and Venezuela), was formed in 2000 with the objective of promoting Integrated Water Resources Management (IWRM) in order to "maximize the economic results and social well-being in an equal way without compromising the sustainability of ecosystems" (GWP-SAMTAC 2003).

The committee began by organizing high-level meetings in each of the member countries in order to communicate the goals and objectives of the GWP and to familiarize stakeholders with its purpose. The next step, which SAMTAC is currently involved in, is to create partnerships through a lead organization within each of the countries to promote cooperation among all parties (GWP-SAMTAC 2003).

As of 2005, the members of SAMTAC decided to consolidate and formalize what was before an *ad hoc* committee of representatives from each country on the continent, acting as advisors, to become an institutionalized entity with members elected democratically from each country. This, in effect, transformed SAMTAC into a different entity, now known as the South American Water Partnership (CEPAL 2005).

SAMTAC and now the South American Water Partnership have only been in existence for five years; as this is a new experience for all involved, there will be a period of development and evolution before its presence is felt throughout the continent. And time was lost during the transition from SAMTAC to the Partnership and activities have not yet begun since the change. What is important to realize is that an institution is making significant efforts to address the regional situation in South America and move forward with integrated management of water resources, attempting to include all stakeholders and promote public participation. The lack of a regional management body may not hinder strategies of multinational institutions confronting international water basins, but with an umbrella entity guiding the way, this can help the management process immensely and prevent conflicts from arising.

### 3.2.2.4 Public Participation

One of the newest elements of the management of international water resources is the inclusion of


*"Fish sold here, 24 hours." Fish market and village on banks of Amazon. Photo credit: Iva Nafzinger.*

public participation in decision-making processes. This has not only aided in future planning of basins, but also has provided an avenue for other resources, such as local governments, NGOs, and the private sector, to be involved in a process that they were not included in before (Beekman and Biswas 1998). Including all stakeholders in a conversation before projects take place helps reduce the number of conflicts in the future, as more interests are met at the outset, rather than trying to meet them after the fact. One of the positive initiatives is that of SAMTAC. Although it is too soon to see the results of their efforts, they have taken the correct step in forming coalitions of stakeholders before confronting the issues at hand. The more parties one can bring together earlier in the process, the more likelihood there will be for an effective, sustainable agreement.

A different situation exists in the management of the Lake Titicaca basin, however, where the Binational Lake Titicaca Authority (ALT) has been very good on the technical and political side of the issues, but severely lacking in terms of public participation (Revollo 2001). There are two reasons for this: the first is a lack of education and environmental awareness among lakeside residents. Because environmental education and a culture of water preservation are not taught, it is very difficult for people to know how *not* to pollute the lake. Therefore, there is no public participation in these matters. There would have to be a shift in the norm of thinking about water in order to create an atmosphere to conserve the precious resource.

The second has more to do with the exclusiveness of ALT itself and the failure to allow the public into the processes. Not only are there no initiatives to include the public in management activities, but information is hard to obtain if one is from outside ALT (Ronteltap et al. 2004). With such a negative presentation towards the public, it is hard for the Binational Authority to fully achieve its goals. It is essential to include people at the local level to change behavioral patterns towards the contamination of water resources,


*Loading lumber, Peruvian Amazon and tributaries near Iquito. Photo credit: Iva Nafzinger.*

whether in South America or elsewhere around the globe. Participation through education breeds an active consciousness of sustainability. Without this, conflicts are prevalent, as stakeholders fight for the interests they have that were not met during a process they were not a part of.

## 3.2.3 Socioeconomic Factors

The following section will discuss the socio-economics of South America and how this affects the risk of conflict within the shared basins of the continent. Poverty and sanitation are not at levels found in more developed regions of the world such as North America or Europe and this influences the potential for dispute in the region.

The population distribution of the region varies widely. Brazil has a population of over 180 million inhabitants, while the populations of countries like French Guinea, Guyana, and Suriname do not exceed 1 million (UN 2004). This is also true of the international basins. Sixteen of the thirty-eight international basins do not have even 5,000 inhabitants, while basins such as the Amazon and La Plata have 21 and 59 million, respectively (TFDD 2004). With some basins more extensive than others, population density can play a role in the severity of impacts to the water resources (see Map 4a). With projected population growth figures, one can estimate the amount of stress each basin will face by the year 2025 (see Map 4b).

### 3.2.3.1 Demographics and Development

As the countries of South America develop, modernize, and increase in population, the demand for freshwater resources is going to increase. The population growth rate has hovered around 2.0%–2.5% annually on the continent over the past few decades and is projected to do the same in the international basins of the continent until 2025 (TFDD 2004). Due to economic growth and the movement of peoples from rural areas to urban centers, which both require more water per capita, the amount of water necessary to sustain such a population will have to increase incrementally more than the population growth.

The most recent figures put the number of people living in cities in South America at 80% and the projections for 2025 raise this number to 94%. The attraction of services in cities such as education, health, and employment and the improvements in agricultural technology that

*Woman earns income by selling craftwork and posing for pictures in traditional dress, riverside park, Peru. Photo credit: Keith M. Davis.*

have reduced the necessary labor force in rural areas, are causing people to move to the cities (Jáuregui 2000). As a result of this influx of city-dwellers, industrial and domestic water consumption will rise and pollution will increase, particularly since sanitation services are already behind the demand. While many international basins in South America are projected to see a decrease in population over the next two decades (Patia, Mira, Zarumilla, Valdivia, and Chira), the majority are expected to grow substantially, increasing the amount of stress on the water resources. The La Plata Basin, the most water-stressed basin on the continent, is estimated to see an increase in population of more than 22 million, reducing the amount of available water per capita by almost 40% (TFDD 2004).

As industry expands, economic development will also increase the demand for freshwater, and the need for energy to power this growth will require South American countries to look toward remedies. With hydropower being a large potential source of energy in the region, many countries will explore possibilities of expansion in that direction.

### 3.2.3.2 Poverty

South America is a poor continent compared with North America and Europe. The average GDP per capita is approximately $3,274 (DOE 1998), the poorest country being Bolivia, at $2,400, and the wealthiest being Uruguay, at $12,600 (CIA 2003). Issues of water quality and access are already major concerns among all the nations of South America, but with such high levels of poverty in some of the international basins (see Map 5a), the problems are only exacerbated. The Lake Titicaca basin is a prime example. Of Peruvians in the basin, 73% live under the poverty line; the Bolivians do not fare much better at 70% (UNESCO 2003b). Both populations are among the poorest in each country. While poverty is not the root of vulnerability of international basins, it plays a key role in their management. As can be seen in the River Basin Organizations Sheet, most of the RBOs have economic development of the watersheds as a primary goal. The social and economic development of populations in the basins contributes to the well-being of the water systems in that

there will be more resources available for basic sanitation services and education of water conservation practices. This, in turn, will reduce water pollution and stress on the basin.

### 3.2.4 Hydropolitical Vulnerability: The Silala, a Small-Scale Example

The Silala, a shared river between Bolivia and Chile, is a current example of how political and socioeconomic forces can cause a dispute over a body of water (Figure 3.1). The two perspectives on this currently shared body of water differ and, as a result, the political, economic, and hydrological situation is suffering. This virtually unknown case illustrates the concept of hydropolitical vulnerability characterized in the introduction to this report as "the likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change," on various levels.

In 1908, the prefecture of the Bolivian province of Potosí gave a concession of the waters of the Silala River to a Chilean railroad company known as the Antofagasta-Bolivian Railway Company (now called the Ferrocarril Antofagasta-Bolivia) for the use of the railroad that traveled between the city of Antofagasta, Chile, and Oruro, Bolivia.

Bolivia asserts that Chile, in using the water for the railroad, constructed a series of canals that made the waters come together and form the Silala River. Otherwise, the waters of the springs would have stayed where they were in Bolivian territory. In other words, Chile constructed a canal that moved the water artificially from Bolivia to Chile.

When, in 1962, diesel engines replaced steam-powered engines, the Silala waters were no longer used for the purpose for which the water concession was given (steam-powered engines) and the water was diverted for other uses such as mining and sanitation services. Since the concession of the Silala was not for such uses, Bolivia would like to charge Chile retroactively for the 40-plus years it has been using the waters (Toromoreno 2000).

In 2000, the Bolivian government gave a concession for the Silala waters to a Bolivian company called DUCTEC SRL for $46.8 million over 40 years. DUCTEC, in order to make money for what it paid for, decided to charge CODELCO, the Chilean national copper mining company, and Ferrocarril

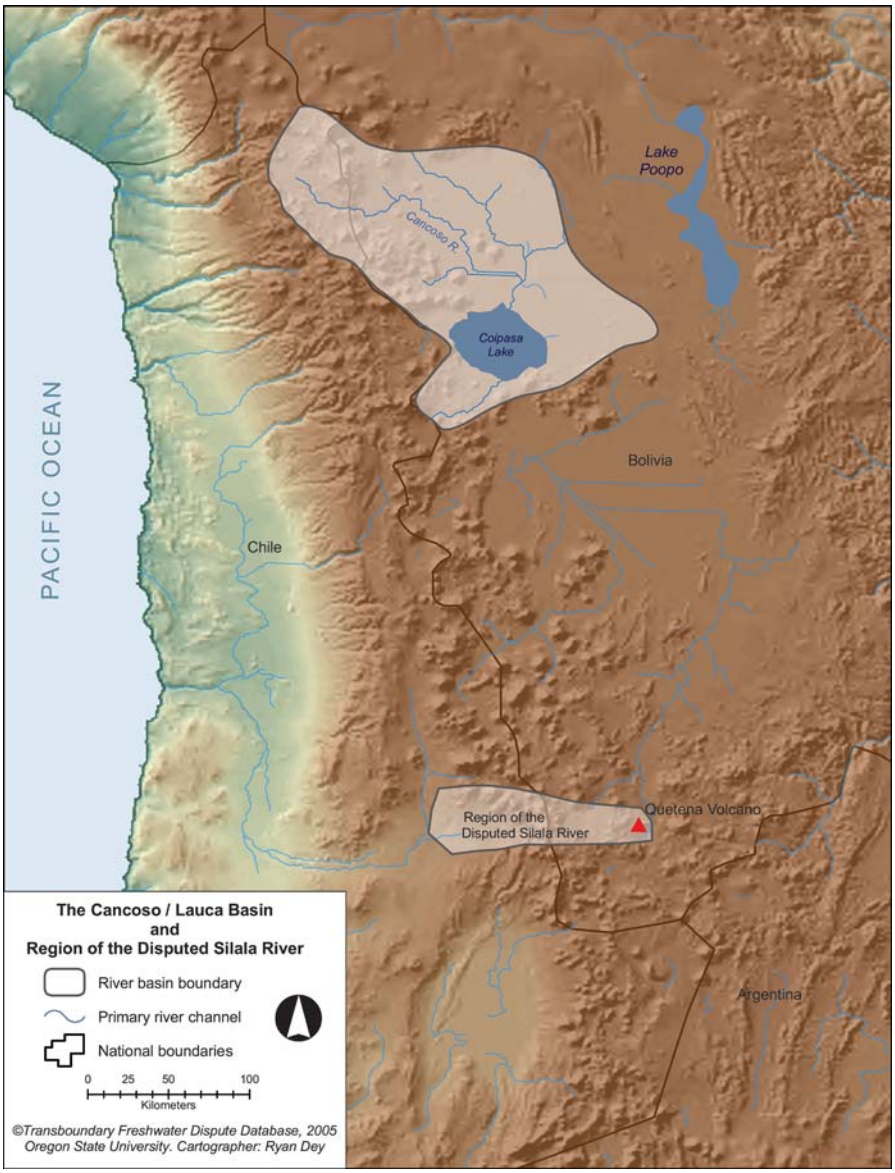



*Figure 3.1 The Silala Basin.*


*Public infrastructure project (road construction) in El Alto, north of La Paz, Bolivia. Photo credit: USAID.*

Antofagasta-Bolivia for the use of the Silala waters. As of 2004, no bills have been paid (Toromoreno 2000).

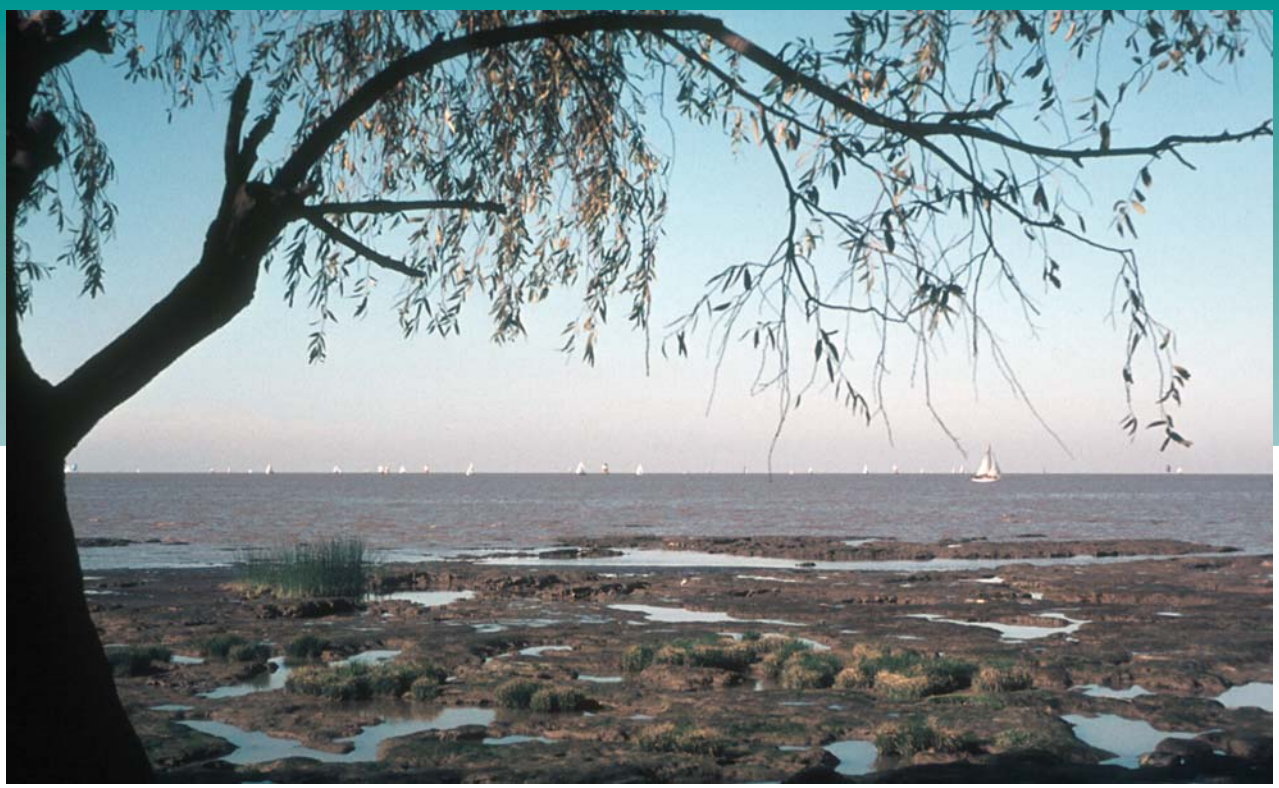
Bolivia claims ownership of the Silala River because it originates in springs on the Bolivian side of the border and is "carried" artificially to Chile, rather than being a naturally occurring phenomenon. Bolivian scientists believe the water comes from an aquifer below the surface and its natural discharges are what emerge from the springs (Silala 2004). The water would not travel to Chile without the works of the Chilean railroad companies almost 100 years ago. Hence, Bolivia believes it can control the flow and/or charge Chile for the use of the water.

Chile's position is much more simple than Bolivia's point of view. Chile claims that the waters were never diverted from the springs to form a river, but that they naturally canalized to establish the Silala River. By this logic, the Silala is therefore an international river and, under the 1997 United Nations Convention on the Law of Non-navigational Uses of International Watercourses, Chile has the right to a "reasonable and equitable" share of the water. It is interesting to note that Chile voted for and Bolivia abstained from the voting of this Convention (see Map 7b). Hence, Chile does not believe it should pay for the use of the Silala and has not done so up until this point. Chile does not recognize the Silala concession to DUCTEC, because Chile has asserted a sovereign right to the water as an international watercourse.

On the surface, the entire debate seems to be over whether the Silala River is an international basin. But, because of the underlying issues of politics, economics, sovereignty, and history, the Silala has become one of the most hydropolitically vulnerable basins in the world. Drivers such as Chile's use of the water for its world-leading copper mining industry and Bolivia's threats to cut the water off if Chile does not grant land for a Bolivian port on the Pacific are not small issues that are easily resolved.

The problem is only exacerbated by the fact that the two governments do not have official diplomatic relations, although they do have

*Farmers, villagers, and local officials build a reservoir to supply water to farms in Santa Rosa de Ocana, in Ayacucho, Peru. Photo credit: USAID.*



*La Plata, from Buenos Aires during low tides exposing sedimentary base. Sailboats are a common sight on this river. Photo credit: Rolando León.*

consulates in either country. So, how does one reduce the vulnerability of disputes in a situation as delicate as that of the Silala? And how does one confront such issues in larger-scale basins with more stakeholders and sectors involved?

## 3.3 Mitigation of International Waters Conflict in South America

Even though hydropolitical vulnerability is found in all international water basins to a certain extent, the number of cooperative efforts far exceeds the number of conflicts that have arisen from such susceptibility, making cooperation the rule rather than the exception (Yoffe et al. 2003). Furthermore, by reducing the amount of risk that a basin is subject to, more collaborative efforts will occur, thereby making the institutional mechanisms for international water resources management more effective and efficient and resulting in fewer disputes and improved living conditions for all.

Most of the international river basins in South America are still in the nascent stages of development and management. In the La Plata and Lake Titicaca basins, however, decades of experience have produced steady progress toward more sustainable water management by decreasing the factors of vulnerability through stronger governance, economic development, and international cooperation, even if there is still a need for fundamental institution building.

### 3.3.1 La Plata River Basin

Although the La Plata River basin is often overshadowed by its larger cousin, the Amazon, it is the fifth largest river basin in the world (Environment Canada 2004), and has more inhabitants than any other international basin in South America. The basin covers parts of Argentina, Bolivia, Brazil, Paraguay, and Uruguay (Table 3.3, Figure 3.2). Its tributaries include the Paraná, Paraguay, and Uruguay Rivers, and it contains the Pantanal, the largest wetland area of the world.

The countries have been working together mutually for the joint development and management of the basin since 1967, when discussions were held before the signing of the La Plata River Basin Treaty in 1969 (GEF 2003). An interesting pattern developed in the early years after the signing of the 1969 Treaty: most of the early agreements between the countries were bilateral rather than multilateral agreements among all five basin states. This is evident in the development of hydropower projects in the basin. With such a

high population residing within the watershed, energy demands were the first issues to be addressed by the Intergovernmental Coordinating Committee (CIC), an organization created at the time of the 1969 Treaty. In the early 1970s, construction on two dams began. The first, the Itaipu is still the largest dam in the world, producing 12,600 Mw (TED 1996b); the second, the Yacyretá, has become known worldwide for its inefficiency and huge losses of energy production during the later stages of its construction (TED 1996a). The Itaipu hydroelectric project is solely between Brazil and Paraguay; the Yacyretá is between Argentina and Paraguay, although Paraguay has the option to sell its excess energy to other countries in the region. Over the years, there has been a shift away from the bilateral agreements of the 1970s and 1980s, as countries have moved toward more of a sub-basin-wide approach. Initiatives such as those concerning the Bermejo River between Argentina and Bolivia, the Pilcomayo River (Argentina, Bolivia and Paraguay), and the Intergovernmental Committee on the Paraguay-Paraná Hidrovía, including all riparians, have changed the focus to more all-encompassing programs rather than specific bilateral projects (Calcagno et al. 2002). The Global Environment Facility (GEF) and the European Union, along with the governments of the nations within the basin, all have significant amounts of resources invested in projects aimed at mitigating trans- boundary concerns. These significantly add to the ability to prevent conflicts from occurring (see appendices for more in-depth descriptions of basin initiatives).

Hydrologically, the La Plata River basin has many issues, which make it a delicate basin even though it is one of the largest in the world. Several factors bring about this situation: the first and foremost is that it is one of the most water-stressed international basins in South America (see Map 4b), in that the annual per capita availability for the inhabitants is the lowest in the region. With a projected population increase of 22 million by the year 2025 (TFDD 2004), the situation is only going to deteriorate. The basin provides water for domestic use to

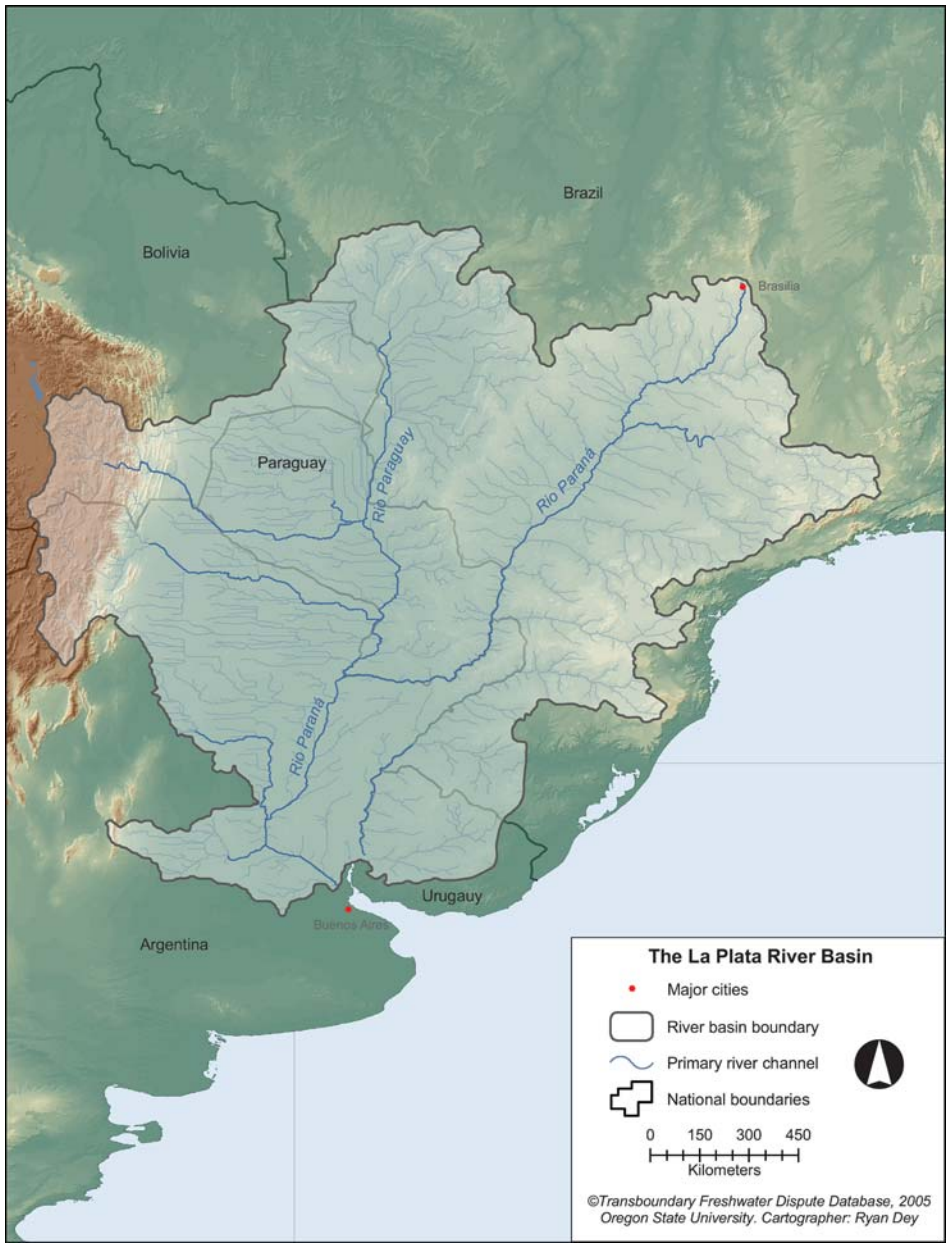
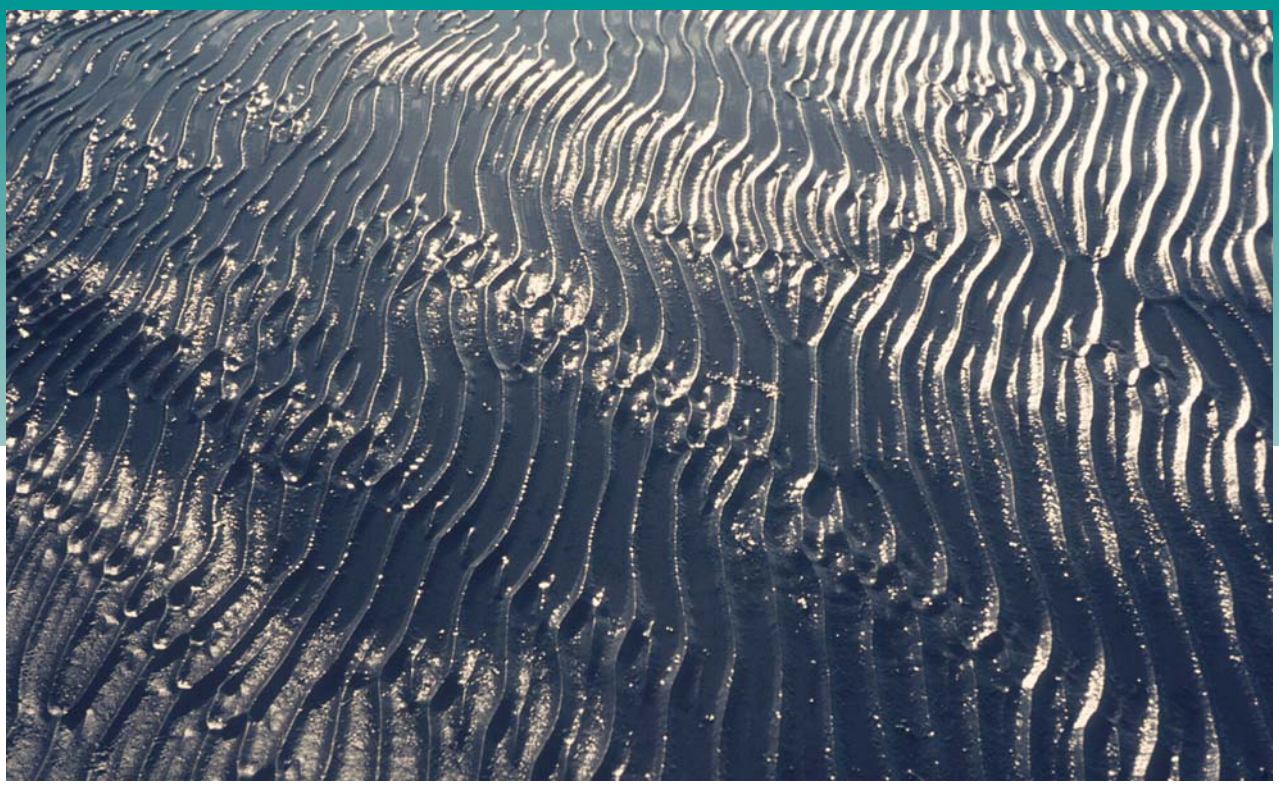



*Figure 3.2 La Plata Basin.*



*Wave pattern in silty soils on La Plata River beach. Photo credit: Rolando León.*

major cities such as Buenos Aires, Asunción, and São Paulo, irrigation, transport, hydroelectric projects, industry/mining and an effluent disposal site (Anton 1996). With such a variety of needs required of the basin, it is difficult to optimize the use of waters.

In looking at the countries within the basin and the dependence they have on waters that originate outside their borders (see Map 6b), all but Brazil receive between 76% and 100% of their waters from other nations. This makes Argentina, Bolivia, Paraguay, and Uruguay more vulnerable to changes that may occur in the system.

Other issues that create higher hydropolitical vulnerability are flooding (San Martin 2002) and the amount of contamination in many of the branches and reservoirs of the La Plata (Tundisi et al. 1998). Given the factors in the above paragraphs, the possibilities of risk for conflict are very high, especially given the institutional difficulties outlined below.

The future project of the Hidrovía, a proposed dredging and straightening of the Paraguay-Paraná Rivers for improved navigation, has also increased the risk of conflict, as stakeholders disagree about the effect

**TABLE 3.3 LA PLATA RIVER BASIN INFORMATION.**

| COUNTRIES | AREA OF BASIN IN COUNTRY KM² | % | POPULATION |
|---|---|---|---|
| Brazil | 1,378,800 | 46.67 | 39,600,000 |
| Argentina | 818,500 | 27.71 | 9,910,000 |
| Paraguay | 399,800 | 13.53 | 5,280,000 |
| Bolivia | 245,400 | 8.31 | 1,470,000 |
| Uruguay | 111,200 | 3.76 | 728,000 |
| Total | 2,954,200 | | |

*Annual Discharge:* 736 km³

*Climate:* Temperate (58%), Tropical (32%), Dry (8%), Polar (2%)

*Management Institution:* Intergovernmental Coordinating Committee (CIC) for the La Plata Basin

*Uruguay River merging into Rio de la Plata (forming the Delta, together with the Paraná River). Photo credit: Rolando León.*

such a project will have on the integrity of the basin. The project is designed to allow large barge ships to travel to and from the landlocked countries of Bolivia and Paraguay. While the economic incentives are large for some, local communities and environmentalists feel the impact will be negative (Wolf 1999).

The geopolitical ramifications of such a project are also very important and give the opportunity for increased cooperation between the nations. This would promote regional and economic development and integration where the agricultural intensive countries of Paraguay and Bolivia would be able to export their goods not only to other markets in South America, but to the entire globe. Urban and industrial development would also increase with the amount of hydrological and construction works needed to maintain such a project (Gottgens 2000). In the end, a middle ground will have to be found in order to balance environment and trade.

The La Plata basin is a very large, complex watershed complete with high population density, significant urban centers, climate variability, and many more adverse elements that a management institution is responsible for mitigating. The Intergovernmental Coordinating Committee (CIC), created at the time of the 1969 La Plata River Basin Treaty has been very good at facilitating cooperation among riparians and initiating projects related to transportation (Wolf 1999). In the past few years, CIC has also been able to set criteria for standardized water quality measurements, implement a flood warning system and employ a Geographic Information System (GIS) with databases involving hydrological, legal, institutional and project-related information (Calcagno et al. 2002) in order to facilitate data-sharing between governments. While progress may be with small steps, this is how an institution builds a solid foundation to later confront bigger issues with firmer footing.

CIC was initially only put in place to help facilitate cooperation between basin-states rather than act as an umbrella institution for managing the La Plata River basin. This has caused numerous difficulties throughout its existence in that there is no supra-authority in the basin by which countries are bound to follow as the CIC can only recommend action, not enforce it (Quirós 2003). As a result, the Itaipu and Yacyretá dams, Lake Salto Grande, and the Hidrovía Committee are all autonomous entities that do not have to answer to the CIC (GEF 2003). Combined with the lack of a permanent technical arm of the CIC (Quirós 2003) and the

*Lake Titicaca. Photo credit: Joshua T. Newton.*

result is a very complicated dynamic within a very large and complex basin.

### 3.3.2 Lake Titicaca

Lake Titicaca, located at 3,812 m above sea level, is the highest navigable lake in the world. Fed by rainwater and more than two dozen small tributaries, Titicaca has only one drainage, the Desaguadero River. The lake is situated primarily in Bolivia and Peru, but with a small portion in Chile, and is the largest lake on the continent of South America (Figure 3.3; Table 3.4).

The process through which the Binational Autonomous Authority of Lake Titicaca (ALT) came into being took approximately 50 years to accomplish and has come a long way in advancing efforts in the basin towards a more sustainable approach in managing the lake between Perú and Bolivia.

The primary impetus behind the creation of the organization was founded in two realities in the 1980s. The first was that these two countries were looking at social and economic development and saw a large opportunity in the Lake Titicaca Basin, because of the availability of resources and the mutual benefits that could be gained from cooperation. The second was to mitigate extreme weather events. During the 1980s, a series of natural disasters took place in the basin, which forced both countries to look seriously at how to prevent serious losses from such occurrences in the future. During the rainy seasons of 1982–83 and 1989–90, there was a lack of precipitation, causing droughts and hundreds of millions of dollars of damage to the agricultural industry. In 1986–87, during a period in between the droughts, the basin experienced higher than average rainfall, which produced severe flooding, also bringing about more than one million dollars in damage to the agricultural industry and infrastructure.

After its inauguration in 1996, ALT has been making headway in accomplishing the specific elements of its Master Plan, especially with regards to creating a framework for the sustainable use of the natural resources of the Lake Titicaca basin and the recuperation of the "ecological integrity" of the watershed (UNESCO 2003b).

Of the possible aspects of the basin that might increase hydropolitical vulnerability, the institution has been very successful in some

issues and not in others. The construction of regulatory works has been one of its most (successful) achievements in that ALT is better capable of dealing with extreme weather events. In 2001, a set of regulatory "doors" was created to control the flow of the lake's only outflow, the Desaguardero River. The goal of the Master Plan is to keep the level of Lake Titicaca between 3,808 and 3811 m above sea level. After the construction of the doors, the level has been maintained, even after higher than average precipitation in 2001 (Ronteltap et al. 2004). The people who live around the lake still talk about the floods and droughts of the 1980s, but if these regulatory works prove to function, then a huge stress on the basin has been relieved.

What ALT has not been so successful at is the human development aspect of the region. This comes in two forms. As discussed above, the first is the large lack of public/community participation in the decision-making processes of the institution. There have been various

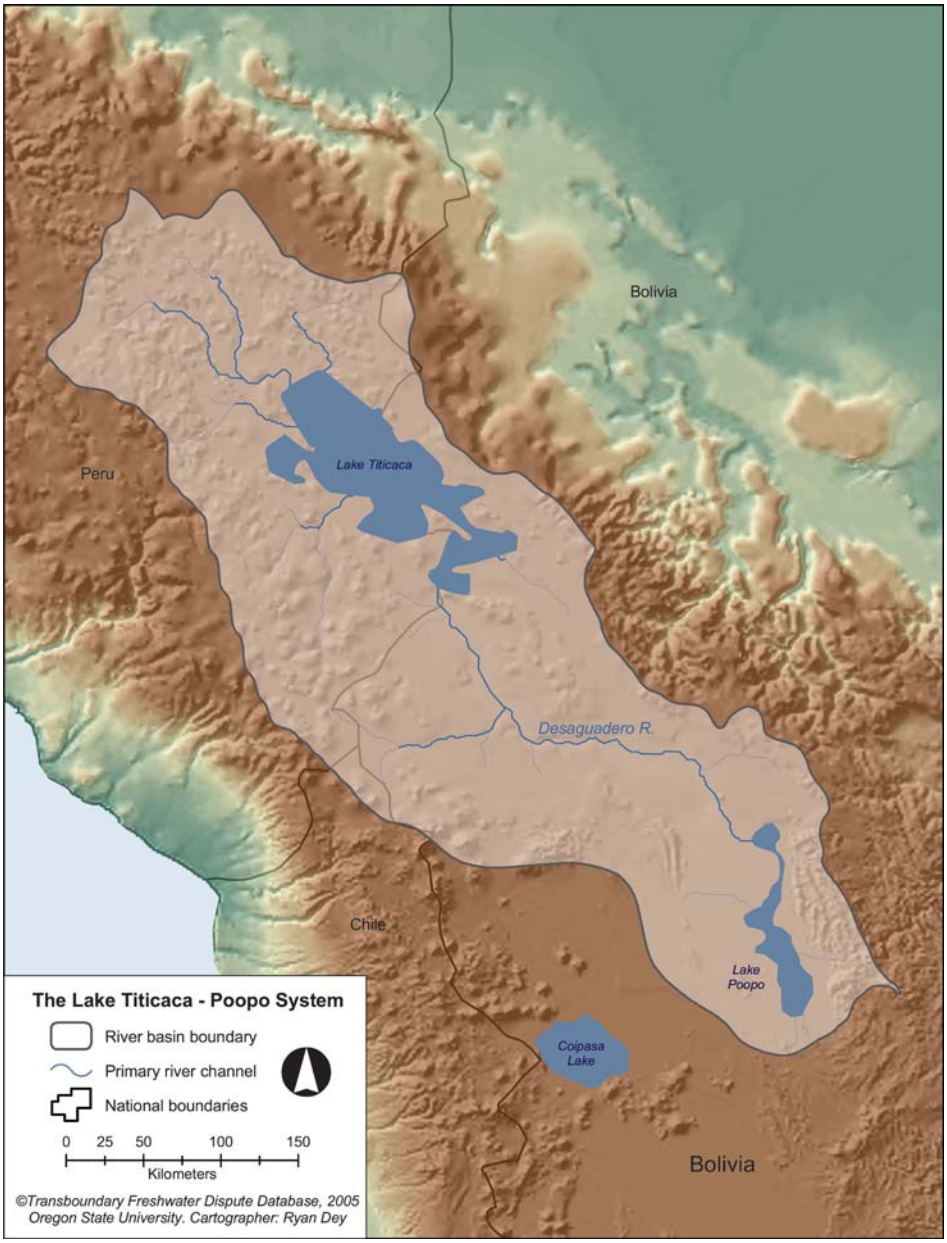



*Figure 3.3. Lake Titicaca Basin.*

## Table 3.4 Lake Titicaca Basin information.

| Countries | Area of basin in country km² | % | Population |
|---|---|---|---|
| Bolivia | 61,700 | 53 | 1,200,000 |
| Perú | 53,600 | 46 | 912,000 |
| Chile | 1,200 | 1 | 4,980 |
| Total | 116,500 | | |

*Annual discharge:* 34 km³

*Climate:* Polar (53%), Dry (34%), Temperate (7%)

*Management Institution:* Binational Autonomous Authority of Lake Titicaca (ALT)

## Table 3.5 Hydropolitical vulnerability in South America's international basins.

### High Risk

*Silala Basin*

***Countries:*** Bolivia, Chile

***Risk Factors:***

- Existing Diplomatic Situation
- Lack of Treaty
- Lack of Management Structure
- Historical Context
- Lack of agreement on whether the basin is international

### Medium High Risk

*Orinoco Basin*

***Countries:*** Brazil, Colombia, Venezuela

***Risk Factors:***

- Lack of Treaty
- Lack of Management Structure
- Increasing Pollution

*Essequibo Basin*

***Countries:*** Brazil, Guyana, Suriname, Venezuela

***Risk Factors:***

- Lack of Treaty
- Lack of Management Structure
- Increasing Pollution
- Border tensions between Venezuela and Guyana

### Medium Low Risk

*Amazon Basin*

***Countries:*** Bolivia, Brazil, Colombia, Ecuador, Guyana, French Guinea, Peru, Suriname, Venezuela

***Risk Factors:***

- Increasing Pollution
- Large Basin
- Young Organization

*La Plata Basin*

***Countries:*** Argentina, Bolivia, Brazil, Paraguay, Uruguay

***Risk Factors:***

- Increasing Pollution
- Hidrovía Project
- Population Increase by 2025

*Lake Titicaca Basin*

***Countries:*** Bolivia, Peru

***Risk Factors:***

- Increasing Pollution
- Young Organization
- Social Unrest

### Low Risk

Remainder of basins

*Crocodiles, Brazil. Photo credit: forestryimages.org.*

*Urubamba River, Peru. Photo credit: Keith Davis.*

reasons suggested for why this is the case, from lack of education of the people in the basin to lack of outreach by ALT to the fact that engineers run most of the organization and their "culture" is thought to look at the technical aspects of the situation, rather than the human aspect (Roneltap et al. 2004). As this area of both countries has been volatile in the past, with rural uprisings due to disagreements between the people and the federal governments and, at least on the Bolivian side, the population living around Lake Titicaca does not look at ALT in a positive light, these play large roles in how susceptible the basin is to potential disputes.

The second factor that contributes to vulnerability which ALT has not been able to make much progress in is the level of poverty that the basin experiences. The poverty levels of both countries in the Lake Titicaca basin, as mentioned earlier, hover around 70%. With such high indexes, successful management is hindered by the lack of basic needs. The population in the basin on the Peruvian side of the border only has 19% coverage of adequate drinking water and 20% for basic sanitation services. The Bolivians are better off in terms of drinking water at 24% coverage, but sanitation is at a lowly 13% (UNESCO 2003b). Improvements in basic services need to be carried out before proper governance can take hold of the basin.

As an institution, ALT operates smoothly and has been very successful at the initiatives it has set out to accomplish (UNESCO 2003b). Although there have been tensions between the national governments of the basin-states and their citizens regarding Lake Titicaca, the two countries have been very close neighbors. The resiliency of the organization runs deep and if more programs are implemented that increase

*Dog on board, Amazon boat. Photo credit: Iva Nafzinger.*

*Micro-hydropower turbine and generator, part of a pilot project to install a renewable-energy "mini-grid" for the remote village of Cachoeira do Aruã in Brazil, 145 km from Santarém up a tributary of the Amazon. Photo credit: Indalma Industria/Nazareno Natalino/USAID.*

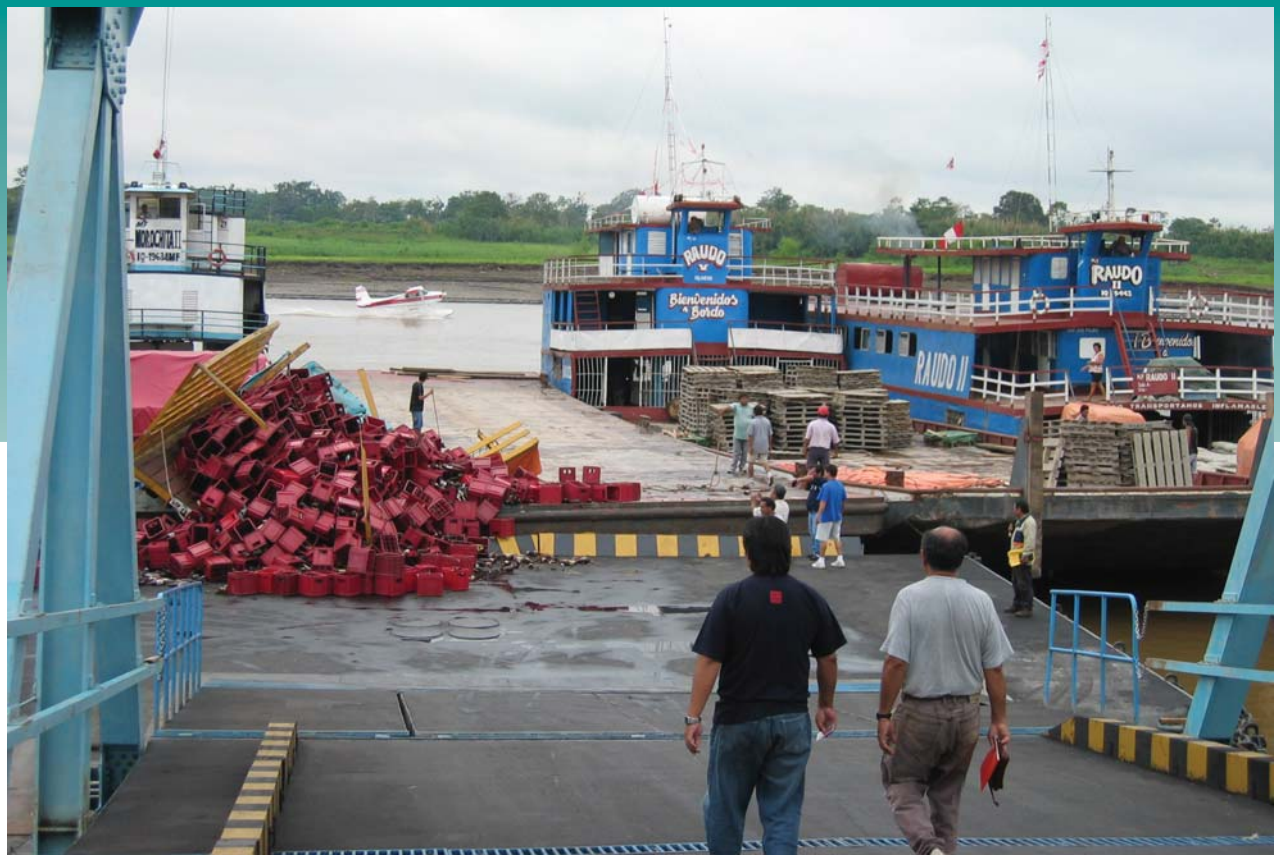
contact with the communities and help alleviate poverty in the basin, then ALT can be a true model for institutional management of an international basin. The organization is only nine years old and it will take much longer to make change happen in a region in such a difficult situation, but there is hope as ALT improves that more sustainable methods of management will be attained.

*Red bellied piranha, Amazon. Photo credit: Iva Nafzinger.*

## 3.4 Conclusions

As long as water is shared between two or more countries or a basin has two or more stake-holders, the potential for conflict will exist. South America's international waters, though abundant, do not escape from this reality. Under the current state of affairs, the continent is susceptible to any number of occurrences that would stress the water situation further. A promising future exists for the region, however, as more institutions are created to confront the issues that are emerging.

South America is unique in that it has an abundance of water resources, but with a lower population density than other continents; therefore, the amount of water per capita is the highest in the world. This exists to an even greater extent in the South America's international river basins, where the average amount of available water per capita is over 36,000 $m^3$ (TFDD 2004), much higher than the world average. This is mainly due to the amount of water that is in the Amazon River, which is the world's largest river in terms of quantity of discharge, but has a relatively low population within the basin.




*Seaplane lands near shipping docks, Amazon (Peru). Photo credit: Iva Nafzinger.*

Even with such a large amount of water, the hydrological factors pressuring the system are stressing many regions of South America. Pollution is reducing the actual amount of water resources available and causing disease and sickness all over the continent. Variations in the climate are exacerbating already stressed conditions. Groundwater use is drying up the region's stored water and endangering its purity.

The institutional framework within the international river basins is inadequate if the governments of South America want to preserve the way of life they already have and improve their standards of living. Public participation is lacking on many levels and overall governance of international water resources is minimal at best. Now that there has been a transition from SAMTAC to the South American Water Partnership, it is unknown whether, after SAMTAC's lack of success, this will be a step in the right direction.

To add to this already bleak situation is that of the human condition in South America. Poverty is a serious problem in many of the transboundary water basin areas and without alleviating this problem, sustainable management will be nearly impossible. With the population rising, especially that of urban areas, water demands are going to go up over the next two decades and stress the situation to a greater degree. With the La Plata River basin growing by 22 million inhabitants by 2025, this will put a large strain on water resources that are already being stressed by pollution and overuse.

As the situation stands at this moment, the potential for conflict, the hydropolitical vulnerability in the region, is high. Too many factors have the possibility of affecting a region where the water is concentrated in certain areas and lacking in others. This does not mean that war is going to be fought over shared waters, but the

*Crab catch, Belém, northern Brazil. Photo credit: Gretchen Bracher.*

*Iguazu river upstream from Iguazu Falls. Photo credit: Rolando León.*

probability of conflict, if the situation were to be aggravated by an extreme event, is relatively high.

The future of South America's international water resources is not as discouraging as the paragraphs above state. The efforts being made at this time are significant and the hope is that new institutions, which are being created every year, especially SAMTAC-South American Water Partnership, will provide a forum for stakeholders to develop and progress towards the sustainable and equitable use of the shared water on the continent. To a certain level, there are already many successes on the continent, such as the Binational Autonomous Authority of Lake Titicaca (ALT), but complete water governance over the basins that allows for the mitigation of the majority of preventable situations is still lacking. The best organizations still have much room to improve.

In South America, it is extremely difficult to define with clarity which basins are most at risk to hydropolitical vulnerability and which are most likely to be resilient to political pressures. For most of the shared basins in the region, there is little information that could be found on the activities being carried out within each basin. What is known is that there are four treaties (Map 7a) and twenty-four basins with international activities (see appendices) operating within the thirty-eight basins on the continent. (An analysis of each of the collaborations was not under the scope of this research, but there is not much information published on the majority of these activities.)

It can be said that, to a certain extent, all the international basins in South America are susceptible to conflict. Only seven have institutions managing them (Map 7b), thus the majority, by far, do not have a framework to mitigate or confront tensions before they escalate to conflict. If a serious issue were to arise within one of the basins without a management body, the governments of the countries involved would have to deal with the issue rather than people within a bilateral or multilateral organization, which would most likely have mechanisms for dispute resolution before going to the governmental level.

Given the fact that there are various elements at work, politically and developmentally, there are basins that are more at risk than others are. Outlined in the Table 3.5 are basins and their risk factors. The Silala is obviously the most vulnerable basin on the continent. Bolivia and Chile are not able to agree on whether the basin is international or not and have taken hard stances on their positions. There have been

*Uruguay River seen from Argentina coast. Photo credit: Rolando León.*

threats to cut off the water on Bolivia's part and both countries have discussed going to the International Court of Arbitration. With the Chilean-Bolivian relations already tense, this topic has the possibility of exacerbating it further.

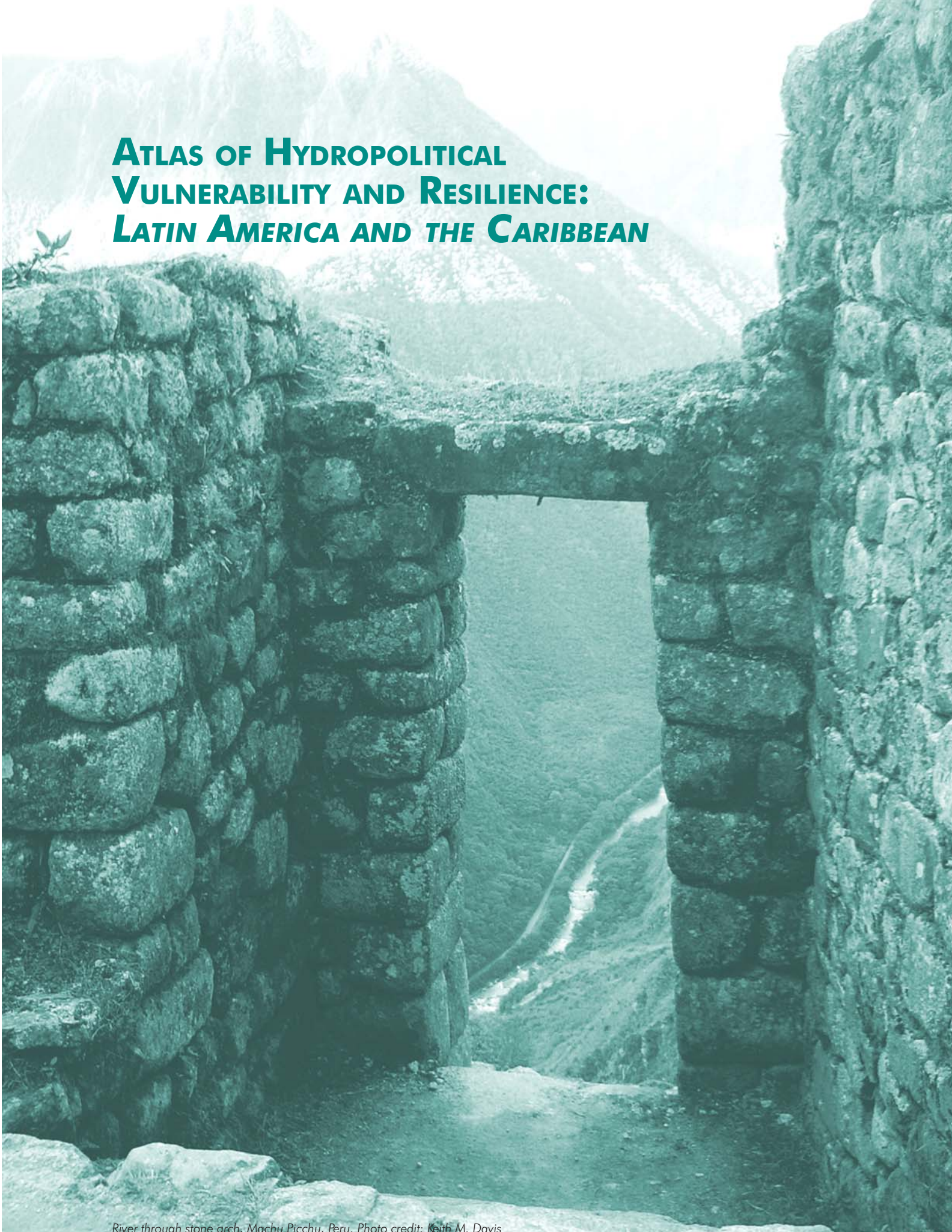
To a lesser extent are the basins of Orinoco and Essequibo in northern South America. These are the second and fourth largest rivers on the continent with regards to discharge and amongst the largest in the world. But, with increasing pollution and their lack of treaties and basin organizations, these have the potential to become problematic in the future without proper mechanisms to deal with conflict. The Essequibo, in particular, in that there are border problems between Guyana and Venezuela. One of the principal issues about these basins is the lack of information that is available. More research needs to be done in order to fully analyze these basins' dynamics.

The Amazon, La Plata, and Titicaca Basins all have treaties and institutions in place to confront disputes when they arise, and for this reason they are given a risk factor of medium low. Each basin has specific issues that have the potential to arise, but given the history of the management of these rivers, there is enough of an institutional framework in place to mitigate these factors. But, considering these factors do exist, and the little experience the RBOs have, these basins still cannot be classified as low risk.

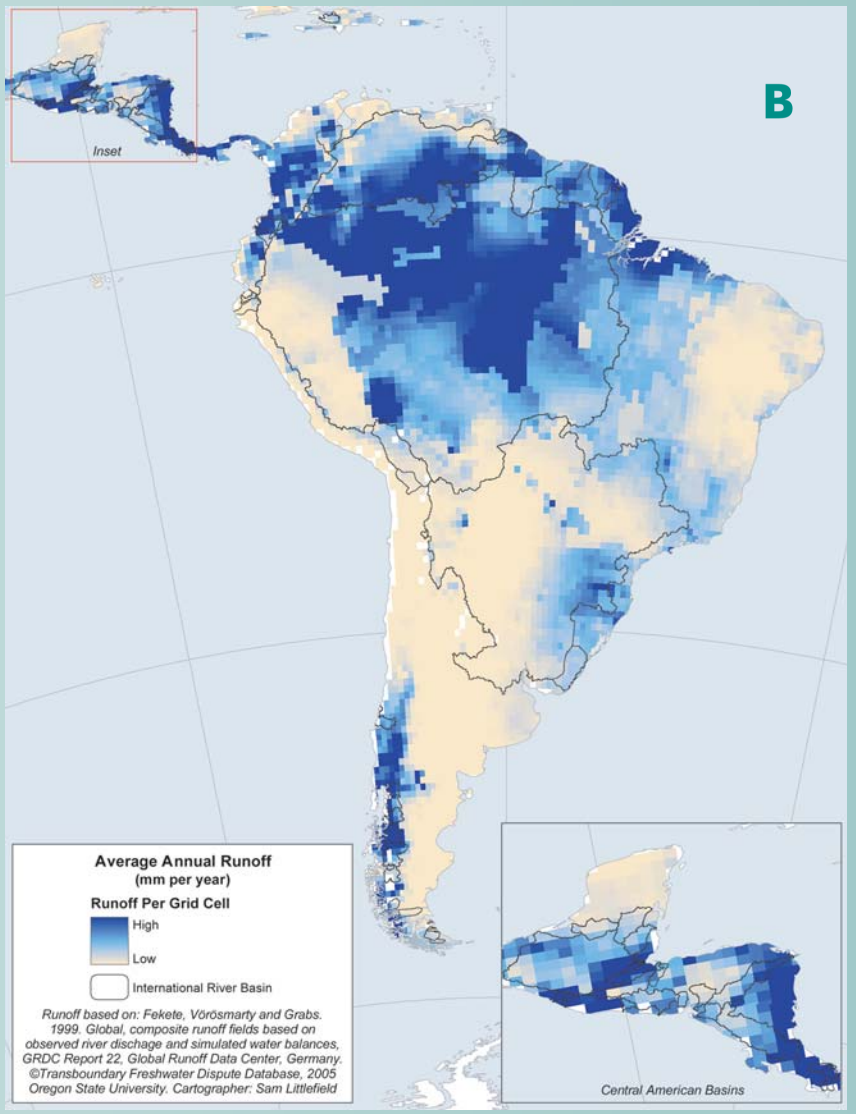
The majority of the other basins either are not in geographic locations whereas to cause major disputes between nations, there are not other reasons to believe their risk factor is high, or there is not enough information available to determine their situation. But, with a severe lack of RBOs on the continent, just over one-fifth of basins being managed by international organizations, it can be said that there is a need for more institutional management of the continent's shared freshwaters.

What is encouraging is the fact that even though the initiatives that do exist have been in effect only a few years, they have already shown how quickly they can adapt to the current state of the international river basins. This leads to hope that, given time, the efforts being made will result in the addition of more international river basin organizations which will aid in the sustainable use of South America's international water resources to the point where people, fauna, flora, and the rivers themselves will benefit from the management practices of humans.

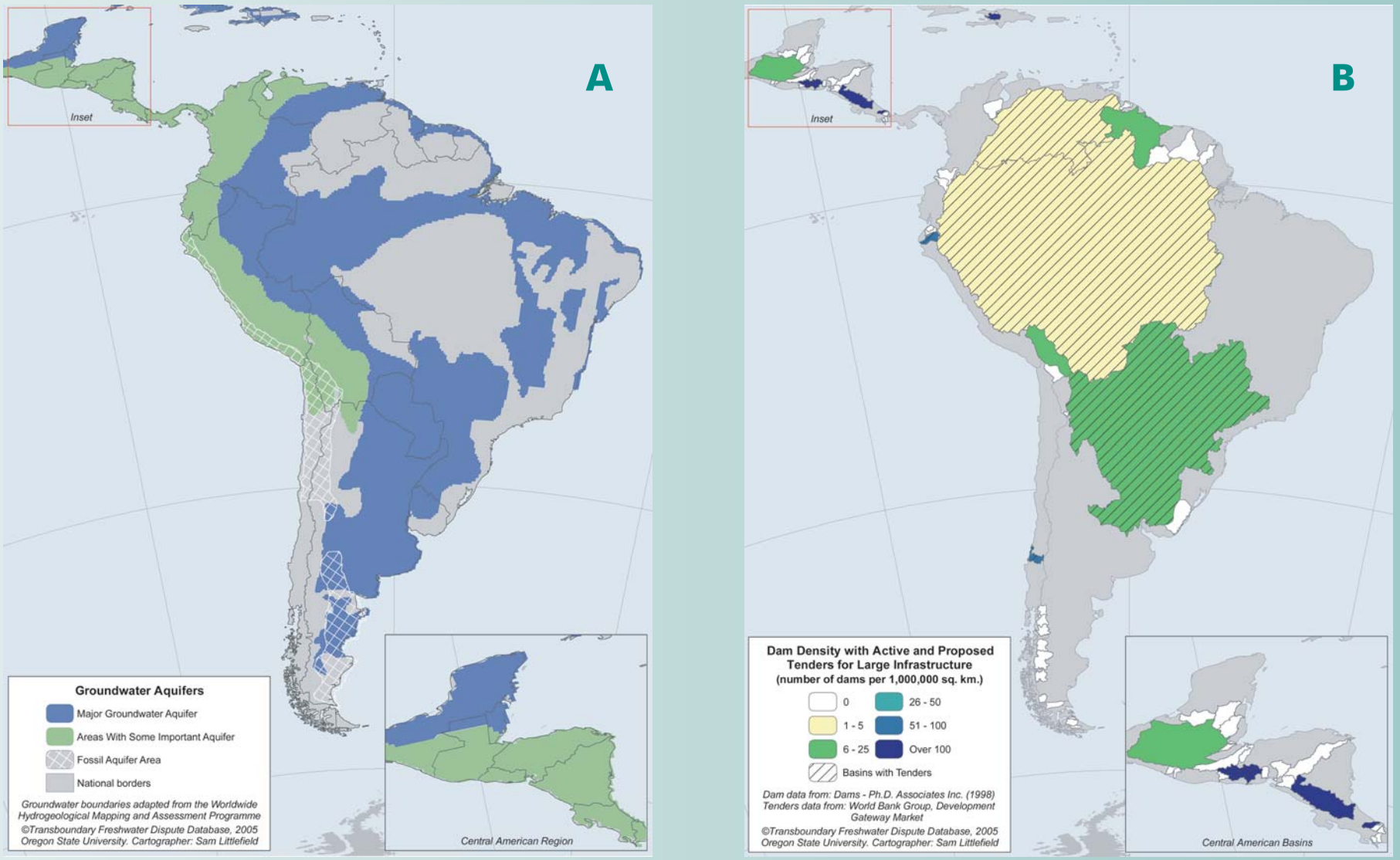
# Atlas of Hydropolitical Vulnerability and Resilience: *Latin America and the Caribbean*



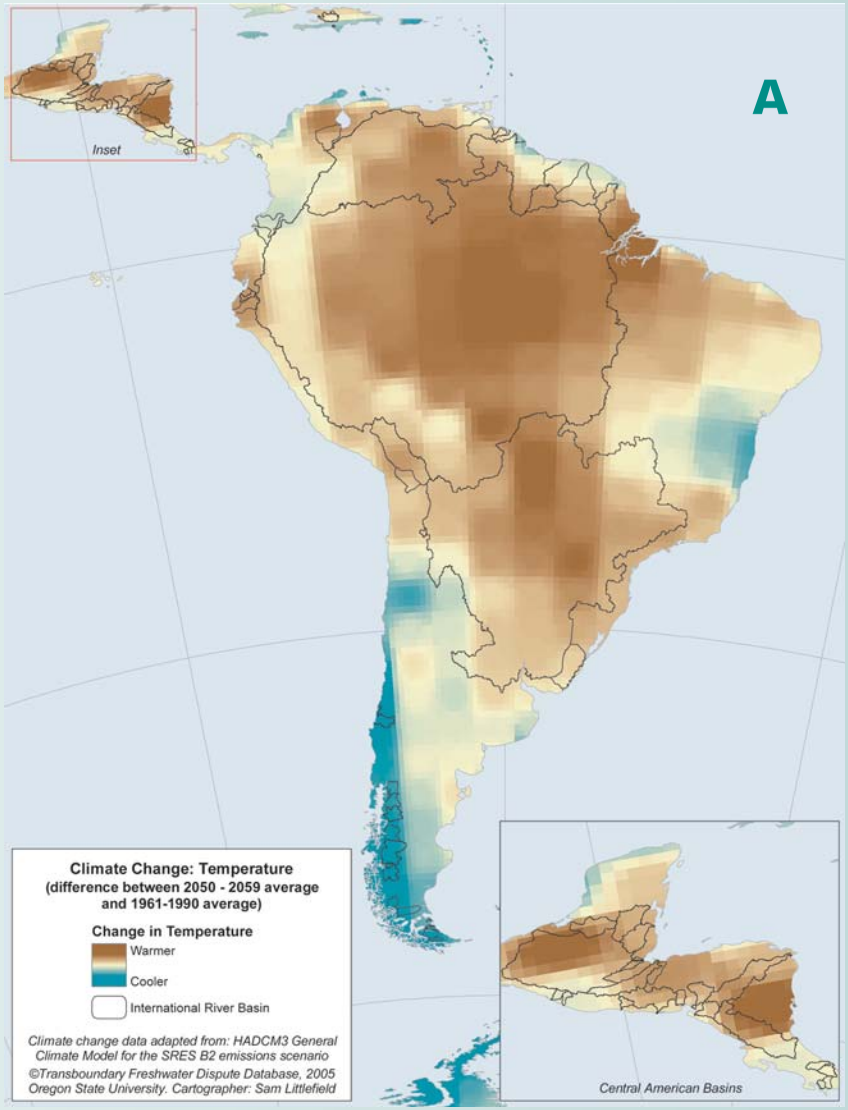
*River through stone arch, Machu Picchu, Peru. Photo credit: Keith M. Davis*

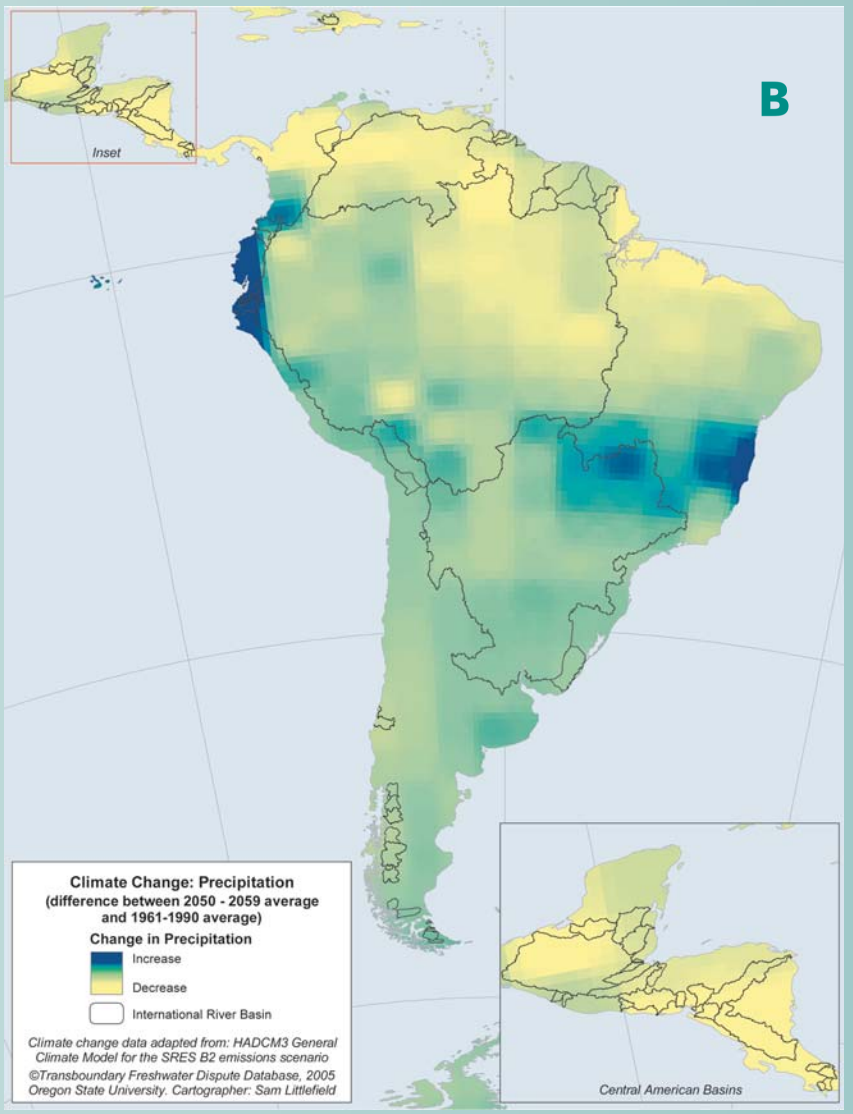




**Map 1 (A) Climate Regions.** *Köeppen climate zones based on a 0.5 decimal degree grid by Leemans and Cramer (1991) published by the International Institute for Applied Systems Analysis (IIASA). The Köeppen system integrates IIASA average monthly rainfall total and average monthly temperature, in most 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$^2$.*

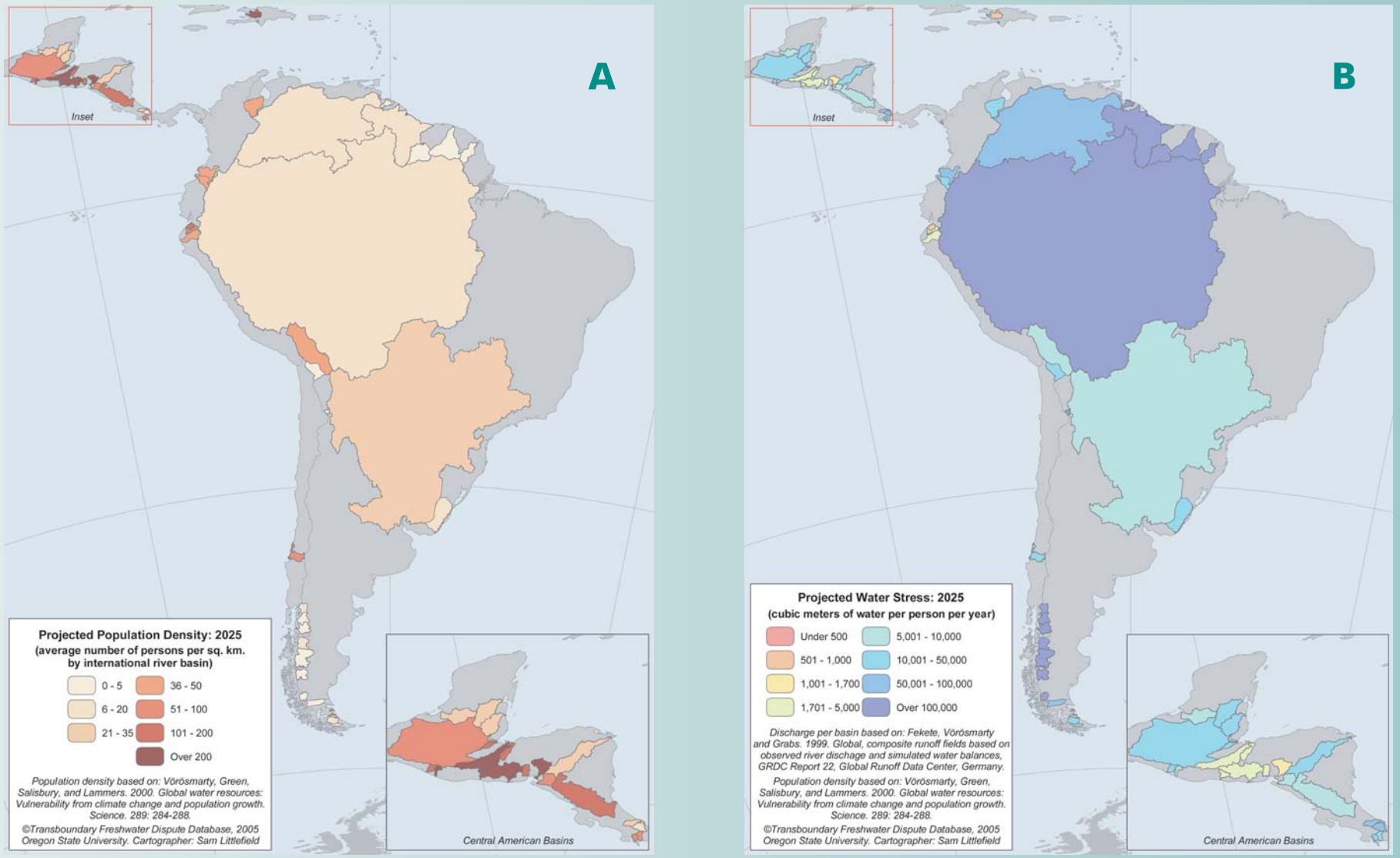



**Map 2 (A) Groundwater Aquifers.** *Adapted from a map developed by the World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP), August 2004. The most important groundwater basins are shown in blue. The green color symbolizes hydrogeological environments of complex structure. Unmarked regions 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 hydrogeologic 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.*

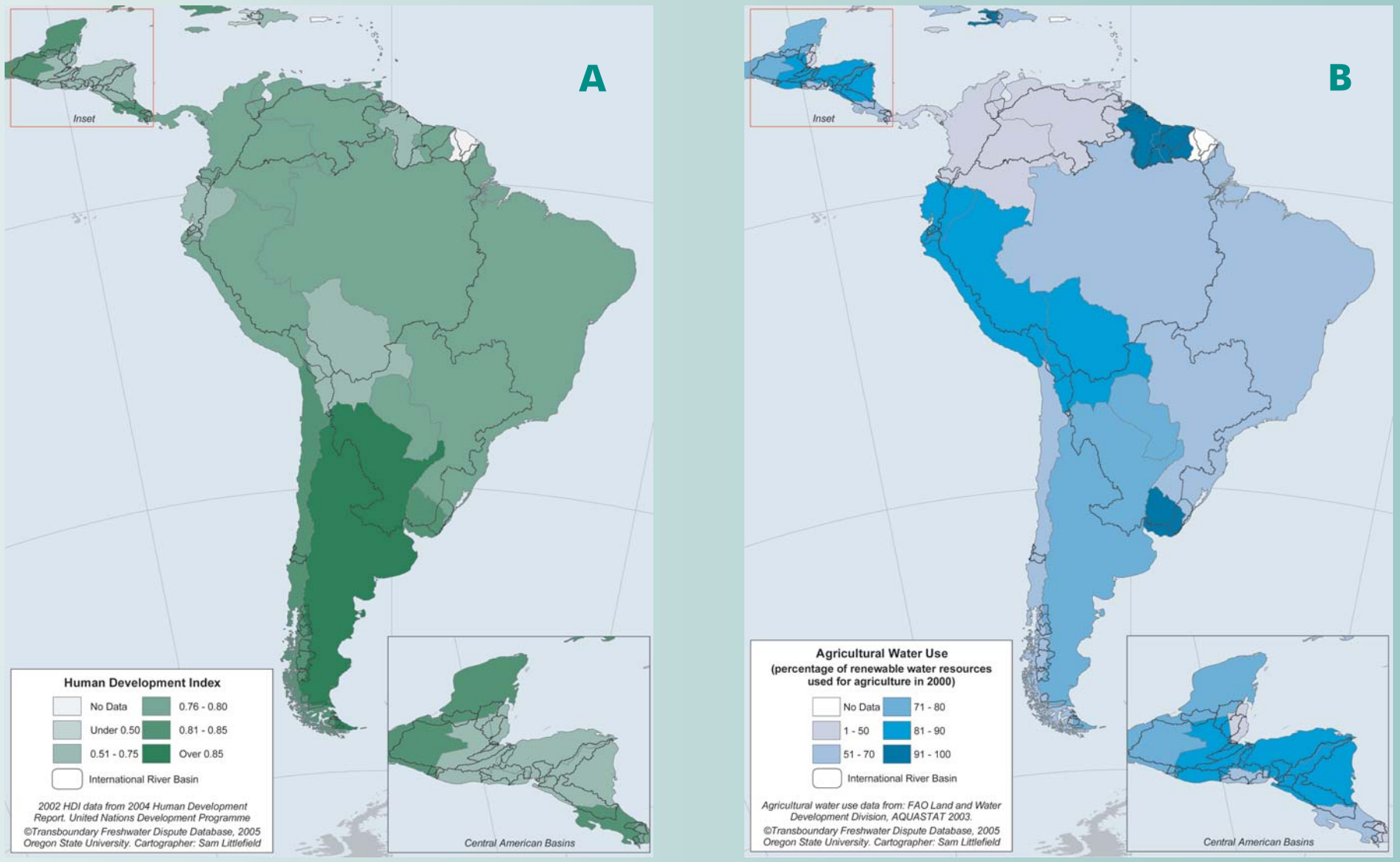


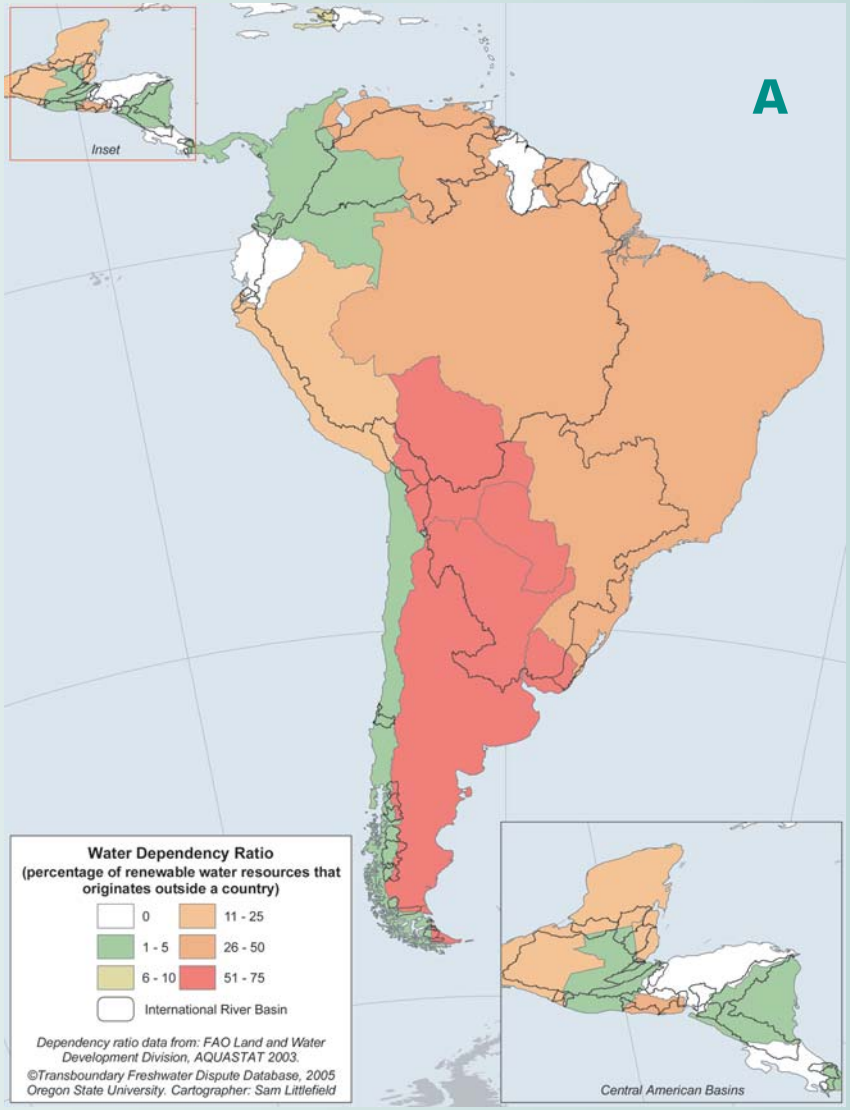

**Map 3 (A) Climate Change, Temperature. (B) Climate Change, Precipitation.** *Based on HADCM3 general climate model using the SRES B2 (moderate emissions, climate change, and technological advancement) emissions scenario. HADCM3 is distributed as 2.5 x 3.5 decimal degree data, which could not be properly 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.*




**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 km²), 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 effecting 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.*

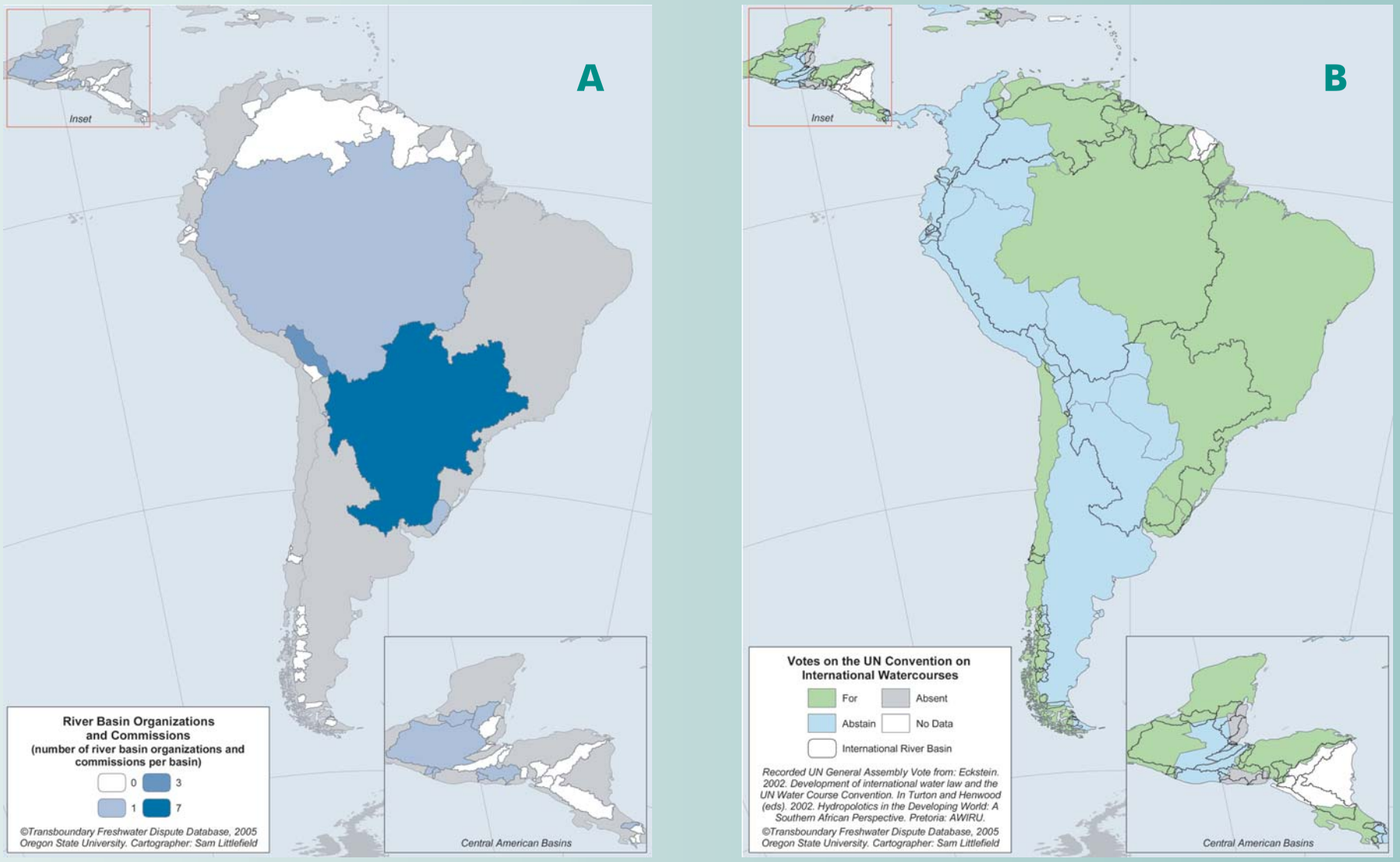



**Map 5 (A) Human Development Index.** *The human development index (HDI) is a composite index that measures the average achievements in a country in three basic dimensions of human development: a long and healthy life, as measured by life expectancy at birth; knowledge, as measured by the adult literacy 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.*

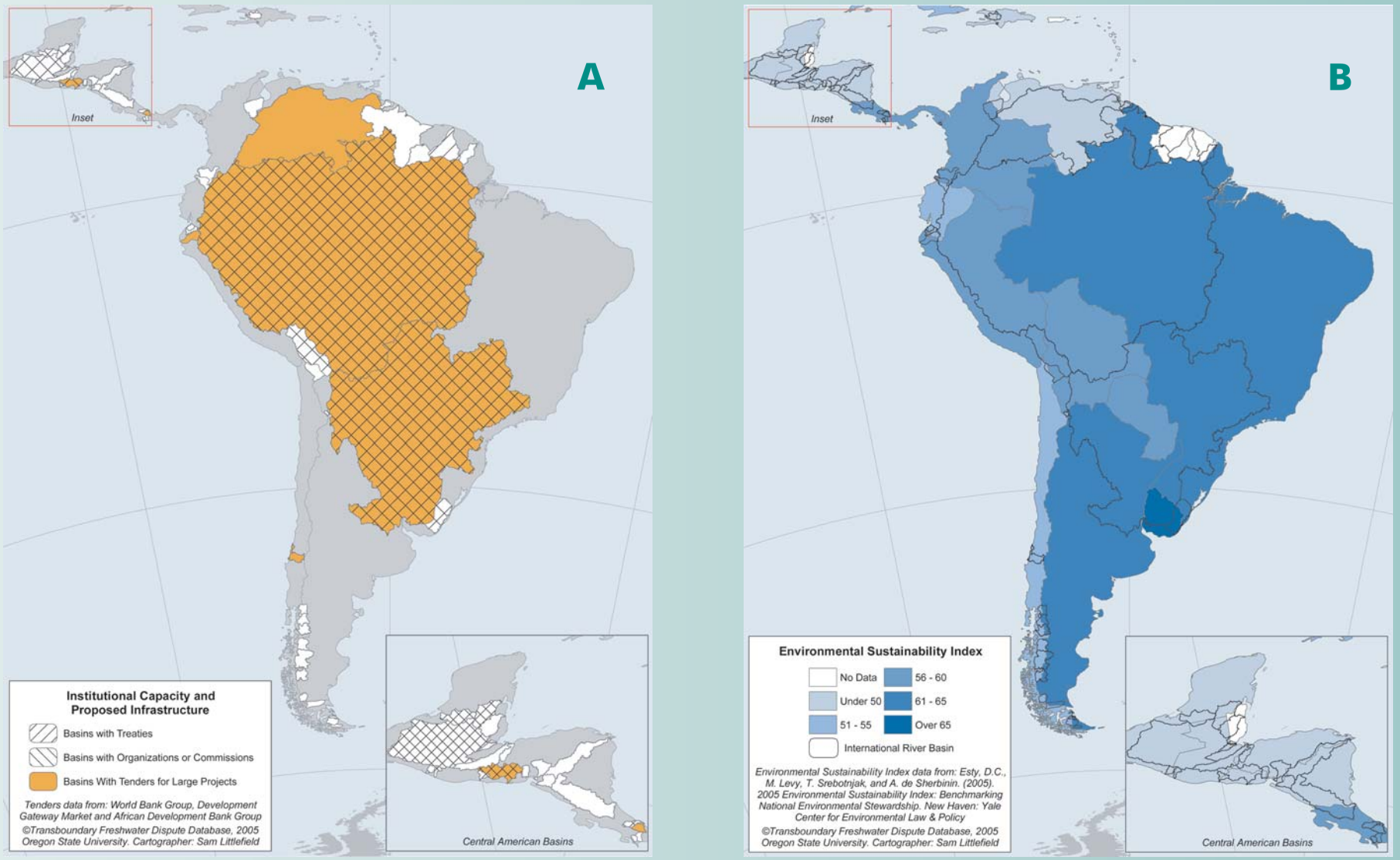




**Map 6 (A) Water Dependency Ratio.** *Water dependency ratio is calculated for AQUASTAT by the FAO Land and Water Development Division. It incorporates total country inflow and outflow of surface water and groundwater after accounting for flow submitted to and reserved by bilateral and multilateral 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*



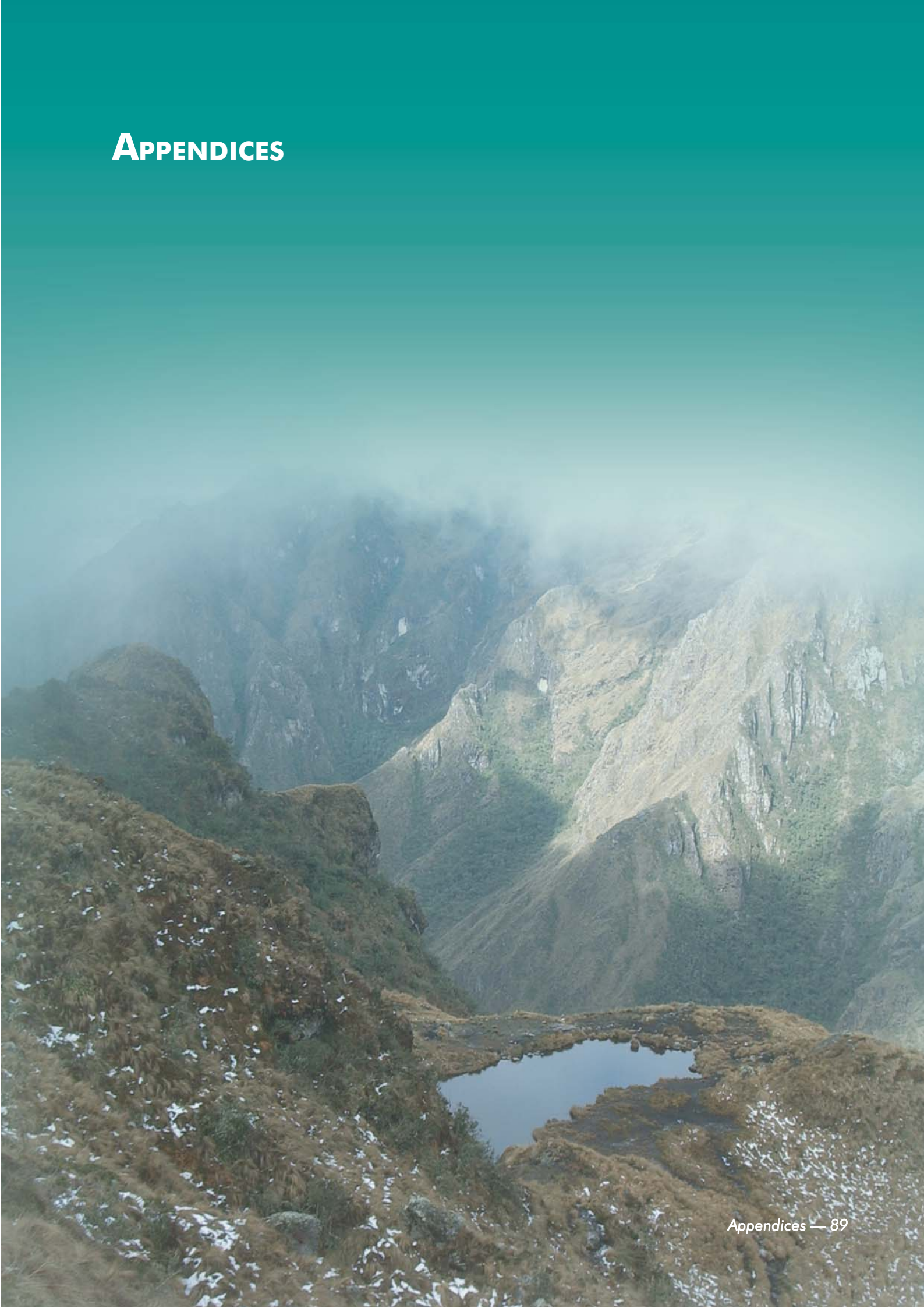

**Map 7 (A) River Basin Organizations and Commissions.** *Data for map was collected over a six month period from July to December 2004, drawing from: a compilation by Johannes Akiwumi at UNEP's Division of Environmental Information and Assessment (Nairobi); and internet searches and email interviews 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



*Sunset, Amazon. Photo credit: Iva Nafzinger.*

# Appendix 1. International Freshwater Agreements, River Basin Organizations, and River Basin Commissions of Latin America and the Caribbean

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., Cancoso/Lauca). 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., Usumacinta-Grijalva).

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.

# AMAZON*

**Total area: 5,866,100 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Brazil | 3,672,600 | 62.61 |
| Peru | 974,600 | 16.61 |
| Bolivia | 684,400 | 11.67 |
| Colombia | 353,000 | 6.02 |
| Ecuador | 137,800 | 2.35 |
| Venezuela | 38,500 | 0.66 |
| Guyana | 5,200 | 0.09 |
| Suriname | 20 | 0.00 |

*"Victoria regia" (Victoria cruziana), in the Paraná-Paraguay basin. Photo credit: Rolando León.*

## TREATIES AND AGREEMENTS

*Exchange of notes constituting an agreement for the construction of a hydroelectric plant in Cachuela Esperanza, supplementary to the agreement on economic and technical cooperation*

Treaty Basin: Beni, Mamoré, Madeira — Date: August 2, 1988

Signatories: Bolivia; Brazil

*Agreement concerning the Cachuela Esperanza hydroelectric plant, supplementary to the agreement on economic and technical co-operation between the government of the Federative Republic of Brazil and the government of the Republic of Bolivia*

Treaty Basin: Amazon — Date: February 8, 1984

Signatories: Brazil, Federal Republic of Bolivia

*Treaty for Amazonian cooperation*

Treaty Basin: Amazon — Date: July 3, 1978

Signatories: Bolivia; Brazil; Colombia; Ecuador; Guyana; Peru; Surinam; Venezuela

*Declaration and exchange of Notes concerning the termination of the process of demarcation of the Peruvian-Ecuadorean frontier*

Treaty Basin: Amazon, Chira, Zarumilla, Tumbes — Date: May 22, 1944

Signatories: Ecuador; Peru

## RIVER BASIN ORGANIZATIONS AND COMMISSIONS

*The contracting parties of the Organization of the Amazon Cooperation Treaty (OTCA)*

OTCA has agreed to undertake joint actions and efforts to promote the harmonious development of their respective Amazonian territories in such a way that these joint actions produce equitable and mutually beneficial results and achieve also the preservation of the environment, and the conservation and rational utilization of the natural resources of those territories.

*Treaty basin:* Amazon — *Date:* July 3, 1978

*Signatories:* Brazil, Peru, Bolivia, Colombia, Ecuador, Venezuela, Guyana, Suriname, French Guiana

# ARTIBONITE

**Total area: 8,800 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Haiti | 6,600 | 74.37 |
| Dominican Republic | 2,300 | 25.55 |

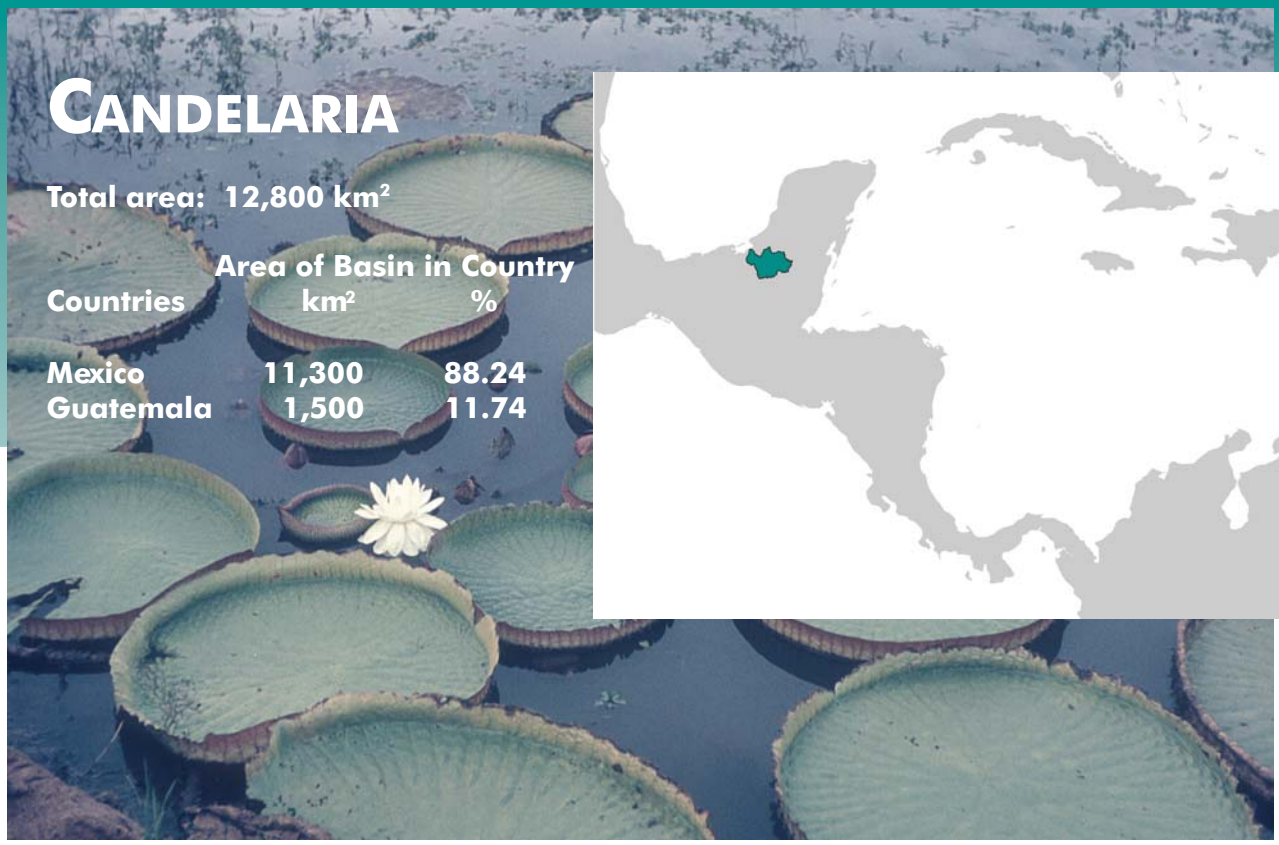


## TREATIES AND AGREEMENTS

*Traité de paix, d'amitié et d'arbitrage entre la République Dominicaine et la République d'HaVti, signé B Saint-Domingue, le 20 Février 1929*

*Treaty Basin:* Frontier or shared waters *Date:* February 20, 1929

*Signatories:* Dominican Republic; Haiti



# CANDELARIA

**Total area: 12,800 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Mexico | 11,300 | 88.24 |
| Guatemala | 1,500 | 11.74 |



## TREATIES AND AGREEMENTS

***Agreement establishing the International Commission on Limits and Water was signed giving treaty status to this Commission.***

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* July 16, 1990
*Signatories:* Guatemala, Mexico

***Convenio entre la República de Guatemala y los Estados Unidos Mexicanos sobre la Protección y Mejoramiento del Ambiente en la Zona Fronteriza, ratificada el 26 de marzo de 1988. 97 Diario de Centro America 2610, Junio 15, 1988.***

*Treaty basin:* Candelaria *Date:* March 26, 1988
*Signatories:* United States of Mexico and Guatemala

***Agreement between the United Mexican States and the Republic of Guatemala on the protection and improvement of the environment of the border area***

*Treaty basin:* Frontier or shared waters *Date:* April 10, 1987
*Signatories:* Guatemala, Republic of, United Mexican States

***Acta No. 5 y Anexo del Grupo Asesor del CILA, 19 de mayo de 1980 y Aprobación***

*Treaty basin:* Candelaria *Date:* May 19, 1980
*Signatories:* United States of Mexico and Guatemala

***Agreement between the United States of Mexico and the Republic of Guatemala creating the International Commission on Limits and Waters. Celebrated by exchange of notes in Guatemala, November 2 and December 21, 1961.***

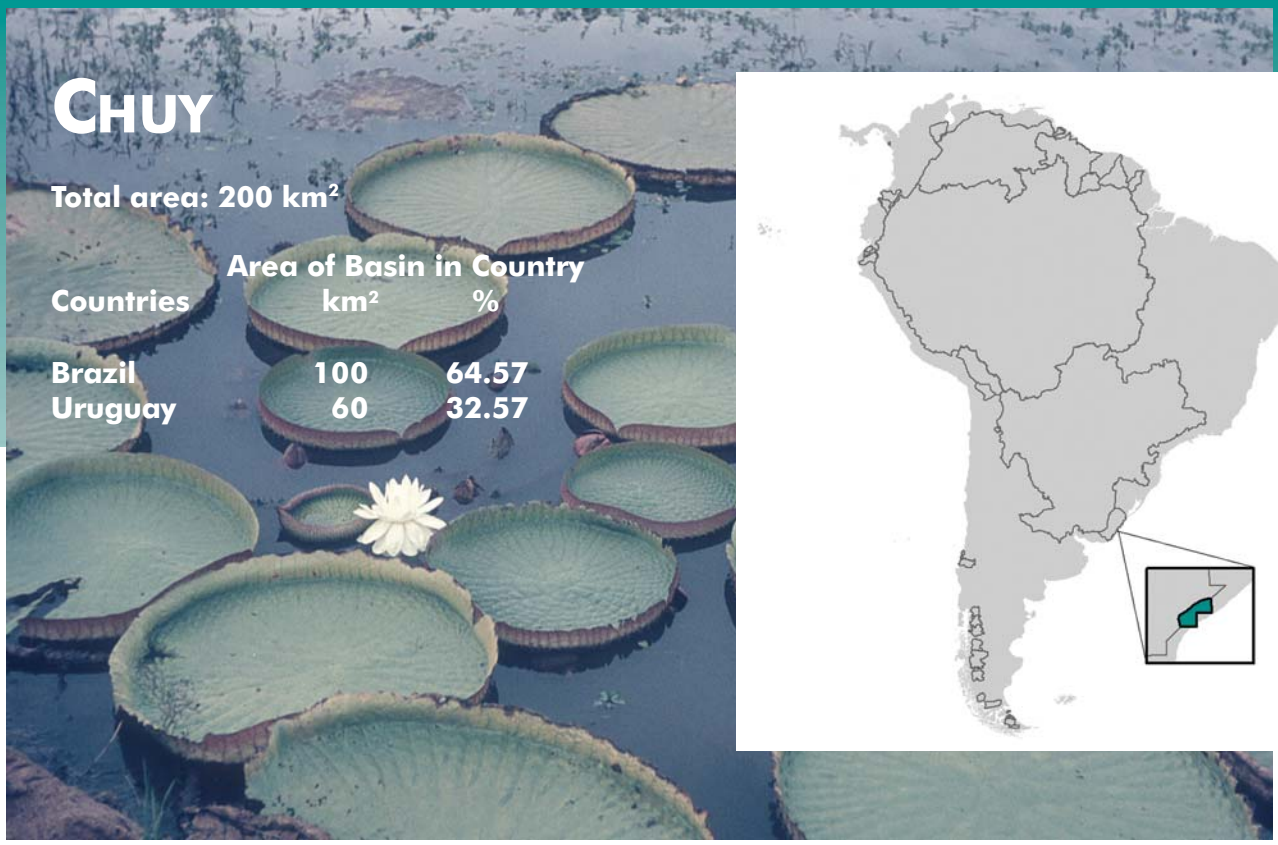
*Treaty basin:* Candelaria *Date:* November 2, and December 21, 1961
*Signatories:* United States of Mexico and Guatemala

## RIVER BASIN ORGANIZATIONS AND COMMISSIONS

***International Commission on Limits and water between Mexico and Guatemala.***

Formally established by exchange of diplomatic notes between the countries. Commission has authority to advise the two countries on border issues and the equitable use of water.

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* November 2, and December 21, 1961
*Signatories:* Guatemala, Mexico

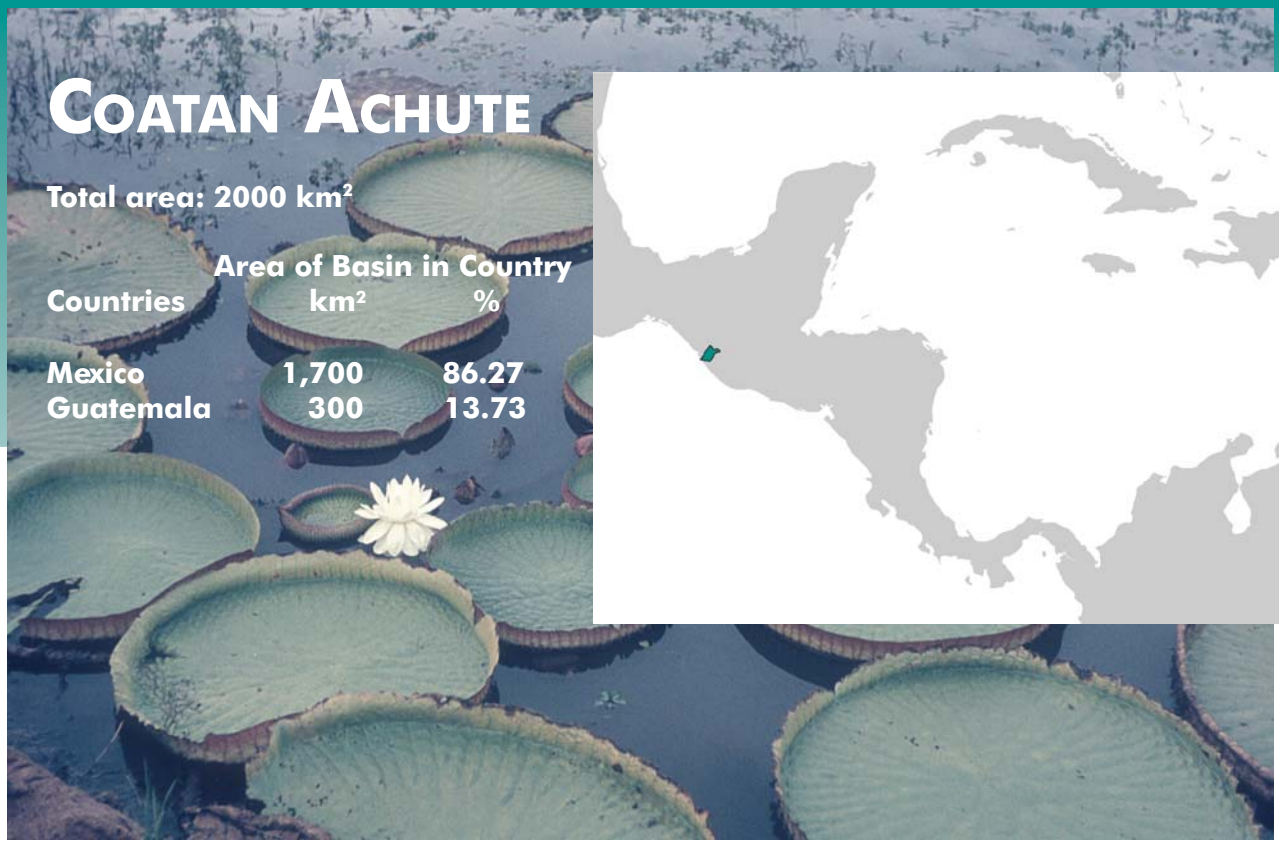



## TREATIES AND AGREEMENTS

*Convention regarding the determination of the legal status of the frontier between Brazil and Uruguay*

*Treaty basin:* Frontier or shared waters *Date:* December 20, 1933

*Signatories:* Brazil; Uruguay



# Coatan Achute

**Total area: 2000 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Mexico | 1,700 | 86.27 |
| Guatemala | 300 | 13.73 |

## Treaties and Agreements

*Agreement establishing the International Commission on Limits and Water was signed giving treaty status to this Commission.*

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* July 16, 1990

*Signatories:* Guatemala, Mexico

*Convenio entre la República de Guatemala y los Estados Unidos Mexicanos sobre la Protección y Mejoramiento del Ambiente en la Zona Fronteriza, ratificada el 26 de marzo de 1988. 97 Diario de Centro America 2610, Junio 15, 1988.*

*Treaty basin:* Coatan Achute *Date:* March 26, 1988

*Signatories:* United States of Mexico and Guatemala

*Agreement between the United Mexican States and the Republic of Guatemala on the protection and improvement of the environment of the border area*

*Treaty basin:* Frontier or shared waters *Date:* April 10, 1987

*Signatories:* Guatemala, Republic of, United Mexican States

*Acta No. 5 y Anexo del Grupo Asesor del CILA, 19 de mayo de 1980 y Aprobación.*

*Treaty basin:* Coatan Achute *Date:* May 19, 1980

*Signatories:* United States of Mexico and Guatemala

## River Basin Organizations and Commissions

*International Commission on Limits and water between Mexico and Guatemala.*

Formally established by exchange of diplomatic notes between the countries. Commission has authority to advise the two countries on border issues and the equitable use of water.

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* November 2, and December 21, 1961

*Signatories:* Guatemala, Mexico

# Dajabón-Massacre

**Total area: 800 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Haiti | 500 | 62.03 |
| Dominican Republic | 300 | 35.96 |

## Treaties and Agreements

*Traité de paix, d'amitié et d'arbitrage entre la République Dominicaine et la République d'HaVti, signé B Saint-Domingue, le 20 Février 1929*

*Treaty basin:* Frontier or shared waters *Date:* February 20, 1929

*Signatories:* Dominican Republic; Haiti

# Hondo

**Total area 14,600.00 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Mexico | 8,900 | 61.14 |
| Guatemala | 4,200 | 28.50 |

## Treaties and Agreements

*Canje de Notas que crea la Comisión Internacional de Límites y Aguas entre México y Belize*

*Treaty basin:* Hondo *Date:* November 1993

*Signatories:* Mexico, Belize

*Agreement establishing the International Commission on Limits and Water was signed giving treaty status to this Commission*

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* July 16, 1990

*Signatories:* Guatemala, Mexico

*Agreement between the United Mexican States and the Republic of Guatemala on the protection and improvement of the environment of the border area*

*Treaty basin:* Frontier or shared waters *Date:* April 10, 1987

*Signatories:* Guatemala, Republic of, United Mexican States

## River Basin Organizations and Commissions

*International Commission on Limits and water between Mexico and Guatemala*

Formally established by exchange of diplomatic notes between the countries. Commission has authority to advise the two countries on border issues and the equitable use of water.

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* November 2, and December 21, 1961

*Signatories:* Guatemala, Mexico

# Lagoon Mirim

**Total area: 55,000 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Uruguay | 31,200 | 56.69 |
| Brazil | 23,800 | 43.24 |

## Treaties and Agreements

*Complementary agreement to the basic scientific and technical cooperation agreement between the government of the Eastern Republic of Uruguay and the Federal Republic of Brazil on cooperation in the area of water resources*

*Treaty basin:* Lagoon Mirim *Date:* March 11, 1991
*Signatories:* Eastern Republic of Uruguay, Federal Republic of Brazil

*Treaty on cooperation for the utilization of the natural resources and the development of the Mirim Lagoon basin (Treaty of the Mirim Lagoon basin) and Protocol (Jaguarão River Protocol)*

*Treaty basin:* Lagoon Mirim *Date:* July 07, 1977
*Signatories:* Brazil, Uruguay

*Exchange of notes constituting an agreement between Brazil and Uruguay establishing a joint commission for the development of the Mirim Lagoon*

*Treaty basin:* Lagoon Mirim *Date:* April 26, 1963
*Signatories:* Brazil; Uruguay

*Convention regarding the determination of the legal status of the frontier between Brazil and Uruguay*

*Treaty basin:* Lagoon Mirim *Date:* December 20, 1933
*Signatories:* Brazil; Uruguay

## River Basin Organizations and Commissions

*Commission for the Development of the Mirim Lagoon Basin (CLM).*

Set up to perform joint initiatives in the Mirim Lagoon, with Brazilian and Uruguayan agents. It acted satisfactorily to address the problems and issues inherent in the proposal of regional development. However, attempts at integrated institutional actions were frustrated, and over the years, each country has established its own agenda. In June 2002, a unilateral legal instrument to help reactivate the Commission was signed.

*Treaty basin:* Lagoon Mirim *Date:* April 26, 1963
*Signatories:* Uruguay, Brazil

# Lake Titicaca-Poopo System

**Total area: 111,800 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Bolivia | 63,000 | 56.32 |
| Peru | 48,000 | 42.94 |
| Chile | 800 | 0.74 |

## Treaties and Agreement

*Agreement between Bolivia and Peru concerning a preliminary economic study of the joint utilization of the waters of Lake Titicaca.*

*Treaty basin:* Lake Titicaca — *Date:* February 19, 1957

*Signatories:* Bolivia; Peru

*Preliminary convention between Peru and Bolivia concerning a study of the joint utilization of the waters of Lake Titicaca*

*Treaty basin:* Lake Titicaca — *Date:* July 30, 1955

*Signatories:* Bolivia; Peru

*Exchange of notes between Peru and Bolivia establishing a joint commission for study of the Puno-Guaqui railway line and joint use of the waters of Lake Titicaca*

*Treaty basin:* Lake Titicaca — *Date:* April 20, 1955

*Signatories:* Bolivia; Peru

*Preliminary convention between Bolivia and Peru for the exploitation of fisheries in Lake Titicaca*

*Treaty basin:* Lake Titicaca — *Date:* July 17, 1935

*Signatories:* Bolivia; Peru

*Treaty between Chile and Peru for the settlement of the dispute regarding Tacna and Africa*

*Treaty basin:* Arica, Tacna — *Date:* June 3, 1929

*Signatories:* Chile; Peru

*Notas reversales related to the creation of the Autonomous Binational Authority of the basin of the Lake Titicaca, Desaguadero river, Lake Poopó, Coipasa Salt Pan system*

*Treaty basin:* Lake Titicaca-Poopo System — *Date:* June 21, 1993

*Signatories:* Bolivia; Peru

## River Basin Organizations and Commissions

***Binational Autonomous Authority of the Lake Titicaca (ALT).***

The ALT is an entity of international public right with autonomy in its decisions and administrations in technical and economic fields; ALT's political functioning is associated with the Peruvian and Bolivian State Secretaries. ALT's General Objective is to promote and conduct actions, programs and projects, to dictate norms of management control and protection of the water resources in the Hydrologic System of the Lake Titicaca, the Desaguadero river, lake Poopo and The Coipasa Salt Lake (TDPS); under the framework of the Master Plan of the TDPS system.

*Treaty basin:* Lake Titicaca-Poopo System *Date:* May 29, 1996

*Signatories:* Bolivia, Peru, Chile

***The Autonomous Binational TDPS System Authority for the TDPS***

*Treaty basin:* Lake Titicaca-Poopo System *Date:* July 1, 1993

*Signatories:* Bolivia, Peru

***Joint Subcommittee for the Development of the Lake Titicaca Integration Zone (SUBCOMILAGO).***

*Treaty basin:* Lake Titicaca-Poopo System *Date:* 1987

*Signatories:* Bolivia, Peru

# La Plata*

**Total area: 2,954,500 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Brazil | 1,379,300 | 46.69 |
| Argentina | 817,900 | 27.68 |
| Paraguay | 400,100 | 13.54 |
| Bolivia | 245,100 | 8.30 |
| Uruguay | 111,600 | 3.78 |

## Treaties and Agreements

*Tratado entre el gobierno de la Republica Argentina y el gobierno de la Republica Federativea del Brasil para el aprovechamiento de los recursos hidricos compartidos de los tramos limitrofes del Rio Uruguay y de su afluente el Rio Pepiri-Guazu.*

*Treaty basin:* Uruguay, Pepiri-Guazu — *Date:* May 17, 1980

*Signatories:* Argentina; Brazil, Federal Republic of

*Agreement on Paraná River projects*

*Treaty basin:* Paraná — *Date:* October 19, 1979

*Signatories:* Argentina; Brazil; Paraguay

*Treaty between Uruguay and Argentina concerning the Rio de la Plata and the Corresponding Maritime Boundary*

*Treaty basin:* La Plata (Del Plata) — *Date:* November 19, 1973

*Signatories:* Argentina, Uruguay

*Treaty between the Federative Republic of Brazil and the Republic of Paraguay concerning the hydroelectric utilization of the water resources of the Parana River owned in condominium by the two countries, from and including the Salto Grande de Sete Quedas or Salto del Guaira, to the mouth of the Iguassu River*

*Treaty basin:* Paraná, Iguassu — *Date:* April 26, 1973

*Signatories:* Brazil; Paraguay

*Treaty of the River Plata Basin*

*Treaty basin:* La Plata (Del Plata) — *Date:* April 23, 1969

*Signatories:* Argentina, Bolivia, Brazil, Paraguay, Uruguay

*Treaty between the Argentine Republic and the Eastern Republic of Uruguay on the boundary constituted by the Uruguay River*

*Treaty basin:* Uruguay — *Date:* April 7, 1961

*Signatories:* Argentina; Uruguay

*Agreement between the Argentine Republic and the Republic of Paraguay concerning a study of the utilization of the water power of the Apipe Falls*

*Treaty basin:* Paraná *Date:* January 23, 1958

*Signatories:* Argentina; Paraguay

*Agreement concerning cooperation between Brazil and Paraguay in a study on the utilization of the water power of the Acaray and Monday Rivers*

*Treaty basin:* Acaray, Monday *Date:* January 20, 1956

*Signatories:* Brazil; Paraguay

*Agreement concerning the utilization of the rapids of the Uruguay River in the Salto Grande area*

*Treaty basin:* Uruguay *Date:* December 30, 1946

*Signatories:* Argentina; Uruguay

*Supplementary boundary treaty between the Argentine Republic and the Republic of Paraguay on the river Pilcomayo and protocol annexed to the treaty*

*Treaty basin:* Pilcomayo *Date:* June 1, 1945

*Signatories:* Argentina; Paraguay

*Supplementary boundary treaty between Argentina and Paraguay, signed at Buenos Aires, July 5, 1939*

*Treaty basin:* Pilcomayo *Date:* July 5, 1939

*Signatories:* Argentina; Paraguay

*Convention regarding the determination of the legal status of the frontier between Brazil and Uruguay*

*Treaty basin:* Frontier or shared waters *Date:* December 20, 1933

*Signatories:* Brazil; Uruguay

*Protocol between Uruguay and Argentina dealing with the questions of the jurisdiction of the River Plate, signed at Montevideo, January 5, 1910*

*Treaty basin:* Plate *Date:* January 5, 1910

*Signatories:* Argentina; Uruguay

## River Basin Organizations and Commissions

*Binational Commission for the Development of the upper Bermejo River and Grande de Tarija River Basins.*

The Bermejo and Tarija River Basins form an international sub-basin within the La Plata River Basin.This Commission is responsible for the administration of the Upper Bermejo River and Grande de Tarija River Basins, in order to promote sustainable development in its area of influence, optimize its natural resources development, contribute to its socioeconomic development, and allow rational and equitable management of water resources.

*Treaty basin:* La Plata (Del Plata) *Date:* June 9, 1995

*Signatories:* Argentina, Bolivia

*Comisión Trinacional para el Desarrollo de la Cuenca del Río Pilcomayo – Tri-national Commission for the Development of the Pilcomayo River Basin.*

The Pilcomayo River Basin forms an international sub-basin within the La Plata River Basin. The Commission is responsible for the study and execution of joint projects in the Pilcomayo River.

*Treaty basin:* La Plata (Del Plata) *Date:* February 9, 1995

***Signatories:*** Argentina, Bolivia, Paraguay

*Comision Binacional Punte Buenos Aires Colonia or Buenos Aires - Colonia Bridge Binational Commission (COBAICO).*

This commission was based on a common interest in increasing commerce between Argentina and Uruguay. In order to facilitate this commerce, a bridge was created across the Plata River which runs between the two national territories. One of the responsibilities of COBAICO is overseeing the sustainable management and preservation of the Plata River.

***Treaty basin:*** La Plata (Del Plata) ***Date:*** 1985

***Signatories:*** Argentina, Uruguay

***Comisión Administradora del Río de la Plata or the Administrative Commission for the Río de la Plata (CARP).***

This is an international organism, of binational character, that offers the legal frame and enables dialogues between the Argentine Republic and the Eastern Republic of Uruguay, for the negotiation in matters of interest common to both nations concerning the Rio de la Plata.

***Treaty basin:*** La Plata (Del Plata) ***Date:*** November 19, 1973

***Signatories:*** Argentina, Uruguay

***Comision Mixta del Rio Parana or Joint Commission of the Parana River (COMIP).***

The Parana forms an international sub-basin within the La Plata River Basin. COMIP was agreed to by both Paraguay and Argentina in 1971. This agreement legally binds both countries to a set of laws regulating the shared use of the Paraná River as a natural resource. COMIP functions as an international organization, as such it is responsible for conducting evaluations in such areas as industrial, agricultural and recreational use of Paraná River.

*Treaty basin:* La Plata (Del Plata) *Date:* 1971

*Signatories:* Argentina, Paraguay

***The permanent Intergovernmental Co-ordinating Committee (CIC) is responsible for ongoing administration ot the La Plata Basin Treaty (1969).***

The committee is composed of representatives of each country and has a secretariat with responsibility for coordination, promotion, and control of the multinational efforts. The 1969 treaty provides an umbrella framework for several bilateral treaties between the riparian, and a direction for joint development of the basin. The treaty requires open transportation and communication along the river and its tributaries, and prescribes cooperation in education, health, and management of 'non-water' resources (e.g., soil, forest, flora, and fauna). The foreign ministers of the riparian states provide the policy direction.

*Treaty basin:* La Plata (Del Plata) *Date:* 1969

*Signatories:* Brazil, Argentina, Uruguay, Paraguay, Bolivia

***Comision Technica de Mixta de Salto Grande (CTMSG).***

The Salto Grande River Basin forms an international sub-basin within the La Plata River Basin.The CTMSG was set up for the production of electrical energy, using the rapids of the Salto Grande between Argentina and Uruguay. Work began in 1974, actual electricity generation starting in 1979. Now the commission manages, operates and maintains the turbines. Argentina and Uruguay have their power markets totally integrated; these turbines contributes 60% of Uruguay's energy demand and covers 10% of the Argentina market.

*Treaty basin:* La Plata (Del Plata) *Date:* December 30, 1946

*Signatories:* Argentina, Uruguay

# Lempa

**Total area 18,000 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| El Salvador | 9,500 | 52.54 |
| Honduras | 5,800 | 32.01 |
| Guatemala | 2,800 | 15.54 |

## Treaties and Agreements

*Treaty for the delimitation of the boundary between Guatemala and El Salvador*

*Treaty Basin:* Lempa, Paz *Date:* April 9, 1938

*Signatories:* El Salvador; Guatemala

## River Basin Organizations and Commissions

*Comisión Trinacional del Plan Trifinio or Trinational Commission of the Trifinio Plan (CTPT).*

The CTPT is the entity in charge of overviewing the execution of the Trifinio Plan, and its continuous updating, with administrative, financial, and technical autonomy, and its own legal status. Also, the Plan Trifinio forms part of the Central American integration process, and is attached to the Central American Integration System (SICA).

*Treaty basin:* Lempa *Date:* 1992

*Signatories:* El Salvador, Honduras, Guatemala

# MARONI*

**Total area: 65,000 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Suriname | 37,500 | 57.64 |
| French Guiana | 27,200 | 41.90 |
| Brazil | 200 | 0.27 |

## TREATIES AND AGREEMENTS

*Convention between France and the Netherlands to fix the boundary between Suriname and French Guiana, signed at Paris*

*Treaty basin:* Maroni, Marowinjne

*Date:* September 30, 1915

*Signatories:* France; Netherlands

# Paz

**Total area: 2,200 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Guatemala | 1,400 | 64.47 |
| El Salvador | 800 | 35.53 |

## Treaties and Agreements

*Treaty for the delimitation of the boundary between Guatemala and El Salvador*

*Treaty Basin:* Lempa, Paz — *Date:* April 9, 1938

*Signatories:* El Salvador; Guatemala

## River Basin Organizations and Commissions

*Comisión Binacional del Río Paz*

*Treaty basin:* Paz — *Date:* No data

*Signatories:* Guatemala, El Salvador

# Pedernales

**Total area: 400 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Haiti | 200 | 67.32 |
| Dominican Republic | 100 | 32.68 |

## Treaties and Agreements

*Traité de paix, d'amitié et d'arbitrage entre la République Dominicaine et la République d'HaVti, signé B Saint-Domingue, le 20 Février 1929*

*Treaty basin:* Frontier or shared waters *Date:* February 20, 1929

*Signatories:* Dominican Republic, Haiti

# San Juan

**Total area: 42,200 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Nicaragua | 30,400 | 72.02 |
| Costa Rica | 11,800 | 27.93 |

## Treaties and Agreements

*Award of the President of the United States on the validity of the treaty of limits of 15 April 1858 between Costa Rica and Nicaragua*

*Treaty basin:* Frontier or shared waters *Dates:* March 22, 1888

*Signatories:* Costa Rica, Nicaragua


## TREATIES AND AGREEMENTS

*Gobierno de Costa Rica/Gobierno de Panamá. 1979.* Declaración de Guabito, 3 de marzo. Declaración Conjunta sobre un Parque de la Amistad. *Signatarios: Lic. Rodrigo Carazo, Presidente de Costa Rica; Dr. Aristides Royo, Presidente de Panamá. San José/Ciudad de Panamá.*

*Treaty basin:* Sixaola *Date:* March 3, 1979

*Signatories:* Costa Rica, Panama

## RIVER BASIN ORGANIZATIONS AND COMMISSIONS

*Comité de la cuenca del río Sixaola (CCRS) or Sixaola River Watershed Committee.*

*Treaty basin:* Sixaola *Date:* No data

*Signatories:* Costa Rica, Panama

# Suchiate

**Total area: 1,600 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Guatemala | 1,100 | 68.79 |
| Mexico | 500 | 31.21 |

## Treaties and Agreements

*Agreement establishing the International Commission on Limits and Water was signed giving treaty status to this Commission.*

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* July 16, 1990

*Signatories:* Guatemala, Mexico

*Convenio entre la República de Guatemala y los Estados Unidos Mexicanos sobre la Protección y Mejoramiento del Ambiente en la Zona Fronteriza, ratificada el 26 de marzo de 1988. 97 Diario de Centro America 2610, Junio 15, 1988.*

*Treaty basin:* Suchiate *Date:* March 26, 1988

*Signatories:* United States of Mexico, Guatemala

*Agreement between the United Mexican States and the Republic of Guatemala on the protection and improvement of the environment in the border area*

*Treaty basin:* Suchiate

*Signatories:* United Mexican States, Republic of Guatemala *Date:* April 10, 1987

*Acta No. 5 y Anexo del Grupo Asesor del CILA, 19 de mayo de 1980 y Aprobación.*

*Treaty basin:* Suchiate *Date:* May 19, 1980

*Signatories:* Guatemala, Mexico

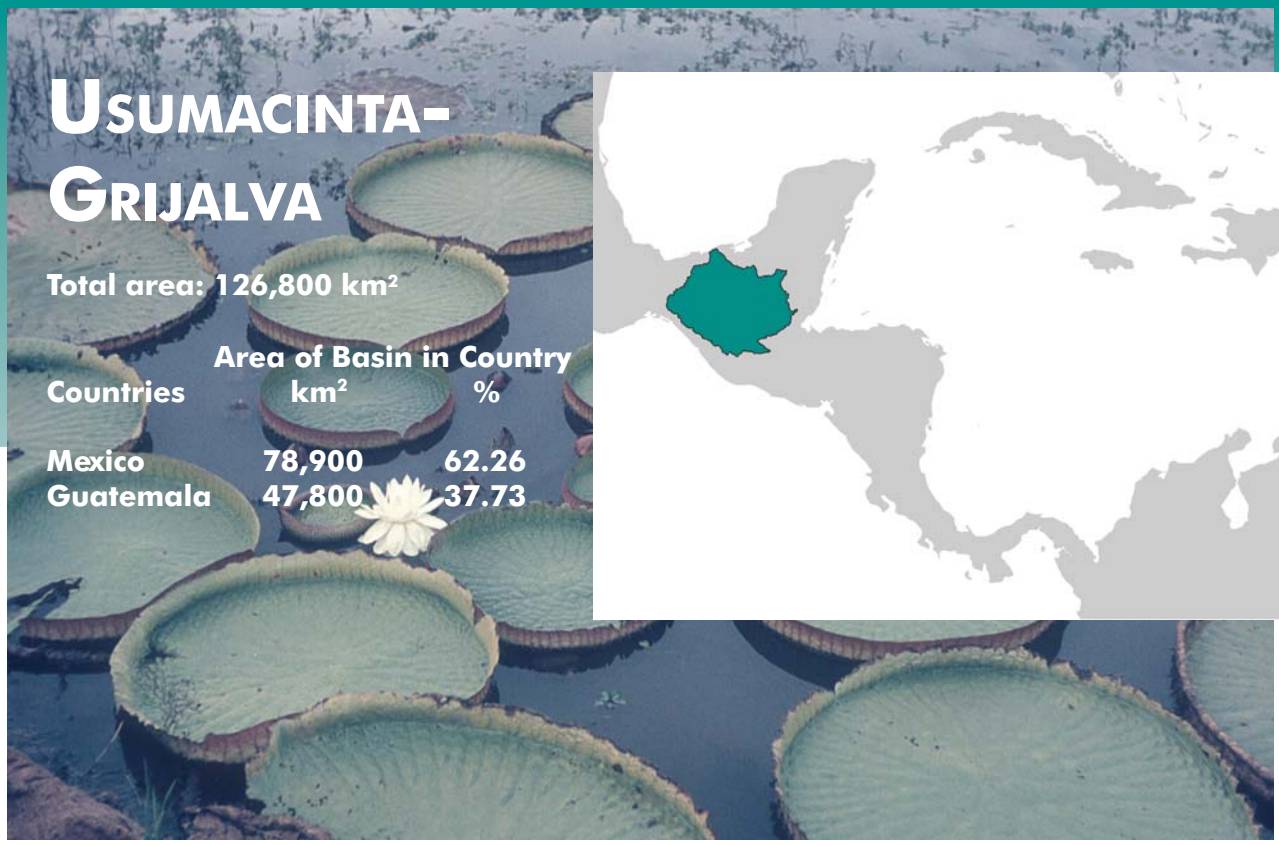
## River Basin Organizations and Commissions

*International Commission on Limits and water between Mexico and Guatemala.*

Formally established by exchange of diplomatic notes between the countries. Commission has authority to advise the two countries on border issues and the equitable use of water.

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* November 2, and December 21, 1961

*Signatories:* Guatemala, Mexico



# USUMACINTA-GRIJALVA

**Total area: 126,800 km²**

| Countries | Area of Basin in Country km² | % |
|---|---|---|
| Mexico | 78,900 | 62.26 |
| Guatemala | 47,800 | 37.73 |



## TREATIES AND AGREEMENTS

*Canje de Notas que crea la Comisión Internacional de Límites y Aguas entre México y Belize.*

*Treaty basin:* Grijalva *Date:* November 1993
*Signatories:* Mexico, Belize

*Agreement establishing the International Commission on Limits and Water was signed giving treaty status to this Commission*

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* July 16, 1990
*Signatories:* Guatemala, Mexico

*Convenio entre la República de Guatemala y los Estados Unidos Mexicanos sobre la Protección y Mejoramiento del Ambiente en la Zona Fronteriza, ratificada el 26 de marzo de 1988. 97 Diario de Centro America 2610, Junio 15, 1988.*

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* March 26, 1988
*Signatories:* United States of Mexico and Guatemala

*Agreement between the United Mexican States and the Republic of Guatemala on the protection and improvement of the environment of the border area*

*Treaty basin:* Grijalva *Date:* April 10, 1987
*Signatories:* Guatemala, Republic of, United Mexican States

*Acta No. 5 y Anexo del Grupo Asesor del CILA, 19 de mayo de 1980 y Aprobación*

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate *Date:* May 19, 1980
*Signatories:* United States of Mexico and Guatemala

## RIVER BASIN ORGANIZATIONS AND COMMISSIONS

*International Commission on Limits and water between Mexico and Guatemala*

Formally established by exchange of diplomatic notes between the countries. Commission has authority to advise the two countries on border issues and the equitable use of water.

*Treaty basin:* Candelaria, Coatan Achute, Grijalva, Hondo, Suchiate
*Signatories:* Guatemala, Mexico *Date:* November 2, and December 21, 1961

# Appendix 2. Notes on Basins

## Amazon

Chile and Ecuador rejected Peru's November 2005 unilateral law to shift the axis of their joint treaty-defined maritime boundary along the parallel of latitude to an equidistance line which favors Peru (CIA World Factbook 2007).

## Chira

Three sections of the boundary between Ecuador and Peru have been in dispute. The areas cover over 324,000 km$^2$ and include portions of the Amazon and Maranon rivers. The districts of Tumbes, Jaen, and Maynas are claimed by Ecuador and administered by Peru. In December 1998, Peru and Ecuador signed a joint agreement on the implementation of a permanent development policy for the border region. A joint commission was created to determine their common land boundary (Encyclopedia of International Boundaries 1995; CIA World Factbook 2007; Columbia Gazetteer 1998; BBC Summary of World Broadcasts, 12/3/98; Xinhua News Agency, 12/11/1998).

## Corantijn/Courantyne

The boundary upstream from the confluence of the Courantyne/Koetari (Kutari) River with the New (Upper Courantyne) River remains unsettled. Guyana administers the triangle formed by the two rivers, while Brazil and Suriname continue to claim the area. Suriname also claims the west bank of the Courantyne River below the New River as the boundary, but *de facto* the boundary continues to follow the thalweg (Encyclopedia of International Boundaries 1995; CIA World Factbook 2007).

Suriname claims a triangle of land between the New and Kutari/Koetari rivers in a historic dispute over the headwaters of the Courantyne (CIA World Factbook 2007).

## Essequibo

Talks are ongoing between Guyana and Venezuela regarding their boundary dispute. Venezuela claims all of the area west of the Essequibo River (CIA World Factbook 2007; IBRU 1999).

## Lake Fagnano

A short section of the southeastern boundary of Chile with Argentina, in the area of the Beagle Channel, remains unclear. The 1991 Aylwin-Menem Treaty delineates the boundary between Argentina and Chile in the continental glaciers area. As of March 1999, the treaty has not been ratified by the Congresses of either country (CIA World Factbook 2007; IBRU 1999).

Action by the joint boundary commission, established by Chile and Argentina in 2001, for mapping and demarcating the disputed boundary in the Andean Southern Ice Field (Campo de Hielo Sur) remains pending (CIA World Factbook 2007).

## La Plata

A short section of the boundary between Brazil and Paraguay, just west of Salto das Sete Quedas (Guaira Falls) on the Rio Parana, has yet to be precisely delimited (CIA World Factbook 1998).

Two short sections of the boundary between Brazil and Uruguay are in dispute: the Arroio Invernada (Arroyo de la Invernada) area of the Rio Quarai (Rio Cuareim) and the islands at the confluence of the Rio Quarai and the Uruguay River (CIA World Factbook 2007).

## Maroni

Suriname and French Guiana are in dispute over which of the upper tributaries of the Maroni River was originally intended to carry the boundaries down to the Brazilian boundary. The disputed area is administered by France as a region of the overseas department of French Guiana and claimed by Suriname. The area lies between the Riviere Litani and the Riviere Marouini, both headwaters of the Lawa (Encyclopedia of International Boundaries 1995; CIA World Factbook 2007).

## Tumbes-Poyango

Three sections of the boundary between Ecuador and Peru have been in dispute. The areas cover over 324,000 $km^2$ and include portions of the Amazon and Maranon rivers. The districts of Tumbes, Jaen, and Maynas are claimed by Ecuador and administered by Peru. In December 1998, Peru and Ecuador signed a joint agreement on the implementation of a permanent development policy for the border region. A joint commission was created to determine their common land boundary (Encyclopedia of International Boundaries 1995; CIA World Factbook 2007; Columbia Gazetteer 1998; BBC Summary of World Broadcasts, 12/3/98; Xinhua News Agency, 12/11/1998).

# Appendix 3. Riparian Country Collaborations

## Amazon

*BID Inter American Bank project*

Plan modelo para el desarrollo de las comunidades vecinas entre el eje Taba Tinga Apaporis or Tabatinga Apaporis Plan or TabatingaApaporis Plan.In agreement with the directives, policies and programs defined for the development of the Amazonía of Colombia and Brazil, the objectives defined by the Plan, for the region in study, can be synthesized in the following way: (1) Improvement of the standard of life of the population, generating productive activities and sources of work, as well as the physical infrastructure installation and basic, compatible economic partner with the aspirations of the natural inhabitants, resources and the ecological conditions of the zone. (2) Identification of the potential use of the natural resources of the zone with intentions of maintained development, to consolidate the present occupation and to orient the future establishments, avoiding the degradation of environment and (3) Provision of the social services and adjustment of the basic infrastructure to guarantee the improvement of the quality of life of the population located in the area of the Plan.

*Participating countries:* Brazil, Columbia *Date:* July 1, 1987

*Level/Type of Collaboration:* Official/Economic, social and environmental program

*Principal Issue:* Water quality, economic development, joint management, technical cooperation/assistance

*Source:* http://www.transboundarywaters.orst.edu

*OAS project*

Programa de acción integrado peruanoboliviano or PeruBolivia Integrated Action Program (PAIPB). In accordance with the objectives, policies, and programs in the development plans of both countries, the regional objectives for the study area can be summarized as follows: (1) Full incorporation of the area into the economic and productive activity of Bolivia and Peru (2) Improvement of the standard of living through the creation of productive activities and sources of employment and the installation of appropriate physical and socioeconomic infrastructure. (3) Effective occupation of the territory based on sustained long-term models of production that take the local ecology into account and have the active participation of the residents in the development process (4) Identification of natural resources potentially useful for development purposes (5) Substantial improvement of the territorial, social, legal, economic and ecological aspects of indigenous communities and the preservation of areas they have traditionally inhabited.

*Participating countries:* Bolivia, Peru *Date:* Data not available

*Level/Type of Collaboration:* Official/ Economic program

*Principal Issue:* Water quality, economic development, joint management, technical cooperation/ assistance

*Source:* http://www.oas.org/usde/publications/Unit/oea81s/oea81s.pdf

## Artibonite

*UNDP Small Grant Project*

Reforestation, Agroforestry and Environmental Education on Half the Watershed of the Macasias River. The project has increased the forest cover on the higher and section of the Macasías river watershed, through reforestation of native species and establishment of agroforestry practices. The participants have implemented an environmental education program.

*Participating countries:* Dominican Republic, Haiti *Date:* September 1997-September 1999
*Level/Type of Collaboration:* Official/Environmental program
*Principal Issue:* Water quality, other: reforestation
*Source:* http://www.undp.org/sgp/cty/LATIN_AMERICA_CARIBBEAN/DOMINICAN_REPUBLIC/pfs723.htm

***Association of Municipalities for the development and the protection of the river basin of the Macasías River (AROMA)***

The Macasias River Basin forms an international sub-basin within the Artibonite River Basin.AROMA wants to improve the economic level of the communities of the river basin by using the advantages of the natural resources of the river basin. Furthermore, they want to execute coordinated operations of handling the natural resources, by means of the intermunicipal and communitarian coordination.

*Participating countries:* Dominican Republic, Haiti *Date:* May 4, 1999

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Economic development, joint management, technical cooperation/assistance

*Source:* http://www.helvetas.org.do/aroma.html

## Aviles

***Agualtiplano***

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Aysen

***Agualtiplano***

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Baker

***Agualtiplano***

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Belize

*Red de Investigadores sobre el Agua en la Frontera Mexico-Guatemala-Belice (RISAF) or Network of Investigators on Water in the Mexico-Guatemala-Belize Border*

Goal: to strengthen the existing academic capacities in the three countries. By means of conferences, ideas and knowledge are exchanged. This could possibly result in common research projects.

*Participating countries:* Belize, Guatemala *Date:* 2000

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and education

*Source:* http://www.ecosur.mx/redesdecooperacion/redagua/risaf.html

## Cancoso/Lauca

*Agualtiplano*

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile, and Peru.

*Participating countries:* Bolivia, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Candelaria

*Red de Investigadores sobre el Agua en la Frontera Mexico-Guatemala-Belice (RISAF) or Network of Investigators on Water in the Mexico-Guatemala-Belize Border*

Goal: to strengthen the existing academic capacities in the three countries. By means of conferences, ideas and knowledge are exchanged. This could possibly result in common research projects.

*Participating countries:* Guatemala, Mexico *Date:* 2000

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and education

*Source:* http://www.ecosur.mx/redesdecooperacion/redagua/risaf.html

## Carmen Silva/Chico

*Agualtiplano*

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Gallegos-Chico

*Agualtiplano*

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Hondo

***Red de Investigadores sobre el Agua en la Frontera Mexico-Guatemala-Belice (RISAF) or Network of Investigators on Water in the Mexico-Guatemala-Belize Border***

Goal: to strengthen the existing academic capacities in the three countries. By means of conferences, ideas and knowledge are exchanged. This could possibly result in common research projects.

*Participating countries:* Belize, Guatemala, Mexico *Date:* 2000

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and education

*Source:* http://www.ecosur.mx/redesdecooperacion/redagua/risaf.html

## Lake Fagnano

***Agualtiplano***

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile, and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Lake Titicaca-Poopo System

***Agualtiplano***

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile, and Peru.

*Participating countries:* Bolivia, Chile, Peru *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

***USAID, GEF and LakeNet project: Toward a Lake Basin Management Initiative: Sharing Experiences and Early Lessons in GEF and Non-GEF Lake Basin Management Projects***

The project has focused on practical lessons learned from lake basin management efforts around the world, created new knowledge, filled an important gap in lake management experiences on tropical lakes, saline lakes, and lakes in developing countries, and derives lake management lessons from internationally funded projects, principally GEF-financed lake basin projects, as well as lake projects financed by the WB and other agencies and governments.

*Participating countries:* Bolivia, Chile, Peru *Date:* January 2003 - December 2004

*Level/Type of Collaboration:* Official/Environmental program

*Principal Issue:* Water quality, joint management, other: research and education

*Source:* http://www.worldlakes.org/programs.asp?programid=2

***Binational Master Plan for Integral Development of the Lake Titicaca, Desaguadero River, Poopó, Coipasa Salt Marsh System (TDPS System)***

Between October 1989 and June 1993 the Governments of Bolivia and Peru, working through the SUBCOMILAGO, drew up this TDPS System. In December 1992 the Governments of Bolivia and Peru created the Autonomous Binational TDPS System Authority for the TDPS, which began operating through a Transition Committee in July 1993.

*Participating countries:* Bolivia, Peru *Date:* 1989-1993

*Level/Type of Collaboration:* Official/Environmental program

*Principal Issue:* Joint management

*Source:* http://www.oas.org/usde/publications/Unit/oea31s/ch03.htm

## Lake Yelcho

***Agualtiplano***

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## La Plata/Del Plata

***GEF IW project: Environmental Protection of the Rio de la Plata and Its Maritime Front***

Pollution Prevention and Control and Habitat Restoration. The project will contribute to the mitigation of current and emergent transboundary threats to the waterbody by assisting Argentina and Uruguay to prepare a Strategic Action Programme as a framework for addressing the most imminent transboundary issues. The specific objectives include addressing of issues dealing with the riparian population, and local water user groups; to develop mechanisms to aid in decreasing the pollution load of Río de la Plata; to develop and improve local coordination, cooperation, and environmental management strategies and tools; to develop integrated geographical and management information systems; and develop better mechanisms for environmental sustainability and training of environmental managers.

*Participating countries:* Argentina, Uruguay *Date:* January 1, 1999

*Level/Type of Collaboration:* Official/Environmental program

*Principal Issue:* Water quality, economic development, joint management, technical cooperation/ assistance, other: research and education

*Source:* http://www.gefonline.org/projectDetails.cfm?projID=613

***Everglades Pantanal Initiative (EPI)***

This is a virtual meeting place for the Pantanal Matogrossense (Brazil-Bolivia-Paraguay) and the Florida Everglades (USA) in the hope of gathering various sites and documents concerning these two magnificent ecosystems and facilitating any research in support of these tenets. Proposed and facilitated by the Florida Center for Environmental Studies, the Brazilian Institute for Agricultural Research, Ecología em Ação (ECOA), the Secretariat of Environment of Mato Grosso do Sul, and Everglades National Park. Anybody with interest in these topics is welcome to be part of the exchange.

*Participating countries:* Argentina, Bolivia, Brazil, Paraguay, Uruguay *Date:* December 1, 1999

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.transboundarywaters.orst.edu

***Green Cross International / PC—> CP project: La Plata Case Study***

The case study provide an important summary of data related to the hydrology of the river basin, in addition to substantial information on the historical management of the water resources. The legal, political and economical aspects, which make every case unique, were also analysed and assessed. The general objective of the project is to strengthen the efforts of the governments of Argentina, Bolivia, Brasil, Paraguay and

Uruguay to implement their shared vision for the environmentally and socially sustainable economic development of the la Plata Basin.

*Participating countries:* Argentina, Bolivia, Brazil, Paraguay, Uruguay *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.gefonline.org/projectDetails.cfm?projID=2095, http://www.greencrossinternational.net/GreenCrossPrograms/WATERRES/wwf_03/gci_laplata1.pdf and for the report: http://webworld.unesco.org/water/wwap/pccp/cd/plata.html

***Intergovernmental Committee on the Paraguay-Parana Hidrovia or Comite Intergubernamental de la Hidrovia Paraguay Parana (CIH)***

The Parana River Basin forms an international sub-basin within the La Plata River Basin. An international network has been formed to help defend the ecosystems of the Paraguay and Parana Basin, including the Pantanal and Chaco wetlands, as well as the rights of the region's human populations. CIH was created by the five governments to promote and oversee the development in the Pantanal, ultimately creating a commercial waterway known as the Paraguay-Paraná Hidrovia.

*Participating countries:* Argentina, Bolivia, Brazil, Paraguay, Uruguay *Date:* December 1, 1994

*Level/Type of Collaboration:* Official/Economic program

*Principal Issue:* Water quality, economic development, joint management, technical cooperation/assistance

*Source:* http://nativenet.uthscsa.edu/archive/nl/9412/0157.html

***Entidad Binacional Yacyreta or Yacyreta Binational Entity (EBY)***

Dating back to the Argentine-Paraguayan protocol signed in 1926 on the use of the Apipé rapids, the EBY was created through a 1973 agreement between Argentina and Paraguay. The main objectives of the EBY is to harness hydroelectric power for distribution in surrounding areas of both countries, improve navigability in that particular zone, regulate flooding and water volume in general and to mitigate negative environmental effects.

*Participating countries:* Argentina, Paraguay *Date:* 1973

*Level/Type of Collaboration:* Official/Economic program

*Principal Issue:* Hydro-power/hydro-electricity, navigation, flood control/relief, joint management, technical cooperation/assistance

*Source:* http://www.eby.org.ar

***Agualtiplano***

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*Participating countries:* Argentina, Bolivia *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

***EU project: Proyecto de Gestión Integrada y Plan Maestro de la Cuenca del Río Pilcomayo***

The Pilcomayo River Basin forms an international sub-basin within the La Plata River Basin.The Trinational Commission for the Development of the River basin of the Pilcomayo wants to develop and implement a Project of Integrated Management and Masterplan for the River basin.

*Participating countries:* Argentina, Bolivia, Paraguay *Date:* July 2003 - July 2008

*Level/Type of Collaboration:* Official/Environmental program

*Principal Issue:* Joint management

*Source:* http://www.transboundarywaters.orst.edu

***GEF IW project: Strategic Action Programme for the Binational Basin of the Bermejo River***

The Bermejo River Basin forms an international sub-basin within the La Plata River Basin.The project is designed to identify priority transboundary concerns and needs within the Basin and to assist in developing a watershed-based approach for integrating environmental and development concerns into the planning programs of the two Governments, with a view toward protecting and maintaining the essential ecological structure and functioning of the entire system, including its downstream components.

*Participating countries:* Argentina, Bolivia *Date:* November 1, 1996

*Level/Type of Collaboration:* Official/Environmental program

*Principal Issue:* Joint management

*Source:* http://www.gefonline.org/projectDetails.cfm?projID=176

***GEF IW project: Implementation of Strategic Action Program for the Bermejo River Binational Basin: Phase II.***

This project catalyzes the implementation of the Strategic Action Program for the Bermejo River Binational Basin. Strengthening of Basin institutions, building of agency and organizational capacity, and integration of environmental concerns into economic development activities on a sustainable basis, and the promotion of the public awareness and participation are key elements of this project.

*Participating countries:* Argentina, Bolivia *Date:* May 1, 2001

*Level/Type of Collaboration:* Official/Environmental program

*Principal Issue:* Joint management

*Source:* http://www.gefonline.org/projectDetails.cfm?projID=886

***Programa Estratégico de Acción (PEA)***

The implementation of the PEA is a joint effort of the governments of Argentina and Bolivia, throug the Binational Commission for the Development of the High River basin of the River Bermejo and the River Grande de Tarija.

*Participating countries:* Argentina, Bolivia *Date:* Data not available

*Level/Type of Collaboration:* Official/Economic program

*Principal Issue:* Economic development, joint management, technical cooperation/assistance

*Source:* http://www.cbbermejo.org.ar/pea3.html

## LEMPA

***Green Cross International / PC—>CP case study***

Outcome of this project was a report: The Case of the Trifinio Plan in the Upper Lempa: Opportunities and Challenges for the Shared Management of Central American Transnational Basins. This case reflects the importance of political will for advancing the building of frameworks for institutional trans-national watersheds. At the same time, it also reveals the obstacles in the transition from those processes that are stimulated by a top-down approach towards a process involving strategies arising from the local actors. Strategies by local actors inherently lend the necessary support to the functioning and sustainability of actions, and in the long run tend towards the integrated management of trans-national watershed hydrological resources.

*Participating countries:* El Salvador, Guatemala, Honduras *Date:* 2001-2003

*Level/Type of Collaboration:* Non-official/International initiative, social / health program

*Principal Issue:* Joint management, other: research and education

*Source:* http://webworld.unesco.org/water/wwap/pccp/cd/trifinio.html, and for report see http://unesdoc.unesco.org/images/0013/001333/133304e.pdf

***IDB project: Programa Trinacional de Desarrollo Sostenible de la Cuenca Alta del Río Lempa (PTCARL) or Trinational program of sustainable development of the high river basin of Rio Lempa***

General mission: To diminish the environmental degradation and to contribute to fight the poverty in the high river basin of the Lempa river. The general objective is to improve the quality of life of the inhabitants of the upper Lempa River basin, through actions that promote sustainable development in the target area and that seek to break the cycle of poverty and destruction of natural resources. The specific objectives are: (i) to achieve sustainable management of the region's renewable natural resources; (ii) to decrease vulnerability to natural hazards; (iii) to promote productive activities and economic diversification; and (iv) to strengthen local governments and improve the organizational capacity of communities, in the context of trinational integration.

*Participating countries:* El Salvador, Guatemala, Honduras *Date:* July 1, 2001

*Level/Type of Collaboration:* Official/Economic, social and environmental program

*Principal Issue:* Economic development, water quality, joint management, other: poverty eradication

*Source:* http://www.iadb.org/exr/doc98/apr/gu1331e.pdf, http://www.iadb.org/NEWS/Display/PRView.cfm?PR_Num=129/01&Language=english

*Plan Trifinio*

The Plan Trifinio contemplates actions to be developed, tending to enhance economic and social conditions. These projects are contemplated within the Economical Growth, Social Development, Infrastructure, and Institutional Development Programs. The execution of the proposed pre-investment studies, intends to strengthen the developing actions launched by the Plan Trifinio Trinational Committee.

*Participating countries:* El Salvador, Guatemala, Honduras *Date:* November 12, 1986

*Level/Type of Collaboration:* Official/Economic, social and environmental program

*Principal Issue:* Water quality, economic development, joint management, infrastructure/development, technical cooperation/assistance

*Source:* http://www.sgsica.org/madrid/pdf-en/IV/20/20c%20.pdf

## Negro o Guasaule

*Zamorano: Programa Regional Manejo de Cuencas (Procuencas)*

Zamorano is a Pan-American Center of higher education whose mission is to prepare leaders for the Americas in sustainable agriculture, agribusiness, agroindustry, natural resources management and rural development. Procuensas focuses on protecting watersheds by working with communities to prevent and control forest fires, promote sustainable agricultural practices, and raise environmental consciousness.Over the past year, Zamorano students and faculty worked extensively with other organizations and institutions such as local governments, community groups, NGOs, and international universities.

*Participating countries:* Honduras, Nicaragua *Date:* May 1, 1905

*Level/Type of Collaboration:* Non-official/Environmental program

*Principal Issue:* Economic development, joint management, irrigation, technical cooperation/assistance

*Source:* http://www.zamorano.edu/Ingles/

## Palena

*Agualtiplano*

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*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Pascua

*Agualtiplano*

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*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Patia

*Sida project: Plan for the Management and Sustainable Development for the Mira Mataje and Carchi Guaytara River Basins (Plan de ordenamiento y manejo de la cuenca Mira-mataje)*

The principal objective of the Project is to build better livelihoods for the people in the area of the Mira Mataje and Carchi-Guaitara river basins, through increasing the capacity of local and regional institutions,

enhancing the infrastructure, increase the productivity in agriculture production, obtain sustainable environment conditions and increase the access to clean water, and thereby ensuring a better health and better production possibilities for the people in the area. In addition, the project is to increase the capacity of the national counterparts in the field of watershed management.

*Participating countries:* Colombia, Ecuador *Date:* May 2003 - May 2005

*Level/Type of Collaboration:* Official/Economic, social and environmental program

*Principal Issue:* Water quality, economic development, joint management, infrastructure/development, technical cooperation/assistance

*Source:* http://www.orgut.se/websites/orgutse/filbank/default.asp?id=369

## Paz

***Río Paz Binational Basin Integrated and Sustainable Development Master Plan***

The Plan contemplates two components: Agricultural-livestock Development, and Hydrological Resources Management. The plan is an important instrument for a territorial order oriented policy, and for an actual integration among the different components dealing with the sustainable use, defense, protection and management of natural resources.

*Participating countries:* El Salvador, Guatemala *Date:* Prepared 1997-2000; not yet implemented

*Level/Type of Collaboration:* Official/Economic program

*Principal Issue:* Water quality, economic development, joint management, infrastructure/development, border issues

*Source:* http://www.sgsica.org/madrid/pdf-en/IV/21/21.pdf

## Puelo

***Agualtiplano***

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Rio Grande (South America)

***Agualtiplano***

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*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## San Juan

***GEF/UNEP IW project: Formulation of a Strategic Action Programme for the Integrated Management of Water Resources and the Sustainable Development of the San Juan River Basin and its Coastal Zone***

The Strategic Action Programme formulated under this project will contribute to the conservation of natural ecosystems and to social and economic development in order to satisfy present and future demands minimizing water conflicts.

*Participating countries:* Costa Rica, Nicaragua *Date:* January 2001 - 2004

*Level/Type of Collaboration:* Official/Economic, social and environmental program

*Principal Issue:* Water quality, economic development, joint management, technical cooperation/assistance

*Source:* http://www.environment-directory.org/Search/showDetails.asp?i=193&v=2&t=0&ti=2&st=0&pu=0&

***IUCN project: International System of Protected Areas for Peace***

In February of 1988 at the XII General Assembly of the IUCN, the Ministers of Natural Resources of Nicaragua and Costa Rica signed a letter of intent to facilitate the establishment of an International System of Protected Areas for Peace (SI-A-PAZ). In 1989 the countries requested the continued participation of IUCN, which acted to some extent as broker between the countries, in order to strengthen the binational intentions for biodiversity conservation which were viewed favorably by the international community. In August of 1990 at the meeting of the Central American Commission on Environment and Development (CCAD) the Ministers of Natural Resources established a SI-A-PAZ National Commission in each country as well as a Binational Coordinating Commission.

*Participating countries:* Costa Rica, Nicaragua *Date:* 1988

*Level/Type of Collaboration:* Official/Economic, social and environmental program

*Principal Issue:* Joint management, border issues

*Source:* http://www.unep-wcmc.org/

***OAS project: Dialogue on Water and Climate in the San Juan River Basin, Costa Rica and Nicaragua***

Binational workshop. The objective of the workshop was to identify the practices used by the Basin's population to confront climate variability.

*Participating countries:* Costa Rica, Nicaragua *Date:* September 3 and 4, 2002

*Level/Type of Collaboration:* Official/Environmental program

*Principal Issue:* Joint management, other: research and education

*Source:* http://index.html?http://www.unep-wcmc.org/protected_areas/transboundary/somersetwest/somersetwest-40.html~main

## San Martin

***Agualtiplano***

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*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Sarstun

***Red de Investigadores sobre el Agua en la Frontera Mexico-Guatemala-Belice (RISAF) or Network of Investigators on Water in the Mexico-Guatemala-Belize Border***

Goal: to strengthen the existing academic capacities in the three countries. By means of conferences, ideas and knowledge are exchanged.

*Participating countries:* Belize, Guatemala *Date:* June 22, 1905

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and education

*Source:* http://www.ecosur.mx/redesdecooperacion/redagua/risaf.html

## Seno Union/Serrano

*Agualtiplano*

Agualtiplano is a virtual center of information about water resources of the area, create to compile, organize, analyze and spread the information that identifies problem areas, to identify knowledge caveats, to promote applied investigation, to solve conflicts that involve the indigenous populations and as a reference for drafting up proposals and policies for the altiplánicas zones of Argentina, Bolivia, Chile and Peru.

*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Suchiate

*IUCN Water and Nature Initiative project: Conservation and sustainable management of the Tacaná River Basin ( Mexico, Guatemala )*

The Tacana River Basin forms an international sub-basin within the Suchiate River Basin.This project will allow the establishment of a wide awareness raising and capacity building effort throughout the basin. Based on a thorough basin-wide assessment with full public and institutional support, a master plan and management plan for the basin is to be developed.

*Participating countries:* Guatemala, Mexico *Date:* 2000-2006

*Level/Type of Collaboration:* Official/Environmental project

*Principal Issue:* Joint management, other: research and education

*Source:* http://www.waterandnature.org/c1.html

*IUCN demonstration site: Tacana, working together to turn the trend*

The Tacana River Basin forms an international sub-basin within the Suchiate River Basin.Partners work together to improve management practices, stakeholder involvement, legal and institutional arrangements, financial and economic systems, and information management. Partners include government agencies, basin organisations, NGOs, research institutes and local community organisations. It aims to keep rivers healthy and improve the wellbeing of local communities who depend on natural resources.

*Participating countries:* Guatemala, Mexico *Date:* 2000-2006

*Level/Type of Collaboration:* Official/Economic program

*Principal Issue:* Joint management, other: research and education

*Source:* http://www.waterandnature.org/1c.html

## Tumbes-Poyango

*Binational Developmental Plan for the Border Region (Plan binacional de desarrollo de la región fronteriza)*

*Participating countries:* Ecuador, Peru *Date:* February 4, 1999

*Level/Type of Collaboration:* Official/Environmental program

*Principal Issue:* Joint management

*Source:* http://www.planbinacional.gov.ec/

*OAS project: binational hydraulic projects*

*Participating countries:* Ecuador, Peru *Date: No data*

*Level/Type of Collaboration:* Official/ Data not available

*Principal Issue:* Water quantity, hydropower/hydroelectricity, economic development, joint management

*Source:* http://www.oas.org/usde/publications/Unit/oea02s/ch05.htm

## Usumacinta-Grijalva

***Red de Investigadores sobre el Agua en la Frontera Mexico-Guatemala-Belice (RISAF) or Network of Investigators on Water in the Mexico-Guatemala-Belize Border***

Goal: to strengthen the existing academic capacities in the three countries. By means of conferences, ideas and knowledge are exchanged. This could possibly result in common research projects.

*Participating countries:* Belize, Guatemala, Mexico *Date:* 2000

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and education

*Source:* http://www.ecosur.mx/redesdecooperacion/redagua/risaf.html

## Valdivia

***Agualtiplano***

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*Participating countries:* Argentina, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Zapaleri

***Agualtiplano***

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*Participating countries:* Argentina, Bolivia, Chile *Date:* 2001

*Level/Type of Collaboration:* Non-official/International initiative

*Principal Issue:* Other: research and training

*Source:* http://www.agualtiplano.net/

## Zarumilla

***Binational Developmental Plan for the Border Region (Plan binacional de desarrollo de la región fronteriza)***

*Participating countries:* Ecuador, Peru *Date:* February 4, 1999

*Level/Type of Collaboration:* Official/Economic program

*Principal Issue:* Joint management

*Source:* www.planbinacional.gov.ec/

# Appendix 4. Tenders for Large Projects

## Amazon

*Umbrella of Hydro Projects/P080093*

The umbrella project includes the development of three run-of-river hydroelectric plants of sub-projects, Abanico, Sibimbe, and Sabanilla. *Source:* World Bank (WB) Group 2005.

*Country:* Ecuador *Sector:* Energy & Mining (Renewable Energy)

*Cost in millions (USD):* 1.81 *Status:* Approved Feb 4, 2005

*Sponsors:* Hidrelgen

*Source:* http://web.worldbank.org/external/projects/main?pagePK=104231&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P080093

## Changuinola

*Bonyic Hydroelectric Project/PN-0155*

This project involves the design, development, construction, operation and maintenance of a 30 MW hydroelectric power plant and a small regulating day reservoir. Transmission facilities, including an 11 km, 115 KV transmission line and associated substation will also be constructed. The project is located on the Quebrada Bonyic in northwestern Panama in the province of Bocas del Toro. The power will be transmitted to the city of Changuinola, instituting a predicted positive developmental impact on the impoverished region by providing a reliable source of reasonably priced electricity for the region. *Source:* Inter-American Development Bank (IADB) 2005b.

*Country:* Panama *Sector:* Private

*Cost in millions (USD):* 50.0 *Status:* Due Diligence

*Sponsors:* Empresas Publicas de Medellin, Administradora Serviagro, Consultores Asociados de Ingenieria, S.A., MacEnergy Limited

*Source:* http://www.iadb.org/exr/doc98/pro/apn0155.pdf

## Chira

*Poechos Hydropower Project*

This project will support a small 15.4 MW hydropower project. The main civil works built will be the intake and forced pipes, the machine house, the discharge canal, 100 m of access roads, and 38 km of transmission lines. The project will generate ~60 GWh per year, to be sold for distribution in northwest Peru. *Source:* World Bank (WB) Group 2005.

*Country:* Peru *Sector:* Energy & Mining (Renewable Energy, Power)

*Cost in millions (USD):* 16.7 *Status:* Approved Dec 3, 2004

*Sponsors:* Sinersa

*Source:* http://web.worldbank.org/external/projects/main?pagePK=104231&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P081954

# La Plata

*Power Plant Dona Francisca/BR0315*

A 125-MW hydroelectric project on the Jacui River in the state of Rio Grande do Sul, Brazil.

*Country:* Brazil *Sector:* Hydropower

*Cost in millions (USD):* 118.0 *Status:* Approved 2000

*Sponsors:* Inepar Energia, S.A., Centrais Eletricas de Santa Catarina, Companhia Paranaen se de Energia, Gerdau, S.A., Desenvix, S.A.

*Source:* http://www.iadb.org/pri/english/dbase/projectSummary.cfm?ProjectNumber=BR0315

*Campos Novos Hydroelectric Power Project/BR0370*

The Campos Novos Hydro power plant is located on the Canoas River, in the State of Santa Catarina. The project consists of the development of an 880-MW HPP. The plant is comprised of three different parts: (i) three 293-MW turbines, (ii) a 196-meter rock filled dam, (iii) an 11 km transmission line that will be connected to the Campos Novos substation. The site location will allow the Project to generate significant amounts of electricity from a comparatively small reservoir area.

*Country:* Brazil *Sector:* Energy

*Cost in millions (USD):* 523.9 *Status:* Approved 2004, Completion 2006

*Sponsors:* CPFL Geraçno S.A., Companhia Brasileira de Alumínio S.A., Companhia Níquel Tocantins S.A., Companhia Estadual de Energia Elétrica S.A., Centrais Elétricas de Santa Catarina S.A.

*Source:* http://www.iadb.org/exr/doc98/pro/abr0370.pdf

*Yacyreta Hydroelectric Project/P006036*

This project will consist of a 65 Km earth dam in the main channel of the Parana River, about 80 km from the cities of Posada, Argentina & Encamacion, Paraguay. 20 Kaplan turbines of 155 MW each will be built for a total capacity of 3100 MW. Will create a reservoir of 1065 Sq. Km with the potential to flood 107,000 hectares and affect over 13,000 families.

*Country:* Argentina *Sector:* Energy & Mining (Power)

*Cost in millions (USD):* 1300.0 *Status:* Approved Sep 29, 1992. Closing Date Dec 31, 2000

*Sponsors:* EBY

*Source:* http://web.worldbank.org/external/projects/main?pagePK=104231&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P006036

*Barra Grande Hydroelectric Power Plant*

The hydroelectric power plant of Barra Grande is under construction in the River Pelotas, between the counties of Anita Garibaldi, SC, and Pinhal da Serra, RS. Its reservoir will have a volume of 5 $km^3$, an installed power of 708 MW and the power ensured for CBA will be of 500 thousand MWh/year.

*Country:* Brazil *Sector:* Power

*Cost in millions (USD):* Baesa (Energética Barra Grande S.A.) (merge of five companies: Alcoa Alumínio [42.2%], Companhia Paulista de Força e Luz (CPFL) [25%], Companhia Brasileira de Alumínio (CBA) [15%], Camargo Corrêa Cimentos [9%], and DME Energética [ 8.8%] received investments of about R$ 1.5 billion and will invest another R$ 200 million by means of compensation measures, aiming to mitigate social and environmental impacts caused by the enterprise. *Status:* Completion 2005

*Sponsors:* CBA

*Source:* http://www.aluminiocba.com.br/en/usina_barra_grande.php

*Ourinhos Hydroelectric Power Plant*

The hydroelectric power plant of Ourinhos will be built by CBA along the waters of the River Paranapanema, between the cities of Ourinhos, SP, and Jacarezinho, PR. The installed potential will be of 44 MW, and the power generated about 207 thousand MWh/year. The concession period is of 35 years, which started in July 2000.

*Country:* Brazil *Sector:* Power

*Cost in millions (USD):* 62.3 *Status:* Exacation, Completion 2005

*Sponsors:* CBA

*Source:* http://www.aluminiocba.com.br/en/usina_ourinhos.php

## Lempa

*La Esperanza Hydro Project/P088256*

The development objective of this project is to support a small 12 MW on the river Intibuca that would guarantee a reliable and steady supply of electricity to the town of La Esperanza and many of the surrounding communities.

*Country:* Honduras
*Sector:* Energy & Mining (Renewable Energy, Power)
*Cost in millions (USD):* 1.4
*Status:* Approved Feb 1, 2005, Completion 2005
*Sponsors:* Consorcio de Inversiones S.A. (CISA)
*Source:* http://web.worldbank.org/external/projects/main?pagePK=104231&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P088256

## Orinoco

*Tocoma Hydroelectric Project/VE-L1003*

Last of 4 dams to be built on the Caroni River. The previous three provide nearly 72% of the energy used in Venezuela and the completement of the Lower Caroni Hydroelectric Complex is hoped to enhance Venezuela's supply of energy that is derived from renewable sources.

*Country:* Venezuela
*Sector:* Energy
*Cost in millions (USD):* 750
*Status:* Final Stages of Feasibility Study & Site Preparation
*Sponsors:* Venezuelan Corporation for Guyana (CVG-EDELCA)
*Source:* http://www.iadb.org/exr/doc98/pro/pvel1003-06eng.pdf

*Caruachi Hydroelectric Power Plant Project/788/OC-VE*

The purpose of this project is to harness the water resources of the lower Caroni River to help meet the growing demand for electric power within the country. The project will call for a hydroelectric power plant with a capacity for 2,160 MW and a concrete 360 meter gravity dam, a 900 meter right-abutment rockfill closure dam, and a 4,200 meter left-abutment earth and rockfill closure dam.

*Country:* Venezuela
*Sector:* Energy
*Cost in millions (USD):* 2,130.4
*Status:* Approved 1993
*Source:* http://www.iadb.org/exr/doc98/apr/ve788e.htm

## Valdivia

*Ralco Dam*

Installed capacity of the scheme is 570 MW, and includes a 150m high roller compacted concrete dam, which forms a reservoir that covers an area of 3395 hectares with total volume of 1,222 million cubic.

*Country:* Chile
*Sector:* Hydropower
*Cost in millions (USD):*
*Status:* Completion 2002
*Sponsors:* International Finance Corporation (IFC) 2005.
*Source:* http://enr.construction.com/features/environment/archives/020819.asp

*La Higuera/21315*

270 MW hydroelectric power project on the Tinguiririca River.

*Country:* Chile
*Sector:* Hydropower
*Cost in millions (USD):* 260.0
*Status:* EIS Approved 2004, Completion 2010
*Sponsors:* Pacific Hydro Ltd, Statkraft Norfund Power Invest AS (SNPI)
*Source:* http://ifcln1.ifc.org/IFCExt/spiwebsite1.nsf/0/60f859e0234948ad85256f7100773628?OpenDocument

*Chacabuquito Hydro Power Project/P074619*

The Chacabuquito Hydro Power Project will consist of a run-of-the-river power plant with a capacity of 25 MW. The project will utilize the waters of the Aconcagua river and will supply energy to the 5th region of Chile, near Los Andes, about 100 km Northeast of Santiago.

*Country:* Chile
*Sector:* Energy & Mining (Power)
*Cost in millions (USD):* 260.03.5
*Status:* Proposed
*Sponsors:* Hidroelectrica Guardia Vieja SA
*Source:* http://web.worldbank.org/external/projects/main?pagePK=104231&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P074619

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# Index of Basin Names


Amazon ..... 93, 114, 116, 128
Artibonite ..... 94, 116
Aviles ..... 117
Aysen ..... 117
Baker ..... 117
Belize ..... 118
Cancoso/Lauca ..... 118
Candelaria ..... 95, 118
Carmen Silva/Chico ..... 118
Changuinola ..... 128
Chira ..... 114, 128
Chuy ..... 96
Coatan Achute ..... 97
Corantijn/Courantyne ..... 114
Dajabón-Massacre ..... 98
Essequibo ..... 114
Gallegos-Chico ..... 118
Hondo ..... 99, 119
Lagoon Mirim ..... 100
Lake Fagnano ..... 114, 119
Lake Titicaca-Poopo System ..... 101, 119
Lake Yelcho ..... 120
La Plata/Del Plata ..... 103, 115, 120, 129
Lempa ..... 106, 122, 130
Maroni ..... 107, 115
Negro o Guasaule ..... 123
Orinoco ..... 130
Palena ..... 123
Pascua ..... 123
Patia ..... 123

Paz ..... 108, 124
Pedernales ..... 109
Puelo ..... 124
Rio Grande (South America) ..... 124
San Juan ..... 110, 124
San Martin ..... 125
Sarstun ..... 125
Seno Union/Serrano ..... 126
Sixaola ..... 111
Suchiate ..... 112, 126
Tumbes-Poyango ..... 115, 126
Usumacinta-Grijalva ..... 113, 127
Valdivia ..... 127, 130
Zapaleri ..... 127
Zarumilla ..... 127