

AN ABSTRACT OF THE DISSERTATION OF

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Title: Mechanisms of Cooperation for States' Construction of Large-Scale Water  
Infrastructure Projects in Transboundary River Basins

Abstract approved:

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How does transboundary water cooperation begin at the initial stages? Countries in many transboundary basins either do not cooperate at all or have ceased cooperation altogether. Yet cooperation does often prevail, resulting in 688 water-related treaties signed between 1820 and 2007. The question we address here is, by which practices can development partners best design and implement collaborative projects in the earliest stages? This paper identifies lessons and strategies for the initiation of cooperation drawing from global experience. We also identify the impact of securitization framing on initiating cooperation. We completed the following: 1) We culled from the Oregon State University Transboundary Freshwater Dispute Database (TFDD) a compilation of all transboundary water resources projects over the last decade that have multinational participation (official or unofficial). 2) We further refined our culling to include only projects that fit filtering criteria which included: a) Funding exclusively or primarily from outside sources b) Inclusion of non-official (Track II) stakeholders in project design and implementation c) Absence of formal relations around water

resources, in the form of a treaty or River Basin Organization (RBO), between or among the riparian countries in advance of the project discussed d) Project design including at least the possibility of enhancing hydropolitical relations. Using the above filtering criteria, we selected 10 case studies. Findings suggest that it is best to focus on project designs that respect the autonomy of participating riparians, create basinwide networks of scientists, allow for each partner to garner responsibility for project activities, and consult a diverse group of stakeholders.

Although the costs and benefits of dam construction are generally borne by one country in national basins, absence or softness of legal frameworks in many international basins may increase the incentive for riparian countries to build dams since certain riparians may enjoy the benefits of dam construction while externalizing many of the costs. To determine whether the transboundary nature of river basins is associated with increased dam construction, and whether the existence of transboundary institutions offsets any such increase, this paper analyzes the extent to which i) the large dam construction rate in international watersheds differs from that of national watersheds, and ii) the rate and distribution of large dam construction differs between transboundary waters with and without agreements. Data on large dam locations, river basin boundaries, and international borders were collected, mapped in GIS and analyzed to determine dam construction rates in national and transboundary basins, and in transboundary basins with and without an agreement. The results indicate that large dam construction rates in national basins exceeds that of transboundary basins, and construction rates in

areas covered by a transboundary water agreement exceed construction rates in areas not covered by an agreement. Further, it appears that agreement formation in transboundary basins enables relatively greater and more distributed development. These results indicate that dynamics of transboundary waters may be at odds with experiences in other common pool natural resources, and the existence of cooperative institutional frameworks on transboundary river basins may be linked to more equitable, mutually beneficial outcomes.

Projecting future hotspots of hydropolitical tension in river basins across the world may allow countries to take measures to prevent hydropolitical conflict. The Zambezi River Basin has been identified as a basin at risk of future hydropolitical conflict. This paper analyzes the hydropolitical resilience of the Zambezi River Basin using two approaches: i) a global analysis of factors that indicate change and a basin's institutional capacity, and ii) an in-depth examination of the basin's hydropolitical history and its present-day status using interviews with basin stakeholders, academics, NGOs, and policy makers. Results of the global analysis indicate that the Zambezi River Basin on the whole has comparatively higher institutional capacity, lower to medium rates of new dam development, lower human development and security values, lower water scarcity, yet higher projected water variability. When examining the basin's hydropolitical history results show that the values of the global indicators only tell a partial story. This paper argues that while global analyses of hydropolitical resilience are valid for indicating areas of possible tension over shared water resources, analyzing a basin's hydropolitical

resilience on the basin scale through tracing its hydropolitical history and interviews puts the global results into context and adds nuance that is crucial to identify specific aspects of the basin that may push the basin into a state of conflict.

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Mechanisms of Cooperation for States' Construction of Large-Scale Water  
Infrastructure Projects in Transboundary River Basins

by  
Jacob D. Petersen-Perlman

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

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Jacob D. Petersen-Perlman, Author

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## CONTRIBUTION OF AUTHORS

Chapter 2 was co-written with Dr. Aaron Wolf. Dr. Wolf was involved with design and writing of Chapter 2. Chapter 3 was co-written with Dr. Jonathan Lautze. Dr. Lautze was involved with the design and writing of Chapter 3, as well as assisted in the interpretation of the data.

## TABLE OF CONTENTS

	<u>Page</u>
Chapter I. Introduction .....	1
Thesis Objectives .....	1
Variables Influencing Cooperation .....	2
Perceived Risk and Barriers .....	2
Enhancing Cooperation.....	5
Country Drivers .....	6
Internal Drivers .....	6
External Drivers.....	7
Cooperation-inducing design.....	8
Track I and Track II Diplomacy .....	9
Transboundary River Basins as a Common Pool Resource .....	11
Hydropolitical Resilience and Variables that Influence it .....	13
Hydropolitical Resilience and Hydropolitical Vulnerability.....	13
Transboundary Waters and Conflict .....	15
Barriers against and Drivers toward Water Cooperation .....	21
Key Concepts and Limitations .....	23
Methods .....	25

## TABLE OF CONTENTS (continued)

	<u>Page</u>
Chapter II. Getting to the first handshake: Enhancing security by initiating cooperation in transboundary river basins .....	31
Introduction.....	31
Variables Influencing Cooperation .....	34
Perceived Risk and Barriers .....	34
Enhancing Cooperation.....	37
Country Drivers .....	38
Internal Drivers .....	38
External Drivers.....	39
Cooperation-Inducing Design .....	40
Track I and Track II Diplomacy .....	42
Methods .....	43
Transboundary Project Selection Criteria.....	44
Case Study Selection Criteria .....	45
Classification of Transboundary Water Cooperation .....	49
Case Study Evaluation.....	50
Results .....	51
Aquifer Management in South America .....	51

## TABLE OF CONTENTS (continued)

	<u>Page</u>
Biodiversity Conservation in South America .....	52
Aquifer Protection in North Africa .....	53
Water Management System in the Southern Balkans .....	55
Regional Water Data Banks in the Central Middle East .....	55
Climate Change Modeling and Stakeholder Preparedness in East Africa .....	57
Reducing Transboundary Degradation in the Caucasus .....	57
Improving Basinwide Relations in the Middle East .....	59
Improved Management of Water Resources in Central Asia .....	60
Creating a Transboundary Water Commission in Central Asia .....	61
Discussion .....	61
Jurisdiction .....	61
Project Design .....	63
Stakeholders .....	65
Negotiating .....	66
Conclusion .....	66
Bibliography.....	70
Chapter III. Water resources development, international river basins, and transboundary water law: Anomaly of the commons? .....	74

## TABLE OF CONTENTS (continued)

	<u>Page</u>
Abstract .....	74
Introduction.....	74
Methods .....	81
Data Compilation .....	81
Data on large dams .....	81
Data on river basin boundaries.....	81
Data on international agreements applying to transboundary waters.....	82
Data Classification.....	83
Coding the dams .....	83
Classifying dams according to agreement presence or absence.....	83
Classifying dams according to their position in transboundary basins .....	84
Categorizing dams as up, mid, or downstream .....	84
Normalization .....	86
Global analyses focused on the period 1950-2009 .....	87
Accounting for border changes .....	87
Data Analysis.....	88
Results .....	90
Are Dam Construction Rates Greater in Transboundary Basins?.....	90

## TABLE OF CONTENTS (continued)

	<u>Page</u>
Do Construction Rates in Transboundary BCUs without Agreement Exceed those of Transboundary BCUs with Agreement? .....	91
How Does Dam Construction Vary by Geographic Region? .....	93
Discussion .....	95
Conclusion .....	97
Bibliography.....	100
Chapter IV. Projecting river basin resilience in the Zambezi River Basin through global analyses and basin realities.....	104
Abstract .....	104
Introduction.....	104
Literature Review .....	107
Transboundary Waters and Conflict.....	109
Barriers Against and Drivers Toward Water Cooperation.....	114
Measuring Hydropolitical Resilience .....	115
Results and Discussion of Global Analysis for the Zambezi .....	123
Factors that may Enhance Resilience .....	123
Factors that may Decrease Resilience .....	125
Discussion of Global Analysis Results .....	128
Hydropolitical Resilience Analysis of the Zambezi River Basin .....	129

## TABLE OF CONTENTS (continued)

	<u>Page</u>
Study Area.....	130
The Zambezi: An Introduction .....	131
Before the Dams .....	132
Dam Construction .....	133
Hydropolitical Conflict and Cooperation in the Zambezi.....	137
Current Status in the Zambezi .....	142
Projected Climate Variability .....	143
Future Infrastructure Possibilities/Hydropolitical Hotspots.....	144
Summary .....	147
Discussion .....	148
Factors that may Enhance Resilience .....	148
Factors that may Decrease Resilience .....	151
Conclusion .....	152
Bibliography .....	154
Chapter V. Results, Discussions and Conclusions .....	162
Results of the Appended Pages.....	163
Discussion .....	166



## TABLE OF CONTENTS (continued)

	<u>Page</u>
Jurisdiction .....	166
Project Design .....	167
Stakeholders .....	169
Negotiating .....	170
Factors that may Enhance Resilience .....	173
Factors that may Decrease Resilience .....	176
Conclusions.....	178
Bibliography .....	183
Appendices .....	196

## LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
2.1 Risks and opportunities for collaboration .....	35
3.1 Hypothetical basin displaying riparian position based upon “downstreamness” .....	86
3.2 Comparison of dam construction rates in national and transboundary basins by decade .....	91
3.3 Comparison of normalized dam construction rates in BCUs with an agreement, without an agreement, and national basins by decade. ....	92
3.4 Percentage of global transboundary river basin area under an agreement (cumulative), 1950-2009. ....	93
4.1 Indicators that enhance and decrease hydropolitical resilience.....	118
4.2 Human Development Index values and Human Security Index values for BCUs .....	124
4.3 Treaty coverage for global BCUs.....	125
4.4 Results of Sen’s-slope calculated over the past 117 months. ....	126
4.5 Projected dam densities for global BCUs.....	127
4.6 Projected coefficients of variability for 2030 (above) and 2050 (below) in global BCUs. ....	128

## LIST OF TABLES

<u>Table</u>	<u>Page</u>
2.1 Case Study Selection Criteria Matrix .....	48
2.2 Types and Faces of Transboundary Water Interaction (A First Approximation).. .....	50
3.1 Rates of dam construction by continent for national basins, transboundary BCUs with an agreement, and transboundary BCUs without an agreement.....	94
3.2 Distribution of dam construction in basins with and without agreement, defined by “downstreamness.” .....	95
4.1 Methods for determining dam density and b) institutional capacity for BCUs. .....	122

## Mechanisms of Cooperation for States' Construction of Large-Scale Water Infrastructure Projects in Transboundary River Basins

### CHAPTER 1. INTRODUCTION

The world's transboundary surface water basins (river basins that cross international boundaries) comprise 47% of the earth's land area. These basins are also home to 40% of the world's population (Wolf et al. 1999). Transboundary waters are relied upon for, among other aspects, life, economic well-being, and ecosystem goods and services. Competition between riparians for the resources transboundary river basins have to offer may lead to international conflict over water quantity, quality, timing, and/or impoundment. Yet cooperation does often prevail, resulting in 688 water-related treaties signed between 1820 and 2007.

What variables (or combination of variables) may cause actors in the river basin to move from non-conflict into conflict? Wolf, Stahl, & Macomber (2003, p. 2) suggested the following relationship between change, institutions, and likelihood of conflict: "[t]he likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change." This suggests that two important dimensions exist in transboundary water disputes: 1) a high rate of change in the system; and 2) a low institutional capacity of a system to absorb change, e.g. low hydropolitical resilience.

#### **Thesis Objectives**

Since water resources are so critical to socio-economic and physical systems, it is important to further understand the nature of how nations cooperate and what may

disrupt cooperation in places where water is shared. This dissertation, which is based on a compilation of three research papers, intends to (i) illuminate which practices may be used to best design and implement collaborative water projects in the earliest stages, (ii) examine the relationship of dam construction and cooperation in transboundary basins, which may act as an agent or deterrent of hydropolitical resilience, and finally (iii) analyze the utility of measuring a basin's hydropolitical resilience through global indicators where basin-wide cooperation is in its beginning stages and where dam construction is slated to occur.

In this introduction, an overview will be provided of (i) the various issues that countries weigh before committing to cooperation, (ii) the relationship of transboundary common-pool resources and negative externalities, and (iii) hydropolitical resilience and transboundary water conflict. A discussion about the scientific methods used in this dissertation will follow.

## **Variables Influencing Cooperation**

### *Perceived Risk and Barriers*

Perceived risk has been defined as the perception that an act of cooperation will expose the country to harm, will jeopardize something of value to the country, or will threaten the political future of individual policy makers (Subramanian, Brown, and Wolf 2012). It is a core consideration for country decision makers; ideally, countries cooperate when there is more opportunity than risk and more benefit than cost (Figure 1). If a country cannot find a way to compensate for or control risk, it may choose not to

enter into a cooperative agreement. Countries may also unilaterally develop projects within their own territories to avoid the political intricacies posed by sharing resources (Wolf et al. 2005).

Subramanian, Brown, and Wolf (2012) developed five general categories of risk perceived by decision makers. The first category is the capacity and knowledge risk. This is where countries feared they would be at a disadvantage in negotiations, which manifested in two major ways:

- Countries perceived they had less negotiating capacity than their co-riparians.
- Countries perceived they did not have adequate or accurate information about the basin.

Decision makers experienced the second category, the accountability and voice risk, with the following:

- Fear the co-riparians, third parties, or regional institution may not deliver benefits
- Concern that the respective country's interests would not be adequately considered in joint decision-making processes
- Perception of a high probability that the regional institutional arrangement would not result in the flow of benefits

To a greater or lesser extent, all of the cases examined reflected the significant risk of sovereignty and autonomy. This risk occurs when a decision maker senses the danger of intrusion into the country's authority to make sovereign decisions. It addresses both of the following:

- The desire to have control over national development goals and related development of resources and infrastructure
- The right to make decisions independently

Another risk identified was the risk of equity and access:

- Fairness in any deal, regarding specified quantity or quality of water, benefit flows, or project costs
- Entitlement to use the river. Some countries viewed entitlement as the right to continuing with historic uses; others as gaining access to a river running through (or originating in) its territory; and yet others viewed it as attaining benefits in proportion to a country's relative size in (or percent contribution to) the basin.

The risk of stability and support had both direct national and personal implications. All countries in the study had to consider this, but it was a stronger consideration for countries with diversified and powerful stakeholders. The risk applied to both of the following:

- The implementability of an agreement due to the presence or absence of key stakeholder support
- A decision maker's positive or negative public image

In a study of transboundary water governance in western Canada and the United States, interviewees identified key barriers to cooperation, which included mismatches in governance structures and integration, as well as mismatches in intra-jurisdictional integration within countries. Other barriers included distinct and sometimes

incompatible governance cultures and mandates; shortcomings in institutional capacity, financial resources, participation capacity, and data availability; social and spatial distance between parties; and psychosocial factors, including mistrust and a lack of leadership (Norman and Bakker 2005). Blomquist and Ingram (2003) also detailed differences in water use across boundaries; distinctions in ethnicity, culture and religion; and differences in economic, political, and/or military resources across boundaries as compounders of transboundary resource problems.

### *Enhancing Cooperation*

Political opportunity also helped to enhance cooperation in many cases. In a workshop focused on sharing and managing transboundary aquifers, researchers emphasized how the beginning of the cooperation process needs to begin with confidence building measures, especially joint monitoring and data sharing, and the establishment of conflict resolution mechanisms (Feitelson and Haddad 1998). Subramanian, Brown, and Wolf (2012) found examples of the perception of resulting national and regional political gains even trumped residual risk, in that some countries were willing to cooperate even with some risks given sufficient political opportunity. Third parties were also identified as those who could play important roles in supporting countries with risk reduction. Examples of this assistance included engaging with countries at an appropriate scale (e.g., the entire basin, sub-basin, or country level); conducting detailed risk assessments; designing risk reduction strategies, including



financing and guarantees to target dominant risks; and periodically reassessing the risk situation, employing new strategies as needed.

### *Country Drivers*

This is the critical question for explaining integrated water resources management at the level of a river basin: what drives countries to enter into an agreement?

### *Internal Drivers*

The basic needs of food, water, and energy security for its people drives developing countries to search for solutions to achieve their goals through water development (Lautze, Giordano, and Borghese 2005; Subramanian, Brown, and Wolf 2012). This process begins with countries crafting national plans, at times relying on knowledge and financial assistance from development partners; these plans can then be followed with regional plans and partnerships. This is done because regional production centers of food and energy as well as regional markets are seen as an attractive means of meeting national goals and are often less costly for countries (Subramanian, Brown, and Wolf 2012).

Subramanian, Brown, and Wolf (2012) also stated that a sense of a nation's rights pervade the thinking on water management and cooperation in international waters. Because of this, countries stake claims on shared waters based on their respective sense of rights. Factors such as commonly held beliefs about the river flowing through one's country and legacies of use and management under legal and

constitutional instruments shape how people perceive these rights. Culture and tradition related to water also often instill values that influence how rights are perceived. Norman and Bakker (2005) also mentioned more informal drivers for cooperation, including leadership, contacts, personal relationships and networks.

### *External Drivers*

Regional institutions, shared culture and ethnicity, regional geopolitics, and regional thinking on norms, concepts, and best practices in sustainable development have been identified as regional influences (Lautze, Giordano, and Borghese 2005; Subramanian, Brown, and Wolf 2012). Norman and Bakker (2005) included legal obligations and bureaucratic transparency as minor drivers of water cooperation. Global trends can also exert influence on cooperation, given the history of ideas and experience regarding international waters that countries and their partners contemplating cooperation can draw from.

The current status of regional and global geopolitics can either provide stimulus for or against cooperation. Examples discussed in the case studies include the breakup of Yugoslavia and dissolution of the Soviet Union for countries in the Aral Sea Basin.

Norman and Bakker (2005) also mentioned how cooperation is facilitated by proximity. A future driver of cooperation could be climate risks. However, the evidence for climate risk-cooperation is not forthright. De Stefano et al. (2010) examined the relationship between basins likely to experience change in variability due to climate change and the robustness of the basin institutions' capacity for dealing with variability. The results of

the study found significant gaps in institutional capacities to deal with variability (especially in South America and Asia).

### *Cooperation-inducing design*

In a review of several scholarly works, Blomquist and Ingram (2003) pointed to building institutional capital, achieving fairness and equity, and meeting needs that accord with cultural values on both sides of the border as important to success in transboundary water management. This is all well and good, but what can be done when none of these things exist? How is institutional capital built, for example?

Wolf (1995) listed general guidelines for cooperation-inducing implementation, using the pre-peace treaty Jordan Basin as his case study:

- Control of one's major water sources. It is necessary both to address past and present grievances as a prerequisite for market-driven solutions. As such, an initial "dis-integration" of the basin is recommended.
- Opportunities for cooperation may be hidden in the details of each entity's bargaining mix.
- Water basin development can then proceed from "small and doable" projects to ever-increasing cooperation and integration, remaining always on the cutting edge of political relations.

One step that is often proposed for riparians in the nascent stages of cooperation is data and information exchange between riparians. Uitto and Duda (2002) cited the development of a science-based diagnostic analysis as an essential tool for,

among other components, breaking issues into manageable parts with the aim of developing a strategic action program.

Strategic joint fact-finding among nations engaging in a project can serve as an important catalytic tool for developing political buy-in and fostering participation (Feitelson and Haddad 1998; Uitto and Duda 2002; Blomquist and Ingram 2003; Wolf et al. 2005). Joint fact-finding also lowers the perceived risks of cooperation, as it has low sovereignty infringement and lower transaction costs. Factors cited as promoting this exchange of data and information include the presence of compatible needs, absence of legacies of mistrust, increasing water resources stress, perceptions of mutual benefit, external pressure and funding, comparable levels of institutional capacity, popular and political concern about water resources management, and functional formal or informal cooperative arrangements (Chenoweth and Feitelson 2001). Chenoweth and Feitelson (2001) mentioned, however, that this may not be useful as a first step in establishing more comprehensive cooperation depending on the situation. Also, it is important that data collection for its own sake may not be particularly useful due to a large amount of data that has been collected but never used (Van der Gun 2001).

#### *Track I and Track II Diplomacy*

While any project can be designed to be cooperation-inducing, it is necessary for nations involved to also go through diplomatic processes to agree upon a framework. Though it is not possible for third parties to create a conducive, political environment

alone, they can provide incentives both directly and indirectly to cooperate through playing a brokerage role:

- Providing technical competence and examples of best practices
- Assisting in negotiation and mediation skills, including the provision of legal and other water experts
- Facilitating investments in transboundary settings (Phillips et al. 2006).

Four different strategies of third party support can be identified (Mostert 2005): Track I Diplomacy (cooperation); Track II Diplomacy (collaboration); Track III Diplomacy (transformation); and Continuing Support. Track I Diplomacy involves supporting the conclusion of a formal agreement between riparian states, typically through mediation and facilitation. Track II Diplomacy tries to arrive at feasible development strategies on the ground through promoting informal dialogues, research and studies, and capacity building. Track III Diplomacy addresses policies at the national and local levels, which are typically at the root of transboundary water problems. Finally, financial support may be required to sustain cooperation, which third parties can provide for a river basin organization or loans for development projects.

None of these strategies are mutually exclusive; for example, Track II Diplomacy efforts may eventually lead to the initiation of more formal, Track I discussions (Qaddumi 2008). This occurred during the Israeli–Palestinian negotiations for the Oslo Accords, where Norway played an active role in elevating the talks from an informal bridge-building exercise to formal negotiations (Waage 2005).

### **Transboundary River Basins as a Common Pool Resource**

Broader notions related to common pool resources (e.g., Hardin, 1968; Wade, 1987; Ostrom et al., 1999; Dietz, Ostrom, and Stern 2003; Marothia, 2003; Anderies and Jansen, 2013) suggest that common access to a shared resource may lead to over-exploitation of that resource, but that this dynamic is mitigated by effective institutions. Perhaps most prominently, Hardin (1968) pointed to the common accessibility of natural resources as a contributor to overexploitation. Wade (1987) stated that people will not restrain their use of a common-pool resource without an external enforcer. Notably, however, literature on common pool resources also highlights how the presence of an accepted governing mechanism can reduce overuse and negative externalities. Ostrom et al. (1999), for example, stated that effective rules limiting access and defining users' rights and duties prevents overuse that ignores negative effects on others. Marothia (2003) described how institutions are an important variable for stemming the decline of common-pool resources. Dietz, Ostrom, and Stern (2003) asserted that absence of scale-appropriate, effective governance institutions jeopardizes natural resources and the environment. Finally, Anderies and Jansen (2013) said that institutions help mitigate the overexploitation of common-pool resources.

The nature of transboundary rivers are unique in common-pool resources in that externalities are unilateral; that is, one party generates externalities, affecting users downstream (Quiggin 2001). Externalities may be both positive and negative. Positives that may result in the case of unilateral externalities include, for example, when a

landholder constructs a riparian buffer zone at their own cost to prevent or intercept nutrient and sediment flows, this action generates ecosystem services that improves water quality both locally and downstream (Ibid.). This creates a dynamic whereby the downstream user benefits without any cost incurred. Nonetheless, examples of negative externalities due to unilateral upstream development (e.g.; reductions or alterations to river flow) are also fairly abundant. Daoudy (2009), for example, described how Turkey's Great Anatolian Project generates benefits for Turkey but leaves downstream countries with greatly reduced river flow during dam filling, and Hammond (2013) highlighted Ethiopia's plans to build dams that will result in less water for downstream countries.

A set of papers (Yetim 2002; Giordano 2003; Wolf 2007) has fueled speculation that the common property or "fugitive" nature of transboundary waters has accelerated dam construction – particularly in upstream countries. Yetim (2002), for example, described how the unilateral exploitation of transboundary waters can lead riparians to extract water from the watercourse at rates above average replenishment. Giordano (2003) stated that nations may have an incentive to overexploit certain transboundary water resources, because the benefits of use (e.g. irrigation, hydropower) accrue to one nation while the costs (e.g., reductions or alterations to river flow) may be passed on to other riparians. Further, Wolf (2007) noted how riparians of an international basin may at times implement water development projects unilaterally in order to avoid political intricacies of negotiation over use of the shared resource.

A riparian's location affects the degree to which it can internalize benefits and externalize costs. If a riparian is upstream, it is more likely that the riparian may build a dam where it can internalize most of the benefits and pass the costs downstream. Dinar (2006) found that side-payments frequently occur to offset this asymmetric, or "upstream-downstream," geographic relationship between upstream and downstream states. Dinar (2006) also pointed out, however, that upstream riparians tend to be at an advantage in river basins with more suitable dam locations.

Consistent with broader literature on common pool resources, presence of institutions in transboundary waters may offset incentives for unilateral exploitation of the shared resource and foster greater distribution of benefits. Sarker et al. (2008) posited that regulations, monitoring and imposition of penalties comprise the main instruments to mitigate adverse externalities issues borne by transboundary waters. Drieschova, Giordano, and Fischhendler (2009) described how international environmental cooperation may lead to positive-sum outcomes for the states involved, Fischhendler, Dinar, and Katz (2011) stated how international environmental regimes may be designed to internalize externalities and reduce transaction costs associated with cooperation.

### **Hydropolitical Resilience and Variables that Influence it**

#### *Hydropolitical Resilience and Hydropolitical Vulnerability*

The concepts of "resilience" and "vulnerability" as related to water resources are frequently assessed within the framework of "sustainability" and relate to the ability of



biophysical systems to adapt to change (e.g., Gunderson and Pritchard 2002). As the sustainability discourse has broadened over time from describing engineered and ecological systems to include human systems, research has also been increasingly geared towards identifying indicators of resilience and vulnerability within this broader concept (e.g., Lonergan, Gustafson, & Carter 2000; Turner et al. 2003; Bolte et al. 2004).

Many scholars have written about conflict and its influence on the resilience of transboundary water systems. The likelihood of escalated, even violent, conflict over water resources is one that scholars have debated about over the past decades (e.g., Gleick 1993; 2000; Wolf 2000; 2007; Nordås & Gleditsch 2007; Cooley & Gleick 2011). This debate falls within the framework of “hydropolitics” (Waterbury 1979), which relates to the ability of geopolitical institutions to manage shared water resources in a manner that is politically sustainable, i.e., without tensions or conflict between political entities (McNally, Magee, and Wolf 2009). But what allows these institutions to manage water resources in a politically sustainable manner? What are disruptors to a sustainable paradigm?

Examining transboundary water system resilience within a hydropolitical context leads to the concept of “hydropolitical resilience,” which is defined as the complex human-environmental systems’ ability to adapt to permutations and change within these systems. In contrast, “hydropolitical vulnerability” is the risk of political dispute over shared water systems (Wolf 2005). The characteristics of a basin that would tend to enhance hydropolitical resilience to change include: international agreements and

institutions, a history of collaborative projects, generally positive political relations, and higher levels of economic development. Facets that tend toward vulnerability, on the other hand, include the following: rapid environmental change, increased hydrologic variability, rapid population growth or asymmetric economic growth, major unilateral development projects, absence of institutional capacity, the potential for the “internationalization” of a basin, and generally hostile relations (Wolf 2005). When examining characteristics that would tend to enhance or detract from hydropolitical resilience in combination, it becomes clear that the settings of hydropolitical conflict are most likely with major water projects, such as dams, diversions or diversion schemes, built in the absence of agreements or collaborative organizations, that can mitigate for the transboundary impacts of these projects (Petersen-Perlman et al. 2013).

The previous subsection explored factors that may lead to hydropolitical conflict. Yet what constitutes hydropolitical conflict needs to be defined. The next subsection addresses the nature of transboundary waters and conflict.

### *Transboundary Waters and Conflict*

Scholars have debated whether this clash between nations due to the transboundary nature of water may lead to violent conflict; the debate appears to be centered on how “transboundary water conflict” is defined. Wolf (2000) has argued that while there is a growing literature describing water as an historic, and, by extrapolation, a future cause of warfare, a close examination of case studies cited in this literature reveals looseness in the classification categories; in other words, how one defines water

“wars.” De Stefano et al. (2010a) found only 38 acute disputes (i.e., those involving water-related violence) between 1948 and 2008; of those, 31 were between Israel and one or more of its neighbors, with no violent events occurring between Israel and its neighbors after 1970 (De Stefano et al. 2010a). This means most of the cases cited were: 1) caused by political tensions or instability rather than about warfare, 2) the cases were using water as a tool, target, or victim of armed conflict. These are important issues, but are not the same as water “wars.” Then again, Wolf (2000) also cited many water related incidents of violence at the sub-national level; the identified incidents were generally between tribes, water use sectors, or provinces. Cooley and Gleick (2011) wrote that while the likelihood of war over water is small, there exists a long history of violence associated with transboundary water resources, and that future pressures, including (but not limited to) population and economic growth and climate change, could increase tensions. Some characteristics that make water likely to be a source of strategic rivalry between nations are: the degree of scarcity; the extent to which the water supply is shared by more than one region or state; the relative power of the basin states; and the ease of access to alternative freshwater sources (Gleick 1993). Nations have also cut off access to shared water supplies for various political and military reasons; nations have also aimed for new water supplies through aggressive military expansion. Gleick (1993) also cited inequalities in water use as the source of many regional and international frictions and tensions.

The previous paragraph reveals discrepancies in the literature for how “transboundary water conflict” is defined. For the context of this paper, I define “transboundary water conflict” as verbal, economic, or militarily hostile actions between nations over shared water resources. Within that realm, “violent conflict” is defined as militarily hostile actions between nations over shared water resources.

Several instances of transboundary water conflict have occurred over the unilateral construction of large water infrastructure in transboundary basins. One of these instances occurred in the Tigris-Euphrates Basin. In 1990 Turkey finished construction on the Ataturk Dam, the largest of 21 dams constructed for the Southeastern Anatolia Project (GAP), and interrupted the flow of the Euphrates for a month to partly fill the reservoir. Despite Turkey warning of a temporary cutoff of flow, Syria and Iraq protested that Turkey now had a water weapon that could be used against them. Later that year the President of Turkey, Turgut Ozal, threatened to restrict water flow to Syria to force it to withdraw support for Kurdish rebels operating in southern Turkey (Gleick 1993). Another example of water infrastructure-related conflict is the 1986 case of North Korea announcing plans to build the Kungansan Dam on a tributary of the Han River, upstream of Seoul, the capital of South Korea (Gleick 1993). Gleick (1993) said that this led to fears in South Korea that the dam could be used as a weapon to flood Seoul through sudden releases of the reservoir. South Korea built a series of levees and check dams upstream of Seoul to try to mitigate possible impacts. More recently, rhetoric has escalated over Ethiopia’s construction of the Grand

Ethiopian Renaissance Dam over concerns on how the dam would impact flows of the Nile for downstream countries. Before his removal from power, Muhammed Morsi was reportedly quoted as saying, “We will defend each drop of the Nile with our blood” (Natsios 2013). These are strong examples that feature how water management decisions from an upstream riparian can be used (or viewed) as a political weapon to impose its will upon downstream co-riparian nations.

What are other conditions that would have to come to fruition for an interstate water conflict to occur? Wolf (1998) hypothesized that the aggressor would have to be both downstream and the regional hegemon. He also stated that the upstream riparian would have to launch a project which decreases either the quantity or the quality of water resources, knowing that it will antagonize a stronger downstream neighbor. The downstream power would then have to decide whether to launch an attack, and would have to weigh not only an invasion, but also an occupation and depopulation of the entire watershed to prevent any retribution (Wolf 1998). Also, both countries would most likely not be democracies, as two democracies have never been at war with one another (Ibid.). Climate change is also expected to intensify hydropolitical tensions within countries, between countries and/or within river basins (Gleick 1993; Nordås & Gleditsch 2007). Not only may climate change alter the quantity and timing of flow within river basins and increase water scarcity, there may also be the detrimental, indirect negative effects of reducing food availability and increased exposure to new disease vectors, which can undermine the legitimacy of governments, hurt local and

national economies, and affect human health (Barnett 2003). These direct and indirect changes may alter the hydropolitical resilience of the basin; that is, increasing the likelihood of political tensions that are stronger than the institutional capacity to absorb that change (Wolf, Stahl, & Macomber 2003; Wolf 2010). As a consequence, river basins without robust water-related treaties and institutions may be more vulnerable to tension and conflict (De Stefano et al. 2012). To discover more about the nature and likelihood of transboundary water conflict, Yoffe et al. (2004) used Oregon State's Transboundary Freshwater Dispute Database to test three hypotheses on the likelihood and intensity of water resource disputes. The three hypotheses tested were as follows: a) the likelihood and intensity of dispute rises as the rate of change within a basin exceeds the institutional capacity to absorb that change; b) periods of conflict and cooperation at the international scale will correspond to similar periods at the national scale; and c) the likelihood of intense dispute rise as the basin's average precipitation decreases or the variability of precipitation or discharge increases. Testing the first hypothesis found that historical international relations over shared freshwater resources were overwhelmingly cooperative. Conflict, when it occurred, centered on quantity and infrastructure issues (Yoffe et al. 2004). Results also suggested that relationships exist between water and non-water relations, but the nature of the relationships vary considerably by region (Ibid.). Finally, the hypothesized premise that the likelihood of intense dispute rises as the average precipitation within a basin decreases or the variability of precipitation or discharges increases was supported when

examining the relative frequency of the most conflictive events in a basin, but the relationship with cooperation is still complex (Ibid.).

Now that the causes of hydropolitical conflict have been explored, it is natural to discuss what may lessen its likelihood. Building institutional capacity, in the form of treaties and river basin organizations, is described as a mechanism to decrease the likelihood of hydropolitical conflict (Wolf, Stahl, and Macomber 2003; Yoffe, Wolf, and Giordano 2003; Yoffe et al. 2004). McCaffrey (2003:157) wrote, "Treaties stabilize [the relations of states sharing a river] giving them a certain level of certainty and predictability that is often not present otherwise." Giordano and Wolf (2003) cited characteristics that would make a treaty over water effective:

1. An adaptable management structure (including flexibility, allowing for public input, changing basin priorities, and new information and monitoring technologies).
2. Clear and flexible allocating criteria.
3. Equitable distribution of benefits.
4. Detailed conflict resolution mechanisms.

While there is certainly evidence to support these observations, there also may be inherent weaknesses of certain consent-building relations in water. Treaties can be exploited by riparians in a number of ways: treaties are not easily enforceable, can be structured to reflect (or exacerbate) existing inequalities between riparians, and can lead to non-signatory riparians not participating (Zeitoun and Warner 2006). It may not

be the case, then, that the mere presence of treaties does not indicate hydropolitical resilience alone; indeed, perhaps Zeitoun and Warner (2006, p. 437)'s declaration of 'the absence of war does not mean the absence of conflict' may also extend to the presence of agreements does not preclude the absence of conflict. It may also be the parties engaged in treaties/institutions themselves, rather than the treaty or institution's content or presence, which may be at the heart of their success, as suggested by Chasek, Downie, and Brown (2006). Zeitoun and Warner (2006) and Chasek, Downie, and Brown (2006)'s assertions are healthy critiques, but within the context of violent conflict, the relationship of institutional capacity and decreased violent conflict holds, as evidenced by Wolf, Stahl, and Macomber (2003), Yoffe, Wolf, and Giordano (2003), and Yoffe et al. (2004).

### **Barriers against and Drivers toward Water Cooperation**

In the previous paragraphs, we have explored research examining the potential of violent conflict over water. So, in contrast, what factors drive nations towards hydropolitical cooperation? Norman and Bakker (2005) identified both barriers and drivers to cooperation in transboundary water issues. Barriers they identified include: a mismatch in governance structures and intra-jurisdictional integration within countries; distinct and sometimes incompatible governance cultures and mandates; shortcomings in institutional capacity, financial resources, participation capacity, and data availability; distance (spatial and social); and psychosocial factors including mistrust and a lack of leadership. The drivers for cooperation in transboundary water issues are much more



informal; they include leadership, contacts, personal relationships, and networks (Ibid.).

The question of scale in transboundary water issues is also important to consider.

Norman and Bakker (2005) said that transboundary water issues often arise locally whereas resolution mechanisms usually operate at the national level. As a result, mechanisms and actors between two different scales are not always well-linked. This is important to keep in mind when framing the problem in transboundary water negotiations.

In the previous paragraphs, I have discussed variables that the decision makers of riparian countries in international basins weigh before entering into cooperative frameworks, the nature of transboundary river basins as a common-pool resource, variables that influence hydropolitical resilience, and the nature of hydropolitical conflict. While there has been much scholarly progress in understanding these aforementioned areas, there are still some specific questions that need answering. Here are the questions that I attempt to answer:

1. By which practices might development partners best design and implement collaborative projects in their absolute earliest stages?
2. How well do the steps for initiating cooperation mentioned in literature (data exchange, scientific collaboration) work in practice?
3. Does the rate of dam construction in transboundary basins exceed that of national basins?

4. Does the rate of dam construction in transboundary water not covered by an agreement exceed that of transboundary waters covered by transboundary agreements?
5. What regional variation can be evidenced in dam construction rates in national basins, transboundary waters covered by agreements, and transboundary waters not covered by agreements?
6. How does the dam distribution in the presence of a transboundary water agreement differ spatially from the dam distribution in the absence of a transboundary water agreement?
7. The Zambezi River is a transboundary socio-hydrological system currently functioning across international borders in a state of relative peace. What variables or combination of variables—internal and external, current or legacy—could serve to push the Zambezi system over the threshold into conflict?
8. What is added by analyzing hydropolitical resilience at both the global and basin scale?

In the following subsection, I explain in detail how I attempt to answer these questions.

### **Key Concepts and Limitations**

This dissertation is limited to discussing its findings within a transboundary perspective with a focus on surface river basins; transboundary aquifers are not considered. While the focus of this dissertation is from an international management

perspective, the research questions posed here are also valid for intra-national management situations.

The main unit of analysis for this dissertation is the basin-country unit, or BCU. A BCU is defined as the portion of a riparian's land area that is within a certain transboundary river basin. For example, the Columbia River Basin has two BCUs: the land area in the United States that is within the Columbia River drainage, and the land area in Canada.

## Methods

This dissertation is based on two submitted research papers (I, II) and one research paper that is to be submitted soon (III) that each respectively addresses the objectives of this dissertation using different methodologies. The research approach falls within the field of geography that studies the interactions of humans and the environment (e.g., White, 1974; Wescoat, 1993; Lonergan, 1999).

Paper I attempted to identify practices that may enhance the ability of partners to design and implement collaborative projects in the earliest stages. The first task of Paper I was identifying potential case studies by creating a database of all transboundary water resources projects (both surface and groundwater) that had multinational participation, either official or unofficial. Next, the presence of government involvement was investigated, as well as the type of cooperation (which was designated based upon the desired outcome of the collaborative effort). My co-author and I then selected 10 case studies that would have direct implications for a hypothetical pilot project in a basin at the beginning stages of water cooperation. In order to make sure our cases were applicable, we based the selection on the following filtering criteria which operationalize our research questions:

*Criterion #1:* Funding exclusively or primarily from outside sources, for example, donor or NGO

*Criterion #2:* The inclusion of non-official<sup>1</sup>, or Track II<sup>2</sup>, stakeholders in project design and implementation

*Criterion #3:* Absence of formal diplomatic relations between or among riparians nationwide

*Criterion #4:* Project design to include at least the possibility of enhancing hydropolitical relations.

After the projects were narrowed down by the aforementioned criteria and the case studies were selected, each riparian relationship was classified according to the Transboundary Waters Interaction Nexus (TWINS), as described by Zeitoun and Mirumachi (2008). This classification has four groups: Low Conflict – High Cooperation, Low Conflict – Medium Cooperation, Low Conflict – Low Cooperation, and Medium/High Conflict – Low Cooperation (see Table 2 in Chapter II for details).

Each of the case studies selected had in-depth project reports that described its objectives, successes, challenges, and lessons learned. From this information, we identified elements of the projects that were deemed successful by the project reports and organized them into four categories: jurisdiction, project design, stakeholders, and negotiating. These lessons and recommendations gathered from the project descriptions are described in greater detail in the discussion and conclusion sections, respectively.

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<sup>1</sup> This refers to non-official cooperation. Non-official stakeholders are those who are apart from the formal practice of their governments (Joesoef 1977).

<sup>2</sup> Track II refers to a type of diplomacy that tries to arrive at feasible development strategies on the ground through promoting informal dialogues, research and studies, and capacity building, as opposed to Track I, formal diplomacy (Mostert 2005).

Paper II involved data collection on large dams, on river basin boundaries, and on international agreements applying to transboundary waters. For data on large dams, my co-author and I used the Global Reservoir and Dam Database (GRaND), produced by The Global Water System Project (GWSP), as it contains the greatest number of georeferenced dams of any data set examined; this was critical for determining whether each dam was constructed within a transboundary basin and an upstream or downstream riparian. To apply a set of international water agreements relevant to our analyses, criteria developed by Giordano et al. (2013) were applied to agreements contained in the Transboundary Freshwater Dispute Database (Oregon State University, 2013). Criteria elaborated by Giordano et al. (2013) stipulate that transboundary water agreements should contain “provisions related to water as a scarce or consumable resource, a quantity to be managed, or an ecosystem to be improved or maintained”; however, global and regional agreements, as well as agreements focused on areas such as navigational rights, border delineation or fishing rights, and financial aspects of water-related projects should be excluded. Application of these criteria to the 688 agreements contained in the TFDD database (Oregon State University 2013) resulted in 226 agreements included in this analysis. Next, we classified dams by basin, basin category (national, international), riparian position, and country according to their status in the year in which a dam was constructed. We then divided dams in international basins according into two additional categories: i) dams constructed in basin country units (BCUs) without an agreement, or in BCUs with an agreement but before the agreement was concluded, and ii) dams constructed in BCUs with an

agreement. We then classified dams according to their position in transboundary basins.

Criteria applied to select the 10 basins for analysis were as follows:

1. *Number of dams*: Basins with at least 10 dams were sought so as to enable sufficient depth of data for analysis.
2. *Number of riparian nations*: While the majority of transboundary basins have only two riparian nations, the number of nations in a basin can be as many as 18. Basins were selected to reflect a spectrum in number of riparians and diversity of geographic location.
3. *Basin configuration*: Transboundary basin configurations vary. Dinar (2006) identified three basin configuration types: through-border, border-creator, and partial border-creator. Selected basins fall into all three configuration types.
4. *Regional variation*: Efforts were made to avoid concentration of selected basins in one region (e.g., sub-Saharan Africa).

Paper II adopts a framework of defining upstream, midstream and downstream areas based upon methods defined by Van Oel, Krol, and Hoekstra (2009). The data was then normalized by area to offset the potential confounding effects of the different areas covered by national versus transboundary basins. The scope of analyses were delimited to years between 1950 and 2009 due to the fluidity of international borders in the world before 1950. Boundary changes that triggered a change in basin status were accounted for and incorporated into analyses. A border database that delineated all of the international border changes since 1948 was used (Weidmann et al. 2010).

The methodology of Paper III is in two parts. For part one, this paper examined hydropolitical resilience on a global scale using social, political, and physical indicators that measure potential change and institutional capacity to absorb these changes. To measure hydropolitical resilience, I need to incorporate social, political, and physical data; thus I have chosen a series of indicators that will help to determine the degree to which hydropolitical resilience is present. I used two social indicators: the Human Development Index (UNDP, 2012) and the Human Security Index (HSI 2012). For physical changes, I utilized a layer measuring water scarcity within the last 10 years, a dataset that contains information for recent and projected dam construction, and a layer of projected water variability. Finally, I examined institutional capacity through a dataset of current international water treaties available on Oregon State University's Transboundary Freshwater Dispute Database (TFDD). All analyses were performed at the BCU level.

The second part of Paper III used the results of part one and put the results into context. For example, does the fact that seven of the nine Zambezi BCUs have either low (or non-existent) rates of dam development indicate that the nations in the Zambezi have a low chance of dam-related conflict? This is not necessarily the case. Part two examined the political history of cooperation and conflict, as well as past, current, and predicted physical, political, and social changes to the basin. I also incorporated information gathered from 25 semi-structured interviews and surveys across the Zambezi River Basin that helped to inform the current status of the basin's hydropolitics.



In sum, I have described how I attempt to answer my research questions. By the end of this dissertation, I hope to have added knowledge to best practices for development partners in initiating cooperative activities; how well steps for initiating cooperation mentioned in the literature work in practice; the relationship between dam construction, geographic location, and transboundary water agreements; and the utility of global and basin-scale analyses of hydropolitical resilience. I follow with my first research paper on initiating cooperation in transboundary river basins.

## CHAPTER II. GETTING TO THE FIRST HANDSHAKE: ENHANCING SECURITY BY INITIATING COOPERATION IN TRANSBOUNDARY RIVER BASINS

*Jacob D. Petersen-Perlman and Aaron T. Wolf*

### **Abstract**

How does transboundary water cooperation begin at the initial stages? Countries in many transboundary basins either do not cooperate at all or have ceased cooperation altogether. Yet cooperation does often prevail, resulting in 688 water-related treaties signed between 1820 and 2007. The question we address here is, by which practices can development partners best design and implement collaborative projects in the earliest stages? This paper identifies lessons and strategies for the initiation of cooperation drawing from global experience. We also identify the impact of securitization framing on initiating cooperation. We completed the following: 1) We culled from the Oregon State University Transboundary Freshwater Dispute Database (TFDD) a compilation of all transboundary water resources projects over the last decade that have multinational participation (official or unofficial). 2) We further refined our culling to include only projects that fit filtering criteria which included: a) Funding exclusively or primarily from outside sources b) Inclusion of non-official (Track II) stakeholders in project design and implementation c) Absence of formal relations around water resources, in the form of a treaty or River Basin Organization (RBO), between or among the riparian countries in advance of the project discussed d) Project design including at least the possibility of enhancing hydropolitical relations. Using the above filtering criteria, we selected 10 case studies. Findings suggest that it is best to focus on project designs that respect the autonomy of participating riparians, create basinwide networks of scientists, allow for each partner to garner responsibility for project activities, and consult a diverse group of stakeholders.

**Keywords:** Water cooperation; water security; hydropolitics; cooperation; unofficial cooperation

### **Introduction**

Water security has been defined by UN-Water (2013) as the “capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and

for preserving ecosystems in a climate of peace and political stability.”<sup>3</sup> Allan and Mirumachi (2010) asserted that water security is determined by the possession of a diversified and strong economy. This view was indirectly supported by Wolf et al. (2005), who stated that alleviating poverty is implicitly tied to easing security concerns. Wolf et al. (2005) also emphasized the importance of institutional capacity for water management to enhance water security. Providing water services is seen often as a “peace dividend” that can bolster state legitimacy while also serving the needs of the people after a conflict has occurred (Weinthal, Troell, and Nayakama 2011).

It is possible for water security to be enhanced by cooperation. There are cases where cooperative adaptation between countries may not be possible under protracted conflicts (Fischhendler, Dinar, and Katz 2011). Yet for countries not at war, it is also important to note that the absence of war does not mean the absence of conflict (Zeitoun and Warner 2006). When nations are not warring over water but a protracted conflict exists, alternative solutions may be sought, and, in such cases, “environmental unilateralism” may be preferred by one or more states to achieve certain environmental outcomes (Fischhendler, Dinar, and Katz 2011). Yet cooperation may be a suitable alternative for all parties in a river basin, even allowing for future cooperation over other international issues, as noted by past functionalist writings (Sewell 1966; Mitrany 1975; Jagerskog 2001; Turton 2003).

This is a paper not about cooperation, but rather about how countries go from a total lack of cooperation *towards* cooperation at its most initial stages, and, in the

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<sup>3</sup> This paper draws from an unpublished report, “Lessons Learned from Transboundary Water Collaboration across the World,” done under contract with USAID.

process, enhancing their own water security. Individual policy makers in a country making decisions about cooperation operate within the historical context of their countries, fed by a set of external and internal drivers of decision-making. Before them is a possibility of a deal for cooperation with a set of benefits. At this point, these policy makers must choose, on behalf of their countries, whether or not to cooperate. How do they make this decision? They do not consider benefits alone, as there are many cases of countries not joining other riparians in negotiating a basin agreement (e.g. Nile) or only selectively participating as an observer (e.g. Mekong). It appears that objective or “paper” benefits (as projected in the many studies on regional cooperation or integration e.g., Feitelson and Haddad 1998; Sadoff and Grey 2002; 2005) are only the starting point. In other words, benefits are necessary, but they are not sufficient to induce cooperative action.

There is no one solution for initiating cooperation – each river basin is unique. It is difficult to write prescriptions for how the cooperative process may begin. However, there are underlying principles for how cooperation can be enhanced. In this paper, we attempt to illuminate some techniques of initiating the cooperation process in a basin with little to no cooperation that development partners (defined in this paper as governmental organizations, intergovernmental organizations or non-governmental organizations that may lend political and/or financial support) may use.

We attempt to answer the following questions:

1. By which practices might development partners best design and implement collaborative projects in their absolute earliest stages?

2. How well do the steps for initiating cooperation mentioned in literature (data exchange, scientific collaboration) work in practice?

We begin by discussing various barriers that countries may have that inhibit them from engaging in cooperative processes. We also discuss strategies that development partners may use on how to improve cooperation. Next, we describe our process on selecting case studies in which nations are trying to facilitate transboundary water cooperation and our results of lessons learned from each of these cases. We follow that with a discussion of overall themes from the cases that we found.

### **Variables Influencing Cooperation**

The purpose of this section is to review the various issues that countries weigh before committing to cooperation, to review concepts that have been suggested in academic literature as agents in fostering cooperation, and to define the role that development partners may play in the process. Before this is performed, however, we present a review of subject areas that countries and third parties have considered in past water cooperation endeavors. The factors include: perceived risk, enhancing cooperation, cooperation-inducing design, country drivers, pointers for partners, and Track I and Track II diplomacy.

#### *Perceived Risk and Barriers*

Perceived risk has been defined as the perception that an act of cooperation will expose the country to harm, will jeopardize something of value to the country, or will threaten the political future of individual policy makers (Subramanian, Brown, and Wolf 2012). It is a core consideration for

country decision makers; ideally, countries cooperate when there is more opportunity than risk and more benefit than cost (Figure 2.1).

If a country cannot find a way to compensate for or control risk, it may choose not to enter into a

cooperative agreement. Countries may also unilaterally develop projects

within their own territories to avoid the political intricacies posed by sharing resources (Wolf et al. 2005).

Subramanian, Brown, and Wolf (2012) developed five general categories of risk perceived by decision makers. The first category is the capacity and knowledge risk. This is where countries feared they would be at a disadvantage in negotiations, which manifested in two major ways:

- Countries perceived they had less negotiating capacity than their co-riparians.
- Countries perceived they did not have adequate or accurate information about the basin.

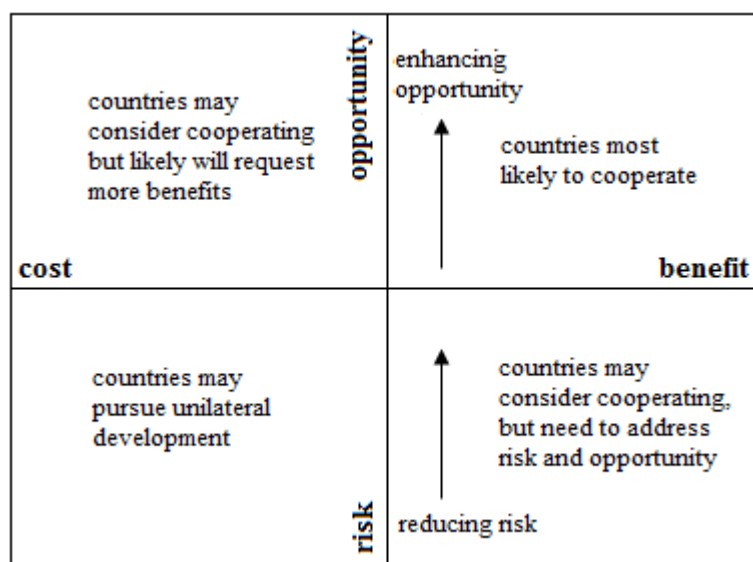


Fig. 2.1 Risks and opportunities for collaboration. Drawn from Subramanian, Brown, and Wolf (2012).

Decision makers experienced the second category, the accountability and voice risk, with the following:

- Fear the co-riparians, third parties, or regional institution may not deliver benefits
- Concern that the respective country's interests would not be adequately considered in joint decision-making processes
- Perception of a high probability that the regional institutional arrangement would not result in the flow of benefits

To a greater or lesser extent, all of the cases examined reflected the significant risk of sovereignty and autonomy. This risk occurs when a decision maker senses the danger of intrusion into the country's authority to make sovereign decisions. It addresses both of the following:

- The desire to have control over national development goals and related development of resources and infrastructure
- The right to make decisions independently

Another risk identified was the risk of equity and access:

- Fairness in any deal, regarding specified quantity or quality of water, benefit flows, or project costs
- Entitlement to use the river. Some countries viewed entitlement as the right to continuing with historic uses; others as gaining access to a river running through (or originating in) its territory; and yet others viewed it as attaining benefits in proportion to a country's relative size in (or percent contribution to) the basin.

The risk of stability and support had both direct national and personal implications. All countries in the study had to consider this, but it was a stronger consideration for countries with diversified and powerful stakeholders. The risk applied to both of the following:

- The implementability of an agreement due to the presence or absence of key stakeholder support
- A decision maker's positive or negative public image

In a study of transboundary water governance in western Canada and the United States, interviewees identified key barriers to cooperation, which included mismatches in governance structures and integration, as well as mismatches in intra-jurisdictional integration within countries. Other barriers included distinct and sometimes incompatible governance cultures and mandates; shortcomings in institutional capacity, financial resources, participation capacity, and data availability; social and spatial distance between parties; and psychosocial factors, including mistrust and a lack of leadership (Norman and Bakker 2005). Blomquist and Ingram (2003) also detailed differences in water use across boundaries; distinctions in ethnicity, culture and religion; and differences in economic, political, and/or military resources across boundaries as compounders of transboundary resource problems.

### *Enhancing Cooperation*



Political opportunity also helped to enhance cooperation in many cases. In a workshop focused on sharing and managing transboundary aquifers, researchers emphasized how the beginning of the cooperation process needs to begin with confidence building measures, especially joint monitoring and data sharing, and the establishment of conflict resolution mechanisms (Feitelson and Haddad 1998). Subramanian, Brown, and Wolf (2012) found examples of the perception of resulting national and regional political gains even trumped residual risk, in that some countries were willing to cooperate even with some risks given sufficient political opportunity. Third parties were also identified as those who could play important roles in supporting countries with risk reduction. Examples of this assistance included engaging with countries at an appropriate scale (e.g., the entire basin, sub-basin, or country level); conducting detailed risk assessments; designing risk reduction strategies, including financing and guarantees to target dominant risks; and periodically reassessing the risk situation, employing new strategies as needed.

### *Country Drivers*

This is the critical question for explaining integrated water resources management at the level of a river basin: what drives countries to enter into an agreement?

### *Internal Drivers*

The basic needs of food, water, and energy security for its people drives developing countries to search for solutions to achieve their goals through water development (Lautze, Giordano, and Borghese 2005; Subramanian, Brown, and Wolf

2012). This process begins with countries crafting national plans, at times relying on knowledge and financial assistance from development partners; these plans can then be followed with regional plans and partnerships. This is done because regional production centers of food and energy as well as regional markets are seen as an attractive means of meeting national goals and are often less costly for countries (Subramanian, Brown, and Wolf 2012).

Subramanian, Brown, and Wolf (2012) also stated that a sense of a nation's rights pervade the thinking on water management and cooperation in international waters. Because of this, countries stake claims on shared waters based on their respective sense of rights. Factors such as commonly held beliefs about the river flowing through one's country and legacies of use and management under legal and constitutional instruments shape how people perceive these rights. Culture and tradition related to water also often instill values that influence how rights are perceived. Norman and Bakker (2005) also mentioned more informal drivers for cooperation, including leadership, contacts, personal relationships and networks.

#### *External Drivers*

Regional institutions, shared culture and ethnicity, regional geopolitics, and regional thinking on norms, concepts, and best practices in sustainable development have been identified as regional influences (Lautze, Giordano, and Borghese 2005; Subramanian, Brown, and Wolf 2012). Norman and Bakker (2005) included legal obligations and bureaucratic transparency as minor drivers of water cooperation. Global trends can also exert influence on cooperation, given the history of ideas and

experience regarding international waters that countries and their partners contemplating cooperation can draw from.

The current status of regional and global geopolitics can either provide stimulus for or against cooperation. Examples discussed in the case studies include the breakup of Yugoslavia and dissolution of the Soviet Union for countries in the Aral Sea Basin. Norman and Bakker (2005) also mentioned how cooperation is facilitated by proximity.

A future driver of cooperation could be climate risks. However, the evidence for climate risk-cooperation is not forthright. De Stefano et al. (2010) examined the relationship between basins likely to experience change in variability due to climate change and the robustness of the basin institutions' capacity for dealing with variability. The results of the study found significant gaps in institutional capacities to deal with variability (especially in South America and Asia).

#### *Cooperation-Inducing Design*

In a review of several scholars, Blomquist and Ingram (2003) pointed to building institutional capital, achieving fairness and equity, and meeting needs that accord with cultural values on both sides of the border as important to success in transboundary water management. This is all well and good, but what can be done when none of these things exist? How is institutional capital built, for example?

Wolf (1995) listed general guidelines for cooperation-inducing implementation, using the pre-peace treaty Jordan Basin as his case study:

- Control of one's major water sources. It is necessary both to address past and present grievances as a prerequisite for market-driven solutions. As such, an initial "dis-integration" of the basin is recommended.
- Opportunities for cooperation may be hidden in the details of each entity's bargaining mix.
- Water basin development can then proceed from "small and doable" projects to ever-increasing cooperation and integration, remaining always on the cutting edge of political relations.

Perhaps the most applicable guideline for this paper would be the second. As demonstrated in the next section, negotiations over each riparian's "share" of water resources have stalled. Creative solutions will be needed to foster the first steps of cooperation.

One step that is often proposed for riparians in the nascent stages of cooperation is data and information exchange between riparians. Uitto and Duda (2002) cited the development of a science-based diagnostic analysis as an essential tool for, among other components, breaking issues into manageable parts with the aim of developing a strategic action program.

Strategic joint fact-finding among nations engaging in a project can serve as an important catalytic tool for developing political buy-in and fostering participation (Feitelson and Haddad 1998; Uitto and Duda 2002; Blomquist and Ingram 2003; Wolf et al. 2005). Joint fact-finding also lowers the perceived risks of cooperation, as it has low sovereignty infringement and lower transaction costs. Factors cited as promoting this

exchange of data and information include the presence of compatible needs, absence of legacies of mistrust, increasing water resources stress, perceptions of mutual benefit, external pressure and funding, comparable levels of institutional capacity, popular and political concern about water resources management, and functional formal or informal cooperative arrangements (Chenoweth and Feitelson 2001). Chenoweth and Feitelson (2001) mentioned, however, that this may not be useful as a first step in establishing more comprehensive cooperation depending on the situation. Also, it is important that data collection for its own sake may not be particularly useful due to a large amount of data that has been collected but never used (Van der Gun 2001).

#### *Track I and Track II Diplomacy*

While any project can be designed to be cooperation-inducing, it is necessary for nations involved to also go through diplomatic processes to agree upon a framework. Though it is not possible for third parties to create a conducive, political environment alone, they can provide incentives both directly and indirectly to cooperate through playing a brokerage role:

- Providing technical competence and examples of best practices
- Assisting in negotiation and mediation skills, including the provision of legal and other water experts
- Facilitating investments in transboundary settings (Phillips et al. 2006).

Four different strategies of third party support can be identified (Mostert 2005): Track I Diplomacy (cooperation); Track II Diplomacy (collaboration); Track III Diplomacy (transformation); and Continuing Support. Track I Diplomacy involves supporting the

conclusion of a formal agreement between riparian states, typically through mediation and facilitation. Track II Diplomacy tries to arrive at feasible development strategies on the ground through promoting informal dialogues, research and studies, and capacity building. Track III Diplomacy addresses policies at the national and local levels, which are typically at the root of transboundary water problems. Finally, financial support may be required to sustain cooperation, which third parties can provide for a river basin organization or loans for development projects.

None of these strategies are mutually exclusive; for example, Track II Diplomacy efforts may eventually lead to the initiation of more formal, Track I discussions (Qaddumi 2008). This occurred during the Israeli–Palestinian negotiations for the Oslo Accords, where Norway played an active role in elevating the talks from an informal bridge-building exercise to formal negotiations (Waage 2005).

This paper attempts to identify practices that may enhance the ability of partners to design and implement collaborative projects in the earliest stages. Here we have reviewed relevant literature in order to present what may lead a riparian nation towards, and away from, the cooperation process, as well as approaches in program design. In the following section, we detail our criteria for transboundary project and case study selection, in which we identify lessons and recommendations based upon reports regarding project successes and failures.

## **Methods**

In this section, we describe the initial identification and filtering process for the list of transboundary projects from which the case studies were selected, as well as the

criteria we used for case study selection and evaluation. The previous section reviewed variables that development partners weigh as they deliberate on entering cooperative processes. We now explain the methods we used to test our argument.

### *Transboundary Project Selection Criteria*

The first task was identifying potential case studies. As previously noted, we culled information from Oregon State University's Transboundary Freshwater Dispute Database (TFDD) to create a database of all transboundary water resources projects (both surface and groundwater) that had multinational participation, either official or unofficial. The TFDD includes 315 projects identified as cooperative projects between two or more riparians on international waters.

To determine whether these 315 projects involved official or non-official cooperation, we investigated the involvement of governments in these projects. Of these projects, 80 had non-official cooperation, 232 had official cooperation, and three had both official and non-official cooperation. We catalogued details of the most relevant projects and organized each transboundary water project into a spreadsheet, listing the basin name, project name, participating countries, level of cooperation (official or non-official), type of cooperation, principal issues, date of the project, description of the project, project tasks, and the source of information.

The type of cooperation was designated based upon the desired outcome of the collaborative effort. Questions asked to determine the type of cooperation are as follows: What type of change in the river basin was targeted? Was the project primarily an effort to improve the economic capability of the region, or was the project an effort

to preserve, or conserve, some natural resource and therefore largely an environmental initiative?

The type of project was divided into IGO, NGO, or GOV depending on whether the initial agreement or project plan included official governmental agreements and/or participation. In the event that the project was largely funded and initiated by a non-profit, the designation NGO was assigned. If intergovernmental organizations such as the United Nations was largely involved and some form of intergovernmental panel or group was formed, the designation IGO was assigned to the project. If a government funded the majority of the project, the project was given the designation GOV. There were 128 projects in the IGO category, 94 projects in the NGO category, and 68 projects in the GOV category.<sup>4</sup> Thirty-five projects did not have any information regarding its funding sources, and were therefore eliminated.

The tasks and/or goals of the projects were usually sourced from some type of project plan where possible. If the tasks were already completed, then we updated information on each project to reflect both current and original goals.

We then refined the database to select our ten case studies, using the criteria described below.

#### *Case Study Selection Criteria*

We then selected 10 case studies (Table 1) that would have direct implications for a pilot project that have commenced project operations within the last 15 years. In

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<sup>4</sup> It should be noted that four projects were categorized as both NGO and IGO, four projects were categorized as GOV and IGO, and one project was categorized as GOV and NGO due to the fact there were entities from multiple categories funding these projects.



order to make sure our cases were applicable, we based the selection on the following filtering criteria which operationalize our research questions:

*Criterion #1:* Funding exclusively or primarily from outside sources, for example, donor or NGO

*Criterion #2:* The inclusion of non-official<sup>5</sup>, or Track II<sup>6</sup>, stakeholders in project design and implementation

*Criterion #3:* Absence of formal diplomatic relations between or among riparians nationwide

*Criterion #4:* Project design to include at least the possibility of enhancing hydropolitical relations.

The first criterion used to trim the list of 315 transboundary projects was whether the project involved official funding and sponsorship or was largely the effort of a non-profit, intergovernmental organization or other NGO (Criterion #1). Removing the projects involving outside government funding and sponsorship culled the list to 222 possible projects. This was deemed most important, due to the purpose of this study of finding best practices applicable for development partners. Similarly, the entries were then narrowed to those projects where the tasks and activities of the project involved stakeholders in the region and were meant to promote change at a local or regional level (Criterion #2). For example, development of the Zamorano project (officially, The Zamorano Pan-American Agricultural School) between Honduras and Nicaragua in the

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<sup>5</sup> This refers to non-official cooperation. Non-official stakeholders are those who are apart from the formal practice of their governments (Joesoef 1977).

<sup>6</sup> Track II refers to a type of diplomacy that tries to arrive at feasible development strategies on the ground through promoting informal dialogues, research and studies, and capacity building, as opposed to Track I, formal diplomacy (Mostert 2005).

Choluteca River Basin in 1948 resulted in a collaborative institution of higher education with the intention of enacting social, economic, and environmental changes.

The project list was then narrowed down by Criterion #3: riparians that either had no relations, or the relations for which had recently warmed. An example of a setting where relations are comparatively recent is Eco-TIRAS, an organization formed in 2004 that promotes cooperation between Moldova and the Ukraine—two countries whose relations were less than 10 years old.

All projects selected sought to improve the hydropolitical relations within the transboundary region, meaning, the project design has to actually consider what the current hydropolitics are, and how the project influences hydropolitics (Criterion #4). We also selected cases from diverse locations, especially water-stressed areas, because those project designs might be more relevant to a water-stressed basin.

As all of the criteria could not be met by most projects (e.g., only six of the ten cases had both sources of funding that were primarily or exclusively from outside sources AND stakeholder involvement), we selected cases that came the closest to meeting all four criteria, placing emphasis on Criteria #1 and #2.

Table 2.1. Case Study Selection Criteria Matrix. The 10 projects: 1. Aquifer Management in South America (2003-07. Argentina, Brazil, Paraguay and Uruguay); 2. Biodiversity Conservation in South America (2003-04. Bolivia and Peru); 3. Aquifer Protection in North Africa (2003-06. Algeria, Libya and Tunisia); 4. Water Management System in the Southern Balkans (1998-2001. Greece and Bulgaria); 5. Regional Data Water Banks in the Central Middle East (2002-present. Israel, Jordan and Palestinian Authority); 6. Climate Change Modeling and Stakeholder Preparedness in East Africa (2000-06. Kenya and Tanzania); 7. Reducing Transboundary Degradation in the Caucasus (2009-present. Armenia, Azerbaijan, Georgia and Iran); 8. Improving Basinwide Relations in the Middle East (2008-11. Iraq, Syria and Turkey); 9. Improved Management of Water Resources in Central Asia (2008-present. Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan); 10. Creating a Transboundary Water Commission in Central Asia (2003-04. Kazakhstan and Kyrgyzstan)

### *Classification of Transboundary Water Cooperation*

The riparian relationships presented in each case study was classified according to the Transboundary Waters Interaction Nexus (TWINS), as described by Zeitoun and Mirumachi (2008). This classification has four groups: Low Conflict – High Cooperation, Low Conflict – Medium Cooperation, Low Conflict – Low Cooperation, and Medium/High Conflict – Low Cooperation (see Table 2 for more details). The characterizations reveal three types of interactions: positive, neutral, and negative. Positive interaction is defined as interstate interaction that generally tends to meet the other actors' interests, and contributes to improvement or sustained relations at the broader political level; neutral interaction is defined as interactions which may have no inherent effect on the broader political context; and negative interaction is defined as interactions inducing a significant degree of resentment with one or more actors, thereby negatively affecting the broader political context (Zeitoun and Mirumachi 2008).

Table 2.2 Types and Faces of Transboundary Water Interaction (A First Approximation). Dashed lines indicate fuzzy frontiers – there is overlap between each and every category. IWL = international water law (1997 UN Convention on the Non-navigational Uses of Transboundary Watercourses); RBO = river basin organization. Source: Zeitoun and Mirumachi (2008).

Characterization of Interaction nexus (TWINS)	Types of Interaction	Examples of Interaction	Potential Driving Forces (non-exhaustive)
Low Conflict – High Cooperation	[positive interaction] Cooperation on equal terms; Cooperation across a broad range of issues; Tensions reduced through deliberative processes	Putting in place and exercising principles (i.e. equitable use, no harm); Creation of transboundary regimes; Negotiation of a treaty based on IWL; Conclusion of an effective treaty (Kistin)	Benefit sharing / expanding the pie  Reduction of environmental uncertainty  Economic / Developmental Goals
Low Conflict – Medium Cooperation	[neutral interaction] Narrow cooperation (cooperation on select issues); Token cooperation; Mild verbal expressions of Conflict	Joint pollution management; Joint infrastructure; Benefit-sharing based on agreements; Creation of RBOs	Issue linkage  Mutual distrust  Improvement of international reputation
Low Conflict – Low Cooperation	[neutral interaction] Minimal or no interaction; Self-interested cooperation; Tactical functional cooperation; Unstable cooperation	Minor information exchange; Technical commissions or meetings	Sharing of resources  Changes in power symmetry
Med/High Conflict – Low Cooperation	[negative interaction] Securitised Conflict; Coercive Cooperation; Dominative Cooperation; Violent Conflict	Contained conflict; Negotiation of treaties not based on IWL; Resource capture; Unilateral environmentalism (Fischhendler)	Control of resources

### *Case Study Evaluation*

Each of the case studies selected had in-depth project reports that described its objectives, successes, challenges, and lessons learned. From this information, we identified elements of the projects that were deemed successful by the project reports and organized them into four categories: jurisdiction, project design, stakeholders, and

negotiating. These lessons and recommendations gathered from the project descriptions are described in greater detail in the discussion and conclusion sections, respectively.

## **Results**

This section presents a brief summary of each case study. A more detailed view of each case study will be available in an online appendix. Table 2 provides an explanation for how each case matches the criteria outlined above.

### *Aquifer Management in South America*

The Guarani Aquifer Program is preventative in character—anticipating potential problems associated with future expansion in the use of the Guarani Aquifer groundwater for public water—supply, hydrogeothermal applications and supplementary irrigation, and with significant land use changes that could impact aquifer recharge rates and/or quality. This project was launched in May 2003 by Argentina, Brazil, Paraguay and Uruguay under the supervision of the World Bank, coordination of the Organization of American States (OAS) and with support of the International Atomic Energy Authority (IAEA). Because of each nation's projected use, potential conflict could occur due to excessive pumping in certain areas and a lack of aquifer protection for pollution in aquifer recharge areas.

The Guarani Aquifer Project completed a full inventory of production boreholes in the Guarani Aquifer System. The Project also made significant efforts to improve deficiencies in groundwater regulations and/or tools in all four countries. Another success mentioned by Foster et al. (2009) is that the Guarani Aquifer Project addressed

the “lack of adequate common understanding” about the Guarani Aquifer System. However, significant concerns about the institutional capacity for enforcement of groundwater regulations still remain. There also has been reluctance or difficulty in retaining the services of the Pilot Project Facilitators, which Foster et al. (2009) explain is “critical to continuity and effectiveness” of the projects. Foster et al. (2009) also mention that continuing the further development and operation of the information system and regular exchanges of scientific data and management experiences should be future priorities. The riparians preferred creating a Steering Council instead of a semi-independent “Transboundary Guarani Aquifer Commission.” This was due to its implied high transaction costs and the risk of the Commission being out of touch with national and state groundwater issues, capabilities and procedures (Foster et al. 2009).

#### *Biodiversity Conservation in South America*

The project, “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,” has focused on practical lessons learned from lake basin management efforts around the world, 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. This project aimed to restore biodiversity and improve the population of native species residing within the Lake Titicaca-Poopó Basin (TDPS). The

project was designed to deal with the global loss of the TDPS biodiversity. In order to accomplish this, central actions included:

- Demonstrating sustainable techniques for the management of habitats and endemic endangered species through pilot projects;
- Increasing capacity of the stakeholders and local governments; and
- Strengthening of the management of the protected areas.

Also, a plan for the management of biodiversity to frame the management of protected areas was to be elaborated upon (Revollo, Lieberman Cruz, and Lescano Rivero 2006).

The project had a cost-benefit policy geared to face the global loss of the biodiversity in the TDPS system, which helped to demonstrate sustainable techniques for the management of the habitats and the endemic endangered species through pilot projects (Revollo, Lieberman Cruz, and Lescano Rivero 2006).

#### *Aquifer Protection in North Africa*

The project for the Transboundary Aquifer System of the Northern Sahara (Algeria, Libya and Tunisia), Protection of the North West Saharan Aquifer System (NWSAS) and Related Humid Zones and Ecosystems, has as its objective the protection of this critical resource, and in particular of the recharge areas and humid zones and ecosystems related to the aquifer. It includes two complementary components: (1) improving the knowledge of the aquifer and related ecosystems and (2) implementing a consultation mechanism at the hydrogeologic basin level. At the time of the project's inception, Sahara groundwater's had been intensively exploited by Algeria and Tunisia for fifty years, and more recently, with increased use from Libya. Over 85% of the water



drawn from the NWSAS is used for agriculture; each government anticipated an expansion of agriculture in coming years, yet wanted to develop it sustainably “if the relevant information for decision-making is available” (GEF 1999, p. 16). The project is made up of two elements: updating the evaluation of the water resources in the NWSAS, and implementing a consultation mechanism that could be used at the basin level (GEF 1999).

Three models of the NWSAS have been constructed and calibrated. The study of the piezometric network has been completed and validated. Water demand, and projections, has been evaluated, as well as the efficiency of the irrigation modes. The cartography of salty waters and of wetlands has been made, as well as national and synthesis reports analyzing the causes and distribution of salty-soil zones. The wetlands have also been inventoried “in an exhaustive way” in each country. A GIS-connected database has been “complemented and enhanced” and dedicated databases have been established in the three study zones. A geographic server that allows cartographies of aggregate data has been developed. Perhaps most significantly, the three ministers of water signed a formalized agreement that creates a permanent Consultation Mechanism for the NWSAS. The studies related to understanding the exchanges between the Chotts/Sebkhas and the underlying aquifers “have been initiated but not completed” (Puyoô 2007, p. 2). At the time the report was issued, though, the water quality monitoring network had not been put in place. The analysis of the phenomena of water level rises in the surface aquifers had also not been conducted. Also, the link modes between the GIS Data Base and local databases had not been clearly established.

Stakeholder involvement was limited during the project, though it “should be increased for downstream activities” (Puyoô 2007, p. 57).

#### *Water Management System in the Southern Balkans*

The System for Water Monitoring and Sustainable Management Based on Ground Stations and Satellite Images (WATERMAN) Project was implemented in the Struma River Basin, which consists of Bulgaria, Greece, and Macedonia. The project’s aim was to improve monitoring the Struma River Basin, to control and forecast water quantity and quality, and to create a decision support system to make objective management decisions on the river. Before this project’s implementation, there were no bilateral agreements that were operational.

Cooperation between the partner teams “was very fruitful,” as collaboration and transfer of knowledge took place from each team to all of the other teams, and was slated to continue in future projects (WATERMAN 2001). Some of the project’s successes include developments of various models and databases for the Struma River Basin as well as many other technological advances. The main problem of the WATERMAN project was the collection, detection and pre-processing of data. This was due to data being published in annuals and not provided in digitalized form making it very difficult to pre-process the data needed (WATERMAN 2001).

#### *Regional Water Data Banks in the Central Middle East*

The Regional Water Data Banks Project (Project EXACT), a project of the Multilateral Working Group on Water Resources, is composed of two representatives from each of the Core Parties (Israelis, Jordanians, and Palestinians) and from each of

the Donor Parties (currently composed of the United States, European Union, and The Netherlands). The Project consists of a series of actions to be taken by the Core Parties to foster the adoption of common, standardized data collection and storage techniques, improve the quality of water resources data collected in the region, and to improve communication among the scientific community in the region.

Some of the successes of this project include:

- hundreds of hours of training for both water managers and field technicians;
- donor parties have assisted the Core Parties to improve their groundwater, surface water, water quality, and meteorological monitoring networks, as well as field data-collection techniques;
- a pilot real-time monitoring system for hydro-meteorological data measurements, transmission, processing, storage, and interpretation was being implemented;
- mobile laboratories for water quality field equipment for each party.
- the Parties developed a joint database to store, process, and analyze rainfall intensity data;
- an inventory of wastewater-related concerns was completed; and
- “effective and continuing communication channels” have been established among Core Party participating agencies (EXACT 2002).

The project goal had not been fully achieved by the end of 2010, as water treatment plants and artificial recharge trials were still in progress (EXACT 2011). There was also frustration on the part of many of the participants that the project was not, by design, a vehicle for actually resolving any of the issues at conflict, such as water rights

and allocations and water quality issues. Also, Syria and Lebanon refused to participate in any of the multilateral working groups, meaning that a comprehensive settlement of the conflicts related to the Jordan or Yarmouk Rivers is precluded from discussions (Wolf and Newton 2008).

#### *Climate Change Modeling and Stakeholder Preparedness in East Africa*

The Pangani River Basin Management Project (PRBMP) is generating technical information and developing participatory forums to strengthen Integrated Water Resources Management in the Pangani River Basin of Kenya and Tanzania, including mainstreaming climate change, to support the equitable provision and wise governance of freshwater for livelihoods and environment for current and future generations.

From reading the PBWB/IUCN *Future of the Basin* report, it appears that this project was a successful first step in gathering and disseminating knowledge about the present and future conditions of the basin across both countries. But, this project was delayed multiple times due to attempts to obtain acceptable climate-change and other data. This caused the project to extend over several years with gaps in time between activities. The *Summary Report* writers state that a preferable plan would have been to have a sequence of shorter projects with well-defined end points (PBWO/IUCN 2009).

#### *Reducing Transboundary Degradation in the Caucasus*

The immediate objectives of the project “Reducing Transboundary Degradation in the Kura-Aras Basin” are: (i) to foster regional cooperation; (ii) to increase national and regional capacity to address water quality and quantity problems; (iii) to make noticeable improvements to water quality/quantity at some points along the river; (iv)

to develop sustainable financial and institutional arrangements for long-term management and protection of the rivers; (v) and to promote changes in the economic sectors which cause pollution, water shortages and habitat degradation.

The project had a Qualitative Stakeholder Analysis (SHA) that was considered by the writers of the final report because it “served as key input for the Technical Diagnostic Assessment and technical task team (UNDP/BRC 2009, p.2). The Quantitative SHA was also considered to be successful overall, despite an inability to obtain complete survey data from Azerbaijan and Iran due to “trepidation about project activities” (UNDP/BRC 2009, p. 4). Other successes drawn from the project by March 2007 include:

- Strengthening the regional network of technical experts working on groundwater issues. The regional meeting was the first time many of the experts had met since the breakup of the U.S.S.R.
- Three national reports and a regional report on groundwater have been completed.
- An initial demonstration project document has been produced and reviewed for the Alazani–Agrichay (Georgia–Azerbaijan) transboundary aquifer.
- An initial project document was being prepared, along with possibilities of development of a demonstration project in Samtskhe–Javakheti (Georgia–Armenia) (UNDP/BRC 2009).

It was found that the groups most hesitant to participate in the Quantitative SHA were those in higher government positions (UNDP/BRC 2009). Those in ministries as well as those in high positions in industry were found unable or unwilling to provide full responses to the questions. In some cases, the subjects felt that they were not

permitted to participate in the survey without prior approval, despite assurances that their responses would be confidential. Other challenges included:

- A lack and/or absence of valid and reliable data;
- No capacity to undertake integrated management of water resources at the basin level. It is also unclear whether it is implementable in the short to medium term (UNDP/BRC 2009).

Another challenge is that all riparians within the basin did not participate. Turkey was absent in this program.

### *Improving Basinwide Relations in the Middle East*

In May 2005, nine founders created the Euphrates Tigris Initiative for Cooperation (ETIC) as a new approach for sustainable cooperation on regional development. The goal of ETIC is to establish cooperation for economic, technical and social sustainable development within the Euphrates and Tigris region through mobilizing collective expertise, catalysing processes and developing appropriate partnerships to encourage riparian cooperation and development through Track II Diplomacy.

Since its inception, ETIC has held several meetings, workshops and seminars (PSD 2007, n.p.). However, civil unrest in Syria undoubtedly complicates further basinwide cooperation at this point. It appears that creating opportunities for dialogue and workshops amongst the three riparians has been successful, though there seems to be no mention of pilot projects, stakeholder involvement or improving public awareness taking place.

*Improved Management of Water Resources in Central Asia*

This project takes place in one of the world's most infamously mismanaged water-stressed areas – the Aral Sea Basin. This project also involves many riparians that have formed new diplomatic relations after the breakup of the Soviet Union. The project had three components: (i) an improved knowledge base for the Amu Darya, (ii) strengthening the institutional framework and institutionalization of regional cooperation for water resources, and (iii) support to the Chu-Talas Joint Rivers Commission.

The Technical Assistance provided in this project is claimed by the ADB as its first regional initiative in Central Asia that helped to depoliticize regional water discussions and achieve positive results (ADB 2009). Representatives of all the Central Asia states resumed water discussions suspended since 2002 under the second component. Seventeen working group meetings were also held to draft a new Syrdarya Agreement, and stakeholders also started working on two new interstate agreements; one on the use of water and energy resources in the Amu Darya Basin, and one on database and information exchange (ADB 2009). Three training programs were conducted to satisfy the third component, which were rated satisfactory (ADB 2009). Some challenges included delays in implementation of the Technical Assistance, due to poor performance of an international consultant. There also was “less than adequate” ADB staff involvement due to the Technical Assistance requiring day-to-day coordination with stakeholders in the region, which proved difficult to achieve from ADB headquarters.

### *Creating a Transboundary Water Commission in Central Asia*

The project, entitled “UNECE, UNESCAP and OSCE Project: Support for the creation of a transboundary water commission on Chu and Talas Rivers between Kazakhstan and Kyrgyzstan,” is aimed to assist Kazakhstan and Kyrgyzstan in making the "Agreement on Utilization of the Water Facilities of Interstate Use on the Chu and Talas Rivers between the Government of the Republic of Kazakhstan and the Government of the Kyrgyz Republic of 21 January 2000" operational.

In the Final Project Report, the authors state that “there existed no comparable cooperative projects in Central Asia at the start-up of the project and this cooperation can therefore be seen as a nascent initiative in that direction” (p. 6). This project was also seen as progress towards coordinating water resources management between these two countries “in a methodological and stable manner” (OSCE 2006, p. 6). No significant challenges in implementing the project were mentioned in the Final Project Report.

### **Discussion**

The following discussion is built mostly on what has been learned from our in-depth qualitative analysis of the chosen case studies. The review has highlighted the need for further discussion around four distinct themes: jurisdiction, project design, stakeholders, and negotiating.

#### *Jurisdiction*

A balance of autonomy and cooperation within a project design can foster success where each riparian is allowed to assume responsibility for the continuation of



one of a project's primary activities, as was seen in the Aquifer Management in South America case. While each country's interdependence on a shared resource must be acknowledged, each country's autonomy must be respected. In order to respect this, it was advised that riparians should not be pushed toward ceding authority to a basin-wide (or aquifer-wide) agency for the Aquifer Management in South America and Improved Management of Water Resources in Central Asia cases. These lessons culled from the case studies align with Subramanian, Brown, and Wolf (2012)'s writings about the risk of sovereignty and autonomy when nations consider initiating cooperation. The autonomous nature of the riparian teams in carrying out activity tasks can help bridge gaps in the collaboration process. Since government officials in the riparian countries are the decision makers in any action, however, they should be informed about watershed activities and recommendations, which was also stressed by Norman and Bakker (2005).

When it comes to timing, it is never too early to get started with the cooperation process. No matter when the process begins, there is always some existing knowledge of the river and its people, and this knowledge can inform stakeholders and decision makers. Plus, implementation of an agreed desired river state and environmental flow is a long and complex task. Time is needed to help alleviate what Subramanian, Brown, and Wolf (2012) coined as the capacity and knowledge risk. Governments, scientists, and stakeholders (including local subsistence users of the river) must work together as a team to achieve truly sustainable use of the river; this speaks to Blomquist and Ingram

(2003)'s highlighting of building institutional capital as a key element in transboundary water management.

The creation of a longer term, stable and mutually beneficial framework for cooperation, such as a bilateral commission between two riparians, can foster more prudent mechanisms for regional governance. Specifically, the establishment of a basin commission is cited as a motivator for other international organizations to provide assistance to the basin water authorities in the Creating a Transboundary Water Commission in Central Asia case.

### *Project Design*

Along with respecting each nation's autonomy in jurisdictional matters, giving each project partner responsibility for certain activities allows for more ownership within each of a project's tasks. Building a scientific team from different partner nations appears to be a very successful activity, as noted in the Water Management System in the Southern Balkans and Improving Basinwide Relations in the Middle East cases, allowing for knowledge transfers between teams and creating a building block for cooperation in future projects. This was one of the elements of the cooperation process cited by Feitelson and Haddad (1998) that were recommended for successful cooperative efforts.

For initial cooperative activities, a basin-wide integrated flow assessment should be done at the earliest possible stage of water resources planning, so that a fair trade-off between development and river protection can be agreed upon, as noted in the Climate Change Modeling and Stakeholder Preparedness in East Africa case. This should

then guide all future water-management decisions for the river. Data sharing also appears to be a good starting point for fostering cooperation among riparians. These initial cooperative activities correlate with Feitelson and Haddad (1998)'s and Uitto and Duda (2002)'s writings.

This act of building a basin-wide network of senior and young scientists may be used in future activities, as noted in the Water Management Systems in the Southern Balkans case. Again, this is an example of building institutional capital, mentioned by Blomquist and Ingram (2003) as important to success in transboundary water management. Once this network is established, using this spirit of cooperation among the riparian experts is an effective means of producing a valuable source of data.

Effectively managing change to physical components of a river system requires equal consideration of the social system. If the flow regime of a river changes then the river ecosystem will change in response. People might feel positive and/or negative impacts. To manage the change ecological and social issues in a structured and agreed way need to be automatically included into water-resource management plans so that the future implications can be understood and an acceptable future chosen. Having these socio-economic and environmental syntheses, as well as having related workshops and the setting up of national steering committees, was cited as instrumental in broadening the scope of the project stakeholders by involving ministries which were not part of the Aquifer Protection in North Africa project's initial decision-making process. This was also recommended in the Climate Change Modeling and Stakeholder Preparedness in East Africa case.

## *Stakeholders*

Consultation with a “wide array of stakeholders” could reveal further scenarios of interest to the basin population at large, as was found in the Aquifer Protection in North Africa and Climate Change Modeling, Stakeholder Preparedness in East Africa, and Reducing Transboundary Degradation in the Caucasus cases. It was found that a qualitative stakeholder assessment may be a key to the project’s success. It may enable the project to obtain an initial assessment of stakeholder concerns, especially those who are underrepresented or not represented in official capacities. Performing a qualitative stakeholder assessment, especially with traditionally underrepresented groups, provides a significant amount of support for transboundary diagnostic assessment development in the Reducing Transboundary Degradation in the Caucasus case. Local stakeholder involvement has the potential to be a strong guiding force in the project’s development and implementation. Of course, it may be advisable to clarify with governments and hosting organizations the nature of a qualitative stakeholders’ assessment, so as to avoid misunderstandings and different expectations for this component.

In designing certain projects due consideration should be given to (i) stakeholders’ commitment and ownership to avoid implementation delays, (ii) engagement of mature international consultants with good record of regional experience to avoid promotion of blue-print solutions; and (iii) development of a longer-term vision to ensure consistent support, as was noted in the Improved Management of Water Resources in Central Asia case.

### *Negotiating*

The first task of water negotiations between particularly hostile riparians may be simply to get individuals together talking about relatively neutral issues, which could be part of what Wolf (1995) refers to as the ‘bargaining mix.’ Successful negotiations might include an eventual simultaneous narrowing and broadening of focus, to move from the neutral topics necessary in early stages of negotiation to dealing with the contentious issues at the heart of a water conflict. This was also cited by Waage (2005), when this occurred during the Israeli-Palestinian negotiation of the Oslo Accords. Concepts of integrated water management may also be included.

In attempts at resolving particularly contentious disputes, solving problems of politics and resource use is best accomplished in two mutually reinforcing tracks, cited in examples by Waage (2005) and Qaddumi (2008). Of course, Track Two dialogues lose much of their utility if there is no mechanism for feeding ideas generated into the main negotiating track.

### **Conclusion**

Our discussion has highlighted practices where development partners may play a role in designing and implementing collaborative projects in the earliest stages. Here, we examine the framework provided by Subramanian, Brown, and Wolf (2012) and discuss how the framework matches with the four categories discussed in the discussion. This section poses the answer to the questions posed at the beginning of the paper and closes with final recommendations drawn from lessons learned and project recommendations from the case studies.

We identified many successful design elements of projects that proved successful in case studies, including respecting autonomy of each participating riparian, creating and supporting basin-wide networks of scientists, considering both the physical and social components of basin management, consulting with (and including ideas by) stakeholders in project design and implementation, and creating Track Two dialogues. We have also found that our findings from this selection of case studies have aligned with previous scholarly thinking on what constitutes successful transboundary water management. However, we must qualify our results in saying that each river basin offers unique challenges and problems and no one combination of product design strategies may fit the needs of all riparians. Also, this paper's focus does not extend to analyzing the events after these initial cooperative projects may be completed.

We discussed in our jurisdiction sub-section how respecting riparians' autonomy during cooperative processes can foster success. This lesson align with Subramanian, Brown, and Wolf (2012)'s writings about the risk of sovereignty and autonomy when nations consider initiating cooperation.

Our discussion described how in designing the projects, allowing each partner to garner responsibility for project activities allows for more ownership and allays the risks of accountability and voice and sovereignty and autonomy, as identified by Subramanian, Brown, and Wolf (2012). Other elements of designing a project that we suggest, including basin-wide integrated flow assessments and building a basin-wide network of senior and young scientists, address Subramanian, Brown, and Wolf (2012)'s capacity and knowledge risk.

We identified that consulting a diverse group of stakeholders may also serve as a useful tool in project design and implementation. This allays Subramanian, Brown, and Wolf (2012)'s risk of stability and support. Finally, in negotiating, we pointed towards getting individuals together to speak about relatively neutral issues and negotiating in two mutually reinforcing tracks. These two points address Subramanian, Brown, and Wolf's risk of accountability and voice, allowing for opinions to be heard and added into project design.

Using the framework of Subramanian, Brown, and Wolf (2012), we close with offering some recommendations with how development partners may assist riparians in project design:

- First, define the juridical situation of the basin (Revollo, Lieberman Cruz, and Lescano Rivero 2006). Determining who has jurisdiction and over what areas must be made clear. This recommendation is drawn from the Biodiversity Conservation in South America case, but the recommendation also appears to be salient in the Improved Management of Water Resources in Central Asia case. This recommendation addresses Subramanian, Brown, and Wolf (2012)'s risk of sovereignty and autonomy.
- It is also important to carry out basic studies of the basin in a joint basis with other riparians (Revollo, Lieberman Cruz, and Lescano Rivero 2006). Keeping riparians involved allows for all parties to validate the information and creates buy-in among cooperative partners. Designing the studies in a joint way and realizing a system of geographic information to define the positive or negative

aspects that may happen in the future addresses Subramanian, Brown, and Wolf (2012)'s risks of capacity and knowledge, accountability and voice, and equity and access. It would be advantageous to choose national team members who could take part in some way in any specialist studies, even if only in an advisory capability. This recommendation is also drawn from the Biodiversity Conservation in South America case, but this concept was also implemented with success in the Water Management System in the Southern Balkans, Climate Change Modeling and Stakeholder Preparedness in East Africa, and Improving Basinwide Relations in the Middle East cases.

- If necessary, riparians can turn to international assistance from partners to help ensure a smooth process. This is particularly useful in areas where there are high political tensions, as was applicable in the Regional Data Water Banks in the Central Middle East, Reducing Transboundary Degradation in the Caucasus, Improving Basinwide Relations in the Middle East, and Improved Management of Water Resources in Central Asia cases. Allowing for international assistance may also address Subramanian, Brown, and Wolf (2012)'s risk of stability and support.
- After the basic studies are completed, elaboration of a Master Plan to determine the handling of the water resources and its use should be the next step. This was recommended by Revollo, Lieberman Cruz, and Lescano Rivero (2006) in the Biodiversity Conservation in South America case. Riparians are more likely to buy into the cooperative process after completing in a collaborative basic study of the basin together, as by this point, Subramanian, Brown, and Wolf (2012)'s risks



of capacity and knowledge and equity and access should be allayed. This increases the chances of riparians creating a more plan to manage shared waters, like in the Creating a Transboundary Water Commission in Central Asia case.

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### CHAPTER III. WATER RESOURCES DEVELOPMENT, INTERNATIONAL RIVER BASINS, AND TRANSBOUNDARY WATER LAW: ANOMALY OF THE COMMONS?

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#### **Abstract**

Although the costs and benefits of dam construction are generally borne by one country in national basins, absence or softness of legal frameworks in many international basins may increase the incentive for riparian countries to build dams since certain riparians may enjoy the benefits of dam construction while externalizing many of the costs. To determine whether the transboundary nature of river basins is associated with increased dam construction, and whether the existence of transboundary institutions offsets any such increase, this paper analyzes the extent to which i) the large dam construction rate in international watersheds differs from that of national watersheds, and ii) the rate and distribution of large dam construction differs between transboundary waters with and without agreements. Data on large dam locations, river basin boundaries, and international borders were collected, mapped in GIS and analyzed to determine dam construction rates in national and transboundary basins, and in transboundary basins with and without an agreement. The results indicate that large dam construction rates in national basins exceeds that of transboundary basins, and construction rates in areas covered by a transboundary water agreement exceed construction rates in areas not covered by an agreement. Further, it appears that agreement formation in transboundary basins enables relatively greater and more distributed development. These results indicate that dynamics of transboundary waters may be at odds with experiences in other common pool natural resources, and the existence of cooperative institutional frameworks on transboundary river basins may be linked to more equitable, mutually beneficial outcomes.

*Keywords:* Transboundary rivers; International freshwater agreements; Large dams; Unidirectional externalities.

#### **Introduction**

The 20<sup>th</sup> Century saw a surge in large dam construction with an estimated 45,000 large dams<sup>7</sup> built worldwide (World Commission on Dams 2000). The proliferation of large dams fundamentally changed the world's watercourses, and

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<sup>1</sup> Large dams are classified by the World Commission on Dams as dams with a height equaling or exceeding 15 m.

some 60% of the world's rivers have now been affected by dams and diversions (Ibid.). Dam construction has brought clear human benefits, especially in terms of irrigation, hydropower, and flood control, but it has also imposed clear costs to the environment as well as to human populations who have been directly displaced or whose livelihoods have been altered. In many cases, costs disproportionately accrue downstream, such as reduced flow for economic activities or ecological degradation of a river (Klaphake and Scheumann 2006).

Interest and investment in dam construction declined starting in the 1980s (World Commission on Dams 2000) but is again on the rise (Wang, Dong, and Lassoie 2014). Much of this interest, as well as the most promising opportunities for intervention, lie in transboundary river basins (McCartney 2007; Wang, Dong, and Lassoie 2014). New sources of financing for dam construction in these basins have come from China (Bosshard 2007) and the private sector (Merme, Ahlers, and Gupta 2014), whereas in the past financing would often involve multi-lateral lending institutions and/or the host government (Worm, Dros, and van Gelder 2003). Importantly, new financing sources may not necessarily require satisfaction of environmental and social safeguards associated with past lending. Therefore, receiving funds through new funding sources for dam construction may attenuate the need to mitigate externalities such as adverse downstream impacts. If benefits of dam construction accrue to the host country, but a good portion of environmental and human costs are passed on to downstream neighbors, there may be incentive for “over” investment and construction.

Broader notions related to common pool resources (e.g., Hardin 1968; Wade 1987; Ostrom et al. 1999; Dietz, Ostrom, and Stern 2003; Marothia 2003; Anderies and Jansen 2013) suggest that common access to a shared resource may lead to over-exploitation of that resource, but that this dynamic is mitigated by effective institutions. Perhaps most prominently, Hardin (1968) pointed to the common accessibility of natural resources as a contributor to overexploitation. Wade (1987) stated that people will not restrain their use of a common-pool resource without an external enforcer. Notably, however, literature on common pool resources also highlights how the presence of an accepted governing mechanism can reduce overuse and negative externalities. Ostrom et al. (1999), for example, stated that effective rules limiting access and defining users' rights and duties prevents overuse that ignores negative effects on others. Marothia (2003) described how institutions are an important variable for stemming the decline of common-pool resources. Dietz, Ostrom, and Stern (2003) asserted that absence of scale-appropriate, effective governance institutions jeopardizes natural resources and the environment. Finally, Anderies and Jansen (2013) said that institutions help mitigate the overexploitation of common-pool resources.

The nature of transboundary rivers are unique in common-pool resources in that externalities are unilateral; that is, one party generates externalities, affecting users downstream (Quiggin 2001). Externalities may be both positive and negative. Positives that may result in the case of unilateral externalities include, for example, when a landholder constructs a riparian buffer zone at their own cost to prevent or

intercept nutrient and sediment flows, this action generates ecosystem services that improves water quality both locally and downstream (Ibid.). This creates a dynamic whereby the downstream user benefits without any cost incurred. Nonetheless, examples of negative externalities due to unilateral upstream development (e.g.; reductions or alterations to river flow) are also fairly abundant. Daoudy (2009), for example, described how Turkey's Great Anatolian Project generates benefits for Turkey but leaves downstream countries with greatly reduced river flow during dam filling, and Hammond (2013) highlighted Ethiopia's plans to build dams that will result in less water for downstream countries.

A set of papers (Yetim 2002; Giordano 2003; Wolf 2007) has fueled speculation that the common property or "fugitive" nature of transboundary waters has accelerated dam construction – particularly in upstream countries. Yetim (2002), for example, described how the unilateral exploitation of transboundary waters can lead riparians to extract water from the watercourse at rates above average replenishment. Giordano (2003) stated that nations may have an incentive to overexploit certain transboundary water resources, because the benefits of use (e.g. irrigation, hydropower) accrue to one nation while the costs (e.g., reductions or alterations to river flow) may be passed on to other riparians. Further, Wolf (2007) noted how riparians of an international basin may at times implement water development projects unilaterally in order to avoid political intricacies of negotiation over use of the shared resource.



A riparian's location affects the degree to which it can internalize benefits and externalize costs. If a riparian is upstream, it is more likely that the riparian may build a dam where it can internalize most of the benefits and pass the costs downstream. Dinar (2006) found that side-payments frequently occur to offset this asymmetric, or "upstream-downstream," geographic relationship between upstream and downstream states. Dinar (2006) also pointed out, however, that upstream riparians tend to be at an advantage in river basins with more suitable dam locations.

Consistent with broader literature on common pool resources, presence of institutions in transboundary waters may offset incentives for unilateral exploitation of the shared resource and foster greater distribution of benefits. Sarker et al. (2008) posited that regulations, monitoring and imposition of penalties comprise the main instruments to mitigate adverse externalities issues borne by transboundary waters. Drieschova, Giordano, and Fischhendler (2009) described how international environmental cooperation may lead to positive-sum outcomes for the states involved, Fischhendler, Dinar, and Katz (2011) stated how international environmental regimes may be designed to internalize externalities and reduce transaction costs associated with cooperation.

In the context of this broader literature, this paper seeks to test if the pace of dam construction is in fact greater in transboundary basins, if the presence of institutions offsets that pace, and if dam construction is more concentrated in upstream countries of international basins given the ability of upstream countries to

externalize costs. More specifically, this paper compares dam construction in national basins, transboundary waters without an agreement, and transboundary waters with an agreement related to water scarcity, quantity, distribution, impoundment, and/or ecosystem maintenance/improvement in order to identify the extent to which the transboundary nature of river basins accelerates dam construction, and a cooperative transboundary framework attenuates dam construction. The paper further seeks to understand how transboundary agreements are associated with dam distribution within transboundary basins, and how findings vary over time and across regions. This paper responds to the following four questions:

1. Does the rate of dam construction in transboundary basins exceed that of national basins?
2. Does the rate of dam construction in transboundary water not covered by an agreement exceed that of transboundary waters covered by transboundary agreements?
3. What regional variation can be evidenced in dam construction rates in national basins, transboundary waters covered by agreements, and transboundary waters not covered by agreements?
4. ,How does the dam distribution in the presence of a transboundary water agreement differ spatially from the dam distribution in the absence of a transboundary water agreement?

Structurally, the next section (section II) presents the methods, which includes an explanation of document collection, classification and analysis. Results (section III) are then presented, followed by a discussion (section IV) that explores the degree to which the findings align with other common-pool resources literature. Finally, a conclusion section (section V) explores how the dynamics of transboundary waters may be at odds with notions of overexploitation of common-pool resources not governed by institutions.

## Methods

### *Data Compilation*

To explore relationships among geographical location of dams, the rate of dam construction, and the presence of agreements potentially affecting the rate of construction, the analysis required that three main pieces of data be collected: i) Data on large dams, ii) Data on river basin boundaries, and iii) Data on international agreements applying to transboundary waters.

### *Data on large dams*

Several databases were examined to determine the spatial and temporal distribution of large dam construction<sup>8</sup>. We used the Global Reservoir and Dam Database (GRaND), produced by The Global Water System Project (GWSP), as it contains the greatest number of georeferenced dams of any data set examined; this was critical for determining whether each dam was constructed within a transboundary basin and an upstream or downstream riparian.

### *Data on river basin boundaries*

We next obtained a global map of river basins (national and transboundary) into which georeferenced large dams could be classified. Several Geographic Information System (GIS) layers with river basin delineations were found to exist: i) Oregon State

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<sup>2</sup> We first examined the set of large dams listed in the International Commission on Large Dams (ICOLD) Register of Dams. The most comprehensive database on large dams, ICOLD lists some 37,641 large dams. Though it would have been preferable to use ICOLD's database given the number of large dams it contains, ICOLD's database fails to provide the coordinates of each dam—critical to mapping dams within river basins.

University's (OSU) Transboundary Freshwater Dispute Database (TFDD), ii) the International Water Management Institute's (IWMI) map of global basins, iii) the WaterBase database, and iv) the Global Runoff Data Center (GRDC). IWMI and WaterBase's databases were found to be incomplete, and OSU's database applied only to international basins. The GRDC data set was the most comprehensive. The shapefile provided by the GRDC was therefore spatially joined with the GRaND dataset in ArcGIS in order to enable classification of each large dam into a basin and country.

*Data on international agreements applying to transboundary waters*

To apply a set of international water agreements relevant to our analyses, criteria developed by Giordano et al. (2013) were applied to agreements contained in the Transboundary Freshwater Dispute Database (Oregon State University 2013). Criteria elaborated by Giordano et al. (2013) stipulate that transboundary water agreements should contain "provisions related to water as a scarce or consumable resource, a quantity to be managed, or an ecosystem to be improved or maintained"; however, global and regional agreements, as well as agreements focused on areas such as navigational rights, border delineation or fishing rights, and financial aspects of water-related projects should be excluded. Application of these criteria to the 688 agreements contained in the TFDD database (Oregon State University 2013) resulted in 226 agreements included in this analysis.

## *Data Classification*

### *Coding the dams*

We classified dams by basin, basin category (national, international), riparian position, and country according to their status in the year in which a dam was constructed. Dams in international basins were then classified by basin country unit (BCU). A BCU is defined as a portion of an international river basin contained within a single country<sup>9</sup>. We also classified dams by continent. Dams without a listed construction date (i.e., 405 dams) were excluded from analyses related to the timing of agreements, as the lack of a dam's listed construction date makes it impossible to ascertain whether the dam was built before or after an agreement was signed. The major driver for categorization at the scale of BCU was the fact that many agreements do not apply to entire basins but rather certain areas in basins. The scale of BCU allowed for more precise division of basins into areas covered versus not covered by agreements, so as to enable comparative analysis of dam construction in such areas.

### *Classifying dams according to agreement presence or absence*

We divided dams in international basins according into two additional categories: i) dams constructed in BCUs without an agreement, or in BCUs with an agreement but before the agreement was concluded, and ii) dams constructed in BCUs with an agreement. Dams completed the same year as the conclusion of a

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<sup>3</sup> For example, Egypt's area within the Nile River Basin would be one BCU, where Sudan's area within the Nile Basin would be another BCU, and so on. For any dam that was listed in two countries (i.e., the dam physically spans a river that serves as a border between two countries), each BCU was considered to contain  $\frac{1}{2}$  of the dam and assigned a value of 0.5.

transboundary water agreement were treated as being constructed without an agreement, as presumably the riparians would have been informed about the construction of the dam before the agreement was concluded.

*Classifying dams according to their position in transboundary basins*

Due to the labor-intensive nature of classifying dams according to their position in basins, analysis of dam construction rates according to geographic position (up, mid, downstream riparian) in transboundary waters was confined to 10 case study basins.

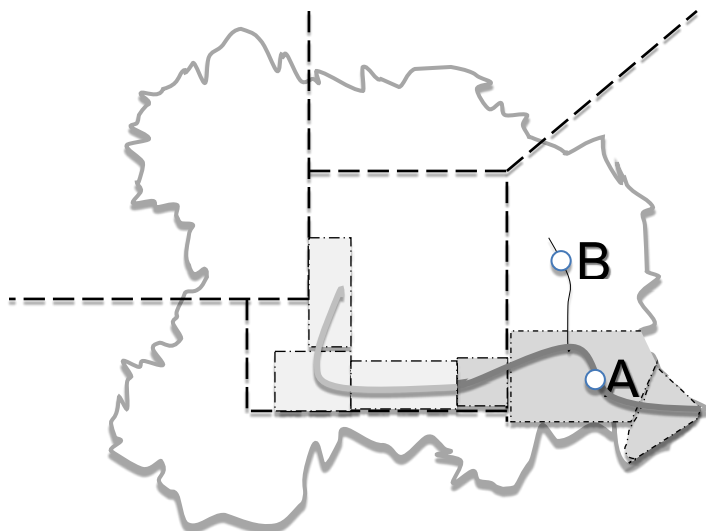
Criteria applied to select the 10 basins for analysis were as follows:

1. *Number of dams*: Basins with at least 10 dams were sought so as to enable sufficient depth of data for analysis.
2. *Number of riparian nations*: While the majority of transboundary basins have only two riparian nations, the number of nations in a basin can be as many as 18. Basins were selected to reflect a spectrum in number of riparians and diversity of geographic location.
3. *Basin configuration*: Transboundary basin configurations vary. Dinar (2006) identified three basin configuration types: through-border, border-creator, and partial border-creator. Selected basins fall into all three configuration types.
4. *Regional variation*: Efforts were made to avoid concentration of selected basins in one region (e.g., sub-Saharan Africa).

*Categorizing dams as up, mid, or downstream*

This paper adopts a framework of defining upstream, midstream and downstream areas based upon methods defined by Van Oel, Krol, and Hoekstra (2009). Portions of the river basin were determined to be “upstream”, “midstream,” and “downstream” by calculating a point’s “downstreamness” based on dividing a dam’s upstream area by the total basin area. Dam locations were mapped within sub-federal administrative borders (GADM 2012) and a river network layer dataset (Lehner, Verdin, and Jarvis 2006) to enable distinction between i) dams in a particular BCU located on a river’s main stem with inflows from upstream reaches of the basin (e.g., point A in Figure 3.1), and ii) dams in the same BCU located on a tributary which emanates in the same country (e.g., point B, Figure 3.1). The former (point A) was classified as mid or downstream, the latter (point B) was classified as upstream. Based upon the thresholds by Van Oel, Krol, and Hoekstra (2009), we defined the downstream portion as river segments in which 50-100% of the basin area lies upstream. The midstream portion of the river was defined as river segments in which 20-50% of the river basin’s area lies upstream of that particular river segment. The remaining area of the basin was defined as upstream.





**Figure 3.1.** Hypothetical basin displaying riparian position based upon “downstreamness.” The area in dark grey represents the downstream portion of the basin. The area in light grey represents the midstream portion of the basin. The area in white represents the upstream portion of the basin. Dashed lines represent country boundaries, while the dash-dotted lines represent sub-federal boundaries.

### *Normalization*

Normalization by area was necessary to offset the potential confounding effects of the different areas covered by national versus transboundary basins. In all analyses, total numbers of dams in national versus transboundary basins were therefore divided by the aggregate area (km<sup>2</sup>) of national basins and transboundary basins, respectively. We also divided the total number of dams in BCUs without agreements and BCUs with agreements, by the area of BCUs without agreements and the area of BCUs with agreements, respectively. For our analysis on dams by riparian position, we also divided the number of dams in upstream, midstream, and downstream areas by their respective areas.

### *Global analyses focused on the period 1950-2009*

The scope of analyses were delimited to years between 1950 and 2009 due to the fluidity of international borders in the world before 1950. This resulted in the inclusion of 4,923 large dams. It was possible to definitively identify all boundary changes for the 10 transboundary basins used in analysis of dam construction rates and riparian position, so we extended the time period for this final analysis from 1900 to 2009.

### *. Accounting for border changes*

Boundary changes that triggered a change in basin status were accounted for and incorporated into analyses<sup>10</sup>. A border database that delineated all of the international border changes since 1948 was used (Weidmann et al. 2010). A byproduct of these border changes is that certain basins have changed from national to transboundary and others have changed from transboundary to national. For example, the Volga River Basin (GRaND database) was completely within the U.S.S.R.'s borders until 1991, when the Soviet Union fragmented into several states that rendered the Volga River Basin international. With the dissolution of the Soviet Union and Yugoslavia, 21 river basins transitioned from national to transboundary and one transitioned from

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<sup>4</sup> Small outposts changing hands (e.g., Macau, Walvis Bay) and regions not recognized by a majority of nations (e.g., Transnistria in Moldova) were ignored. Basins that were transboundary prior to Malaysia's independence, i.e., between the Malaysian states of Sarawak and Sabah, were ignored due to small size.

transboundary to national<sup>11</sup>. If a dam was constructed at a time when a basin was considered national, our classification system coded that dam as being constructed in a national basin—even if that basin subsequently became transboundary. For example, the Volgograd Dam, constructed in 1958 in the then-national Volga River Basin, was considered a dam constructed in a national basin. Any change in the status of a basin was acknowledged in the first full year of its new status.

### *Data Analysis*

With data compiled and classified, a set of analyses were undertaken that responded to the core objectives of this paper. Specific analyses were designed to answer the four central questions posed at the end of the introduction. In addition, analyses were slightly expanded to investigate temporal changes in dam construction rates. Central questions are provided below with an explanation of associated methods.

*Does the rate of dam construction in transboundary basins exceed that of national basins?* We first determined dam construction rates in national and transboundary basins, normalized by area, and compared variation in development rates over time. To compare the rates of dam construction in national basins with international basins over time, we classified all transboundary dams by the decade (from 1950 to 2009) in which they were constructed for each river basin<sup>12</sup>.

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<sup>5</sup> Germany's Weser River Basin was transboundary during the country's partition following World War II and became a national basin after the reunification in 1990.

<sup>6</sup> One transboundary basin (Great Scarcies) was excluded from this analysis due to the absence of a specific date for agreement completion.

*Does the rate of dam construction in transboundary water differ due to the presence of an agreement?* We next investigated how the rate of dam construction in international basins is affected by presence of an international agreement. Dams constructed were summed by decade, and stratified into those constructed in a BCU covered by an agreement versus those constructed in a BCU not covered by an agreement. Finally, the sum of dams constructed in each decade in BCUs covered by an agreement was divided by the summed global area of BCUs covered by an agreement for that same decade, and the sum of dams constructed in each decade in BCUs not covered by an agreement was divided by the summed global area of BCUs not covered by an agreement for that same decade. To generate values on a decadal basis for areas covered and not covered by transboundary agreements, annual values were averaged in each category across the 10 years in a decade.

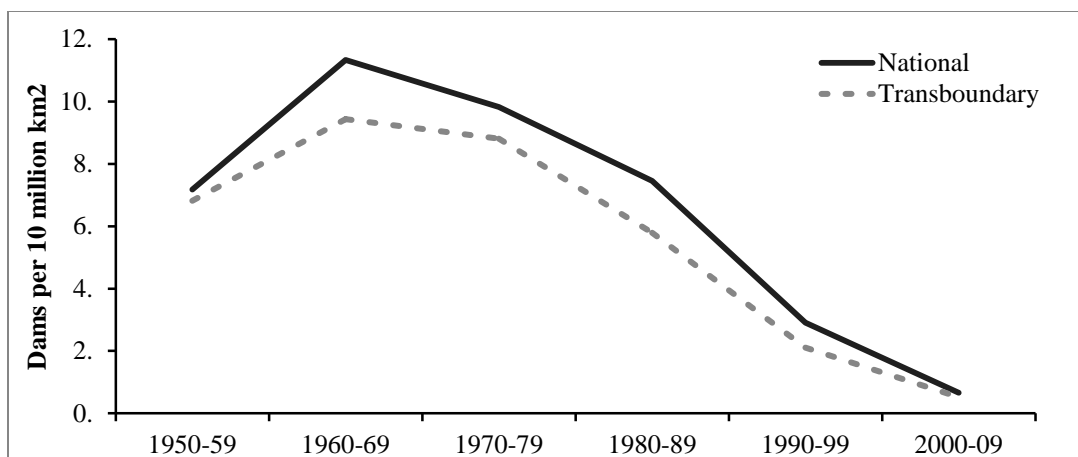
*What regional variation can be evidenced in dam construction rates in our three types of basins?* Our third analysis focused on dam construction by continent. We examined how rates of dam construction within national basins, international BCUs without agreements, and international BCUs with agreements vary in different parts of the world. To do this, we determined decadal rates of dam construction in national basins, transboundary BCUs with agreements and transboundary BCUs without agreements for each continent, which was then divided by the decadal averages of the areas covered by national basins, transboundary BCUs with agreements and transboundary BCUs without agreements, respectively.

*What are the spatial differences between dam distribution in the presence of a transboundary water agreement and the dam distribution in the absence of a transboundary water agreement?* Finally, we examined how international water agreements affect dam distribution within a set of transboundary basins. We examined 10 transboundary basins' dam construction rates for upstream, midstream and downstream countries both with and without agreements. This was done to ascertain the relationship in construction rates both before and after cooperation based upon riparian position. We speculate that there will be higher dam construction rates in upstream countries without agreements as costs can be most easily passed downstream.

## **Results**

### *Are Dam Construction Rates Greater in Transboundary Basins?*

Overall, the normalized rate of large dam construction is slightly higher in national basins than transboundary basins in our dataset. The average rate of dam construction in national basins is 6.6 dams per 10 million km<sup>2</sup>/yr, whereas the average rate of dam construction in transboundary basins is 5.6 dams per 10 million km<sup>2</sup>/yr. We also analyzed the rates over time to identify any notable decadal variation. Comparing temporal variation in dam construction rates in national and transboundary basins (Figure 3.2) reveals that construction rates are greater in national basins in every decade. Patterns of dam construction in national and transboundary basins nonetheless exhibit remarkable similarity. Both trends show a peak in dam construction in the 1960s followed by a decline through the first decade of the 21<sup>st</sup> century.

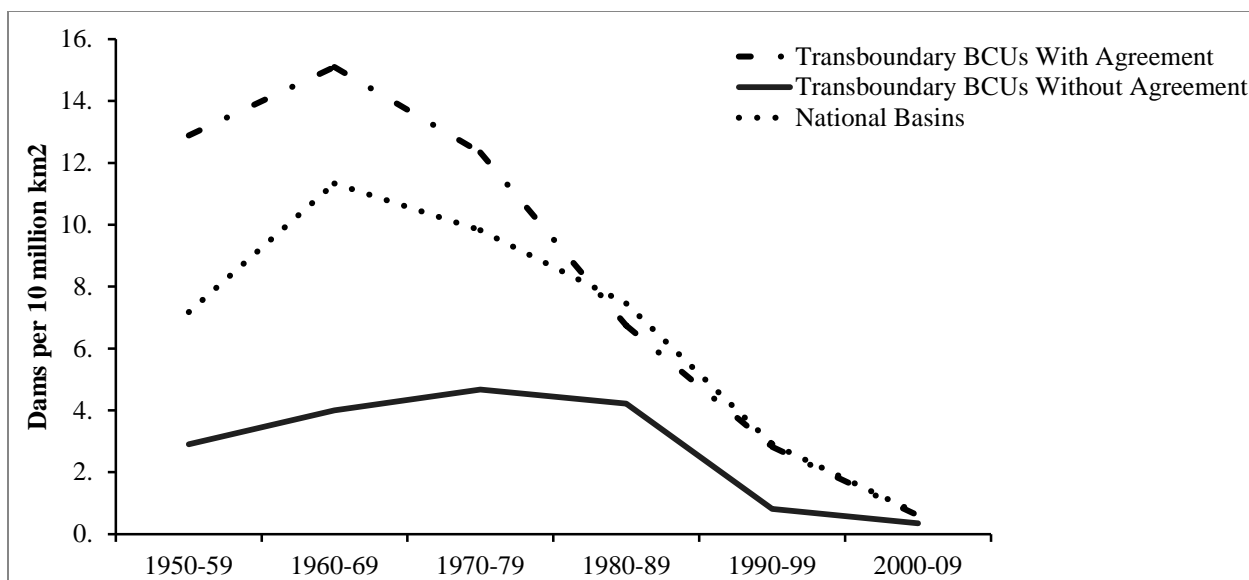


**Figure 3.2.** Comparison of dam construction rates in national and transboundary basins by decade. All figures show dams/10 million km<sup>2</sup>.

*Do Construction Rates in Transboundary BCUs without Agreement Exceed those of Transboundary BCUs with Agreement?*

On average, the rate of construction in BCUs with an agreement is 8.4 dams per 10 million km<sup>2</sup>/yr, compared with 2.8 dams per 10 million km<sup>2</sup>/yr in BCUs without an agreement. Compared against results presented above on dam construction rates in national basins, rates in BCUs covered by agreements are greater than those of national basins, but rates in BCUs not covered by agreements are lower.

Comparing evidence among transboundary BCUs without agreements, transboundary BCUs with agreements, and national basins over time reveals that dam construction rates in transboundary BCUs with an agreement exceed rates in the other two groups through the 1980s (Figure 3.3). Dam construction in transboundary BCUs without an agreement has been comparatively low throughout. Dam construction in national basins overtook dam construction in transboundary BCUs covered by an agreement in the 1980s.

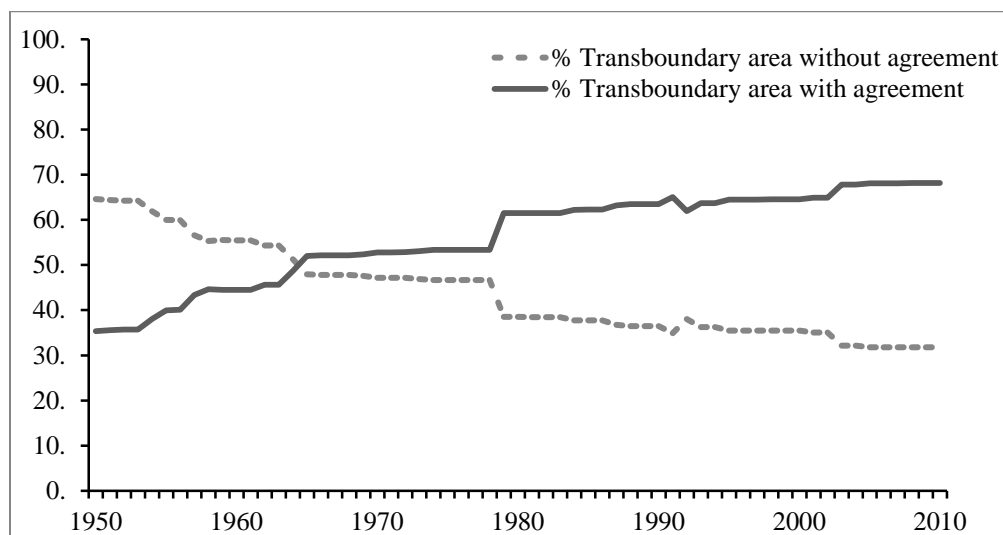


**Figure 3.3.** Comparison of normalized dam construction rates in BCUs with an agreement, without an agreement, and national basins by decade.

Although somewhat tangential to the core questions of this analysis, a finding unearthed through our work relates to the precise extent of the growth in area covered by transboundary water agreements. Whereas less than 40% of the area in transboundary basins was covered by an agreement in 1950, 68% of land located within transboundary river basins is currently covered under a transboundary agreement (Figure 3.4). Nonetheless, of the 752 transboundary BCUs identified through our analysis, only 363 (48%) are currently covered by a transboundary water agreement<sup>13</sup>. In light of this evidence, it is clear that any temporal comparison of dam construction rates in BCUs with versus without an agreement needs to account for the changing area

<sup>7</sup> The 363 BCUs under an agreement account for 68% of the global transboundary area. BCUs with larger areas are more likely to have agreements apply to them.

to which agreements apply, as findings would be very misleading if we did not control for differences in area over time.



**Figure 3.4.** Percentage of global transboundary river basin area under an agreement (cumulative), 1950-2009. \*Global transboundary area in 1991 decreases due to the breakups of the USSR and Yugoslavia.

#### *How Does Dam Construction Vary by Geographic Region?*

Stratifying dam construction rates by continent reveals a lack of uniformity in rates across regions (Table 3.1). Diverging from global findings, construction rates in Asia and South America are greatest in national basins; in Africa, construction rates in transboundary BCUs not covered by an agreement are greatest. Consistent with global findings, Europe and North America have much higher rates of construction in BCUs with an agreement than in BCUs without an agreement and in national basins. Aggregated evidence on dam construction in transboundary waters of North America is heavily influenced by data from the Mississippi River Basin, which possesses most of the continent's dams and an applicable agreement since 1909.



**Table 3.1.** Rates of dam construction by continent for national basins, transboundary BCUs with an agreement, and transboundary BCUs without an agreement. \*The countries included for Oceania (Australia and New Zealand) have no transboundary river basins.

<i>Continent</i>	<i>Transboundary BCUs without Agreement (Dams per 10 million km<sup>2</sup>/yr)</i>	<i>Transboundary BCUs with Agreement (Dams per 10 million km<sup>2</sup>/yr)</i>	<i>National Basins (Dams per 10 million km<sup>2</sup>/yr)</i>
Africa	4.3	2.5	2.8
Asia	1.2	3.7	5.2
Europe	16.7	32.3	26.4
North America	4.3	14.3	6.1
Oceania	*	*	6.7
South America	1.3	2.0	3.7

#### *How do Rates of Dam Construction Vary According to the Riparian's Position in a River*

##### *Basin?*

Formation of agreements appears to foster more equitable, distributed dam developments (Table 3.2). Whereas pre-agreement dam construction is most concentrated in upstream areas, post agreement downstream construction is far more balanced throughout river basins. All three portions have higher rates of post-

agreement construction. The findings support the notion that agreement formation supports more equitable development throughout the basin.

**Table 3.2.** Distribution of dam construction in basins with and without agreement, defined by “downstreamness.”

	<i>Without Agreement (Dams per 100,000 km<sup>2</sup>/yr)</i>	<i>With Agreement (Dams per 100,000 km<sup>2</sup>/yr)</i>	<i>Multiplier</i>
Upstream Portion	1.8	4.6	2.6
Midstream Portion	0.7	2.9	4.1
Downstream Portion	1.0	4.5	4.5

## Discussion

Three major findings were produced through this work. A first major finding is that – contrary to expectations – dam construction rates are greater in national basins than transboundary basins. The second major finding is that –contrary to expectations– dam construction rates in areas of transboundary basins with an agreement exceeds dam construction rates in areas of transboundary basins without an agreement. Thirdly, consistent with expectations, agreement formation appears to foster more equitable dam distribution across the river basin. At a more minor level, the paper also identified that i) temporal patterns of dam construction in national basins and areas of transboundary basins with an agreement broadly mirror each other, and ii) dam

construction trends in Africa, Asia and South America diverge from globally-aggregated evidence.

The paper's first finding that dam construction rates are slightly greater in national basins is inconsistent with prevailing hypotheses related to environmental resources with unclear property rights. Hardin (1968) pointed to commonly accessible natural resources as contributing to a tragedy of overexploitation, for example, and Giordano (2003) suggested that a commons problem of over-development was likely to occur from the international nature of transboundary water resources. The results of our work provide evidence to the contrary.

The paper's second major finding that dam construction rates are greater in areas covered by transboundary agreements conflicts with theories found in some previous literature. Ostrom et al. (1999), Marothia (2003) and Anderies and Janssen (2013) all asserted that institutions prevent overuse and overexploitation of natural resources. However, evidence presented in this paper shows that the presence of institutions correlates with accelerated dam construction on transboundary waters.

The paper's third major finding that agreement formation appears to foster more equitable dam distribution across the river basin is consistent with prevailing thought. Logic contained in theories outlined above (e.g., Giordano 2003) point to greater incentive for upstream development in the absence of an agreement: upstream countries can capture benefits and pass costs downstream without an agreement, whereas the conclusion of an agreement is likely to spur need for greater sharing of benefits and hence less direct benefit accruing to upstream riparians. Indeed, evidence

suggesting that agreements foster a style of development that minimizes negative externalities (e.g.; Dinar 2006; Drieschova, Giordano, and Fischhendler 2009; Fischhendler, Dinar, and Katz 2011) is consistent with the more distributed development evidenced in basins covered by agreements. The paper found that there was greater upstream development in the absence of an agreement. This finding suggests that upstream countries may not be afraid of political costs to unilateral development, as suggested by some (e.g., Daoudy 2009), though it should be pointed out that greater development throughout the basin occurred after an agreement was signed.

Finally, greater construction rates in national basins in Asia and South America, and transboundary BCUs without agreements in Africa, trigger broader questions about factors that explain the divergence in dam construction patterns in these regions. The reality is that these regions are overwhelmingly comprised of developing countries. While the precise explanation of the different transboundary water dynamics evidenced in developing countries is unclear, one might speculate that requirements associated with international financing for dam construction in transboundary waters may play some role in the trends evidenced.

## **Conclusion**

This paper has combined georeferenced data on nearly 5,000 large dams, a database that contains more than 200 transboundary water agreements, and a global map of river basin boundaries to understand how internationalization of river basins – and presence of cooperative legal frameworks in international basins -- affect rates of dam construction. The paper adopted BCUs as the unit of analysis in transboundary

basins to account for the fact that many agreements apply to some, rather than all, countries in a basin. The results of this work constitute the first systematic attempt to capture how dam construction rates vary between transboundary and national basins, between areas in transboundary basins covered versus not covered by agreements, and among countries in transboundary basins.

This paper sought to systematically test the degree to which a commons dynamic exists in the context of transboundary waters, and the degree to which institutions offset that dynamic. Contrary to theories contained in past research, we found that the rate of dam construction in national basins has been slightly greater than the rate in transboundary basins in our sample, and that the rate of dam construction in transboundary waters with agreements in our sample is substantially greater than the rate of dam construction in transboundary waters without agreements. We also found that upstream water resources development is greater before agreements compared to midstream and downstream areas, and concluding a transboundary water agreement fosters more distributed water resources development throughout the basin.

The results of this paper call for caution when making assertions that may sound plausible based on examination of a few selected examples. Analogous in some ways to debunked assumptions of more conflict than cooperation on transboundary waters (Yoffe et al. 2003), this paper found that transboundary waters are not associated with accelerated dam construction. Further, the existence of cooperative institutional frameworks appears to accelerate rather than attenuate dam construction in transboundary basins. These findings remind us that systematic research should be

undertaken before drawing definitive conclusions—particularly concerning transboundary waters.

These results spur at least three more specific recommendations. First, the results support the notion that transboundary water cooperation may help nations meet water management objectives, regardless of whether the objective of cooperation is water resources development or environmental regulation. Indeed, if there may have been a perception that cooperation leads to slower, more protracted and ultimately less development (e.g. Uitto and Duda 2002), evidence presented here shows that perception to be unfounded. Second, if one posits that more distributed dam development is better development, then the results amplifies the case for arguing that cooperative river basin development may lead to further water cooperation within the basin. Third, combining these findings with evidence that more than 30% of the total area in transboundary basins is currently without an agreement suggests there is work to be done in expanding the area under cooperation in transboundary basins.

Despite the findings in this paper, at least two limitations should be acknowledged. First, land area was the only parameter applied to normalize rates of dam construction across categories that were considered (national basins, transboundary waters with and without an agreement). Additional variables could be used to normalize dam construction rates, such as water resources endowment, population, and the degree of rainfall variability. Second, this paper focused on presence or absence of agreements in transboundary BCUs but did not focus on agreement depth and content as a means to gauging institutional strength.

In conclusion, this paper has worked to dispel a generalized notion of a commons dynamic in transboundary waters by determining that i) dam construction rates are slightly greater in national basins than transboundary basins, and ii) dam construction in transboundary waters with an agreement exceeds that of dam construction rates in transboundary waters without an agreement. Further, the fact that agreement conclusion appears to trigger greater development regardless of riparian position suggests that agreement formation helps, not hinders, the development ambitions of all countries in a basin, including those located upstream. Taken together, these findings indicate that while exploitation of transboundary waters may be at odds with experiences in other common pool natural resources, the existence of cooperative institutional frameworks on transboundary river basins can be linked to positive outcomes—their creation should thus be promoted.

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## **CHAPTER IV. PROJECTING RIVER BASIN RESILIENCE IN THE ZAMBEZI RIVER BASIN THROUGH GLOBAL ANALYSES AND BASIN REALITIES**

### **Abstract**

Projecting future hotspots of hydropolitical tension in river basins across the world may allow countries to take measures to prevent hydropolitical conflict. The Zambezi River Basin has been identified as a basin at risk of future hydropolitical conflict. This paper analyzes the hydropolitical resilience of the Zambezi River Basin using two approaches: i) a global analysis of factors that indicate change and a basin's institutional capacity, and ii) an in-depth examination of the basin's hydropolitical history and its present-day status using interviews with basin stakeholders, academics, NGOs, and policy makers. Results of the global analysis indicate that the Zambezi River Basin on the whole has comparatively higher institutional capacity, lower to medium rates of new dam development, lower human development and security values, lower water scarcity, yet higher projected water variability. When examining the basin's hydropolitical history results show that the values of the global indicators only tell a partial story. This paper argues that while global analyses of hydropolitical resilience are valid for indicating areas of possible tension over shared water resources, analyzing a basin's hydropolitical resilience on the basin scale through tracing its hydropolitical history and interviews puts the global results into context and adds nuance that is crucial to identify specific aspects of the basin that may push the basin into a state of conflict.

### **Introduction**

The world's transboundary surface water basins comprise 47% of the earth's land area. These basins are also home to 40% of the world's population (Wolf et al. 1999). Transboundary waters are relied upon for, among other aspects, life, economic well-being, and ecosystem goods and services. Competition between riparians for the resources transboundary river basins have to offer may lead to international conflict over water quantity, quality, timing, and/or impoundment.

What variables (or combination of variables) may cause the river basin to move from non-conflict into conflict? Wolf, Stahl, & Macomber (2003, p. 2) suggested the following relationship between change, institutions, and likelihood of conflict: "[t]he likelihood of conflict rises as the rate of change within the basin exceeds the

institutional capacity to absorb that change.” This suggests that two important dimensions exist in transboundary water disputes: 1) a high rate of change in the system; and 2) a low institutional capacity of a system to absorb change, e.g., low hydropolitical resilience.

Several factors may increase the likelihood of a shift to conflict in a river basin, including rapid environmental change, increased hydrologic variability, unilaterally constructed dams, and the absence of institutional capacity (Wolf 2010; Petersen-Perlman et al. 2013). Analyzing these factors globally may point towards certain basins and countries within those basins that deserve further analyses, but how full of a picture do these indicators paint? The purpose of this paper is to gage how the results of such a global assessment align with realities on the ground at a river basin scale. I attempt to answer the following questions:

1. The Zambezi River is a transboundary socio-hydrological system currently functioning across international borders in a state of relative peace. What variables or combination of variables—internal and external, current or legacy—could serve to push the Zambezi system over the threshold into conflict?
2. What is added by analyzing hydropolitical resilience at both the global and basin scale?

In this case, I will “ground-truth” the results of this global analysis of hydropolitical resilience using a single case: the Zambezi River Basin.

The Zambezi River Basin is an interesting case for assessing its hydropolitical resilience for many reasons. The basin is home to many lower-income but rapidly-growing economies whose demands may change the current dynamics of the river basin, possibly in the form of new dam development or inter-basin transfers. The Zambezi also has a history of intra-basin hydropolitical tension between riparians, exhibited through civil wars that spilled across international borders, and other conflictive events. However, quite recently, riparians have taken steps toward basin-wide cooperation with the formation of the first river basin organization in the Zambezi, the Zambezi River Commission (hereafter known as ZAMCOM). This commission's institutional capacity may be challenged with future hydropolitical conflicts, as well as other physical factors; for example, the Zambezi River Basin is projected to exhibit the worst potential effects of climate change among 11 major sub-Saharan African river basins, according to the International Panel on Climate Change (Nengomasha 2013). The continued rapid socioeconomic, biophysical and geopolitical changes within this basin has led some scholars to believe that the Zambezi might be at risk for future conflict (Mutembwa 1998; Wolf, Yoffe, and Giordano 2003; Pearce 2013).

Before I begin analyzing the hydropolitical resilience of the Zambezi, I first trace the theoretical framework of hydropolitical resilience and explore the nature of hydropolitical conflict. I continue with a detailed explanation of the methods I employ for measuring hydropolitical resilience across the globe, followed by the results of my global analysis. I then examine the utility (and shortcomings) of the global analysis by comparing its results within the Zambezi River Basin with realities on the ground by

tracing the basin's history of hydropolitical cooperation and conflict through past events and the results of semi-structured interviews conducted with stakeholders across the Basin in 2012. I then conclude by detailing that while global assessments in hydropolitical resilience are useful to a degree in identifying areas of concern, it is incredibly important to incorporate a basin's nuances to fully understand the basin's hydropolitical risks and opportunities.

## **Literature Review**

### *Hydropolitical Resilience and Hydropolitical Vulnerability*

The concepts of “resilience” and “vulnerability” as related to water resources are frequently assessed within the framework of “sustainability” and relate to the ability of biophysical systems to adapt to change (e.g., Gunderson and Pritchard 2002). As the sustainability discourse has broadened over time from describing engineered and ecological systems to include human systems, research has also been increasingly geared towards identifying indicators of resilience and vulnerability within this broader concept (e.g., Lonergan, Gustafson, and Carter 2000; Turner et al. 2003; Bolte et al. 2004).

Many scholars have written about conflict and its influence on the resilience of transboundary water systems. The likelihood of escalated, even violent, conflict over water resources is one that scholars have debated about over the past decades (e.g., Gleick 1993; 2000; Wolf 2000; 2007; Nordås & Gleditsch 2007; Cooley & Gleick 2011). This debate falls within the framework of “hydropolitics” (Waterbury 1979), which relates to the ability of geopolitical institutions to manage shared water resources in a

manner that is politically sustainable, i.e., without tensions or conflict between political entities (McNally, Magee, and Wolf 2009). But what allows these institutions to manage water resources in a politically sustainable manner? What are disruptors to a sustainable paradigm?

Examining transboundary water system resilience within a hydropolitical context leads to the concept of “hydropolitical resilience,” which is defined as the complex human-environmental systems’ ability to adapt to permutations and change within these systems. In contrast, “hydropolitical vulnerability” is the risk of political dispute over shared water systems (Wolf 2005). The characteristics of a basin that would tend to enhance hydropolitical resilience to change include: international agreements and institutions, a history of collaborative projects, generally positive political relations, and higher levels of economic development. Facets that tend toward vulnerability, on the other hand, include the following: rapid environmental change, increased hydrologic variability, rapid population growth or asymmetric economic growth, major unilateral development projects, absence of institutional capacity, the potential for the “internationalization” of a basin, and generally hostile relations (Wolf 2005). When examining characteristics that would tend to enhance or detract from hydropolitical resilience in combination, it becomes clear that the settings of hydropolitical conflict are most likely with major water projects, such as dams, diversions or diversion schemes, built in the absence of agreements or collaborative organizations, that can mitigate for the transboundary impacts of these projects (Petersen-Perlman et al. 2013).

The previous subsection explored factors that may lead to hydropolitical conflict. Yet what constitutes hydropolitical conflict needs to be defined. The next subsection addresses the nature of transboundary waters and conflict. It is then followed with an explanation of how this paper attempts to measure hydropolitical resilience within the Zambezi River Basin.

### *Transboundary Waters and Conflict*

Scholars have debated whether this clash between nations due to the transboundary nature of water may lead to violent conflict; the debate appears to be centered on how “transboundary water conflict” is defined. Wolf (2000) has argued that while there is a growing literature describing water as an historic, and, by extrapolation, a future cause of warfare, a close examination of case studies cited in this literature reveals looseness in the classification categories; in other words, how one defines water “wars.” De Stefano et al. (2010a) found only 38 acute disputes (i.e., those involving water-related violence) between 1948 and 2008; of those, 31 were between Israel and one or more of its neighbors, with no violent events occurring between Israel and its neighbors after 1970 (De Stefano et al. 2010a). This means most of the cases cited were: 1) caused by political tensions or instability rather than about warfare, 2) the cases were using water as a tool, target, or victim of armed conflict. These are important issues, but are not the same as water “wars.” Then again, Wolf (2000) also cited many water related incidents of violence at the sub-national level; the identified incidents were generally between tribes, water use sectors, or provinces. Cooley and Gleick (2011) wrote that while the likelihood of war over water is small, there exists a long history of



violence associated with transboundary water resources, and that future pressures, including (but not limited to) population and economic growth and climate change, could increase tensions. Some characteristics that make water likely to be a source of strategic rivalry between nations are: the degree of scarcity; the extent to which the water supply is shared by more than one region or state; the relative power of the basin states; and the ease of access to alternative freshwater sources (Gleick 1993). Nations have also cut off access to shared water supplies for various political and military reasons; nations have also aimed for new water supplies through aggressive military expansion. Gleick (1993) also cited inequalities in water use as the source of many regional and international frictions and tensions.

The previous paragraph reveals discrepancies in the literature for how “transboundary water conflict” is defined. For the context of this paper, I define “transboundary water conflict” as verbal, economic, or militarily hostile actions between nations over shared water resources. Within that realm, “violent conflict” is defined as militarily hostile actions between nations over shared water resources.

Several instances of transboundary water conflict have occurred over the unilateral construction of large water infrastructure in transboundary basins. One of these instances occurred in the Tigris-Euphrates Basin. In 1990 Turkey finished construction on the Ataturk Dam, the largest of 21 dams constructed for the Southeastern Anatolia Project (GAP), and interrupted the flow of the Euphrates for a month to partly fill the reservoir. Despite Turkey warning of a temporary cutoff of flow, Syria and Iraq protested that Turkey now had a water weapon that could be used

against them. Later that year the President of Turkey, Turgut Ozal, threatened to restrict water flow to Syria to force it to withdraw support for Kurdish rebels operating in southern Turkey (Gleick 1993). Another example of water infrastructure-related conflict is the 1986 case of North Korea announcing plans to build the Kungansan Dam on a tributary of the Han River, upstream of Seoul, the capital of South Korea (Gleick 1993). Gleick (1993) said that this led to fears in South Korea that the dam could be used as a weapon to flood Seoul through sudden releases of the reservoir. South Korea built a series of levees and check dams upstream of Seoul to try to mitigate possible impacts. More recently, rhetoric has escalated over Ethiopia's construction of the Grand Ethiopian Renaissance Dam over concerns on how the dam would impact flows of the Nile for downstream countries. Before his removal from power, Muhammed Morsi was reportedly quoted as saying, "We will defend each drop of the Nile with our blood" (Natsios 2013). These are strong examples that feature how water management decisions from an upstream riparian can be used (or viewed) as a political weapon to impose its will upon downstream co-riparian nations.

What are other conditions that would have to come to fruition for an interstate water conflict to occur? Wolf (1998) hypothesized that the aggressor would have to be both downstream and the regional hegemon. He also stated that the upstream riparian would have to launch a project which decreases either the quantity or the quality of water resources, knowing that it will antagonize a stronger downstream neighbor. The downstream power would then have to decide whether to launch an attack, and would have to weigh not only an invasion, but also an occupation and depopulation of the

entire watershed to prevent any retribution (Wolf 1998). Also, both countries would most likely not be democracies, as two democracies have never been at war with one another (Ibid.). Climate change is also expected to intensify hydropolitical tensions within countries, between countries and/or within river basins (Gleick 1993; Nordås & Gleditsch 2007). Not only may climate change alter the quantity and timing of flow within river basins and increase water scarcity, there may also be the detrimental, indirect negative effects of reducing food availability and increased exposure to new disease vectors, which can undermine the legitimacy of governments, hurt local and national economies, and affect human health (Barnett 2003). These direct and indirect changes may alter the hydropolitical resilience of the basin; that is, increasing the likelihood of political tensions that are stronger than the institutional capacity to absorb that change (Wolf, Stahl, and Macomber 2003; Wolf 2010). As a consequence, river basins without robust water-related treaties and institutions may be more vulnerable to tension and conflict (De Stefano et al. 2012). To discover more about the nature and likelihood of transboundary water conflict, Yoffe et al. (2004) used Oregon State's Transboundary Freshwater Dispute Database to test three hypotheses on the likelihood and intensity of water resource disputes. The three hypotheses tested were as follows:

- a) the likelihood and intensity of dispute rises as the rate of change within a basin exceeds the institutional capacity to absorb that change;
- b) periods of conflict and cooperation at the international scale will correspond to similar periods at the national scale; and
- c) the likelihood of intense dispute rise as the basin's average precipitation decreases or the variability of precipitation or discharge increases.

Testing the first

hypothesis found that historical international relations over shared freshwater resources were overwhelmingly cooperative. Conflict, when it occurred, centered on quantity and infrastructure issues (Yoffe et al. 2004). Results also suggested that relationships exist between water and non-water relations, but the nature of the relationships vary considerably by region (Ibid.). Finally, the hypothesized premise that the likelihood of intense dispute rises as the average precipitation within a basin decreases or the variability of precipitation or discharges increases was supported when examining the relative frequency of the most conflictive events in a basin, but the relationship with cooperation is still complex (Ibid.).

Now that the causes of hydropolitical conflict have been explored, it is natural to discuss what may lessen its likelihood. Building institutional capacity, in the form of treaties and river basin organizations, is described as a mechanism to decrease the likelihood of hydropolitical conflict (Wolf, Stahl, and Macomber 2003; Yoffe, Wolf, and Giordano 2003; Yoffe et al. 2004). McCaffrey (2003:157) wrote, "Treaties stabilize [the relations of states sharing a river] giving them a certain level of certainty and predictability that is often not present otherwise." Giordano and Wolf (2003) cited characteristics that would make a treaty over water effective:

1. An adaptable management structure (including flexibility, allowing for public input, changing basin priorities, and new information and monitoring technologies).
2. Clear and flexible allocating criteria.
3. Equitable distribution of benefits.

#### 4. Detailed conflict resolution mechanisms.

While there is certainly evidence to support these observations, there also may be inherent weaknesses of certain consent-building relations in water. Treaties can be exploited by riparians in a number of ways: treaties are not easily enforceable, can be structured to reflect (or exacerbate) existing inequalities between riparians, and can lead to non-signatory riparians not participating (Zeitoun and Warner 2006). It may not be the case, then, that the mere presence of treaties indicates hydropolitical resilience alone; indeed, perhaps Zeitoun and Warner (2006 p. 437)'s declaration of 'the absence of war does not mean the absence of conflict' may also extend to the presence of agreements does not preclude the absence of conflict. It may also be the parties engaged in treaties/institutions themselves, rather than the treaty or institution's content or presence, which may be at the heart of their success, as suggested by Chasek, Downie, and Brown (2006). Zeitoun and Warner (2006) and Chasek, Downie, and Brown (2006)'s assertions are healthy critiques, but within the context of violent conflict, the relationship of institutional capacity and decreased violent conflict holds, as evidenced by Wolf, Stahl, and Macomber (2003), Yoffe, Wolf, and Giordano (2003), and Yoffe et al. (2004).

#### *Barriers Against and Drivers Toward Water Cooperation*

In the previous paragraphs, we have explored research examining the potential of violent conflict over water. So, in contrast, what factors drive nations towards hydropolitical cooperation? Norman and Bakker (2005) identified both barriers and drivers to cooperation in transboundary water issues. Barriers they identified include: a

mismatch in governance structures and intra-jurisdictional integration within countries; distinct and sometimes incompatible governance cultures and mandates; shortcomings in institutional capacity, financial resources, participation capacity, and data availability; distance (spatial and social); and psychosocial factors including mistrust and a lack of leadership. The drivers for cooperation in transboundary water issues are much more informal; they include leadership, contacts, personal relationships, and networks (Ibid.). The question of scale in transboundary water issues is also important to consider. Norman and Bakker (2005) said that transboundary water issues often arise locally whereas resolution mechanisms usually operate at the national level. As a result, mechanisms and actors between two different scales are not always well-linked. This is important to keep in mind when framing the problem in transboundary water negotiations.

In this literature review, I have discussed how perturbations may drive nations into conflict, how nations may be more likely to be cooperative, and how institutional capacity may serve as a tool to counteract these perturbations. I have also described how scholars have determined what may affect hydropolitical resilience in river basins. The question now is: how does one *measure* hydropolitical resilience for a river basin?

#### *Measuring Hydropolitical Resilience*

Returning to the premise of Wolf, Stahl, and Macomber (2003; p. 2)'s conclusion: 'The likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change', one needs to quantify both a) the amount of change and b) the amount of institutional capacity in order to determine

hydropolitical resilience. Using this concept, Turton et al. (2005) based their analysis of hydropolitical resilience of African river basins on Wolf, Stahl, and Macomber (2003)'s conclusion. Turton et al. (2005) stated that an analysis of hydropolitical vulnerability in Africa must examine both the underlying factors that create or drive change and the legal and social responses to such change. In the following section, I detail my approach for measuring hydropolitical resilience and vulnerability both globally and for the Zambezi River Basin, similar to the approach used by Wolf, Yoffe, and Giordano (2003) and Turton et al. (2005).

### **Methods for Global Analysis**

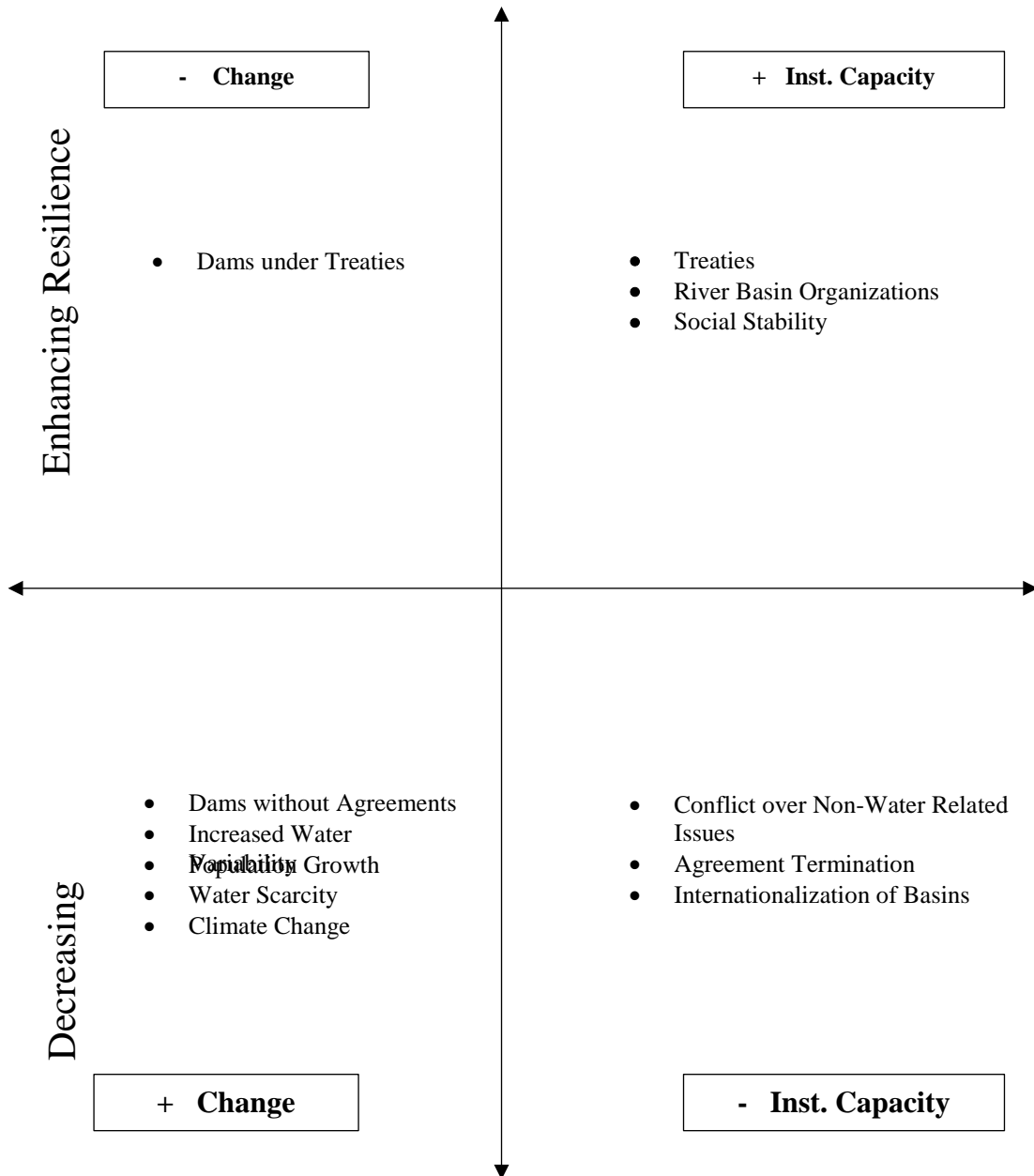
In the preceding paragraphs, I have discussed what hydropolitical resilience consists of, described factors that may influence hydropolitical resilience, and how quantifying both the rate of change and the amount of institutional capacity to manage that change may determine hydropolitical resilience. Wolf, Yoffe, and Giordano (2003, p. 29)'s research identifying basins at greatest risk of political stress in the next 5-10 years used biophysical, socio-economic and geopolitical indicators to "determine history-based indicators for future tensions along international waterways." In this paper, I argue while that using history-based indicators to indicate future tensions is a valid approach, a closer analysis at the basin scale is needed to truly pinpoint which specific characteristics within a basin are critical for influencing the hydropolitical resilience of a river basin.

The methodology for this paper is therefore divided into two parts: a) a global analysis and b) a river basin analysis. For this analysis, I will be examining hydropolitical

resilience on a global scale using factors that both enhance and detract from hydropolitical resilience by measuring the potential for change and institutional capacity to absorb these changes. To measure hydropolitical resilience, I need to incorporate social, political, and physical data; thus I have chosen a series of indicators that will help to determine the degree to which hydropolitical resilience is present. I am using two social indicators: the Human Development Index (UNDP 2012) and the Human Security Index (HSI 2012). For physical changes, I utilize a layer measuring water scarcity within the last 10 years, a dataset that contains information for recent and projected dam construction, and a layer of projected water variability. Finally, I examine institutional capacity through a dataset of current international water treaties available on Oregon State University's Transboundary Freshwater Dispute Database (TFDD). All analyses will be performed at the basin-country unit (BCU) level. A BCU is defined as the portion of a riparian's land area that is within a certain transboundary river basin. For example, the Columbia River Basin has two BCUs: the land area in the United States that is within the Columbia River drainage, and the land area in Canada. This section begins with a description of my methods for the global analysis.

Here, I explain the indicators I use to examine hydropolitical resilience of BCUs across the globe. This serves two purposes: a) to get a global sense of hydropolitical resilience in BCUs globally and see where the areas of higher and lower hydropolitical resilience is located, and b) to understand where the Zambezi River Basin fits in this context. The indicators I use fall into two broad categories: those that enhance resilience, and those that decrease resilience (Figure 4.1).





**Figure 4.1.** Indicators that enhance and decrease hydropolitical resilience. Indicators listed in the upper left quadrant represent factors that mitigate change, enhancing resilience. Indicators listed in the upper right quadrant represent factors that enhance institutional capacity, also enhancing resilience. Indicators listed in the lower left quadrant increase change, decreasing resilience, while indicators listed in the lower right quadrant detract from institutional capacity, decreasing resilience.

### *Factors Enhancing Resilience*

There are two groups of factors which indicate higher hydropolitical resilience within a river basin: either having factors that enhance the river basin's institutional capacity, or having factors that mitigate change. To partly measure factors that enhance institutional capacity, this analysis uses two indices to measure social stability in each country: the Human Development Index (HDI), for measuring economic development, and the Human Security Index (HSI), for measuring human security. The HDI is a composite index created by the United Nations Development Programme that measures "average achievement in three basic dimensions of human development – a long and healthy life, knowledge and a decent standard of living" (UNDP 2012, p.1). The HSI, meanwhile, is an index of over 30 economic, environmental, and social components, to measure the human condition across the globe (HSI 2010).

The presence of treaties and river basin organizations ostensibly enhance hydropolitical resilience. Each BCU is assigned a score by the presence or absence of the following three aspects, adapted from De Stefano et al. (2010b): the presence of at least one treaty with an allocation mechanism; the presence of at least one treaty with a mechanism for hydropower, flood control, or dam construction; and the presence of at least one treaty with a conflict resolution mechanism.

### *Factors Mitigating Change/Exacerbating Change*

Dams may both enhance and detract from hydropolitical resilience in transboundary river basins. On the one hand, dams may mitigate change in that they may be used for managing increased water variability, in the form of storing water in

times of drought or helping to moderate the pace of water moving downstream in times of floods. Of course, dams may also alter the hydrograph, as well as inhibit the migration of aquatic species and the distribution of nutrient-carrying sediment. It is therefore dependent on the institutional capacity of that BCU, e.g., whether there are agreements between countries in place, whether those agreements have allocation mechanisms, whether those agreements have a mechanism for the dam's function, and whether the agreement has a conflict resolution mechanism.

Therefore, I have created a metric for measuring both the potential dam development density within transboundary basins and the BCU's institutional capacity for dams. Wolf, Yoffe, and Giordano (2003) identified dams constructed in upstream riparians without an agreement in place as one of the strongest indicators of a basin's hydropolitical tensions. To that end, I examine the potential for dam construction both globally and within the Zambezi River Basin. I classify each dam based on three categories:

1. *Proposed*. This means that this dam has been proposed as being potentially built, either from a government or an outside funding agency. This includes if the dam has been studied for feasibility/impacts, etc.
2. *Planned*. This includes dams that have tenders where there is financing identified. This category means that the dam has been approved and there are plans for it to be constructed, or construction has already begun.
3. *In operation*.

In this analysis, I exclude dams that are "rehabilitated." Rehabilitation can be defined in numerous ways: repairing a cracked dam wall or heightening the dam are included. A rehabilitated dam, presumably, must be one that has been previously constructed, meaning that the dam must have had some transboundary impact felt already.

The number of dams are calculated for each BCU. I then divide the number of dams in each BCU by their respective land areas and determine the dam density for each BCU. The projected dams are given a weight based upon the likelihood of completion. A constructed dam is given full value, whereas a planned dam is given a value of 0.67 and a proposed dam is valued as 0.33.

Next, each BCU is scored by the presence or absence of the following three aspects, adapted from De Stefano et al. (2010b): the presence of at least one treaty with an allocation mechanism; the presence of at least one treaty with a mechanism for hydropower, flood control, or dam construction; and the presence of at least one treaty with a conflict resolution mechanism.

Each basin and BCU are assigned a score based on its total dam density and the presence of the aforementioned treaty aspects. The basins/BCUs with the lowest scores are at highest risk for conflict, while basins/BCUs with the highest scores are at the lowest risk (Table 4.1).

Tables 4.1a and 4.1b. a) Methods for determining dam density and b) institutional capacity for BCUs.

<b>Presence of &gt;= one treaty w/allocation mechanism</b>	Yes	
	No	
<b>Presence &gt;= one treaty w/mechanism for hydropower, etc.</b>	Yes	
	No	
<b>Presence &gt;= one treaty w/mechanism for conflict resolution</b>	Yes	
	No	
<b>TOTAL</b>		0/3

Low dam density Basin or BCU	<i>Assign 3 points</i>
Medium dam density Basin or BCU	<i>Assign 2 points</i>
High dam density Basin or BCU	<i>Assign 1 point</i>

### *Factors Decreasing Resilience*

While periods of seasonal water resource deficits can lead to conflict regarding water resources in the short-term, long-term drought as well as anthropogenic-caused water scarcity may lead to exacerbated tensions across river basin riparians. The GRACE satellite (NASA and the European Space Agency) measures changes in water storage anomalies at monthly time intervals. Using 117 months of GRACE data the Sen's-slope (Sen 1968) measures the overall trend without being over-influenced by outliers, which in this case would be an abnormally wet or dry period. I utilize Sen's slope calculations

made in De Stefano et al. (forthcoming), calculated at 1° resolution (same as GRACE data inputs) over a period of 117 months. The spatial mean of the Sen's slope was calculated for each BCU.

In addition to measuring past water scarcity trends as a way to capture increasing change within a river basin, predicting future water variability is another way to project high rates of change. De Stefano et al. (2010b) calculated river basin resilience to future climate change-induced water variability for 2030 and 2050. This was done by a) upgrading the TFDD database to incorporate data on institutional capacity by BCU; b) categorizing treaties according to their treaty and basin organization capacity; c) classifying baseline hydrological variability and future change in hydrological variability for each BCU; and d) classifying basins according to their institutional capacity and exposure to present and future hydrological availability.

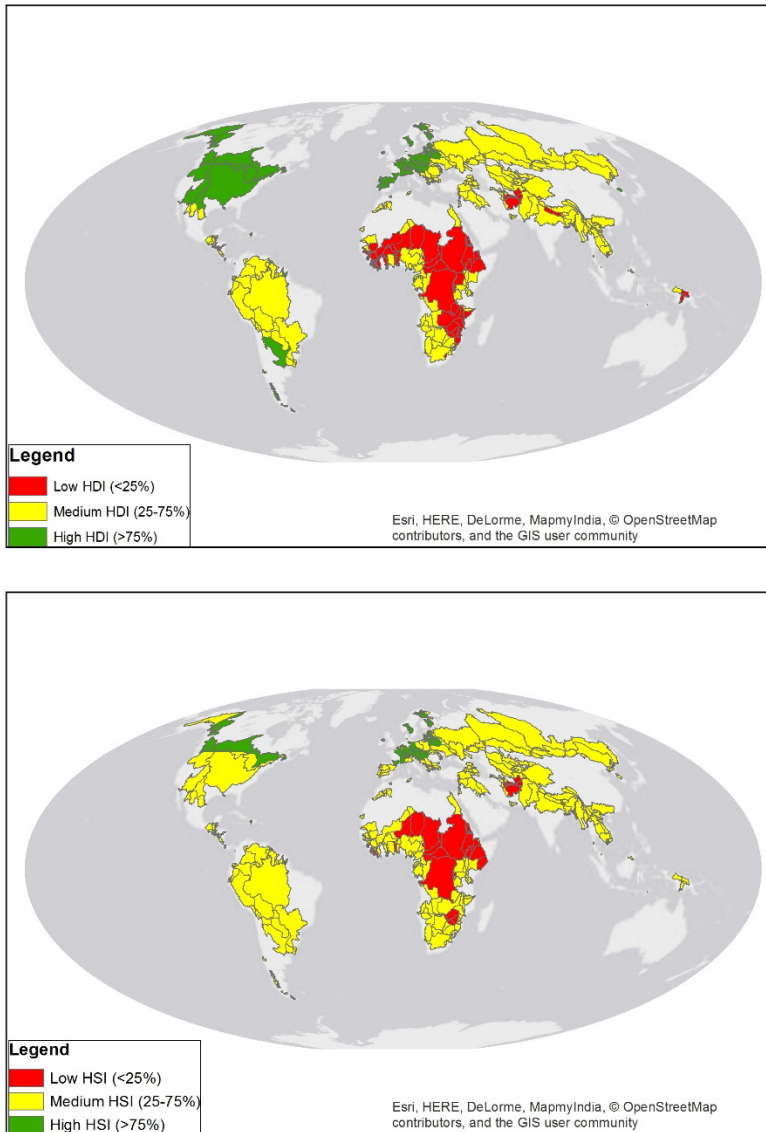
Using the aforementioned factors to measure hydropolitical resilience, I next discuss the results of my global analysis of hydropolitical resilience for the BCUs of the Zambezi River Basin.

## **Results and Discussion of Global Analysis for the Zambezi**

### *Factors that may Enhance Resilience*

Overall, the Zambezi River Basin countries have low scores for both the Human Development and Human Security Indices (Figure 4.2). Only Botswana and Namibia have medium values for both the HDI and HSI (values in the middle 50% of all BCUs). The DRC has the lowest HDI and HSI values of all Zambezi riparians. The four countries that have

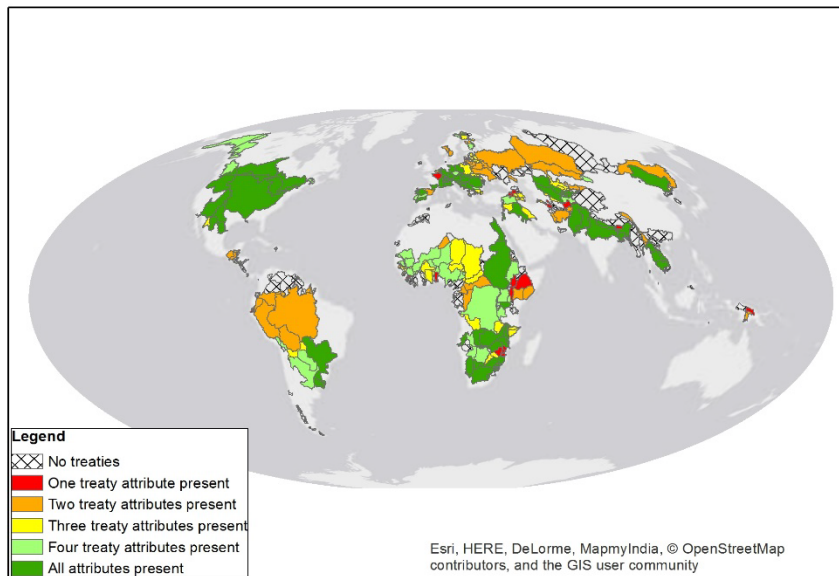
the highest populations of their residents in the Zambezi - Mozambique, Malawi, Zambia, and Zimbabwe – all have low HDI and HSI values.



**Figure 4.2.** Human Development Index values (above) and Human Security Index values (below) for BCUs. Green represents high values, yellow medium values, and red low values.

The Zambezi's treaty coverage for all BCUs (with the exception of the DRC, as the DRC does not participate in basin activities in an official capacity) is high compared with the rest of the world (Figure 4.3). The presence of the ZAMCOM (and ZAMCOM's

mechanisms for allocation, conflict resolution, and variability management), as well as a few other bilateral and trilateral agreements, allows for a higher score.

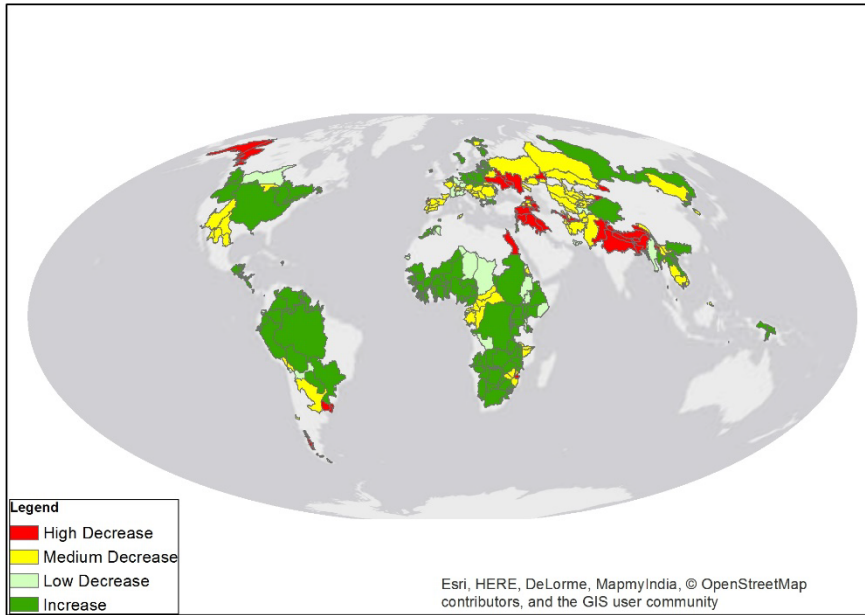


**Figure 4.3.** Treaty coverage for global BCUs. Dark green represents treaty coverage with all five treaty attributes present (presence of a treaty, presence of a river basin organization, presence of conflict resolution mechanism, presence of a variability management mechanism, and presence of an allocation mechanism). Light green represents treaty coverage with four treaty attributes present, yellow three attributes, orange two attributes, and red one attribute. The crosshatch pattern is for BCUs without treaties.

#### *Factors that may Decrease Resilience*

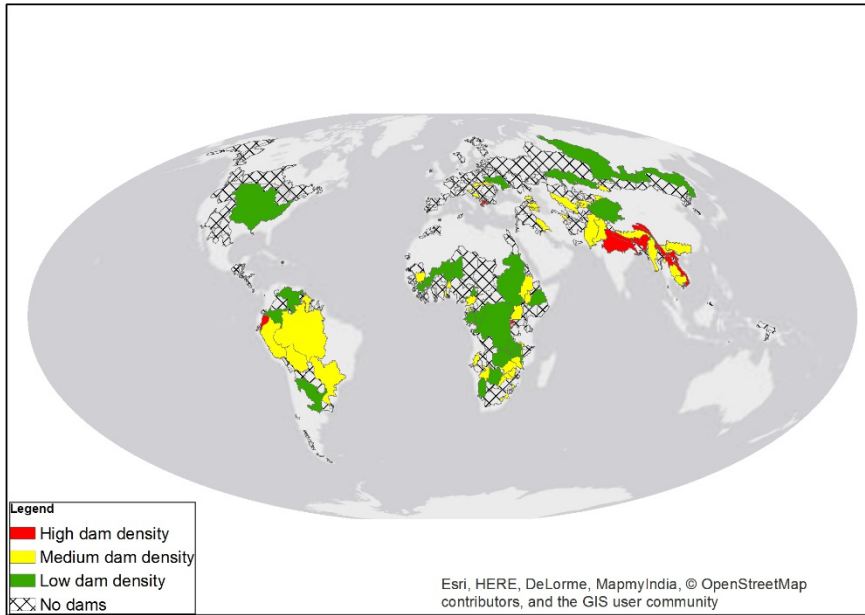
Regarding water scarcity, riparians in the Zambezi have seen an overall modest increase in water storage basin-wide according to the GRACE data. The Tanzania BCU is the only BCU that had a decrease in water storage. The results of the data suggest that within the context of other basins, such as the Tigris-Euphrates and the Ganges-Brahmaputra-Meghna, the Zambezi is in comparatively good shape over the past 117 months (Figure 4.4).





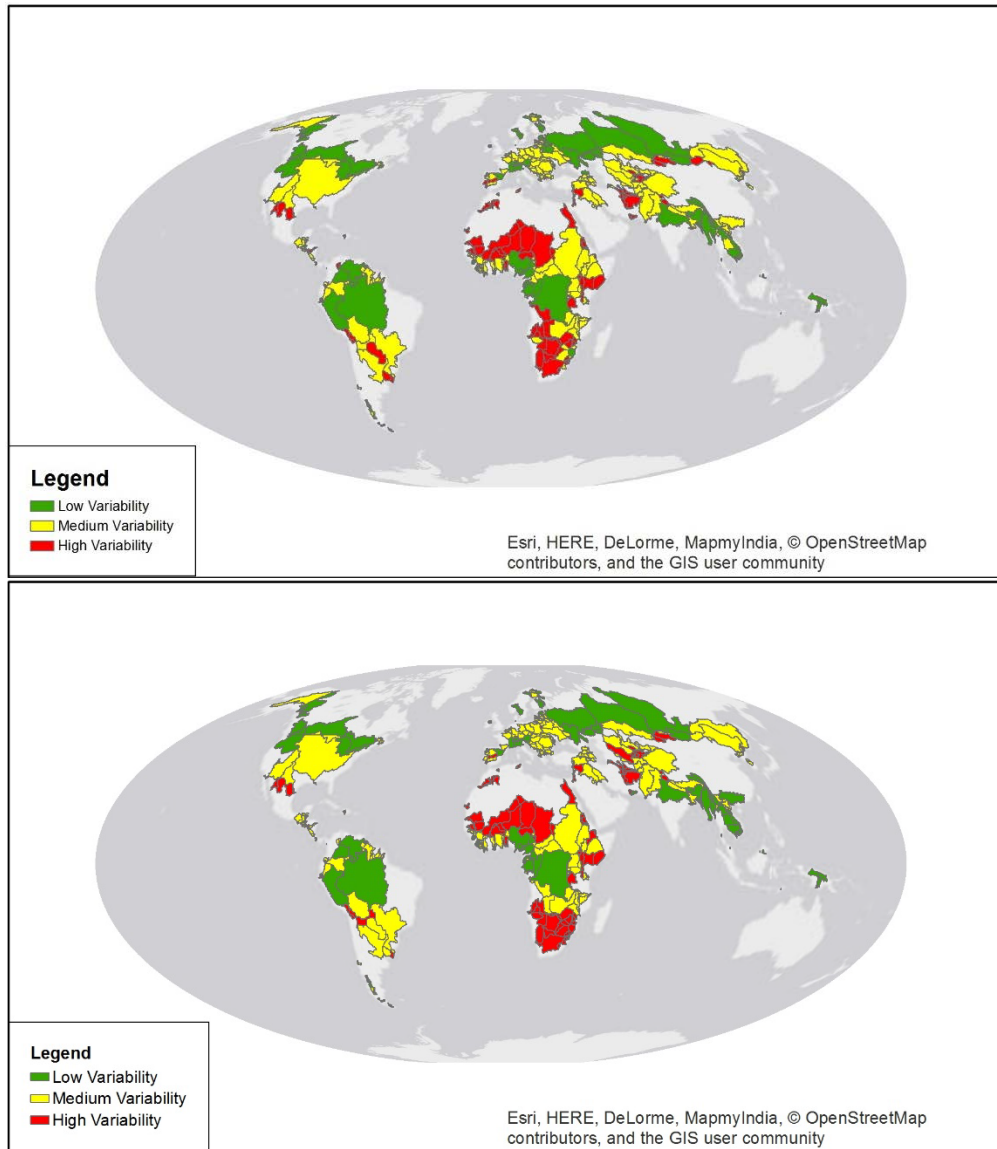
**Figure 4.4.** Results of Sen's-slope calculated over the past 117 months. From De Stefano et al., forthcoming.

The Zambezi's BCUs have low to medium projected dam densities (Figure 4.5). Both Zimbabwe and Tanzania have medium projected dam densities, and Mozambique, Malawi, and Zambia have low projected dam densities. Angola, Botswana, DRC, and Namibia have no projected dams, which is not all too surprising given Botswana, DRC, and Namibia's small share of the watershed area and Angola's low population within its share of the Zambezi.



**Figure 4.5.** Projected dam densities for global BCUs. Red represents high dam densities, yellow represents medium, and green represents low. The crosshatch pattern represents BCUs without new dams.

The World Bank study shows the Zambezi's projected runoff variability to be highest overall in Botswana, Namibia, and Zimbabwe, respectively in both 2030 and 2050 (Figure 4.6). In the year 2030, variability is projected to be high in the majority of the basin, especially in the northern and western (more upstream) BCUs. In 2050, the Zambezi's projected runoff variability is high in Botswana, Namibia, and Zimbabwe, while medium in Malawi and Mozambique (more downstream).



**Figure 4.6.** Projected coefficients of variability for 2030 (above) and 2050 (below) in global BCUs. Green represents low variability, yellow medium variability, and red high variability.

#### *Discussion of Global Analysis Results*

The water scarcity trend (Sen's slope), treaty coverage, and projected dam development all indicate higher projected hydropolitical resilience when compared to other BCUs across the globe. Meanwhile, the factors used to measure social stability for this analysis, the Human Development Index and the Human Security Index, indicate

that the Zambezi Basin, on the whole, has comparatively low social stability, indicating decreased hydropolitical resilience. Other measured factors that would suggest decreased hydropolitical resilience include projected higher climatic variability in 2030 and 2050.

It's important to clarify that these "mixed" results do not cancel each other out. For example, BCUs within the Zambezi River Basin has comparatively high treaty coverage and low social stability values. The diversity of results does not indicate that the Zambezi River Basin has a "medium" risk of hydropolitical tension. Rather, these indicators are merely trying to show where hydropolitical tensions are more likely to occur.

So, after performing this analysis, one might conclude that the Zambezi has low social hydropolitical resilience, but high institutional capacity. And, while there is relatively low water scarcity, there is a risk of higher hydrologic variability within the basin in 2030 and 2050. Yet the mere presence of these agreements does not automatically translate to high institutional capacity, which would, in turn, enhance hydropolitical resilience. Also, having relatively lower physical water scarcity at the BCU level may not imply water scarcity within the entire BCU level. Next, I explore how valid the conclusions from the global analysis are, by examining the history of the states that have signed these treaties and looking for the evolution of the relationships between them. I examine major internal conflicts within Zambezi River Basin riparians, such as civil wars, separatist movements, and ethnic conflicts, within basin countries.

### **Hydropolitical Resilience Analysis of the Zambezi River Basin**

In the previous section I described the results of my global analysis, which indicated that the projected hydropolitical resilience in the Zambezi's BCUs is mostly higher than average regarding treaty coverage, recent water scarcity, and dam construction, while having mostly lower than average hydropolitical resilience values in future hydrologic variability and social stability. These values, however, need to be put into context. For example, does the fact that seven of the nine Zambezi BCUs have either low (or non-existent) rates of dam development indicate that the nations in the Zambezi have a low chance of dam-related conflict? This is not necessarily the case. I will argue in the Discussion section that while these numbers presented by the dam development indicator (and other indicators) may serve as a guide, they mask the nuance of realities on the ground. Therefore, it is absolutely necessary to cover the hydropolitical history of the basin. This section will examine the political history of cooperation and conflict, as well as past, current, and predicted physical, political, and social changes to the basin. I also incorporate information gathered from 25 semi-structured interviews and surveys across the Zambezi River Basin that helped to inform the current status of the basin's hydropolitics.

### *Study Area*

My study area focuses on the Zambezi River Basin (Angola, Botswana, D.R.C., Malawi, Mozambique, Tanzania, Zambia and Zimbabwe. As stated above, the Zambezi River Basin nations are in the nascent stages of basin-wide cooperation after initially signing the ZAMCOM treaty.

### *Interview Data*

I have conducted 25 semi-structured interviews with water policy officials and stakeholders within the Zambezi Basin. These interviews have taken place in Botswana, Mozambique and Zambia, and were meant to provide on-the-ground perspectives from basin citizens. I spoke with academics, NGOs, policy makers, governmental officials, and citizens who have been displaced by dam construction.

### *The Zambezi: An Introduction*

The Zambezi River is the fourth-largest waterway in Africa and the largest African river system that flows into the Indian Ocean (Isaacman and Isaacman 2013). The Zambezi River Basin has drainage in nine countries- Angola, Botswana, Democratic Republic of the Congo (DRC)<sup>14</sup>, Malawi, Mozambique, Namibia, Tanzania, Zambia, and Zimbabwe. Angola, Botswana, DRC, Malawi, Namibia and Tanzania can be considered upstream countries, while Zambia, Zimbabwe, and Mozambique can be considered downstream countries, as both Zambia and Zimbabwe have a large percentage of the basin's area and Mozambique is situated at the river's delta.

Arguably the most pivotal event that shaped (and continues to shape) the hydropolitics of the Zambezi River Basin occurred in the late 19<sup>th</sup> century, when European colonial powers divided the Zambezi Basin in the 1884-1885 Berlin Congress. These divisions created, more or less, the modern-day borders of the Zambezi Basin states. The Zambezi was split between British (present-day Botswana, Malawi, Zambia and Zimbabwe), German (Namibia and Tanzania) and Portuguese (Angola and

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<sup>14</sup> It should be noted, however, that the DRC has a very small area within the Zambezi River Basin and does not participate in ZAMCOM or in any other basin organization.

Mozambique) rule with arbitrary political boundaries, completely ignoring existing political, cultural, ethnic, and linguistic regions. Most of the riparians obtained political independence from European colonial rule during the 1960s and 70s, though political stability did not immediately happen; for most countries, the protectorate forces had not made efforts to provide the indigenous people with education and within many countries, independence coincided to the start of riots or civil war (Bourgeois et al. 2003).

### *Before the Dams*

The Zambezi River Basin has an extremely variable climate, one of the most highly variable of any major river basin in the world (Beilfuss 2012). In some far northern highland areas, average annual rainfall is more than 1,600 mm/yr, compared to less than 500 mm/yr in the more water-stressed southern portion of the basin (Ibid.). Coupled with the Zambezi River Basin's extreme climate variability is extreme variability in flow. Perhaps unsurprisingly, the Zambezi's flow rate varied considerably in the catchment area before the Zambezi or any of its tributaries were dammed (Isaacman and Isaacman 2013). The maximum and minimum flows of the Zambezi mainstem vary considerably. The basin also has experienced catastrophic flooding; on rare occasions (such as those documented in 1914, 1952 and 1958), the Zambezi River has swelled to three times its normal flow rate, leading to catastrophic floods (Chidiamassamba and Liesegang 1997). This flooding (as well as more minor flooding instances) would typically inundate the banks of the Zambezi during its rainy season beginning in December and ending in March. As the waters receded, they left nutrient-rich deposits along the river's

shoreline, sometimes over several kilometers, leaving very desirable agricultural sites in the region (Isaacman and Sneddon 2000).

The Zambezi Basin is abundant in biodiversity, with over 6,000 species of flowering plants, 700 species of birds, and 200 species of mammals (Chenje 2000). Critical for this biodiversity are the basin's wetland resources across the basin, including the Barotse floodplain (133 bird species) and Kafue Flats in Zambia, Malawi's Lower Shire (132 bird species) the Zambezi River Delta (118 bird species) in Mozambique (Chenje 2000). The wetlands sustain fisheries, provide landscapes for floodplain-recession agriculture, and attract tourists (Fox and Sneddon 2007).

#### *Dam Construction*

At least 30 dams with a storage capacity in excess of 12 MCM have been built for domestic, industrial, mining, irrigation, and power generating purposes (Heyns 2003; World Bank 2010). Almost 5,000 MW of hydropower has been developed in the Zambezi River Basin, with a total potential development of 13,000 MW (World Bank 2010). The countries with dams include Malawi (4), Mozambique (1), Zambia (6) and Zimbabwe (21), plus Kariba, which is on the Zambezi mainstem between Zambia and Zimbabwe.

Arguably, large dam construction has been the most influential physical change in altering the Zambezi River Basin and its hydropolitics. Many large dams have been constructed in the Zambezi Basin, with arguably the two most notable hydroelectric schemes being the Kariba the Cahora Bassa Dams on the Zambezi mainstem. Both dams have been used as political tools within the basin. In the following paragraphs, I will briefly detail the histories of these two dams, and demonstrate anecdotally how each of



these dams had profound impacts on Zambezi River Basin hydropolitics, and how these dams would not have registered at projected dam analyses in the past.

The first major dam built in the Zambezi River Basin fundamentally altered the basin's hydropolitics. The Kariba Dam has the largest reservoir by volume in the world (more than 180,000 Mm<sup>3</sup> at full supply level and fourth largest reservoir with respect to surface area (5,577 km<sup>2</sup>) (Beilfuss 2012). It was built amidst power struggles between British colonial interests. Since its construction, Kariba has been the main source of energy for the Zambian-Zimbabwean interconnected electricity supply system, supplying a monthly average of about 600 GWh, with an almost constant distribution throughout the year (Salewicz 2003).

The next major dam to be constructed in the Zambezi occurred further downstream. The Cahora Bassa Dam in Mozambique, when constructed, was praised by engineers and hydrologists for the dam's technical complexity and skill – at the end of its construction in 1974, it was the world's fifth largest hydroelectric power installation (Isaacman and Sneddon 2000). The dam's construction began while Mozambique was under colonial rule, but finished just six months after Mozambique gained its independence. Throughout its history, Cahora Bassa Dam has been used as a political tool by Mozambique (and the region's) political interests. Portuguese colonial officials described Cahora Bassa as an instrument that would lead to expanding irrigated farming, increasing mineral output, stimulating European settlement, facilitating communication and transportation throughout the Zambezi valley, and reducing flooding. They also argued that the dam would provide power to South Africa, giving

Mozambique much needed revenue that would spur further development (Isaacman and Sneddon 2000). On the other side of the debate, opponents of the dam contended that Cahora Bassa was an integral part of the strategic military and political alliance between Portugal and South Africa, which would then permit the latter to thwart advancing African nationalist forces (Ibid.). In areas near the dam site, FRELIMO (The Front for the Liberation of Mozambique), an organization leading a guerrilla campaign for Mozambique's independence, launched a series of attacks to subvert the scheme, claiming Cahora Bassa as a symbol and instrument of colonial oppression (Isaacman and Sneddon 2000). In a radical shift from its previous stance, the newly installed FRELIMO government rebranded the Cahora Bassa dam as a symbol of liberation that would lead to greater economic prosperity after Mozambique gained its independence, but in the 20 years following independence, first Rhodesian and then South African-backed RENAMO guerrillas sabotaged Cahora Bassa's power lines power lines to paralyze the dam and destabilize Mozambique's newly installed FRELIMO government (Isaacman and Sneddon 2000).

The construction of Kariba, Cahora Bassa, and other dams in the Zambezi Basin has had several biophysical and socio-economic impacts. The Zambezi delta, described as the "lifeline of central Mozambique" and "one of the most productive and biologically diverse tropical floodplains in Africa" has been adversely affected with reductions in wetland and tropical areas, infestations of stagnant waterways with non-local vegetation, and intrusions of saltwater since the dams have been constructed (International Crane Foundation n.d.). Tens of thousands of people were also

permanently displaced from their homelands during the construction of each dam, with the impacts still resonant in today's populations of the displaced and their descendants. In my interviews with surviving members of former Gwembe Tonga communities, they discussed how their community was split apart when Lake Kariba came into being, with some of their relatives now living in Zimbabwe. Farming was disrupted for many of the members; many Gwembe Tonga would rely on two growing seasons for food: flood-recession agriculture during the dry season as the Zambezi waters would recede on the riverbanks, and rain-fed agriculture during the rainy season in the highlands above the river. With the forced departure from the riverbank areas, many Gwembe Tonga reportedly starved, disease was more rampant, and economic opportunities were slim.

Nearly all of the Gwembe Tonga elders (people who were displaced during the construction of Kariba) that were interviewed for this paper mentioned the bounty of vegetables that were grown using floodplain-recession agriculture during the period before the dams; this was also cited by other elders in the Tete region of Mozambique who were displaced during the construction of the Cahora Bassa Dam (Isaacman and Sneddon 2000). Fish were also abundant – before Cahora Bassa, approximately 60 species of fish inhabited the Lower Zambezi (Jackson and Rogers 1976 in Isaacman and Sneddon 2000). Today, there is a limited fishing industry at the reservoir sites, but it is overfished, according to interviews conducted with villagers near the river. Isaacman and Sneddon (2000) noted, however, that is important to note how, in light of the enormous poverty which peasants in this region are experiencing today, there is a tendency to romanticize the period before the dams, and the accounts of relative food

security and prosperity in the regions before the dams should not be accepted uncritically.

*Hydropolitical Conflict and Cooperation in the Zambezi*

Riparians in the Zambezi River have engaged at various levels of cooperation throughout its history. While very few conflicts over water in the Zambezi have occurred solely among riparian states, most conflicts have occurred at the sub-national scale; this has most frequently occurred between state agencies and local communities who disagree over water resources projects (Fox and Sneddon 2007).

Hydropolitical cooperation within the Zambezi started in the early 1950s among British colonial governments. The first instance of hydropolitical cooperation occurred when the British colonial governments of Northern (present-day Zambia) and Southern Rhodesia (Zimbabwe) engaged in building the Kariba Dam to satisfy hydroelectricity demand from the copper mines in Northern Rhodesia and demand from the agricultural and mining sectors in Southern Rhodesia (Klaphake and Scheumann 2009). The Kariba Dam was built between 1953 and 1963 on the Zambezi River mainstem, which is the current border between Zambia and Zimbabwe. Northern and Southern Rhodesia established the Central African Power Corporation (CAPCO) to finalize construction work and operate the dam; a Higher Authority for Power, comprised of two ministers from each country, controlled and coordinated CAPCO's activities (Klaphake and Scheumann 2009). The CAPCO was abolished in 1987, with the Zambezi River Authority (ZRA) replacing CAPCO in its responsibilities to manage the Kariba Dam, established in parallel

legislation by the Zambian and Zimbabwean parliaments (Klaphake and Scheumann 2009).

This is not to imply that Zambian-Zimbabwean relations have been completely friendly and cooperative throughout its history. Independence movements in the 1960s changed the hydropolitical and geopolitical dynamics of the Zambezi. Malawi and Zambia, followed by Botswana, were the first independent Zambezi states. The white minority-ruled Rhodesia Front unilaterally declared independence for Rhodesia, which aided in developing a conflict regarding CAPCO's assets. The United Nations imposed mandatory economic sanctions against Rhodesia, which Zambia strictly observed – leading to what Mutembwa (1998, n.p.) classified as a “situation of non-recognition and acute hostility as the overall framework” between the two countries until Zimbabwe's 1980 independence. Relations were so strained that the Kariba Dam was at risk of being destroyed; Zambian President Kenneth Kaunda was forced to request the British government to send troops to guard the dam following reports that saboteurs on the Rhodesian government's payroll had been assigned to destroy it (Chenje 2003).

Attempts at basin-wide cooperation have been made for almost thirty years, with slow, incremental progress. The first basin-wide attempt at cooperative management over the Zambezi Basin was met with limited success. In 1987 the Southern African Development Community (SADC) developed the “Action Plan for the Environmentally Sound Management of the Common Zambezi River System” and initiated the Zambezi River Action Plan (ZACPLAN) to promote joint management of the water resources of the Zambezi River Basin (World Bank, 2010). The development of

ZACPLAN was influenced by the following: (a) the pre-existing cooperative framework between basin countries was rather sector specific (e.g., the agreement between Zambia and Zimbabwe over hydropower production of Kariba Dam); (b) the idea of integrated management of the entire river basin had not yet occurred to decision makers in the riparian countries; and (c) a framework was therefore needed to deal with the shared water resources in a coordinated and comprehensive manner to avoid future riparian conflict (Salewicz 2003). The ZACPLAN recognized not only the environmental aspects of international waters but also the need for transparency and public participation in their management (Bruch 2003). It was adopted by five riparian states of the Zambezi River<sup>15</sup> (Nakayama 2003), and consisted of 19 projects (called “Zambezi Action Projects”), none of which were implemented apart from ZACPRO 6, “Development of an Integrated Water Management Plan for the Zambezi River System”, due to a lack of political and financial commitment and organizational structures (Wirkus and Boege 2005, in Nakayama 2003). The ZACPRO 6 project did, however, result in the development of a database and the conduction of several studies (Klaphake and Scheumann 2009). To implement ZACPLAN, a River Basin Coordinating Unit and a Zambezi Intergovernmental Monitoring and Coordinating Committee were planned, but never came to fruition.

The ZACPLAN, while an important first step in basin-wide cooperation, was deeply flawed. Though the precise aim of the ZACPLAN was environmentally sound and coordinated management of the Zambezi basin, there were few (if any) efforts to

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<sup>15</sup> Botswana, Mozambique, Tanzania, Zambia and Zimbabwe.

manage its water resources in an integrated manner, not to mention the construction of additional dams in some countries (Salewicz 2003). Implementation of ZACPLAN was a slow-going process. Nakayama (2003, p. 101) wrote that, to his surprise, at the time of his writing the ZACPLAN was “still regarded as the guiding document of the basin” regarding an integrated management scheme of the entire basin with due emphasis of the environmental aspects. Perhaps Nakayama’s surprise was due to the inherent weaknesses of ZACPLAN. One example of ZACPLAN’s weaknesses is that it had no provision for resolving conflicts among riparian states (this was in part because political issues were to be addressed by the built-in mechanism of the Southern African Development Coordinating Conference (SADCC) (Nakayama 2003). The ZACPLAN was also lacking donor support. Though UNEP organized meetings for potential donors of funds for implementation of the ZACPLAN, only a few donor countries and international organizations participated in these meetings, without making any substantial pledge of funding; Nakayama (1997) suggested that this means that there was very limited interest in the ZACPLAN due to (a) donors already having good relations with the riparian countries and did not need the ZACPLAN as a “matchmaking” mechanism; (b) the ZACPLAN projects were too general to arouse the interest of donor countries and organizations, and (c) ZACPLAN was regarded as an “anti-South Africa” movement of South Africa’s bordering countries, which was not necessarily appreciated by donors, in particular by developed countries.

The ZACPLAN itself did not initiate basin-wide cooperation in the Zambezi, nor did the SADC Revised Protocol on Shared Water Course Systems (hereafter referred to

as the SADC Protocol), which was signed in 2000 and ratified by all 14 SADC states (including states outside of the Zambezi River Basin) (World Bank 2010). While the SADC Protocol is meant as a tool that enhances hydropolitical resilience by seeking to prevent interstate conflict over the use of transboundary waters (in all of Southern Africa – not just the Zambezi River Basin), there are some underlying weaknesses in its institutional capacity. Fox and Sneddon (2007) wrote that the SADC Protocol has no mechanism for preventing and addressing conflicts at the sub-state scale, nor does it recognize adverse social and ecological effects of river basin development, or make basin states surrender any autonomy, leading to environmental securitization at the expense of socio-ecological security. Article 4 of the Zambezi Protocol, however, contains provisions that stipulate an obligation to consult with or notify its riparian neighbors before implementing planned measures with “possible adverse effects” (SADC 2000).

Next came negotiations between riparians to establish a basin-wide organization starting in 1996, continuing with several rounds of negotiations in 2002 chaired by the SADC Secretariat (Klaphake and Scheumann 2009). To help spur the birth of ZAMCOM, the ZACPLAN process was revised in October 2001 through the launch of ZACPRO 6, Phase II Project (World Bank 2010). After more than a decade of negotiations (Munjoma 2004), ZAMCOM was signed by seven of eight riparian countries in 2004<sup>16</sup> (World Bank 2010). Zambia, the only basin country not to sign, still has not signed, yet announced its intention to do so in 2013 (ZAMCOM 2013). According to the World Bank (2010), Zambia has delayed signing to await the conclusion of the policy reform process and

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<sup>16</sup> The DRC is not included in the World Bank’s count of riparian countries in the Zambezi River Basin.



institutional alignments. Motivated by a recent economic recovery, the riparian countries were eager to develop the basin's resources and viewed a basin-wide agreement as a tool for strengthening political relationships and attracting investment and donor support throughout the basin (Subramanian, Brown, and Wolf 2012). In July 2009, in the absence of a ratified agreement, Zambezi Basin ministers responsible for water adopted an interim ZAMCOM governance structure, and agreed upon the establishment of an interim secretariat in Gaborone, Botswana (World Bank 2010). The organization officially came into force in 2011 (ZAMCOM 2013).

*Current Status in the Zambezi*

More recently, Mozambique, Zambia, and Zimbabwe have made incremental progress in data sharing and exchanging information regarding hydrologic data for the Zambezi River Basin, though according to a Zambian official, collaboration started as early as 1999. Though cooperation may not be strictly codified, according to a Mozambican official, Zambia and Zimbabwe notifies Mozambique about releases of water from their reservoirs. Government officials that I interviewed in both Mozambique and Zambia were both in favor of further exchanges of hydrologic information, especially the furthest-downstream riparian, Mozambique. Basin countries are discussing the implementation of a "Flood Forecasting and Early Warning System Strategy" in partnership with the World Meteorological Organization and the United States Agency for International Development (ZAMCOM 2012).

Even with the ZAMCOM agreement in effect, there still are significant potential barriers for effective basin-wide cooperation within the Zambezi Basin. Chenje (2003)

identified prevailing constraints in the Zambezi Basin working against hydropolitical cooperation:

- Climate, including water distribution and drought;
- Rapid population growth, averaging 2.9 percent annually;
- Poverty;
- Limited options for further supply-side projects;
- Weak legal and institutional framework, including monitoring and enforcement;
- Centralized management systems, including fragmented water-management approaches and institutions;
- Lack of comprehensive knowledge of the water resources available;
- Pollution of the water resources available.

Chenje (2003) wrote that of all natural phenomena regularly affecting the Zambezi, drought is the “single most crucial disaster to affect the Zambezi basin.” Year-to-year rainfall variability is high across the basin, with drought occurring every 10-15 years (Chenje 2003).

#### *Projected Climate Variability*

While Angola and Zambia are predicted to have more adequate water supplies for the future, the rest of the basin is either currently facing shortages or are predicted to face shortages in the coming decades. Namibia has no perennial inland rivers and has great difficulty in mobilizing available water to meet current demand; Botswana relies on groundwater (which is insufficient to meet the demand of its growing population), and while Mozambique, Tanzania and Zimbabwe currently have “reasonable water

resources”, they are predicted to suffer water stress by 2025 (Chenje 2003). Beilfuss (2012) listed key risks to the Zambezi River Basin over the next century, based on the average of diverse climate models:

- A significant warming trend of 0.3 to 0.6° C;
- Increases in open-water evaporation due to temperature increases across the basin;
- Multiple studies cited by the IPCC estimate decreases in rainfall across the basin by 10-15%;
- Significant changes in the seasonal pattern of rainfall across the basin are predicted, including changes in timing, duration and intensity;
- Significant reductions of average annual stream flow; multiple studies estimate that runoff of the Zambezi will decrease by 26-40% by 2050;
- Increasing water stress in semiarid parts of the Zambezi Basin.

Both the significant changes in seasonal rainfall patterns and increasing water stress in semiarid parts of the Zambezi Basin align with the results of the World Bank projected water variability data.

#### *Future Infrastructure Possibilities/Hydropolitical Hotspots*

Perhaps the most pressing matter at hand in the Zambezi Basin is the potential collapse of Kariba Dam, where it has been reported that the dam wall has developed “serious structural weaknesses” and was on the verge of collapse (Warhoose 2014). If

the dam was to collapse, at least 3.5 million people would be in danger downstream (Warhoose 2014).

On the eastern side of the basin, the land-locked countries of Malawi and Zambia are very interested in using the Zambezi waterway as a cheap transport route for importing and exporting goods. It was reported that the three nations signed a trilateral memorandum of understanding on this project in April 2007 (Inter Press Service 2007). The project calls for the construction of a port at Nsanje in Malawi, expanding and modernizing the port of Chinde, Mozambique, and dredging the Shire-Zambezi waterway (Inter Press Service 2007). Through the SADC Secretariat, the three governments have received a grant from the African Development Bank to conduct a feasibility study for this project (SADC 2012). This has been put on hold, as it was reported that Mozambican authorities refused to allow barges up to Nsanje (Nyasa Times 2012). Now, it appears that the port remains idle, after the Malawian government reportedly grabbed land from 300 farmers for the port (IRIN 2012).

Though there are now a limited number of viable dam sites within the basin (Chenje 2003) as most readily accessible and easily exploitable dam sites, a few potential dam sites are worth mentioning as they might alter the basin's hydrological resilience. Mozambique's construction of the Mphanda Nkuwa Dam, while providing the country with an additional source of hydroelectric power, will make it difficult for water ministers and managers in the Zambezi basin to ameliorate the aforementioned negative hydrological and ecological impacts of the large dams upstream. While some of the power generated from Mphanda Nkuwa will be used within Mozambique for rural

electrification and domestic industries, the vast majority will be sold to nearby states, most prominently South Africa (Fox and Sneddon 2007). Another dam site would be Batoka Gorge. The Batoka Gorge hydropower scheme between Zambia and Zimbabwe is another potential area for dam construction, and has been identified in the past as a potential ‘hydropolitical hot spot’ (Boege 2009). It has been reported that both governments approved its construction in 2012 (Lusaka Voice 2013). One can hope that the Zambezi governments have learned from the mistakes of their colonial predecessors in building dams. Yet, it is likely that the construction of more dams will lead to significant impacts felt both within the country and downstream.

The Zambezi is undergoing what Mutembwa (1998) classifies as a “dramatic swing” from developing non-consumptive uses (mainly hydroelectric power generation) to consumptive uses. This includes water transfers, such as the project supplying water to Botswana and South Africa from the Zambezi (Boege 2009) and the planned transfer of water from the Zambezi to Bulawayo, and the expansion of irrigation across the basin. The Gwayi-Shangani dam is the first step of a larger project to divert water from the Zambezi River to Bulawayo, Zimbabwe (Fox and Sneddon 2007) in the Matabeleland Zambezi Water Project. The second phase would involve the connection of the dam to a Bulawayo pipeline; the project will be complete when the project is connected to a pipeline to the Zambezi River (Tuso 2013). But, China International Water and Electric, which was contracted by the Zimbabwean government to construct the Gwayi-Shangani Dam, reportedly will not meet the 2015 deadline for completion due to shortage of

funds (Tuso 2013). This project is also of interest due to Zambia's previous opposition of this project (MISA 2010), and ZAMCOM's subsequent approval (Tshuma 2011).

The Matabeleland Zambezi Water Project is just one of a few large proposed water diversion projects in the Zambezi River Basin. It was reported that Botswana, while only owning 200 meters of riverfront riparian to the Zambezi, recently received approval from ZAMCOM to build a water transfer scheme of 495 million cubic meters per year of raw water (Creamer Media Reporter 2014). South Africa has also created a large water diversion plan, called the Zambezi Africa, to withdraw water over 1,200 km from the Zambezi through Botswana to Pretoria (Swain 2012).

### *Summary*

Through tracing the hydropolitical history of the Zambezi River Basin, we have seen how development in the form of dams and water diversion projects has dramatically changed (and will continue to dramatically change) the basin. We have seen an overall trend towards cooperation on the basin scale, which is especially evident with the formation of ZAMCOM. However, there are several areas of potential conflict looming for the Zambezi: disagreements over ZAMCOM's governance structure, water transfer projects both inside and outside of the basin, navigational rights, and increased economic development and populations, bringing with it the potential for future water scarcity. This list is incomplete, of course, without the increased likelihood of water variability due to climate change.

Tracing the history makes my analysis of the basin more complete. The scores from the indices I use paint a partial picture of the Zambezi Basin, but without the

nuance that the history brings, it is hard to see what these scores actually mean and whether these scores paint a *correct* picture. In the discussion section, I discuss each indicator and whether each score accurately reflects the hydropolitical resilience within the Zambezi.

## **Discussion**

I used social, physical, and political indicators to measure hydropolitical resilience for the Zambezi River Basin on both a global and basin-wide scale. Using the global scale, the social indicators suggested low hydropolitical resilience on the whole for Zambezi basin countries, while the physical indicators proved to have more mixed results. Regarding its treaty coverage, the results of the global analysis state that the Zambezi has high institutional capacity, indicating higher hydropolitical resilience in that regard. But do these results match the realities on the ground?

### *Factors that may Enhance Resilience*

Both social indicators used in the global analysis, the Human Development Index and the Human Security Index, showed low scores for most Zambezi countries. These results imply that most countries within the Zambezi are, on the whole, less “developed” and less “secure” compared to its counterparts. In terms of hydropolitical resilience, these scores could be interpreted in a number of ways. The low scores could indicate low political stability within basin countries, possibly leading to greater likelihoods of intra-riparian and inter-riparian conflict. Also, these low scores could imply that the Zambezi is potentially vulnerable to water transfers outside of the basin. This may particularly ring true as the most powerful economy in sub-Saharan Africa,

South Africa, has the Zambezi Aqueduct plan that would divert water from the Zambezi into Gauteng Province (Swain 2012). The relative wealth of Botswana as the richest country in the basin may also influence basin dynamics through water transfers to that country.

One significant flaw of using these indices as potential bellwethers of hydropolitical resilience is the lack of scale. Even if a BCU's HDI and HSI scores are relatively low, the scores may not accurately reflect the HDI or HSI of the entire BCU. My observations within the basin is that there appeared to be a lot of economic growth in and near the major cities, with more poverty in rural areas. For example, Lusaka, Zambia, had the appearance of economic growth, while the Mazulu village area in Zambia (home of the Zambian Gwembe Tonga people displaced by the Kariba Dam and reservoir) appeared to have very little economic growth and rampant poverty. If that observation holds, it would show that social stability is much more diverse than a single value for a BCU would imply.

According to the indicators used to measure institutional capacity, the Zambezi River Basin has a high score due to ZAMCOM officially coming into force, and that ZAMCOM has mechanisms for allocation, conflict resolution, and variability management. The problem with this assessment is that the mere *presence* of these mechanisms does not equate with their *effectiveness*. Klaphake and Scheumann (2009, p. 67) argued that the Zambezi basin is an example of “successful harmonious or symmetrical cooperation issues, which transformed into strong organizational forms of regional cooperation.” This statement appears to be based largely on the operations of



the ZRA as opposed to a basin-wide perspective. I disagree with this assertion, as one bilateral cooperative entity and a newer, weak basin-wide organization does not necessarily make for strong regional cooperation. The SADC Protocol may be strong, but ZAMCOM itself is untested.

Part of my questioning of ZAMCOM's effectiveness is connected to Zambia's lack of formal participation. As I stated earlier, Zambia has not officially signed the ZAMCOM agreement (though it has announced its intention of doing so). It has been documented that Zambia would like greater power within the ZAMCOM framework than other riparians due to its majority share of the Zambezi's land area and highest share of water resources. It appears that Zambia has also expressed reluctance at the prospect of entering the basin framework due to how they perceive it would compromise their development plans. It seems that the other countries are hopeful for Zambia to join; the first Interim Secretariat is of Zambian origin. Pearce (2013) compared Zambia's lack of joining ZAMCOM to China's absence in the Mekong Basin Commission, in that both basin organizations are disadvantaged by missing the biggest and most upstream countries in each respective basin.

Perhaps this lack of participation is hurting Zambia's interests, especially considering how Zambia has sought capital to pursue large-scale economic development projects (Subramanian, Brown, and Wolf 2012). Zambia has also not supported Zimbabwe's water transfer project to Bulawayo. Now that ZAMCOM is in effect, it has been reported that ZAMCOM has voted to approve the project (Tshuma 2011) despite

Zambia's disapproval. It seems that by not being a full member of ZAMCOM, Zambia is losing its ability to influence the hydropolitical agenda of the Zambezi at large.

Though the establishment of ZAMCOM points towards a more hydropolitically resilient future, it remains to be seen whether this organization will make strides towards more effective management of the basin's water resources. Swain (2012) cited how major basin countries who have shown their willingness to be part of ZAMCOM have very little interest in joint river management, and that their chief motivation for joining ZAMCOM is primarily guided by expected international support for their planned unilateral water projects.

*Factors that may Decrease Resilience*

Results from the Sen's slope calculations for water scarcity tell a story that on the whole, the basin has not suffered from water scarcity within recent years. This knowledge cannot be applied to a much smaller scale. With a 1° resolution, the GRACE data may tell us the larger story but leave out more localized drought areas – such as the droughts that Bulawayo, Zimbabwe, has had in the last decade. This is especially notable as the planned Matabeleland Zambezi Water Project is meant to directly remedy Bulawayo's chronic water shortages, and the project itself is controversial within the basin, impacting the hydropolitical resilience of the basin as a whole. If one just relied on this coarse data to assess the Zambezi's water scarcity, that nuance would have been lost.

Potential dam development is indicated to be low to medium within Zambezi BCUs when compared to others. This measurement gives a good indicator for how much

the river basin may change in a particular BCU, but not all dams are created equally. The Batoka Gorge Dam is planned to be built with the cooperation of both Zambia and Zimbabwe; presumably with two countries cooperatively building a dam, it lessens the controversy basin-wide. In contrast, Zimbabwe's construction of the Gwayi-Shangani Dam will inevitably prove to be more controversial due to its role in the Matabeleland Zambezi Water Project. Also, calculating the dam densities of these BCUs does not capture the significant changes that may be felt by displaced populations and ecosystems downstream. Measuring the dam density also does not present a full inventory of any dam's impacts; a dam the size of Cahora Bassa or Kariba has profoundly greater impacts than a dam with 5 MW of capacity. Also, one is likely to care most about the dam that lies directly upstream, as that dam will have the most direct impacts. One of the few exceptions to this would be if there was a dam downstream that was stopping fish from migrating upstream.

It is obviously impossible to verify the results of the World Bank study at the present. With that being said, residents of the basin are already noticing the effects of climate change; in my interviews, many mentioned the change of the timing and intensity of the rainy seasons.

## **Conclusion**

This paper has performed a global analysis of hydropolitical resilience in transboundary river basins, as well as performed an in-depth look at the hydropolitical resilience of the Zambezi River Basin. It has found that while the Zambezi Basin may be

perceived as an area of higher political resilience (and higher physical resilience, according to some indices) through a global analysis, the details found at the basin scale may not match the larger story at hand. The indicators written about in this paper are instructive for a larger story of comparative resilience between BCUs. With that being said, these comparisons are fairly limiting in certain regards. Scoring by BCU treats each BCU (and river basin, for that matter) as a “closed system.” The reality, of course, is that even though a river basin on the surface is bound by physical boundaries, these boundaries are permeable and activities outside the river basin may heavily influence the hydropolitics within. The same goes for political boundaries.

Policy makers should be attuned of the huge amount of poverty nearest the Zambezi, especially among the populations of people who have been displaced and their descendants.

The ecological consequences of the dams are not to be taken lightly – they greatly affect the resilience of the entire river basin. New dams could also affect the tourism industry in the Zambezi – for example, Batoka Gorge, as well as Victoria Falls, the Mana pools and Lake Kariba, received over 1.5 million visitors a year at its peak, with most going to the Falls and Batoka (Machena and Maposa 2013).

Functional basin-wide cooperation is, and will continue to be an ever-slow-going, incremental process. Considering the facts that ZACPLAN, a weakly enforced action plan, was considered to be the “guiding document” of basin management after 16 years of its initiation, and that the negotiations on the establishment of ZAMCOM took over a decade to be concluded, suggests that functional and successful basin-wide

management will continue to move at a sluggish pace within the Zambezi. The growth rate of the Zambezi Basin's institutional capacity may not match the rate of change that nations in the Zambezi are currently facing, in a socioeconomic, biophysical and geopolitical manner.

Of course, this analysis has its limitations. With over 40 million people, eight countries, and thousands of plant and animal species, it is impossible to incorporate all of the variables that may influence hydropolitical resilience within this system. No analysis will be able to do so. But, again, while the global analysis may point towards basins and BCUs of low hydropolitical resilience, hydropolitical resilience may not truly be understood without delving into its history.

In conclusion, this paper adds to the conversation of how to project hydropolitical resilience and the means and approaches with which to do it. While I am not suggesting that chronicling a basin's hydropolitical history and interviewing a miniscule fraction of basin stakeholders, policy makers, and government officials is the best means with which to measure hydropolitical resilience, I am merely positing that more nuanced approaches to measuring hydropolitical resilience are needed at the basin (and basin-country) scale.

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## CHAPTER V. RESULTS, DISCUSSIONS, AND CONCLUSIONS

This dissertation has tried to answer the following questions:

1. By which practices might development partners best design and implement collaborative projects in their absolute earliest stages?
2. How well do the steps for initiating cooperation mentioned in literature (data exchange, scientific collaboration) work in practice?
3. Does the rate of dam construction in transboundary basins exceed that of national basins?
4. Does the rate of dam construction in transboundary water not covered by an agreement exceed that of transboundary waters covered by transboundary agreements?
5. What regional variation can be evidenced in dam construction rates in national basins, transboundary waters covered by agreements, and transboundary waters not covered by agreements?
6. How does the dam distribution in the presence of a transboundary water agreement differ spatially from the dam distribution in the absence of a transboundary water agreement?
7. The Zambezi River is a transboundary socio-hydrological system currently functioning across international borders in a state of relative peace. What variables or combination of variables—internal and external, current or legacy—could serve to push the Zambezi system over the threshold into conflict?

8. What is added by analyzing hydropolitical resilience at both the global and basin scale?

In this section, I will describe the results I found trying to answer these questions. This will be followed by a discussion of what those results mean, as well as overall conclusions for the dissertation.

### **Results of the Appended Papers**

In Paper I, the objective was to identify which practices development partners may best design and implement collaborative projects in their absolute stages, as well as to determine how well the steps for initiating cooperation mentioned in literature work in practice. The section presents a brief summary of each case study. The review highlighted the need for further discussion around four distinct themes: jurisdiction, project design, stakeholders, and negotiating. More details will be found in the Discussion section of this chapter.

Paper II's objective was to answer the following four questions: i) Does the rate of dam construction in transboundary basins exceed that of national basins?, ii) Does the rate of dam construction in transboundary water differ due to the presence of an agreement?, iii) What regional variation can be evidenced in dam construction rates in our three types of basins?, and iv) What are the spatial differences between dam distribution in the presence of a transboundary water agreement and the dam distribution in the absence of a transboundary water agreement? We found that, overall, the normalized rate of large dam construction is slightly higher in national basins than transboundary basins in our dataset. We also found that the rate of

construction in BCUs with a transboundary water agreement is higher than in BCUs without an agreement. Stratifying dam construction rates by continent reveals a lack of uniformity in rates across regions (Table 1). Diverging from global findings, construction rates in Asia and South America are greatest in national basins; in Africa, construction rates in transboundary BCUs not covered by an agreement are greatest. Consistent with global findings, Europe and North America have much higher rates of construction in BCUs with an agreement than in BCUs without an agreement and in national basins. Aggregated evidence on dam construction in transboundary waters of North America is heavily influenced by data from the Mississippi River Basin, which possesses most of the continent's dams and an applicable agreement since 1909. For our fourth analysis, we found that the formation of agreements appears to foster more equitable, distributed dam developments (see Table 2 in Paper II). Whereas pre-agreement dam construction is most concentrated in upstream areas, post-agreement downstream construction is far more balanced throughout river basins, with all three portions having higher rates of post-agreement construction.

Although somewhat tangential to the core questions of Paper II's analysis, a finding unearthed through our work relates to the precise extent of the growth in area covered by transboundary water agreements. Whereas less than 40% of the area in transboundary basins was covered by an agreement in 1950, 68% of land located within transboundary river basins is currently covered under a transboundary agreement (see Figure 4 in Paper II).

Paper III found that the Zambezi Basin countries, through the global analysis, have low scores for both the Human Development and Human Security Indices, high treaty coverage, positive water storage according to the GRACE data, low to medium projected dam densities, and high predicted runoff variability. When examining the Basin's history, however, I argue that while the global analysis highlights areas of concern, it masks realities on the ground – not every dam will have the same transboundary impact; the Gwayi-Shangani Dam will invariably have a larger impact than other proposed dams, as it is the first step a larger project to divert water from the Zambezi River to Bulawayo, Zimbabwe (Fox and Sneddon 2007) in the Matabeleland Zambezi Water Project; a project that has been historically opposed by Zambia. Meanwhile, Mozambique's proposed Mphanda Nkuwa hydropower scheme will likely have minimal transboundary impacts, as Mozambique is the furthest downstream riparian.



## Discussion

Paper I's discussion is built mostly on what has been learned from our in-depth qualitative analysis of the chosen case studies. The review has highlighted the need for further discussion around four distinct themes: jurisdiction, project design, stakeholders, and negotiating.

### *Jurisdiction*

A balance of autonomy and cooperation within a project design can foster success where each riparian is allowed to assume responsibility for the continuation of one of a project's primary activities, as was seen in the Aquifer Management in South America case. While each country's interdependence on a shared resource must be acknowledged, each country's autonomy must be respected. In order to respect this, it was advised that riparians should not be pushed toward ceding authority to a basin-wide (or aquifer-wide) agency for the Aquifer Management in South America and Improved Management of Water Resources in Central Asia cases. These lessons culled from the case studies align with Subramanian, Brown, and Wolf (2012)'s writings about the risk of sovereignty and autonomy when nations consider initiating cooperation. The autonomous nature of the riparian teams in carrying out activity tasks can help bridge gaps in the collaboration process. Since government officials in the riparian countries are the decision makers in any action, however, they should be informed about watershed activities and recommendations, which was also stressed by Norman and Bakker (2005).

When it comes to timing, it is never too early to get started with the cooperation process. No matter when the process begins, there is always some existing knowledge of the river and its people, and this knowledge can inform stakeholders and decision makers. Plus, implementation of an agreed desired river state and environmental flow is a long and complex task. Time is needed to help alleviate what Subramanian, Brown, and Wolf (2012) coined as the capacity and knowledge risk. Governments, scientists, and stakeholders (including local subsistence users of the river) must work together as a team to achieve truly sustainable use of the river; this speaks to Blomquist and Ingram (2003)'s highlighting of building institutional capital as a key element in transboundary water management.

The creation of a longer term, stable and mutually beneficial framework for cooperation, such as a bilateral commission between two riparians, can foster more prudent mechanisms for regional governance. Specifically, the establishment of a basin commission is cited as a motivator for other international organizations to provide assistance to the basin water authorities in the Creating a Transboundary Water Commission in Central Asia case.

### *Project Design*

Along with respecting each nation's autonomy in jurisdictional matters, giving each project partner responsibility for certain activities allows for more ownership within each of a project's tasks. Building a scientific team from different partner nations appears to be a very successful activity, as noted in the Water Management System in the Southern Balkans and Improving Basinwide Relations in the Middle East cases,

allowing for knowledge transfers between teams and creating a building block for cooperation in future projects. This was one of the elements of the cooperation process cited by Feitelson and Haddad (1998) that were recommended for successful cooperative efforts.

For initial cooperative activities, a basin-wide integrated flow assessment should be done at the earliest possible stage of water resources planning, so that a fair trade-off between development and river protection can be agreed upon, as noted in the Climate Change Modeling and Stakeholder Preparedness in East Africa case. This should then guide all future water-management decisions for the river. Data sharing also appears to be a good starting point for fostering cooperation among riparians. These initial cooperative activities correlate with Feitelson and Haddad (1998)'s and Uitto and Duda (2002)'s writings.

This act of building a basin-wide network of senior and young scientists may be used in future activities, as noted in the Water Management Systems in the Southern Balkans case. Again, this is an example of building institutional capital, mentioned by Blomquist and Ingram (2003) as important to success in transboundary water management. Once this network is established, using this spirit of cooperation among the riparian experts is an effective means of producing a valuable source of data.

Effectively managing change to physical components of a river system requires equal consideration of the social system. If the flow regime of a river changes then the river ecosystem will change in response. People might feel positive and/or negative impacts. To manage the change ecological and social issues in a structured and agreed

way need to be automatically included into water-resource management plans so that the future implications can be understood and an acceptable future chosen. Having these socio-economic and environmental syntheses, as well as having related workshops and the setting up of national steering committees, was cited as instrumental in broadening the scope of the project stakeholders by involving ministries which were not part of the Aquifer Protection in North Africa project's initial decision-making process. This was also recommended in the Climate Change Modeling and Stakeholder Preparedness in East Africa case.

### *Stakeholders*

Consultation with a "wide array of stakeholders" could reveal further scenarios of interest to the basin population at large, as was found in the Aquifer Protection in North Africa and Climate Change Modeling, Stakeholder Preparedness in East Africa, and Reducing Transboundary Degradation in the Caucasus cases. It was found that a qualitative stakeholder assessment may be a key to the project's success. It may enable the project to obtain an initial assessment of stakeholder concerns, especially those who are underrepresented or not represented in official capacities. Performing a qualitative stakeholder assessment, especially with traditionally underrepresented groups, provides a significant amount of support for transboundary diagnostic assessment development in the Reducing Transboundary Degradation in the Caucasus case. Local stakeholder involvement has the potential to be a strong guiding force in the project's development and implementation. Of course, it may be advisable to clarify with governments and

hosting organizations the nature of a qualitative stakeholders' assessment, so as to avoid misunderstandings and different expectations for this component.

In designing certain projects due consideration should be given to (i) stakeholders' commitment and ownership to avoid implementation delays, (ii) engagement of mature international consultants with good record of regional experience to avoid promotion of blue-print solutions; and (iii) development of a longer-term vision to ensure consistent support, as was noted in the Improved Management of Water Resources in Central Asia case.

### *Negotiating*

The first task of water negotiations between particularly hostile riparians may be simply to get individuals together talking about relatively neutral issues, which could be part of what Wolf (1995) refers to as the 'bargaining mix.' Successful negotiations might include an eventual simultaneous narrowing and broadening of focus, to move from the neutral topics necessary in early stages of negotiation to dealing with the contentious issues at the heart of a water conflict. This was also cited by Waage (2005), when this occurred during the Israeli-Palestinian negotiation of the Oslo Accords. Concepts of integrated water management may also be included.

In attempts at resolving particularly contentious disputes, solving problems of politics and resource use is best accomplished in two mutually reinforcing tracks, cited in examples by Waage (2005) and Qaddumi (2008). Of course, Track Two dialogues lose much of their utility if there is no mechanism for feeding ideas generated into the main negotiating track.

Paper II found three major findings. A first major finding is that – contrary to expectations – dam construction rates are greater in national basins than transboundary basins. The second major finding is that –contrary to expectations– dam construction rates in areas of transboundary basins with an agreement exceeds dam construction rates in areas of transboundary basins without an agreement. Thirdly, consistent with expectations, agreement formation appears to foster more equitable dam distribution across the river basin. At a more minor level, the paper also identified that i) temporal patterns of dam construction in national basins and areas of transboundary basins with an agreement broadly mirror each other, and ii) dam construction trends in Africa, Asia and South America diverge from globally-aggregated evidence.

Paper II's first finding that dam construction rates are slightly greater in national basins is inconsistent with prevailing hypotheses related to environmental resources with unclear property rights. Hardin (1968) pointed to commonly accessible natural resources as contributing to a tragedy of overexploitation, for example, and Giordano (2003) suggested that a commons problem of over-development was likely to occur from the international nature of transboundary water resources. The results of our work provide evidence to the contrary.

The paper's second major finding that dam construction rates are greater in areas covered by transboundary agreements conflicts with theories found in some previous literature. Ostrom et al. (1999), Marothia (2003) and Anderies and Janssen (2013) all asserted that institutions prevent overuse and overexploitation of natural

resources. However, evidence presented in this paper shows that the presence of institutions correlates with accelerated dam construction on transboundary waters.

The paper's third major finding that agreement formation appears to foster more equitable dam distribution across the river basin is consistent with prevailing thought. Logic contained in theories outlined above (e.g., Giordano 2003) point to greater incentive for upstream development in the absence of an agreement: upstream countries can capture benefits and pass costs downstream without an agreement, whereas the conclusion of an agreement is likely to spur need for greater sharing of benefits and hence less direct benefit accruing to upstream riparians. Indeed, evidence suggesting that agreements foster a style of development that minimizes negative externalities (e.g.; Dinar 2006; Drieschova, Giordano, Fischhendler 2009; Fischhendler, Dinar, and Katz 2011) is consistent with the more distributed development evidenced in basins covered by agreements. The paper found that there was greater upstream development in the absence of an agreement. This finding suggests that upstream countries may not be afraid of political costs to unilateral development, as suggested by some (e.g., Daoudy 2009), though it should be pointed out that greater development throughout the basin occurred after an agreement was signed.

Finally, greater construction rates in national basins in Asia and South America, and transboundary BCUs without agreements in Africa, trigger broader questions about factors that explain the divergence in dam construction patterns in these regions. The reality is that these regions are overwhelmingly comprised of developing countries. While the precise explanation of the different transboundary water dynamics evidenced

in developing countries is unclear, one might speculate that requirements associated with international financing for dam construction in transboundary waters may play some role in the trends evidenced.

Paper III found that using the global scale, the social indicators suggested low hydropolitical resilience on the whole for Zambezi basin countries, while the physical indicators proved to have more mixed results. Regarding its treaty coverage, the results of the global analysis state that the Zambezi has high institutional capacity, indicating higher hydropolitical resilience in that regard. But do these results match the realities on the ground?

*Factors that may Enhance Resilience*

Both social indicators used in the global analysis, the Human Development Index and the Human Security Index, showed low scores for most Zambezi countries. These results imply that most countries within the Zambezi are, on the whole, less “developed” and less “secure” compared to its counterparts. In terms of hydropolitical resilience, these scores could be interpreted in a number of ways. The low scores could indicate low political stability within basin countries, possibly leading to greater likelihoods of intra-riparian and inter-riparian conflict. Also, these low scores could imply that the Zambezi is potentially vulnerable to water transfers outside of the basin. This may particularly ring true as the most powerful economy in sub-Saharan Africa, South Africa, has the Zambezi Aqueduct plan that would divert water from the Zambezi into Gauteng Province (Swain 2012). The relative wealth of Botswana as the richest



country in the basin may also influence basin dynamics through water transfers to that country.

One significant flaw of using these indices as potential bellwethers of hydropolitical resilience is the lack of scale. Even if a BCU's HDI and HSI scores are relatively low, the scores may not accurately reflect the HDI or HSI of the entire BCU. My observations within the basin is that there appeared to be a lot of economic growth in and near the major cities, with more poverty in rural areas. For example, Lusaka, Zambia, had the appearance of economic growth, while the Mazulu village area in Zambia (home of the Zambian Gwembe Tonga people displaced by the Kariba Dam and reservoir) appeared to have very little economic growth and rampant poverty. If that observation holds, it would show that social stability is much more diverse than a single value for a BCU would imply.

According to the indicators used to measure institutional capacity, the Zambezi River Basin has a high score due to ZAMCOM officially coming into force, and that ZAMCOM has mechanisms for allocation, conflict resolution, and variability management. The problem with this assessment is that the mere *presence* of these mechanisms does not equate with their *effectiveness*. Klaphake and Scheumann (2009, p. 67) argued that the Zambezi basin is an example of "successful harmonious or symmetrical cooperation issues, which transformed into strong organizational forms of regional cooperation." This statement appears to be based largely on the operations of the ZRA as opposed to a basin-wide perspective. I disagree with this assertion, as one bilateral cooperative entity and a newer, weak basin-wide organization does not

necessarily make for strong regional cooperation. The SADC Protocol may be strong, but ZAMCOM itself is untested.

Part of my questioning of ZAMCOM's effectiveness is connected to Zambia's lack of formal participation. As I stated earlier, Zambia has not officially signed the ZAMCOM agreement (though it has announced its intention of doing so). It has been documented that Zambia would like greater power within the ZAMCOM framework than other riparians due to its majority share of the Zambezi's land area and highest share of water resources. It appears that Zambia has also expressed reluctance at the prospect of entering the basin framework due to how they perceive it would compromise their development plans. It seems that the other countries are hopeful for Zambia to join; the first Interim Secretariat is of Zambian origin. Pearce (2013) compared Zambia's lack of joining ZAMCOM to China's absence in the Mekong Basin Commission, in that both basin organizations are disadvantaged by missing the biggest and most upstream countries in each respective basin.

Perhaps this lack of participation is hurting Zambia's interests, especially considering how Zambia has sought capital to pursue large-scale economic development projects (Subramanian, Brown, and Wolf 2012). Zambia has also not supported Zimbabwe's water transfer project to Bulawayo. Now that ZAMCOM is in effect, it has been reported that ZAMCOM has voted to approve the project (Tshuma 2011) despite Zambia's disapproval. It seems that by not being a full member of ZAMCOM, Zambia is losing its ability to influence the hydropolitical agenda of the Zambezi at large.

Though the establishment of ZAMCOM points towards a more hydropolitically resilient future, it remains to be seen whether this organization will make strides towards more effective management of the basin's water resources. Swain (2012) cited how major basin countries who have shown their willingness to be part of ZAMCOM have very little interest in joint river management, and that their chief motivation for joining ZAMCOM is primarily guided by expected international support for their planned unilateral water projects.

*Factors that may Decrease Resilience*

Results from the Sen's slope calculations for water scarcity tell a story that on the whole, the basin has not suffered from water scarcity within recent years. This knowledge cannot be applied to a much smaller scale. With a 1° resolution, the GRACE data may tell us the larger story but leave out more localized drought areas – such as the droughts that Bulawayo, Zimbabwe, has had in the last decade. This is especially notable as the planned Matabeleland Zambezi Water Project is meant to directly remedy Bulawayo's chronic water shortages, and the project itself is controversial within the basin, impacting the hydropolitical resilience of the basin as a whole. If one just relied on this coarse data to assess the Zambezi's water scarcity, that nuance would have been lost.

Potential dam development is indicated to be low to medium within Zambezi BCUs when compared to others. This measurement gives a good indicator for how much the river basin may change in a particular BCU, but not all dams are created equally. The Batoka Gorge Dam is planned to be built with the cooperation of both Zambia and

Zimbabwe; presumably with two countries cooperatively building a dam, it lessens the controversy basin-wide. In contrast, Zimbabwe's construction of the Gwayi-Shangani Dam will inevitably prove to be more controversial due to its role in the Matabeleland Zambezi Water Project. Also, calculating the dam densities of these BCUs does not capture the significant changes that may be felt by displaced populations and ecosystems downstream. Measuring the dam density also does not present a full inventory of any dam's impacts; a dam the size of Cahora Bassa or Kariba has profoundly greater impacts than a dam with 5 MW of capacity. Also, one is likely to care most about the dam that lies directly upstream, as that dam will have the most direct impacts. One of the few exceptions to this would be if there was a dam downstream that was stopping fish from migrating upstream.

It is obviously impossible to verify the results of the World Bank study at the present. With that being said, residents of the basin are already noticing the effects of climate change; in my interviews, many mentioned the change of the timing and intensity of the rainy seasons.

## Conclusions

In this summary chapter, I have provided an overview on best practices for designing and implementing collaborative water projects in the earliest stages. I have examined in depth the relationship of dam construction (which may act to exacerbate and/or facilitate hydropolitical resilience in transboundary river basins) and the presence of international water agreements. I have also analyzed a case study where both elements of the previous two papers are present; the Zambezi River Basin, where basin-wide cooperation is at its initial stages and where dam construction may exacerbate or relieve tensions between riparians.

The results of my dissertation support the notion that multi-scalar analysis for ascertaining lessons and recommendations to follow in international water cooperation and development is useful, if not crucial, for a more complete understanding of the world's water problems. While transboundary river basins all share commonalities, the very nature of river basins is so dependent on its geography that all general principles in transboundary water cooperation and management need to be considered within the basin's bio-physical, socio-economic, and geopolitical dimensions. Indeed, as Gilbert White aptly stated, "no two [rivers] are found to be the same" (1957, 43). In Paper I, my co-author and I identified lessons and recommendations in project design for initiating cooperation in transboundary river basins. The lessons and recommendations that we identified are meant to be generalized enough to be applicable to any river basin. Yet one could not design a project based solely on these recommendations alone. While the general lessons and recommendations may be used in many different contexts, project

design must be bound by the physical, social, and economic dimensions of each project area.

Within the context of hydropolitical resilience, I demonstrated in Paper III that when one seeks to determine the hydropolitical resilience of a given river basin, doing so by just using global indicators may only give a partial picture of the story. Analyzing each basin indicator that I used on its own presents a compelling case for why a closer analysis of what those indicators may mean at the specific scale in question is needed. For example, given the Zambezi River Basin's institutional capacity values from the indicators applied in this study, one would assume that the basin is relatively better situated to manage high rates of change within the basin compared to other basins in the globe. I argue by citing historical events that the basin's institutional capacity is untested, and, with the lack of official participation of the riparian country with the largest share of the basin's area and population, less legitimate. While one may be able to gather information about a basin's institutional capacity from global indicators, the functionality is much harder to grasp. Another example of where examining data using multiple scales is useful is analyzing drought. Coarse resolution data will show comparatively drier or wetter regions but the data do not capture geographically small areas where drought is acute, as is evidenced in the Zambezi River Basin where GRACE data indicated a lack of water scarcity at coarse resolutions, but areas of localized, severe drought have been present during the timeframe from which the data was gathered.

This dissertation explored the nature of dams and their relationship to international cooperation. In this regard, context is very important. A single dam could be a sign of cooperation between countries, or seen as an act of aggression. The transboundary impacts that a dam may have could lead to international disagreement, as evidenced by Turkey's construction of dams in the Tigris-Euphrates Basin, or could be a result of international cooperation, as evidenced by dams constructed in the Columbia River Basin after the signing of the Columbia River Treaty between the United States and Canada.

Moreover, the perception of a dam may change throughout its lifespan, which may in turn influence the system's hydropolitical resilience. This is seen with the Zambezi's Kariba and Cahora Bassa Dams; these dams were originally built with the intent of expanding colonial hegemony, but also displaced thousands of people and disrupted the ecosystem, and today, while the aforementioned problems persist in some form, these dams are seen as crucial components of each nation's energy infrastructure. Or, one may point towards the Duncan, Arrow and Mica dams in Canada. These dams were originally built with the intent of providing hydropower and flood control in partnership with the United States. Today, however, stakeholders on both sides of the border are hoping to include other values, such as fish passage and tribal rights, to be considered as part of how these dams are managed.

My dissertation's results also point towards agreements not necessarily hindering or ceasing physical development. In fact, the results point towards a relationship between higher rates of dam construction after the signing of

transboundary water agreements. This indicates that countries that are hesitant into initiating transboundary water cooperation due to worries over slowing their development plans should consider re-examining their positions.

These results also suggest that dams may be instruments of further cooperation between countries. Perhaps basin countries could use the aforementioned recommendations listed in Paper I regarding initiating transboundary cooperation to develop dams together as a way of strengthening relationships and sharing both the benefits and the costs of development. This might be especially appropriate on “border-river” riparian relationships, where the basin’s mainstem or main tributary makes up part or all of the border between riparian countries. This has been suggested by Ethiopia, whose leaders have called for the sharing of the operation of the Grand Ethiopian Renaissance Dam with Egypt and Sudan.

Yet, much more nuance regarding the relationships between dam proliferation and international cooperative water agreements is still needed to be uncovered. Variables such as suitable dam sites, funding availability, and dam purpose may also be significant in determining which dams are built when.

While my dissertation has suggested several global patterns, its results also reinforce the notion of how water management is enormously dependent on local variables: the bio-physical variables of climate, geomorphology, species composition, and hydrology; the socio-economic variables of demographics, standards of living, and resource availability; and the geo-political variables of borders, governance, and hegemony; to name a few. Each must be carefully considered when designing



mechanisms of hydro-cooperation or taking action that may provoke water conflict. In summary, while my dissertation recommends certain practices for initiating transboundary cooperation and dam construction in transboundary river basins, it also stresses the need for more localized analyses for any water-related action that will take a basin, watershed, or country's nuances into account.

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### Appendices

Appendices to this dissertation may be found at the following URL:

[http://www.transboundarywaters.orst.edu/research/Petersen\\_Perlman\\_Dissertation/index.html](http://www.transboundarywaters.orst.edu/research/Petersen_Perlman_Dissertation/index.html)

