AN ABSTRACT OF THE DISSERTATION OF

Meredith A. Giordano for the degree of Doctor of Philosophy in Geography presented on March 7, 2002
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Aaron T. Wolf

Transcending human-defined political and administrative boundaries, the world's transboundary freshwater resources pose particularly challenging management problems. Water resource users at all scales frequently find themselves in direct competition for this economic and life-sustaining resource, in turn creating tensions, and indeed conflict, over water supply, allocation and quality. At the international scale, where the potential for conflict is of particular concern, the international community has devised generalized, global principles for the management of international rivers, most notably through the 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses. While offering a general framework, these principles are rarely explicitly invoked in actual practice. Rather, co-riparian nations have tended to focus on local needs and conditions when developing treaties and similar basin-level agreements to manage shared water bodies, raising the question of whether global rules for basin management can be successful or if the unique characteristics of each basin require independently designed management regimes. The present work explores this question through an examination of transboundary freshwater management from three perspectives: global, regional, and functional. From the global perspective, the first

section examines the dichotomous relationship between international principles and basin-level practices of transboundary water management and suggests that the divergent outcomes stem from the absence of theoretical underpinnings in support of a generalized management framework. From a regional perspective, the second section of the dissertation introduces and applies a unique framework for comparing the dynamics of water cooperation and conflict across basins, finding significant geographic variability in three case studies centered on the Middle East, South Asia and Southern Africa. Finally, the third section of the dissertation takes a functional perspective through a survey of international water quality institutions, the results of which indicate a lack of widespread water quality management frameworks despite the encouragement of the international community. Together, this three-dimensional study of international river basin management highlights the geographic variability of riparian interactions and suggests a need for more spatially focused support and assistance on the part of the international community if its objective of fostering and strengthening cooperation over international freshwaters is to be met.

International River Basin Management: Global Principles and Basin Practice

By
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Meredith A. Giordano, Author

CONTRIBUTION OF AUTHORS

Mr. Mark Giordano was involved in the design of and statistical analysis for the study presented in Chapter Three.

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Chapter One: Introduction

Over the past century, freshwater resources and their management have increasingly captured the attention of the international community. Lack of access to safe drinking supplies and sanitation for much of the developing world's population combined with competing demands, depleting groundwater resources, and degrading water stocks worldwide have prompted greater international involvement in water management issues, particularly concerning the world's international basins. More than 140 sovereign states share at least one of the world's 263 international river basins (see Figure 1), which together are home to roughly 40 percent of the world's population, cover approximately one-half of the earth's surface area (Wolf et al. 1999), and generate an estimated 60 percent of global freshwater discharge.[1] Managing international freshwater systems is complicated by the need for cooperation between nations, a problem that is exacerbated when manifold countries are involved. At present, approximately one-third of all international basins are shared by at least three countries, 19 basins contain five or more countries and one, the Danube, involves 17 riparian states.[2]

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[1] Population and discharge estimates based on data contained in the Transboundary Freshwater Dispute Database, Department of Geosciences, Oregon State University, February 2002.

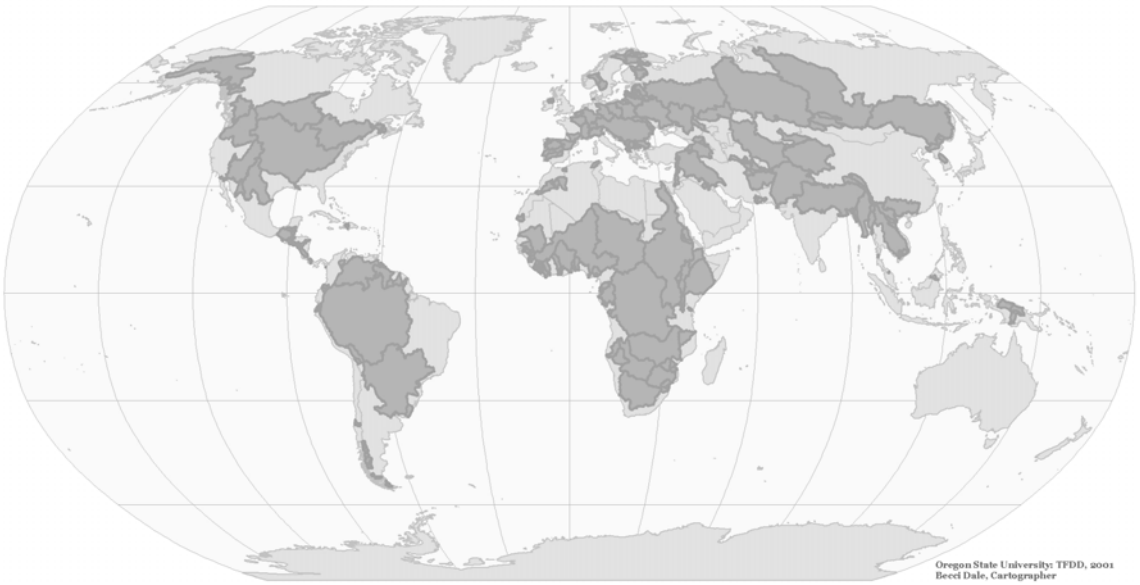
[2] Of these 19, one basin, the Danube, has 17 riparian nations and five basins – the Congo, Niger, Nile, Rhine and Zambezi – are shared by between nine and 11 countries; and the remaining 13 basins – the Amazon, Ganges-Brahmaputra-Meghna, Lake Chad, Tarim, Aral Sea, Jordan, Kura-Araks, Mekong, Tigris-Euphrates, Volga, La Plata, Neman, and Vistula (Wista) – have between five and eight riparian countries (Wolf et al. 1999).

Given their collective nature, international freshwater supplies have become a significant factor in national security discussions**.** Middle Eastern statesmen have proclaimed water to be the only resource that might incite regional conflict (Postel 1999), and leaders such as Ismail Serageldin (see Crossette 1995) and Kofi Annan (2001) have warned of broader geographic implications. Much of the hydropolitical literature has likewise concentrated on the potential for "water wars." Peter Gleick (1998), for instance, has stated that:

> As we move into the twenty-first century, water and water-supply systems are increasingly likely to be both instruments of political conflict and the objectives of military action as human populations grow, standards of living improve, and global climatic changes make water supply and demands more problematic and uncertain (107).

Similarly, Thomas Homer-Dixon of the University of Toronto singled out river water as "the renewable resource most likely to stimulate interstate war" (quoted in Postel 1999, 136).

Figure 1: International River Basins of the World



To respond to this concern, the international community has devised generalized, global principles of shared water management as a means to preempt or resolve disputes over internationally shared water supplies. Throughout the 20th century, the principles have been refined and, most recently, codified in the 1997 UN Convention on the Law of the Non-Navigational Uses of International Watercourses. A review of past and present transboundary water treaties reveals, however, that these legal principles are rarely utilized in practice. Indeed, rather than relying on the generalized principles to resolve or

avert conflict, nations that share international freshwaters have instead formulated agreements focusing on basin-specific needs and conditions.

While there is a substantial literature critiquing the UN Convention and related efforts of the international community to promote cooperative international water management frameworks (Westcoat 1992; McCaffrey 1994; Waterbury 1997; Caflisch 1998; Biswas 1999; Wolf 1999), little research has been conducted on the underlying reasons for the dichotomy between the generalized principles and localized practices or the resulting policy implications. Thus a primary purpose of the present work is to begin to fill this gap in the hydropolitical research by addressing the question of whether global rules for basin management can be successful or if the unique characteristics of each basin consistently require customized management regimes.

Beginning with a global analysis, the first section of the dissertation explores the dichotomy between the generalized, global principles and individual basin-level practices of international river basin management. The roots of this dichotomy are hypothesized to stem from the fact that no global theory of freshwater management currently exists. Rather, intellectual thought on freshwater management has largely focused on the river basin, which encompasses distinct physical and human characteristics, as a discreet spatial unit of analysis. It is thus postulated that the divergent relationship between spatially bound watercourse theory and generalized principles hinders widespread application of international water law.

To determine if an integration of theory and principle might be possible at global or regional scales, the second section of the dissertation employs a comparative study of water dynamics to determine if general patterns of international cooperation exist. The approach uses both quantitative and qualitative techniques to assess co-riparian interactions and the factors influencing relationships among basin states. The proposed research methodology is then applied to three regional case studies to examine both the efficacy of the analytical framework and the consistency of the results across geographic space.

Complementing the regional comparison, the final section of the dissertation evaluates the manner in which riparian communities have addressed a particular component of freshwater management, in this case water quality. To carry out this functional analysis, an extensive survey of international water treaties is conducted. The results of the survey, together with an assessment of the factors influencing water quality negotiations and the role of the international community in support of this process, offer important insights into the current state of international water quality management and possible directions for future policy making.

In summary, this three-dimensional study employing global, regional and functional approaches offers unique perspectives on the nature of cooperation over international

freshwater systems. New insights are provided into the evolution of international water regimes and the factors that influence their creation as well as into important institutional weaknesses in the management of shared watercourses. Together, the analyses not only expand our understanding of transboundary water management institutions but also offer policy guidance for expanding and strengthening cooperation over internationally shared freshwater resources.

Chapter Two: Incorporating Equity into International Water Agreements[3]

Authors: Meredith A. Giordano and Aaron T. Wolf

Abstract

River basins have provided resources for the advancement of human civilization from the earliest historic times. With river basin development has also come conflict, particularly in this past century. In response, the international community has developed generalized, global principles for the equitable allocation of water resources between nation-states, most notably through the 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses. These principles, however, have rarely been explicitly put into practice. To resolve or avert conflict in the world's 263[4] international river basins, riparian nations have instead relied upon treaties that incorporate basin-specific needs and conditions and define equity at the most local level. An examination of the progression of geographic thought on river basin development reveals a spatial focus that has not evolved beyond the basin and landscape scales. The absence of theoretical underpinnings for global frameworks may explain why riparian nations have not widely adopted general principles for the equitable allocation of water resources in actual treaty practice.

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[3] This article has been published in *Social Justice Research* 14 (4), December 2001, pp. 349-366.

[4] The original article cited 261 international basins. Since publishing the article, however, two additional international rivers have been delineated and included in the Transboundary Freshwater Dispute Database, Department of Geosciences, Oregon State University.

Introduction

River basins have provided resources for the advancement of human civilization from the earliest historic times. With river basin development has also come conflict, particularly in the past century. In response, the international community has devised generalized, global principles for the equitable allocation of water resources between nation-states, most recently through the 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses. A review of past and present transboundary water treaties reveals, however, that these legal principles are rarely utilized in practice. Rather, co-riparian nations generally formulate water-sharing agreements to meet basin-specific needs and conditions. The apparent dichotomy between principle and practice may stem from the fact that the spatial focus of geographic thought on water resources management has not evolved beyond basin and landscape scales. As a result, the generalized legal principles lack a commensurate theoretical foundation.

A review of intellectual development in geographic thought on river basins, together with an analysis of transboundary water allocation principles and practices, will illustrate the asymmetry between generalized legal codes and spatially bound theory and applications. The relevance of theory-supported principles to the construction of practical legal code will be demonstrated through a brief discussion of international trade and human rights statutes and their philosophical underpinnings. Finally, this paper will recommend

possible research and policy actions to facilitate the merger of international transboundary water allocation theory and practice.

Origins of River Basin Development

The Nile, Tigris and Euphrates, Indus, and Yellow river basins were home to some of the world's earliest advanced civilizations. Due to the power of their waters, these rivers were a tremendous resource as well as a potential liability for the basins' inhabitants, prompting early experimentation into methods to control their flow. More than 4000 years ago the Sumerians, the Egyptians and later the Chinese constructed complex hydraulic systems for irrigation, flood control, and ultimately transportation purposes. The accruing economic benefits were substantial. Irrigation canals, for example, allowed for increased agricultural production and a greater variety of food products (Heathcote 1983). As irrigation canals were expanded to accommodate transportation needs, military, commercial and political advantages followed (Teclaff 1967).

While these ancient civilizations may have failed to permanently control entire river basins, the interdependencies within the basin were understood, as evidenced by the development of sophisticated legal codes to administer the complex water system networks (Teclaff 1967). As early as the 18th century BC, the Babylonians had drafted comprehensive water laws that were so well contrived that elements can be found in

present day legal codes in the Middle East (Biswas 1970). Excerpts from the Code of Hammurabi highlight the extreme detail of early water laws:

> Sec. 53. If any one be too lazy to keep his dam in proper condition, and does not keep it so; if then the dam breaks and all the fields are flooded, then shall he in whose dam the break occurred be sold for money and the money shall replace the corn which he has caused to be ruined.
>
> Sec 55. If any one open his ditches to water his crop, but is careless, and the water flood the field of his neighbor, then he shall repay his neighbor with corn for his loss (quoted in Biswas 1970, 20-21).

The early "hydraulic civilizations" (Wittfogel 1956) thus invested significant economic and administrative resources into the development and management of river basins. It is not surprising, therefore, that the complex hydraulic landscape that emerged attracted significant scholarly attention. An examination of early Greek and Roman writings concerning the Nile River, for example, illustrates intense interest in and scientific research on the functioning of river channels and the structures that altered them.

Western Geographic Scholarship on River Basins

Water, its origins and physical processes, was a topic of significant discussion among early Greek and Roman scholars that evolved in large part from observations along the Nile River in Egypt. To the ancient academics, one of the Nile's most intriguing physical quality was its annual flooding cycle, which attracted an array of inquiry from such scholars as Thales, Herodotus, Democritus, Strabo and Pliny (Biswas 1970). The Greek geographer and historian Strabo (ca. 64 BC - AD 20), for example, wrote that the Nile's "rising, and its mouths were considered, as they were at the present day, amongst the

most remarkable, the most wonderful, and most worthy of recording of all peculiarities of Egypt" (Biswas 1970, 105). A number of theories were proposed regarding the actual source of the Nile's waters: northerly winds, melting snows, annual changes in solar energy, and the earth's internal heating cycle (Biswas 1970). One of the more enduring theories likened the flow of rivers to the human circulatory system. In this analogy, subterranean "veins and reservoirs" were cited as the primary source of streamflow (Wescoat 1992, 320).

Apart from the natural processes, early historians such as Herodotus and Diodorus were also interested in and documented the water engineering works developed by the Egyptians in the Nile river basin. Herodotus (484 –ca. 425 BC) wrote extensively about the artificial structures built perhaps more than 2500 years before his travels to the Nile Valley. Diodorus, who visited Egypt during the 1st century BC, commended the Egyptian leaders for their ability to control the Nile's waters and thereby protect the inhabitants and their livelihoods not only from floods but also from drought through the construction of reservoirs (Biswas 1970).

While the majority of the early scholarship focused on the physical and man-made properties of river channels, some inquiry was made into the larger land-water interface. For example, Plato (428-348 BC) in his dialogue Critias described the desiccation of rivers following deforestation along the hill-slopes in Attica (Glacken 1967). Further,

Plato's progeny Aristotle (384-322 BC) recognized the role of topography in streamflow origin as illustrated in the following excerpt from Meteorologica: "the headwaters of rivers are found to flow from mountains, and from the greatest mountains there flow the most numerous and greatest rivers" (quoted in Biswas 1970, 67). Yet, while watershed processes were discussed to some extent, the overwhelming scholarly interest of the time concentrated specifically on stream channels (Wescoat 1992).

For several centuries following the fall of the Roman Empire, there was relatively little scientific advancement on river function. The Renaissance period witnessed a renewed interest in Greek and Roman intellectual achievements, but the focus, at least initially, was on summarizing and dissecting the ancient classics rather than expanding upon knowledge through experimentation. By the 16th and 17th centuries, however, the importance of field observation and ultimately the application of quantitative techniques to the field of hydrology initiated the modern concept of the hydrologic cycle (Biswas 1970). Through field observations, Bernard de Palissy (1510-1590), for example, theorized that rainfall could generate streamflow (Wescoat 1992). Most likely inspired by Palissy, Pierre Perrault, Edme Mariotte, and Edmond Halley used empirical analysis to prove his hypothesis as well as to calculate discharge and to demonstrate the importance of evaporation in completing the hydrologic cycle (Biswas 1970). Stemming from these scientific achievements, by the 18th century river basins became a significant unit of spatial analysis. Not only had the terms "watershed," "drainage basin" and "catchment" assumed scientific meaning, but many European geographers began to

describe the broader natural landscape in terms of "natural regions" or patterns of mountain ranges and drainage basins on the earth's surface (Wescoat 1992).

As scientific advances proceeded, the river basin unit became institutionalized through the development of water treaties between co-riparian nations. The 1616 Turkey-Austria Treaty concerning navigation on the Danube was one of the first such agreements. Broader commitments on the allocation of basin waters occurred in the following two succeeding centuries. A general principle that co-riparian nations commonly share watercourses, for example, was pronounced by the French Executive Council in 1792, and a specific co-ownership of the Rhine by Germany and France was declared at the 1804 Convention of Paris (Teclaff 1996).

By the 19th century, environmental concerns among European and American academics encouraged further scientific exploration into the land-water interface in river basins. The German geographer Alexander von Humboldt (1769-1859) and the American scholar and diplomat George Perkins Marsh (1801-1882), for example, both concluded that deforestation resulted in flooding, droughts and the desiccation of rivers and springs (Martin and James 1993; Kollmorgen 1969). John Wesley Powell (1834-1902), the first director of the US Geological Survey, further argued that a river should not be viewed in a piecemeal fashion as any changes at a particular point on a river would ultimately impact the entire basin. Thus, to properly manage developments within a river basin and

to avoid conflicting interests, Powell recommended the formation of political subdivisions that corresponded with watershed boundaries in the western United States, where water is a particularly valuable resource (Reisner 1986). Although Powell's suggestions were not implemented, the idea of treating each river basin as a single entity significantly influenced water management techniques in the 20th century.

Finally, engineering developments during the last two decades of the 19th century advanced the concept of the river basin as a unit for efficient water resources management. The invention of reinforced concrete and "earth-moving" equipment, for example, paved the way for multi-purpose river basin developments such as the Nile's Aswan Dam, which was planned in 1890 to meet both navigational and irrigation needs (Teclaff 1996, 365). Thus by the end of the 19th century much of the scientific, legal and environmental groundwork had been laid for the major river basin development efforts of the 20th century.

Building on the previous century's efforts, the 20th century marked a major turning point in river basin development. River basins not only became the source of many major economic development projects, but also were later recognized as an important spatial unit for integrating economic, social and environmental concerns. At the turn of the century, however, the primary focus was on the use of rivers for economic advancement.

In the United States, the federal government, through the creation of the Reclamation Service in 1902 (later renamed the Bureau of Reclamation), became involved in the construction of major river basin structures. The initial reasons for federal involvement included a desire to expand agricultural development in the West, to improve water transport capabilities, and to protect towns and cities from flooding (White 1997). Between 1902 and 1930, the US Government funded the construction of 50 major dams. The trend in dam building was further advanced under the Roosevelt administration, which sought to promote both social change and economic development through large, federally funded construction projects. Consequently, by 1945 the Roosevelt administration had overseen the construction of five of the world's largest dams. Similar trends occurred in other regions of the world. China, for example, erected more than 600 dams annually for three decades following the establishment of the communist regime in 1949, and India allocated a significant portion of its total national expenditures towards dam construction and other related projects for thirty years following independence (Gleick 1998, 69-70).

The U.S. federal government initially favored single-purpose water projects to achieve independent irrigation, flood control, or navigational goals. Concern mounted, however, over the long-term economic, environmental and social consequences of such an approach and ultimately led to the idea of integrated river basin management. One of the key figures in this development was Harlan H. Barrows (1877-1960), a renowned

geographer and public servant. First serving as a professor of geography at the University of Chicago, Barrows later became actively involved in the Water Planning Committee of the National Resources Planning Board and its predecessor organizations, the Mississippi Valley Committee and the Water Resources Committee of the National Planning Board (Colby and White 1961).

In his work on the Water Planning Committee, Barrows expanded upon John Wesley Powell's contributions to the regional river basin development approach. Barrows encouraged a holistic approach to river basin development and together with other Water Planning Committee members formulated a new national water development policy in the 1930s. The new policy advocated multi-purpose structures; cooperation among local, state and federal agencies; and consideration for environmental as well as social aspects of river basin development (Barrows 1938; Colby and White 1961). The policy was epitomized in the formation of the Tennessee Valley Authority (TVA) in 1933. The TVA was a government corporation tasked with a multitude of economic and social development responsibilities. Although never repeated in the United States, the TVA became a model for other autonomous basin-wide institutions that developed elsewhere in the world following World War II (White 1957; Teclaff 1996).

In the 1930s, Barrows was joined by his progeny Gilbert White on the National Resources Planning Board. White expanded upon Barrows' ideas to develop his concept of integrated river basin management which combined multi-purpose storage; basin-wide

designs; comprehensive regional development plans, where wider economic, environmental and social factors were considered; and unified administration at both the national and international level. White believed that through this more comprehensive approach to river basin development the economic and social needs of an entire region could be more fully addressed (White 1957). It is important to note White's emphasis on basin-wide designs, in which he advocated the treatment of each basin as a *single, unified economic and ecological unit.* In a 1957 article, White stressed that a comparative analysis of river basins demonstrates that "no two [rivers] are found to be the same" and:

> while they may be grouped into broad classes according to their combinations of characteristics, the planning of their development always involves a new, adventurous exploration for each stream, revealing differences in flow, channel, sediment, and chemical quality (White 1957, 43).

This perception, which according to Wescoat demonstrates the "primitive state of comparative water resources research" (1992, 304), has remained active throughout the latter half of the past century (Wolf 1999).

In the 1960s and 70s, support for basin level planning continued in the United States and elsewhere, although the focus was changing from purely economic development goals to regional water management. In 1965 the Federal Water Resources Planning Act was passed and led to the establishment of the U.S. Water Resources Council and approved federal-state river basin commissions, on which numerous geographers served in a variety of positions (Platt 1993). France and Great Britain established similar basin

entities, and, on an international scale, joint basin management schemes were developed on the Mekong (1957), Indus (1960), Columbia (1961), and Senegal (1972) rivers (Teclaff 1996, 368). Furthermore, as environmental concerns over water quality mounted in the United States during this period, geographers and other resource managers recognized the basin unit as a useful and logical framework for analyzing point source pollution problems.

During the latter part of the 20th century, national river basin organizations began to decline in prominence in the U.S. and certain European countries due to the growth of powerful, cross-basin municipal water agencies and concerns over increasing centralization and regulation over water resources (Teclaff 1996). However, locally managed sub-basin units concurrently grew in popularity as resource managers recognized their importance, together with accompanying ecological regions, for point and non-point source pollution control as well as for providing planning units that would allow for closer contact with local communities (Omernick and Bailey 1997; White 1997). In addition, the movement away from basin-level planning in some countries contrasted with the adoption or expansion of river basin networks in other parts of Europe, Southeast Asia and Latin America (Teclaff 1996). Thus the river basin, or sub-units thereof, remains a predominant spatial unit of water resources management. Even broad concepts such as integrated river basin development established within the

geographic field have at their core the notion of a single basin with unique needs and conditions, as evidenced by White's 1957 statement above.

Generalized Principles of Transboundary Water Allocation

As population and development pressures have grown within many of the world's river basins, water has become a significant source of political conflict, particularly in the world's 263 international river basins. Water, for example, has led to disputes between Arabs and Israelis, Indians and Bangladeshis, Americans and Mexicans, and among all ten Nile basin co-riparians (Wolf 1999). Often at the heart of such conflicts are considerations over justice or equity (Syme et al. 1999). To mitigate problems of water allocation, the international legal community has established generalized, global legal and economic principles in contrast with the spatially bound geographic theory of water resources management described above. The generalized principles include: absolute sovereignty, absolute riverine integrity, limited territorial sovereignty, and economic criteria (Wolf 1999; Buck et al. 1993).

Of these four principles, the most extreme are the doctrines of absolute sovereignty and absolute riverine integrity. Absolute sovereignty is based on hydrography and implies unilateral control over waters within a nation's territory. While this doctrine is often the initial claim by upstream riparians during treaty negotiations, it has rarely been applied in actual water treaties and has never been invoked in any international law judgment (Wolf 1999). The doctrine of absolute riverine integrity lies at the other extreme and is often the

initial bargaining position for downstream riparians. Emphasizing the importance of historical usage, or chronology, absolute riverine integrity suggests that every riparian has a right to the waters that flow through its territory. Like the absolute sovereignty principle, the doctrine of absolute riverine integrity has rarely been applied in international law or in treaty practice (Wolf 1999).

Limited territorial sovereignty and economic criteria represent more moderate water rights positions. Limited territorial sovereignty, for example, reflects the right to reasonable and equitable use of international waters while inflicting no significant harm on any other co-riparian. Like the two antithetical extreme principles, however, the doctrine of limited territorial sovereignty inherently includes two diametrically opposed positions: reasonable and equitable use versus the commitment to inflict no significant harm. Not surprisingly, upstream riparians tend to place more weight on reasonable or equitable use, which has been interpreted to value past, present and potential needs, while downstream riparians in general favor the no significant harm clause, which has been interpreted to protect historic uses (Wolf 1999).

The principle of allocating water based on its economic value is a more recent addition to water conflict resolution. Under this principle, the market is used to allocate water among competing users in an economically efficient manner. While the principle has received considerable attention and has been applied in a number of intrastate settings, water

markets have not yet developed at an international scale due, in large part, to concerns over equity (Wolf 1999).

The international community has drawn from the generalized doctrine of limited territorial sovereignty described above in order to devise international laws concerning the equitable allocation of water resources between nation-states.[5] In 1966, for example, the International Law Association adopted the Helsinki Rules, which provide a set of guidelines for 'reasonable and equitable' sharing of common waterways (Caponera 1985). In 1970, the United Nations General Assembly commissioned is own legal advisory body, the International Law Commission (ILC), to study "Codification of the Law on Water Courses for Purposes other than Navigation." After more than two decades, the ILC completed the Draft Articles on the Non-navigational Uses of International Watercourses in 1994,[6] which the UN later adopted in 1997 as the Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Convention).[7]

As is evidenced by the 27-year period from commissioning to approval, developing a universal set of legal principles with application to the world's 263 international waterways was no simple undertaking. In fact, it might be considered an impossibility.

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[5] The following discussion is drawn from Wolf 1999.

[6] UN Document A/CN.4/L492. For history and commentary, see United Nations Yearbook of the ILC from 1974-1991.

The uniqueness of each basin and its riparian nations suggest that any universal set of principles must, by necessity, be fairly general. However, the requisite generality of the principles may in turn inhibit their ultimate application.

The vague language present in the 1997 UN Convention is plainly demonstrated in the articles concerning water allocation. Drawing from the principle of limited territorial sovereignty, the ILC chose to include provisions for both 'reasonable and equitable use' and an obligation not to cause 'significant' harm. The definition of 'reasonable and equitable use' is based on seven, non-exhaustive factors. These factors include: geographic, hydrographic, hydrological, climatic, ecological, and other natural factors; social and economic needs of each riparian state; population on the watercourse; effects of use in one state on the uses of other states; existing and potential uses; conservation, protection, development and economy of use, and the costs of measures taken to that effect; and the availability of alternatives, of corresponding value, to a particular planned or existing use. The articles, however, neither prioritize these seven factors nor offer any clear order of preference between the inherently opposing provisions of 'reasonable and equitable use' and 'no significant harm.' With regard to the factors of 'reasonable and equitable use,' Article 6 merely suggests that "the weight to be given to each factor is to be determined by its importance," and that "all relevant factors are to be considered together." Further obscuring the issue, Article 10 states that "in the absence of agreement

[7] UN Document A/RES/51/229 of 8 July 1997.

or custom to the contrary, no use...enjoys inherent priority over other uses," and that, "in the event of a conflict between uses...[it shall be resolved] with special regard being given to the requirements of vital human needs."

While such vague language (e.g., 'reasonable,' 'equitable,' 'significant') may have been necessary for reasons of geographic diversity and, ultimately, political expediency, the application of the 1997 UN Convention to specific water conflicts is indeed problematic. As suggested above, the Convention's articles do not offer the specificity necessary to address the distinct needs and settings of individual basins. It is hardly surprising, therefore, that these generalized legal principles are rarely invoked in the actual treaty practice.

Water Allocation in Practice[8]

Since 1814, approximately 300 international treaties dealing with non-navigational issues of water management, flood control or hydropower projects, or allocations for consumptive or non-consumptive uses have been negotiated. Oregon State University has collected and incorporated 149 international water treaties into the University's Transboundary Freshwater Dispute Database (TFDD).[9] [10] Of the TFDD treaties, 49

[8] The following discussion is drawn from Wolf 1999.

[9] http://www.transboundarywaters.orst.edu/

[10] Since the publishing of this article, the TFDD treaty collection has been markedly expanded as described in Chapter Four.

specifically describe water allocations for consumptive or non-consumptive uses. A review of these 49 treaties reveals the lack of reliance on international legal criteria for transboundary water allocation. In fact, the 1966 Helsinki Rules have been used explicitly only once, by the Mekong Committee in formulating its 1975 Joint Declaration of Principles for the Utilization of Waters of the Lower Mekong Basin, to help define water use. Furthermore, while it would be premature to evaluate the success or failure of the 1997 UN Convention, an analysis of the 49 treaties reveals certain trends that highlight the tendency of co-riparians to develop practices that meet basin-specific needs.

From Rights to Needs

First, there is a tendency for a shift in positions to occur during negotiations, from 'rights-based' towards 'needs-based' values. Many of the negotiations surveyed in the study begin with the parties basing their initial positions in terms of rights—the sense that a riparian is entitled to a certain allocation based on hydrography or chronology. In almost all of the water disputes that have been resolved, however, the paradigms used for negotiations have focused on co-riparian 'needs,' defined by irrigable land, population, or the requirements of a specific project. It is important to distinguish between 'rights' in terms of a sense of entitlement and legal rights. Obviously, once negotiations lead to allocations, regardless of how such allocations are determined, each riparian has legal 'rights' to water, even if the allocations were determined by needs.

In agreements between Egypt and Sudan signed in 1929 and in 1959, for example, allocations were arrived at on the basis of local needs, primarily of agriculture. Egypt argued for a greater share of the Nile because of its larger population and extensive irrigation works. In 1959, Sudan and Egypt agreed to divide future water from development projects equally between the two nations. Current allocations of 55.5 BCM/y for Egypt and 18.5 BCM/y for Sudan reflect these relative needs (Waterbury 1979).

Relative Hydrography versus Chronology of Use

Secondly, as described earlier, generalized legal principles focus on some version of upstream versus downstream relations, whether defined in the extreme as absolute sovereignty versus absolute riverine integrity, or more moderately as equitable use versus the obligation not to cause significant harm. In practice, the only settings in which ambiguity between upstream and downstream rights remains are along humid, under-developed rivers. Along arid or exotic streams, where some aspect of consumptive use is involved, there is very little debate—in nearly all cases prior uses are protected in the treaties which describe them and, in general, downstream needs are favored**.** Six Nile basin treaties signed between 1891 and 1959, for example, all involve the protection of Egypt's prior hydraulic uses. Further, the boundary water accords between the United States and Canada and the United States and Mexico all include prior use clauses. Even in humid regions, prior uses tend to be protected. The Horgos River boundary agreement

between Russia and China, for instance, divides the water equally, but protects the uses of existing canals.

Upstream or downstream position is not claimed as an *a priori* basis for water allocation in the 49 treaties. This does not suggest, however, that the upstream/downstream relationship is ignored. Rather when the issue is address, it is done so *implicitly*. In general, the downstream riparian is favored, or at least its allocations are protected, along arid and exotic streams. This is not to say that the downstream riparian receives more water, since this is not always the case—Mexico receives less water on both the Colorado and the Rio Grande/Rio Bravo than the United States—only that the allocations of the downstream riparian are generally delineated and protected. Mexico, Egypt, Bangladesh, and Pakistan all have their needs defined and guaranteed in their respective treaties. This precedence probably comes about as a consequence of two earlier observations—that rights give way to needs and that prior uses are generally protected. Since there is more, and generally older, irrigated agriculture downstream on an arid or exotic stream, and since agricultural practices predate more recent hydroelectric needs—the sites for which lie in upland headwaters—the downstream riparian has a greater claim, whether measured by needs or by prior uses of a stream system. Even at small political scales and where irrigation has been a relatively recent development, "prior use" can be a powerful factor in allocation (see Nancarrow and Syme 2001).

Economic Criteria

Thirdly, while market based water allocations have not been used to allocate international waters, economic criteria have been applied to the division of benefits when hydropower and/or river development projects are defined by treaties. The boundary waters agreement between the United States and Canada, for example, allocates water according to equal benefits in terms of hydropower generation. This results in the odd arrangement that power may be exported out of the basin for gain, but the water itself may not. Furthermore, the relative nature of 'beneficial' uses is exhibited in a 1950 agreement on the Niagara, which provides a greater flow over the famous falls during 'show times' of summer daylight hours, when tourist dollars are worth more per cubic meter than the alternative use in hydropower generation. Finally, the treaty with the strongest economic influence is the 1995 groundwater agreement between Israel and Palestine. While no payments are made outright for water, provisions are included to consider water markets in the future, and the two sides agree not to subsidize marketed water—moves long encouraged by economists to promote efficient use.

The Unique Local Setting

Lastly, the uniqueness of each basin is repeatedly described, both implicitly and explicitly, in the treaty texts further confounding the application of generalized water allocation principles, whether based on legal or economic equity. While most of the debate in the realm of customary international law has focused on accommodating as many concerns as possible in the development of generalized principles for all of the

world's international water, riparians of these basins have been concurrently negotiating agreements that focus specifically on local concerns and conditions. In addition, many of these treaties also include a clause that explicitly disavows the treaty as setting an international precedent, further distinguishing the generalized principles from specific practices. The 1950 accord on Austria/Bavaria boundary waters is typical: "Notwithstanding this agreement," it reads, each nation maintains its "respective position regarding the legal principles of international waters." A more recent treaty, the 1996 Ganges Agreement, includes the similar provision that the parties are "desirous of finding a fair and just solution without...establishing any general principles of law or precedent."

The uniqueness of each basin, whether hydrological, political, or cultural, stands out in the creativity of many of the treaties. Illustrations from several agreements help to demonstrate this point. The 1969 accord on the Cunene River, for example, allows for "humanitarian" diversions solely for human and animal requirements in Southwest Africa as part of a larger hydropower project. In the 1994 Treaty of Peace, Jordan stores water in an Israeli lake while Israel leases Jordanian land and wells. India, under a 1966 agreement with Nepal, plants trees in Nepal to protect its own water supplies. In a 1964 agreement Iraq "gives" water to Kuwait, "in brotherhood," without compensation. Finally, included in a 1957 agreement between Iran and the USSR is a clause that allows for cooperation in identifying corpses found in their shared rivers.

Cultural geography can overwhelm the capacity of generalized principles as well. In 1997 discussions among the riparians of the Euphrates basin, Syria objected strenuously to proposals for water pricing. This led to a temporary impasse until it was explained by an outside observer that some Islamic legal interpretation forbids charging money for water itself; the term was modified to "tariff," to denote costs only for storage, treatment, and delivery, and discussions were able to proceed.

The Relevance of Theory-Supported Principles

The practice of international water allocations as exemplified in the 49 treaties referred to above indicates little explicit influence of the generalized legal or economic principles. Rather, co-riparian nations tend to conclude treaties based on the unique setting of their individual basins, a practice that is consistent with the current state of geographic theory. Thus the dichotomous relationship between principle and practice may stem from the fact that the spatial focus of geographic thought on watercourse management has not evolved beyond the basin-specific scale. The relevance of theory-supported principles to the construction of practical legal code can be demonstrated by a review of international trade and human rights theories and principles.

International Trade Practices

At least as early as Adam Smith (1723-1790), economic theorists have advocated the principle of free trade as a means to achieve economically efficient allocations of scarce resources. In his landmark treatise *An Inquiry into the Nature and Causes of The Wealth*

of Nations, Adam Smith derided prevailing mercantilist protectionist practices while simultaneously using simple economic theory to extol the benefits of free trade:

> It is the maxim of every prudent master of a family, never to attempt to make at home what it will cost him more to make than to buy. The taylor does not attempt to make his own shoes, but buys them of the shoemaker. The shoemaker does not attempt to make his own clothes, but employs a taylor. The farmer attempts to make neither the one nor the other, but employs those different artificers. All of them find it for their interest to employ their whole industry in a way in which they have some advantage over their neighbours, and to purchase with a part of its produce, or what is the same thing, with the price of a part of it, whatever else they have occasion for.
>
> What is prudence in the conduct of every private family, can scarce be folly in that of a great kingdom. If a foreign country can supply us with a commodity cheaper than we ourselves can make it, better buy it of them with some part of the produce of our own industry, employed in a way in which we have some advantage (quoted in Ellsworth and Leith 1984, 47).

Smith's writings inspired successive generations of economists (Sowell 1978) and laid the foundations for the classical theory of comparative advantage as well as modern trade theory. After centuries of refinement, current economic theories of international trade and the benefits derived therefrom are nearly universally recognized, and as a result, modern trade theory has provided the conceptual backbone for numerous intra- and interstate trade compacts. In the United States, for example, Article 1, Section 10 of the US Constitution prohibits US states from instituting trade barriers. At the regional level, barriers to multinational trade and investment have been removed under such agreements as North American Free Trade Agreement (NAFTA), Southern Common Market (Mercosur) Agreement, and the Treaty on European Union. Finally, on a global scale, trade theory has supported the development of the General Agreement on Tariffs and

Trade (GATT) and its successor agency, the 136 member World Trade Organization (WTO), an international organization with legal authority to develop and enforce trade rules governing goods, services and intellectual property rights (World Trade Organization 1999 and 2000). The growing number of regional trade organizations coupled with the fact that the majority of the world's countries are WTO members demonstrates the commitment of most nations to the principles of free trade theory. Furthermore, the wide application of free trade theory in principle and practice is at least in part a consequence of their uniformly generalized nature. Unlike spatially bound watercourse theory, trade theory is not location or commodity specific. Rather, trade theory can be applied in practice at any scale and to any commodity and is thus conducive to application in a variety of geographic and market settings (ergo the *General* Agreement on Tariffs and Trade, which is still in effect under the WTO).

International Human Rights Practices

The concept of human rights is rooted in theories of natural law, which maintain the existence of a moral law granted divinely or through reason to *all* individuals. Discussions on natural law theories can be traced as far back as Cicero (104-43 BC), but were greatly expanded by St. Thomas Aquinas (1225-1274) and John Locke (1632-1704) (Howard and Donnelly 1987). Although natural law definitions impose a set of moral standards, John Locke (1632-1704) has been cited as the first theorist to explicitly link the concept of rights (e.g., life, liberty and property, according to Locke) to natural law

and reason (Barry 1995). By the late 18th century, the notion of human rights (or the rights of man as they were referred to at the time) was not only fundamental to the French and American Revolutions, but was also made manifest in such documents as the US Declaration of Independence (1776), the French Declaration of the Rights of Man and the Citizen (1789) and the US Bill of Rights (originally formed in 1791) (Howard and Donnelly 1987; Nickel 1987).

While the aforementioned references served primarily national purposes, Locke's generic rights to life, liberty and property were expanded and internationalized through the United Nations' Universal Declaration of Human Rights (1948) (Nickel 1987). The Declaration was adopted by the then 58 member nations of the UN with the objective of recognizing certain fundamental and universal human rights and, by 1993, 171 countries had affirmed their support (United Nations 1997). The Declaration itself is considered customary international law and has influenced such subsequent international treaties as the European Convention on Human Rights, the International Covenant on Economic, Social and Cultural Rights and the International Covenant on Civil and Political Rights (Howard and Donnelly 1987; Nickel 1987). The UN Declaration and the subsequent human rights treaties thus indicate a wide acceptance of universal human rights standards (Howard and Donnelly 1987). Furthermore, while implementation and enforcement may continue to be carried out primarily at the national level (Howard and Donnelly 1987), multinational applications, such as the Nuremberg Trials following World War II and the

more recent International Criminal Tribunals for the Former Yugoslavia and Rwanda, do exist.

Recommendations for Future Geographic Research and Policy Actions

A review of international trade and human rights statutes and their theoretical underpinnings demonstrates the relevance of theory-supported principles to the construction of practical legal code. In both examples, widely accepted principles directly evolved from theoretical precedents. International watercourse law, however, lacks a commensurate theoretical foundation. If, as has been suggested herein, the divergent relationship between spatially bound watercourse theory and generalized principles hinders widespread application of international water law, efforts to integrate the two may prove advantageous. To this end, three recommended research and policy actions are described below.

Much of 20th century geographic research focuses on the unique characteristics of river basins, and the "primitive state" of comparative analysis greatly hindered the ILC's efforts at codifying generalized watercourse principles (Wescoat 1992, 304). As Wescoat has suggested (1992) conducting detailed comparisons of international river basin histories and treaty practices, therefore, may allow researchers and policy makers to develop typologies of international water conflicts and methods of resolution, thereby facilitating the development of universal legal principles. Conversely, advancements in comparative research could prove correct Gilbert White's 1957 statement that "[i]f there

is any conclusion that springs from a comparative study of river systems, it is that no two are the same" (White 1957, 43).

If the results of comparative river basin research ultimately demonstrate that the uniqueness of the world's waterways confounds policy generalization, the international community may consider focusing its efforts on conflict resolution at the local level. Encouraging treaty negotiation and other institutional capacity building in particular may provide the greatest benefits. Co-riparians not only tend to rely on treaties to resolve disputes (Burke et al. 1998), but, as argued by Wolf (1999), treaties receive the highest priority in international law and can best reflect the distinct needs and conditions of individual watersheds. Furthermore, local level negotiations avoid the interference of global political issues. As Wolf questions:

> Why should China's concerns over sovereignty interfere with Belgium, France, and the Netherlands developing cooperative integrated management over the Schelde? And in turn, why should the Schelde be the model for the Euphrates, where the direction for international management seems to be toward each riparian being responsible for an agreed-to quantity and quality crossing each respective boundary at agreed-to times (1999, 15)?

Finally, policymakers might consider pooling water resources negotiations with other areas of mutual interest to co-riparians. In most of the 149 water treaties included in Oregon State's TFDD described above, water issues are treated separately from other bi-lateral or multi-lateral matters (Wolf 1999). Potential benefits could accrue, however, by incorporating water into other transboundary negotiations in politics, non-water

resources, trade, transportation and communications. Such multi-purpose linkages may not only provide additional bargaining options, but also, by reducing duplicative efforts, result in a more efficient and mutually beneficial allocation of resources, both natural and monetary (Wolf 1999; Krutilla 1967). Limited precedents for multi-purpose linkages currently exist in international water treaties. The 1964 United States-Canada Columbia River treaty, for example, stipulates that Canada store Columbia River waters for flood control and hydropower generation in exchange for monetary compensation from the United States. As part of the 1975 Mekong River Agreement, Thailand provided financial support to Laos for a hydropower project in exchange for a percentage of the electricity generated. India and Nepal also bundled projects such as irrigation, hydropower, navigation, fishing, and afforestation into two treaties concluded in 1959 and 1966 (Wolf 1999). By building and expanding upon these existing cases, countries may well discover new and creative solutions to transboundary water allocation and management disputes.

Conclusions

As water resources become increasingly scarce, disputes over water allocation in the world's 263 international river basins are likely to increase in frequency and intensity, which highlights a need for pragmatic conflict resolution tools (Wolf 1999). Over the past century, the international community has responded to this need by devising generalized principles for water resource allocation, most recently through the 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses.

The generalized principles upon which the 1997 UN Convention as well as previous legal documents drew, however, lacked the specificity needed for practical application. Co-riparian nations, therefore, have rarely utilized international watercourse law. They have elected, rather, to rely primarily on negotiating basin-specific water-sharing agreements to resolve water allocation differences.

The fact that geographic thought on the spatial aspects of water resources management has not evolved beyond the individual river basin or landscape scales has been offered as one possible explanation for the dichotomy between international watercourse principle and practice. Geographers, just as treaty negotiators, have tended to focus on the uniqueness of each river basin. As a result, river basin typologies necessary for the development of generalized principles do not yet exist. A review of international trade and human rights laws and applications illustrates the importance of theory-based principles that are complementary to each other in terms of scope and scale. While geographic theory and generalized international watercourse laws may currently be incongruous, several suggestions have been provided to facilitate their integration including further research in comparative basin studies, watershed-specific conflict resolution techniques, and multi-resource negotiations. Whichever course of action is ultimately selected, however, researchers and policy makers should at least consider the need for mutually reinforcing legal principles and geographic theories in order to develop pragmatic, and indeed acceptable, transboundary water allocation criteria.

Chapter Three: The Geography of Water Conflict and Cooperation: Internal Pressures and International Manifestations

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Abstract

Studies on transboundary water conflict and cooperation generally consider interstate relations over shared water resources as distinct from intrastate relations. While connections have been made between international water relations and regional relationships in general, it is conceivable that international water conflict and cooperation may also be influenced by domestic water events and vice versa. This paper thus seeks to investigate the dynamics of water interactions across geographic scale and their relationship to broader international affairs. The research approach involves the creation of an analytical framework for assessing possible linkages between external and internal interactions over freshwater resources. The framework is applied then to three case studies regions—the Middle East, South Asia and Southern Africa—utilizing "event data." To validate the findings from the quantitative case study analyses the findings are compared with conventional qualitative understanding of water and overall relations in the three regions. The comparison demonstrates not only the efficacy of the analytical framework in general, but also highlights, at least in terms of the specific case studies selected, the disparate water dynamics across geographic regions and the importance of considering water events, both national and international, within larger political and historical contexts.

Introduction

The history of relations over shared water resources is replete with incidents of conflict. Examples range from intrastate violence along the Cauvery River in India, to California farmers blowing up a Los Angeles water pipeline, to much of the violent history in the Americas between indigenous peoples and European settlers. The desert state of Arizona in the United States even commissioned a navy (made up of one ferryboat) and sent its state militia to stop a dam and diversion on the Colorado River in 1934. At the international level, water has likewise led to hostilities between Arabs and Israelis, Indians and Bangladeshis, Americans and Mexicans, and among all ten Nile basin co-riparian nations (Fradkin 1981; Wolf 1999).

While direct manifestations of water conflict are well documented, water disputes can also have broader political and geographic implications. For example, during thirty years of Israeli occupation in the Gaza Strip, the quality of surface and groundwater supplies steadily deteriorated and water related disease rose. In 1987, the *intifada*, or Palestinian uprising, broke out in the Gaza Strip and quickly spread to the West Bank. While it would be simplistic to claim direct causality, water was undoubtedly an irritant exacerbating an already tenuous situation.

Issues of water security have played a role in regional instabilities in other parts of the globe as well. India's decision to in the 1960s to build the barrage at Farakka on the

Ganges River to control siltation at Calcutta's seaport some 100 miles to the south had a number of adverse impacts on Bangladesh including degraded surface and groundwater supplies, impeded navigation, declining fisheries, and public health risks (Nishat 1996). In Southern Africa, water security concerns have been suggested as one possible motive behind South Africa's 1998 deployment of troops to Lesotho, the upstream riparian to the regionally important Orange River, in response to political turmoil in the mountain kingdom.

These examples illustrate the geographic complexities of water disputes and the possibility for water issues to extend across political boundaries and to become entwined with other political issues. Despite the history of water related discord, however, conflict and cooperation over water has rarely been assessed methodically to determine if quantifiable relationships exist between water related events at varying geographic scales (e.g., domestic and international) and between water and non-water relations. While a recent empirical study assessing the factors contributing to international water conflict and cooperation found an overall correlation between general bilateral relations among nations and bilateral relations regarding water resources (see Wolf et al.), the study did not clarify the direction of linkage nor whether the nature of the linkage is consistent across countries and regions. Furthermore, it did not explain if international issues drive domestic relations over water or vice versa.

The overall purpose of the present work is to establish a conceptual framework for evaluating the spatial relationships between water events—that is, for determining the extent to which domestic and international conditions influence the state of national and international water conflict and cooperation as well as the direction, or existence, of causal flow. The interrelationships between water and broader political events are also examined by investigating the direction of linkage between international relations in general and water relations specifically. Three regions have been selected for the application of the framework—the Middle East, South Asia and Southern Africa—to assess not only the efficacy of the proposed framework but also the consistency of the results across geographically distinct regions. Within each region, one representative country (termed the "primary country") is selected to assess both domestic water conditions and water and non-water relations with co-riparian states (termed "secondary countries"). The paper begins by briefly discussing the political and resource settings of each primary country both domestically and within broader regional contexts. A proposed statistical framework for analyzing each region is then described followed by an application of the framework to the three case study regions. Finally, the fidelity of the quantitative analysis is examined by comparing the statistical results with the initial qualitative descriptions.

Case Study Descriptions

The three geographic regions selected for this study are the Middle East, South Asia, and Southern Africa. These regions were chosen as it was hypothesized that their divergent climatic, historic, and political settings might provide insights into the range of variation in internal/external water relation dynamics. Within each of the three regions, one nation was selected as the primary country of analysis—Israel, India, and South Africa, respectively. Like the larger regions, the three primary countries differ in many respects politically, socio-economically and physically.[11] Furthermore, the historic relations of the primary countries with their neighboring, co-riparian states ("secondary countries") contrast sharply with one another.[12] The resource and general political settings of each of the three primary countries are briefly described below. These descriptions will serve as a qualitative assessment against which quantitative findings will later be compared.

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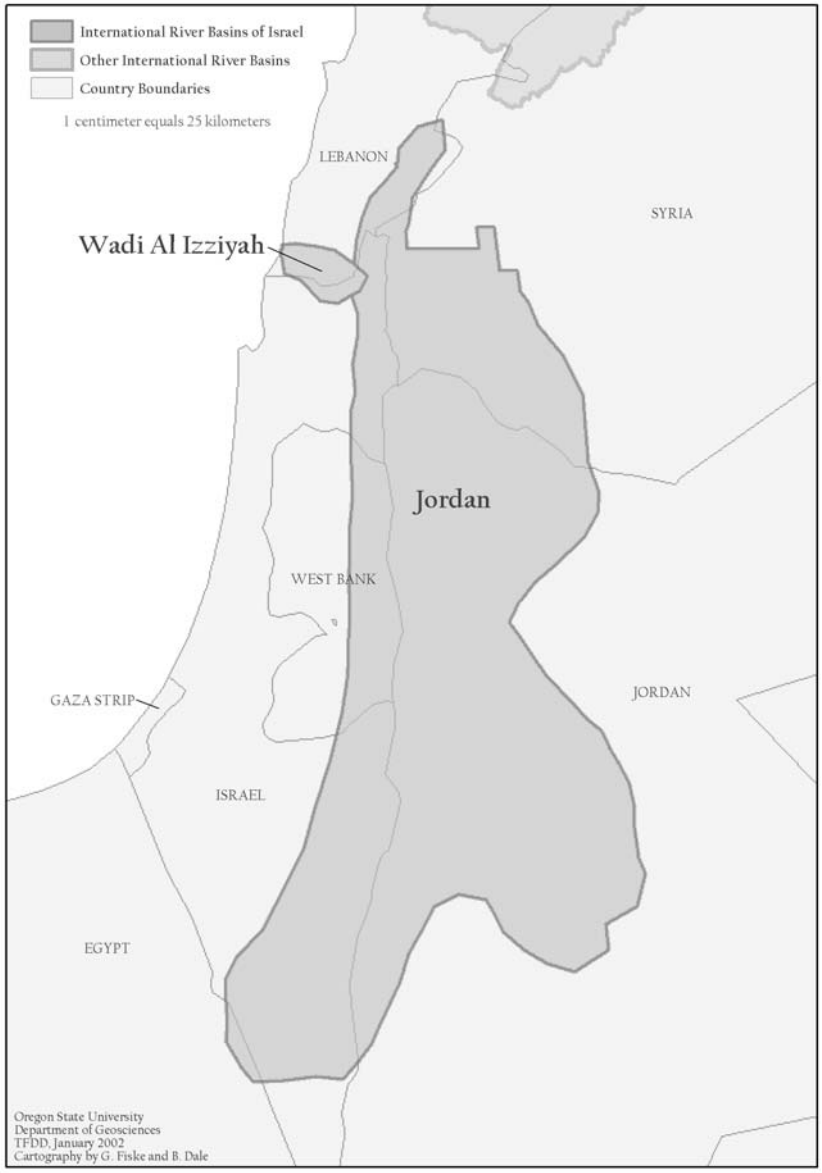
[11] In the case of the primary countries studied here, all are considered regional hegemons. This was viewed as a positive condition for this initial study as domestic water issues within a regional hegemon would appear more likely to influence relations with neighboring countries than vice versa. Future work, however, should also include non-regional powers in the analysis.

[12] The authors recognize, however, that each of the three countries selected share in common a legacy of British colonial rule, which could potentially influence the study results.

Table 1. Case Study Countries/Territories and International Basins

	Middle East	**South Asia**	**Southern Africa**
Primary country	Israel	India	South Africa
Secondary countries/territories	Egypt, Jordan, Lebanon, Palestinian Authority, and Syria	Afghanistan, Bangladesh, Bhutan, China, Myanmar, Nepal, and Pakistan	Botswana, Lesotho, Mozambique, Namibia, Swaziland, and Zimbabwe
Major International Basin(s)	Jordan, Wadi Al Izziyah	Indus, Ganges-Brahmaputra-Meghna, Irrawaddy, Kaladan, Karnaphuli, Fenney	Orange/Senque, Limpopo, Maputo, Incomati, Umbeluzi

Figure 2: Israel's Major International Basins



Israel

Even before the establishment of Israel, Zionists viewed access to water resources as a necessary component for the long-term viability of a Jewish state. At the 1919 Paris Peace Conference, for example, the World Zionist Organization insisted that the future Jewish state control not only the water resources within the British Mandate of Palestine but also the sources of their flow. Since Israel's founding in 1948, water has remained inextricably linked with national security and water use has been viewed as a means for both agricultural and economic output as well as national survival (Lowi 1995).[13]

Access to adequate water supplies to support a growing population and an agriculture largely dependent upon irrigation has been a constant concern for Israel's leaders since the nation's establishment. Located in one of the driest areas on earth, Israel is reliant upon the Jordan River and its tributaries as well as delicate groundwater reserves to meet ever-increasing water resource demands. Since 1949, for example, Israel's population

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[13] A quote from Moshe Sharett, Israel's Prime Minister from 1954-1955, serves to illustrate the importance of water in the Israeli setting:

> Water for Israel is not a luxury; it is not just a desirable and helpful addition to our system of natural resources. *Water is life itself*. It is bread for the nation—and not only bread. Without large irrigation works we will not reach high production levels…to achieve economic independence. And without irrigation we will not create an agriculture worthy of the name…and without agriculture….we will not be a nation rooted in its land, sure of its survival, stable in its character, controlling all opportunities of production with material and spiritual resource (Quoted in Lowi 1995,129).

and irrigated area have both increased approximately sixfold,[14] severely straining the nation's water supplies. Uneven spatial and temporal water distribution further complicates an already precarious resource situation. The country's primary water sources are located in the northern Israel, a substantial distance from the nation's agricultural, industrial and population centers, and the Mediterranean climate separates winter rainy season supplies from peak summer irrigation demands.

Viewing agriculture, and the supporting water resources, as necessary for the nation's economic and political vitality, the Israeli government has maintained central control over water supplies and management. From the country's establishment, the Israeli government has committed substantial resources to increase the efficiency of the country's scarce water supplies through research and development; water allocation, monitoring and pricing structures; and financial incentives (Postel 1999). Israel's first national project, in the 1950s, for example, was the draining of the Huleh swamps just north of the Sea of Gallilee, expanding agricultural land and increasing runoff to the Gallilee, Israel's only major surface reservoir. Its second national project, in the 1960s, was to build the National Water Carrier, to bring approximately 500 mcm/year from the Gallilee to the coastal plains, which contain the bulk of Israel's population, agriculture and industry (Wolf 2000).

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[14] Calculation based on 1949 population and irrigated land figures in Lowi (1995) and 2000 population

Israel's water supplies, however, depend not only on conditions within its borders. The Jordan River is shared with four other political units—Lebanon, Syria, Jordan, and the Palestinian Authority[15]—and the hydrologic interdependency of these countries and territory has become increasingly apparent as utilization rates within the Jordan basin increase. Currently water demand regularly meets or exceeds the naturally replenished supplies of 1,800 mcm/year, the differences being made up by groundwater overpumping and wastewater reclamation. As levels of demand continue to rise in a region marked by significant resource supply constraints, disputes between Israel and its co-riparian neighbors over water have not been an uncommon occurrence. These disputes have included not only numerous verbal exchanges but also two incidents of armed conflict between Israel and Syria in the early 1950s and mid-1960s over proposed water development projects (Wolf 2000).[16]

Regional water supply issues have also been linked to broader relations in the region. For most of its history, Israel has been at a state of war with its Arab neighbors. While territorial issues lie at the heart of Arab-Israeli conflict, notable connections to water exist. The Arab League's plans to divert the headwaters of the Jordan River away from Israel in the early 1960s, for example, has been cited as one contributing factor to the

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statistics and 1997 irrigation statistics in Gleick (2000).

[15] Egypt is also a topographic but rarely hydrologic riparian to the Jordan River.

[16] These events constitute two of only seven document cases of acute international water conflict (Wolf 1998).

tensions leading up to the 1967 War. Furthermore, as the territory occupied by Israel since the 1967 War supplies a substantial percentage of the country's total water supplies, water is undoubtedly an integral part of the continued territorial conflicts in the region (Gleick 1995 and Lowi 1995).[17]

This apparent linkage between water and non-water events can also be seen in more recent movements towards peace in the region. In the 1990s, Israel signed two bilateral peace agreements, both of which included substantial provisions concerning shared water: the 1994 Treaty of Peace between Israel and Jordan and the 1995 Israeli-Palestinian Interim Agreement on the West Bank and the Gaza Strip. In the 1994 agreement, Israel and Jordan outlined the allocation of shared surface and groundwater supplies and agreed to cooperate in the areas of supplementing water supplies and improving the quality of shared water sources. The 1995 interim agreement between Israel and the Palestinian Authority, while postponing full elaboration on water sharing units until permanent status negotiations are held, did incorporate joint water sharing principles and provided for the establishment of cooperative water sharing mechanisms.

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[17] According to Gleick (1995), "approximately forty percent of the ground water upon which Israel is now dependent—and more than thirty-three percent of its total sustainable annual water yield—originates in the territories occupied in the 1967 War" (90-91).

Figure 3: India's Major International Basins

India

India demonstrates a substantially different water resource dynamic. As the world's largest democracy and second most populous country, India's vast physical and demographic size includes a great diversity of human and climatic conditions. Consequently, water resource issues in one area of the country can vary dramatically from another. Additionally, the country's federal system, combined with disparate relations with its neighboring states, further regionalizes not only resource issues themselves but also the corresponding policy responses. A review of India's two primary international basins—the Ganges-Brahmaputra-Meghna and the Indus—serves to illustrate the incongruent water and broader political relationships across the Indian landscape.

The Ganges-Brahmaputra-Meghna (GBM) is India's largest river system. The basin, which in total covers an area of 1.7 km^2 (Wolf et al. 1999), occupies over 30% of India's territory with fifteen Indian states and one union territory falling either fully or partially within its hydrologic bounds.[18] While India is the largest areal contributor to the GBM, the basin's resources are of great importance in particular to downstream Bangladesh,

[18] The states and union territory included within the GBM basin are Assam, Arunachal Pradesh, Bihar, Haryana, Himachal Pradesh, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Rajasthan, Sikkim, Tripura, Uttar Pradesh, West Bengal, and the National Capital Territory of Delhi.

which lies almost entirely within the GBM's topographic limits, and, to a lesser extent, to parts of China, Nepal, Bhutan, and Myanmar.

Climatically, the GBM basin extends through the Indian subcontinent's main monsoonal region and, as a result, receives some of the highest rainfall levels in the world. The vast majority of the rains, however, occur during a four-month period from July to October (Kattelmann 1990; Verghese 1996). The results of the basin's temporally uneven hydrologic regime involve oscillating episodes of severe flooding and drought (Ahmad et al. 2001b; Malla et al. 2001). These adverse climatic conditions, coupled with weak institutions and inadequate regional cooperation, have contributed to the basin's desperate economic situation. For just India alone, the GBM region accounts for some of the country's poorest and most densely populated states. The basin as a whole, however, which constitutes approximately 1% of the earth's total land surface, is home to 10% of the world's population and contains the largest concentration of poor on earth (Ahmad et al. 2001a; Rangachari and Verghese 2001; and Shah 2001).

The Indus basin, in contrast, is characterized by a very different set of physical and social characteristics. While its headwaters commence less than 200 kilometers from the Ganges in the Tibetan Plateau of China, the Indus proceeds through the much drier climatic region of northern India and eastern Pakistan before draining into the Arabian Sea. The Indus basin covers about two-thirds the area of the GBM basin and has

Pakistan as its primary riparian. Indian territory, including six Indian states and one union territory, contributes about one-quarter of the total basin area (Wolf et al. 1999).[19]

Historically, the Indus basin was home to one of the world's earliest civilizations and supported a highly stratified and powerful irrigation society. In the modern era, the Indus has continued to play an important role in the regional economy. The British, Pakistanis and Indians have all constructed irrigation systems within the Indus, and, as a result, the basin now has some of the most extensive irrigation networks in the world, accounting for nearly six percent of total irrigated land globally (Khan 1990; Postel 1999).

Beyond the physical and developmental differences between the GBM and Indus basins, India's political structure also promotes inter-basin variability. With a federal system, responsibility for India's water resources is shared between the national government and the individual Indian States. When water resources are shared by two or more States, as is the case with the GBM and Indus basins in India, the national government retains overall management authority. However, while still under the control of the central government, inter-State river boards, such as the Bhakra Beas Management Board on the Indus basin and the Upper Yamuna River Board on the Ganges, allow for more local level involvement in the management of shared waters among India's individual States. Furthermore, India's State governments are encouraged to cooperatively resolve inter-

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[19] The Indus flows through the Indian states of Chandigarh, Haryana, Himachal Pradesh, Jammu and

State water disputes with central government intervention only as needed through a tribunal process (Government of India, Ministry of Water Resources 2001).

India's divergent international relations with its riparian neighbors on the Indus and GBM seem also to have influenced disparate regional dynamics. Since the partition of India in 1947, India's relations with Pakistan have been especially tense, with the two countries involving themselves in full-scale war on two occasions and with ensuing hostilities over conflicting territorial claims in Kashmir. From 1947 to 1971 Pakistan was a riparian to both the GBM and Indus basins. However, in 1971, when Bangladesh achieved independence, a new dynamic began to evolve in the Indian subcontinent. While Indo-Pakistani relations remained tense, India's assistance to Bangladesh during its war for independence created a new Indian ally in the region (Nakayama 1997).

The history of water relations in the two basins is somewhat different than the history of political relations. In fact, India and Pakistan have demonstrated a remarkable ability to separate water issues from larger conflicts between the two countries. While India and Pakistan approached the "brink of war" in 1948 over the division of the Indus basin (Wolf 1998), since the 1960 conclusion of the Indus Water Treaty, India and Pakistan's water relations have remained remarkably stable despite continued general tensions between the two states. While India's general relations with its immediate neighbors on the Ganges—Nepal and Bangladesh—have been generally positive, cooperative water

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Kashmir, Punjab, Rajasthan, and the National Capital Territory of Delhi.

relations have only recently emerged. The Indian Farakka Barrage, first announced in 1951 and later constructed just a few miles upstream from the Bangladesh border to flush the port of Calcutta, resulted in a decades long disputes between India and Bangladesh (and East Pakistan prior to 1971), ultimately becoming "one of the most dominant and important elements in the Indo-Bangladesh relationship" (Salman 1998, 132). It was not until 1996, nearly thirty years after the completion of the Barrage, that the two countries were able to conclude a long-term water sharing agreement on the Ganges (Nakayama 1997).[20] Similarly, after several decades of unfruitful water negotiations between India and Nepal over the Ganges waters, the 1996 bilateral Mahakali Treaty constituted an important breakthrough in Indo-Nepal water relations (Shah 2001).

[20] The Treaty between the Government of the Republic of India and the Government of the People's Republic of Bangladesh on the Sharing of the Ganga/Ganges Waters at Farakka was signed in 1996. Prior to that four interim agreements were concluded between India and Bangladesh over the Ganges River beginning in 1975. These agreements, however, were considered to be mere short-term solutions, and there are several years between 1975 and 1996 during which no agreement was in place (Salman 1998).

Figure 4: South Africa's Major International Basins

South Africa

South Africa illustrates yet another set of resource and political relations. Like the other two case study countries, water resources are extremely valuable to South Africa's arid

landscape, and, as a major consumer of the region's water resources and a riparian state to five international basins, international water relations are similarly an important element to South Africa's water management.[21] Distinct from the previous two country studies, however, South Africa's pervasive apartheid history uniquely shaped the country's domestic and regional relationships for much of South Africa's post-World War II history.

South Africa's hydrologic regime is marked by relatively low rainfall accumulation, receiving less than half of the world's average mean annual precipitation, with significant temporal and spatial variations. As a result, the county is faced not only with periodic droughts but also with the challenge of linking incongruent water supply and water demand centers. To respond to this challenge, South Africa has relied upon large storage and transfer schemes to control the natural hydrologic variations (Pallett 1997; Smakhtin et al. 2001).

During the country's apartheid years, beginning just after World War II and continuing until South Africa's 1994 all-race elections, the natural inequities of the country's water resource supplies were further exacerbated by the government's discriminatory political system, the legacies from which the new South African government is now trying to

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[21] According to Smakhtin et al. (2001), South Africa's current water consumption represents nearly 50% of total water consumption in the continental Southern African Development Community (SADC) (see footnote 23 for the list of current SADC member states).

redress. During the apartheid era, significant portions of South Africa's population had virtually no access to the political system and were systematically excluded from full participation in the economy. Moreover, the country's discriminatory practices meant that the black townships and nominally autonomous homelands were essentially detached from the central government's water supply mechanisms and did not receive the same level of water and sanitation services available to the white population. As a result, by 1994, the year in which apartheid ended, an estimated 30% of the country's inhabitants lacked access to adequate potable water supplies and more than half were without basic sanitation services (*Water Supply and Sanitation Policy White Paper* 1994).

South Africa's apartheid regime also had significant consequences for the country's regional relationships. As its neighbors gained independence and/or majority rule during the course of the apartheid period, South Africa was increasingly surrounded by "front-line" states hostile to its structure. The polarization of the region became institutionalized through the creation of two regional institutions from which South Africa was excluded until the abolition of apartheid: the Southern African Development Coordination Conference (SADCC) created in 1980 and the Southern African Development Community (SADC) created twelve years later.[22]

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[22] The 1992 *Declaration by the Heads of State or Government of the Southern African States*, signed in conjunction with the SADC Treaty, recognized the political reforms in process at the time in South Africa, and welcomed the country's accession to SADC once a new, majority government was in place.

With the dismantling of the apartheid system in 1994, the majority of South Africa's population was enfranchised and allowed fuller entry into its political and economic systems. On the domestic front, the new, democratically elected South African government has instituted significant policy reforms in an effort to rectify the previous regime's discriminatory practices. The reforms initiated since 1994 have included fundamental changes to the country's water management ethic. South Africa's new constitution, adopted in 1996, for example, declares a universal right to water (Constitution of the Republic of South Africa, Chapter 2, Bill of Rights, Article 27, (1) (b)). Similarly, the 1998 National Water Act designates the national government as trustee of the nation's water resources, responsible for ensuring that "water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner, for the benefit of *all* persons…" [emphasis added] (Article 3 (1)). Internationally, the country's former regional enemies were converted almost overnight into allies, and less than six months following its historic 1994 national elections, South Africa acceded to the Treaty of the Southern African Development Community. With this move, South Africa was integrated into a regional body[23] whose stated goals include not only economic growth and integration but also "sustainable utilization of natural resources and effective protection of the environment" (SADC Declaration and Treaty 1992, Articles 5 (1g)).

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[23] There are currently 14 SADC member states: Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe.

In comparison with its general political relationships, South Africa's international water relations appear to have improved at a substantially earlier stage. As noted above, South Africa is riparian to five international rivers: the Orange/Senque and Limpopo, Incomati, Maputo, and Umbeluzi, which, in sum, occupy approximately 65% of South Africa's land territory (Wolf et al. 1999). Reliant on much of these shared water sources to support the country's agricultural, industrial and domestic water needs, South Africa began concluding bilateral and multilateral water agreements with some of its riparian neighbors prior to the end of apartheid. Despite the country's general political isolation, South Africa concluded an agreement with Mozambique and Swaziland in 1983,[24] and three years later signed the notable Treaty on the Lesotho Highlands Water Project, which outlined a multi-stage plan to transfer water from Lesotho to South Africa's industrial heartland in Gauteng province (Pallett 1997; Smakhtin et al. 2001). Three additional treaties were signed with Namibia and Swaziland in 1992[25] during a period of clear reform in South Africa but still two years prior to the its welcoming into SADC.

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[24] Agreement between the Government of the Republic of South Africa, the Government of the Kingdom of Swaziland and the Government of the People's Republic of Mozambique Relative to the Establishment of a Tripartite Permanent Technical Committee.

[25] Agreement between the Government of the Republic of Namibia and the Government of the Republic of South Africa on the Establishment of a Permanent Water Commission; Treaty on the Establishment and Function of the Joint Water Commission between the Government of the Republic of South Africa and the Government of the Kingdom of Swaziland; and Treaty on the Development and Utilization of the Water Resources of the Komati River Basin between the Government of the Republic of South Africa and the Government of the Kingdom of Swaziland.

Since 1994, South Africa has continued to support international water cooperation efforts. South Africa has concluded at least one new bilateral water treaty[26] with additional agreements in progress and is a signatory to SADC's two regional water protocols.[27] South Africa's commitment to coordinated shared water resource management is also supported by its ratification of the 1997 UN Convention on the Non-Navigational Uses of International Watercourses.[28]

Comparing the Qualitative Assessments

The general review of the water resource and political settings of the three case study countries illustrates a variety of regional dynamics. In the case of Israel, water scarcity issues not only play a central role in the country's domestic policies but have also created international hydrological links, which have both provoked co-riparian disputes and enhanced broader regional peace initiatives. In contrast, water issues in India display a more regionalized character that is manifested not only in the nature of water and non-water relationships but also in the connectivity between the two domains. Finally, South Africa's unique post-World War II history produced shifting, and at times incongruent,

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[26] Joint Water Commission Terms of Reference between South Africa and Mozambique (1996).

[27] Protocol on Shared Watercourse Systems (1995) and Revised Protocol on the Shared Watercourses in the Southern African Development Community (2000).

[28] In fact, South Africa is one of only a handful of countries to have ratified the 1997 UN Convention. According to the UN treaty database, only nine countries had ratified the 1997 Convention as of March 2001: Finland, Hungary, Jordan, Lebanon, the Netherlands, Norway, South Africa, Sweden, and Syria.

water resource and political relationships both domestically and with its neighboring states.

Analytical Framework Description

It is these complex and diverse geographic water resource relations that this study seeks to methodically examine. The proposed analytical framework described in this section explores through a three-stage process the relationships between national and international water cooperation and conflict and the related role of non-water related events. More specifically, the study seeks to address four explicit questions:

1. What, if any, relationships exist between water and non-water relations at the international scale for each of the three primary countries?
2. What, if any, relationships exist between international and domestic water cooperation and conflict for each of the three primary countries?
3. If relationships are found to exist, can the direction of causation be established?
4. If relationships are found to exist, is it possible to generalize across geographic regions?

To answer these questions, the following sections describe in detail the analytical framework developed for this study and its application to the three case study regions.

Stage One – Data Collection

The principal analytical tool utilized in this study is event data.[29] A dataset was developed of conflictive and cooperative interactions ("events") between nation-states.[30] The dataset draws information from two international conflict and cooperation databases—the Conflict and Peace Data Bank (COPDAB)[31] and Global Event Data System (GEDS) Project, the combined coverage of which span the years 1948 to 1994.[32] COPDAB and GEDS—together with news sources (primarily the English language Foreign Broadcast Information Service) and the academic literature—were also utilized to develop a specific international water relations dataset for the years 1948-1999. For the years noted, this dataset includes, to the extent possible, every reported interaction between two or more nations, whether conflictive or cooperative, that involves water as a scarce and/or consumable resource or as a quantity to be managed – i.e., where water is the *driver* of the event (Yoffe and Larson).[33] To date 1,831 water related events—507 conflictive, 1,228 cooperative, and 96 neutral or non-significant—have been compiled.

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[29] See Schrodt 1993 for a description of event data.

[30] The dataset is part of the Oregon State University's Transboundary Freshwater Dispute Database (TFDD) project. The TFDD is located on the internet at the following address: http://www.transboundarywaters.orst.edu

[31] The COPDAB project, directed by Professor Edward E. Azar, has collected inter- and intra-state events for approximately 135 countries covering the period 1948-1978.

[32] GEDS tracks day-to-day interactions among nation-states and other international actors using online news reports. Directed by John Davies, at the University of Maryland, GEDS builds on the Conflict and Peace Data Bank (COPDAB), and contains data archives with over 300,000 event records from 1979 to 1994.

Non-water related events between co-riparian states from COPDAB and GEDS total over 300,000. For the present study, similar sources and methodologies were used to collect and code domestic water events pertaining to the three case study countries for the years 1989-2000.[34] This dataset currently includes over 400 internal water related events between and among governmental and non-governmental actors.[35] For all events, both international and domestic, the intensity of each interaction was given a value ranging from –7, the most conflictive, to +7, the most cooperative, with 0 denoting neutral exchanges. Table 2 outlines the event intensity scale for interactions between nation-states. The event descriptions were modified slightly to categorize domestic events.

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

[34] Given the experimental nature of the study, a smaller timeframe was utilized for the internal events

[35] Certain limitations should be recognized in the domestic data collection procedures for this study. First, the publication sources used to derive the data were essentially national in scope, and thus local level issues likely received much less attention. Second, national news sources may purposefully avoid reporting on certain internal water issues (e.g., electricity rates for pumping irrigation water from tube wells in India, local access to potable water in South Africa) that may place fundamental pressures on national governments to act in the international sphere. Local newspapers and journals, however, are generally not available on-line nor are many available in English. In addition, the number that may be necessary to read is overwhelmingly large, especially for a country such as India, making their use costly, especially if expanded or global analysis is sought.

Table 2: Event Intensity Scale

SCALE	EVENT DESCRIPTION
-7	Formal declaration of war; extensive war acts causing deaths, dislocation or high strategic costs
-6	Extensive military acts
-5	Small scale military acts
-4	Political-military hostile actions
-3	Diplomatic-economic hostile actions
-2	Strong verbal expressions displaying hostility in interaction
-1	Mild verbal expressions displaying discord in interaction
0	Neutral or non-significant acts for the inter-nation situation
1	Minor official exchanges, talks or policy expressions--mild verbal support
2	Official verbal support of goals, values, or regime
3	Cultural or scientific agreement or support (non-strategic)
4	Non-military economic, technological or industrial agreement
5	Military economic or strategic support
6	International freshwater treaty; major strategic alliance (regional or international)
7	Voluntary unification into one nation

Along with event data, the Transboundary Freshwater Dispute Database also includes nearly one hundred layers of spatial information related to water use, including biophysical, socio-economic, and geopolitical parameters. Both domestic and international interactions can be tested against these variables to help determine factors underlying water related cooperation and disputes. Examples of variables that might impact water relations include hydrologic and climatic variables (e.g., floods, droughts), socio-economic data (e.g., population, gross domestic product), and political information (e.g., government type, regime change).

Stage Two – Data Analysis

After collecting and coding international water and non-water related interactions, domestic water events, and supporting hydrologic, socio-economic and political information, a framework for assessing the possible linkages between international and domestic conflict and cooperation over freshwater resources was constructed. The established framework systematically evaluates the event data beginning from the international scale and works towards specific water events at the domestic level. The framework beings with an investigation of general relationships between nations on issues other than water, followed by examinations of water-specific relationships between nations and finally on internal water events.

The fundamental quantitative tool used to carry out the statistical analyses of the data is the Friendship/Hostility (FH) index (Yoffe and Giordano). For general, non-water relationships, the Friendship/Hostility value is calculated by averaging the scale values, described above, assigned all events between two nations or other actors during a given timeframe.[36] By selecting only water related events, a similar calculation yields a Water Friendship/Hostility index (WFH). Water Friendship/Hostility can be determined at either the international (International WFH) or domestic scale (Internal WFH). For both FH and WFH, higher numbers represent more cooperative relationships, and lower numbers suggest greater conflict levels. Water related events were additionally coded by

the international basin in which they occurred, allowing WFH to be calculated by basin as well as by country.

International Analysis

Building from the event data collected for each of the three regions, the international analysis involves three sequential questions, illustrated in Figure 5. The process begins with an analysis of FH levels (excluding water related events) between the country of interest (the primary country) and each of its neighbors (the secondary countries). The question to be answered is whether FH between the primary country and each of its neighbors is correlated (e.g., if relations between South Africa and Namibia are correlated with relations between South Africa and Botswana). Correlation, either positive or negative, would suggest that the relations of a primary country with its neighbors may be influenced by an overarching regional issue rather than some set of bilateral issues. If, in contrast, no correlation exists, specific bilateral issues may be of significance.

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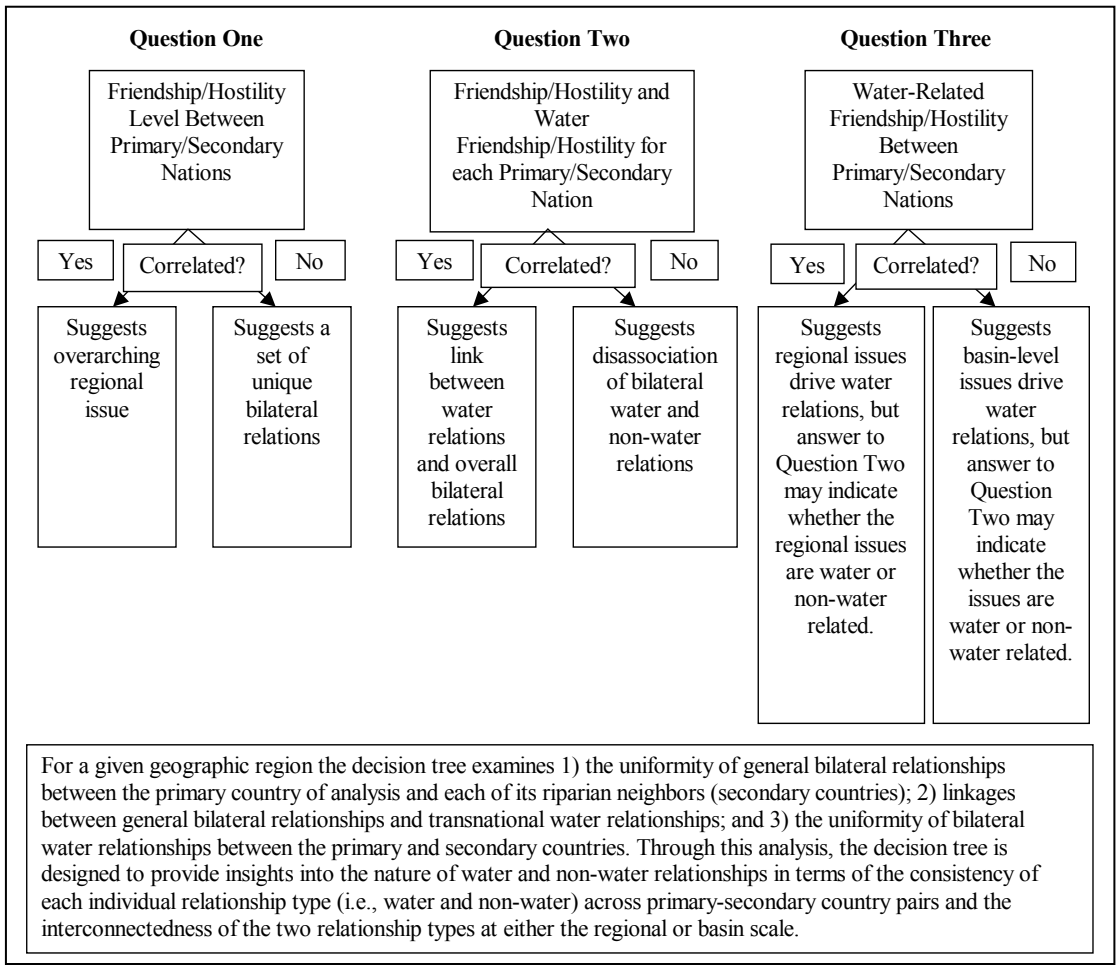
[36] To avoid overstating correlation, the FH calculations for this study excluded all water related events.

Figure 5: Decision Tree



The second question concerns the relationship between FH (again excluding water relations) and WFH. In this case, a correlation, either between a primary country and one of its neighbors, or between the primary country and its neighbors in aggregate, would suggest a connection between water and non-water relations. In general it is assumed that non-water relations drive water relations, but it is conceivable that water issues can

play a non-trivial role in a country's overall relations with a neighbor or group of neighbors. If no relationship is found between water and non-water events, regional water relations are likely distinct from other foreign policy matters, suggesting further analysis of water affairs should be undertaken if a fuller understanding of the primary factors driving water relations is to be gained.

The final question in the international scale analysis involves a comparison of WFH between the primary country and each of its neighboring riparian states. If WFH levels of the primary country and each of its neighbors are correlated (e.g., if water relations between South Africa and Namibia are correlated with water relations between South Africa and Botswana) this suggests that the primary country's national water policies, rather than basin-specific or other local issues, may be driving its water relations with its neighbors as a group. However, the findings from the FH-WFH relationship analysis described in the preceding paragraph would need to be reviewed to see if in fact water is the likely driving force in the relationships, or if water relations simply move with overall bilateral relations. If bilateral relationships over water are not correlated, more localized (e.g., basin level) issues may drive the primary country's water relations with each of its neighbors individually. Given this finding, further analysis at the basin scale would be warranted.

Domestic Analysis

The next step in the analytical framework is to review internal water relations and compare the domestic event data results with those from the international analyses. The domestic analysis can either be concentrated at the national level or at the basin level. If the relationships derived in the international analysis above indicate that regional rather than bilateral issues dominate the primary country's relations with its neighbors, national level water issues may be of more interest. If, for example, the primary country's FH and WFH relations with each of its neighbors are correlated in aggregate, then this might suggest that the primary country's national water policies and related events influence its external water relations (or vice versa). In this case, the primary country's average external WFH level at the nation-state level could be compared with the average internal WFH level (encompassing all basins and localities). Conversely, if the primary country's water relations with each of its neighbors are divergent, a comparison of the primary country's internal and external water relations within specific international basins may be more appropriate.

Stage Three – Contextual Evaluation

The sequential questions set out in Stage Two above systematize an approach to analyzing potential linkages between international and domestic water events. This approach, however, does not substitute for an in-depth knowledge of a country or region's past and present political and environmental settings. Thus, to measure the

fidelity of the analytical results, the final stage of the research framework involves a qualitative review in which the case study descriptions presented above are compared with the statistical findings.

Application of the Analytical Framework

Utilizing the research framework described above, the following sections detail the event data findings from each of the three case study regions. The relations between each of the primary countries and their neighbors are assessed along with the domestic water relations within each primary country.[37] To test the fidelity of the analytical framework, the final section compares the qualitative findings from the statistical analysis with the quantitative descriptions outlined in the first part of the paper.

The first step in the statistical analysis was the examination of each primary country's Friendship/Hostility (FH) level with its neighboring countries over the period 1948-2000.[38] Using correlation coefficients as a means of analysis, the relationship of annual FH levels between sets of primary-secondary country pairs was conducted (e.g., the average annual FH level between South Africa and Namibia was correlated with the

[37] See Appendix I for results of all statistical analyses.

[38]Note that data is not consistently available for each country over the time period of analysis. In some cases, no observations were available for the period of analysis. In the correlation coefficient tables that follow, the number of observations used in each calculation is noted.

average annual FH level between South Africa and Botswana).[39] The test revealed on average mild correlation between Israel and South Africa and their respective neighbors, suggesting that the two nations' international relations are affected by some set of overarching regional issues. The same analysis for India revealed no correlation, suggesting that India's relations with its neighbors is more a function of bilateral rather than regional issues.

The average annual FH and Water Friendship/Hostility (WFH) levels for the primary countries were then compared with their respective secondary countries in aggregate and bilaterally. Israel's overall FH and WFH levels were found to be correlated, though the relationships were weaker when correlations were considered bilaterally rather than in aggregate. In the case of India, no correlation either in the aggregate or bilaterally was found. Too few chronologically overlapping FH and WFH data points were available to make substantive statements concerning relationships for South Africa.[40]

The final stage of the international analysis involved an examination of WFH levels between each of the primary countries and their respective neighbors. Analogous to the

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[39] For the following analysis correlation coefficients are reported and, for simplicity in exposition, typified as uncorrelated (absolute value between 0.0 and 0.33), mildly correlated (absolute value >0.33 and <0.67), or correlated (absolute value >0.67). However, as noted above, the number of observations used in each calculation varies and so the significance, in a statistical sense, of each value differs. The values of statistics presented here and their descriptions should be considered as general indicators only, not as formal statistical tests of significance.

first step above, the relationship of annual WFH between sets of primary-secondary country pairs was conducted (e.g., the average annual WFH level between South Africa and Namibia was correlated with the average annual WFH level between South Africa and Botswana). On average, aggregate bilateral WFH levels were found to be mildly correlated between Israel and South Africa and their respective neighbors while no correlation was found between India and its neighbors. These results suggest that for Israel and South Africa, overarching regional issues may influence international relations over water just as they were found to influence overall international relations. For India, the findings suggest that relations over water, like the country's non-water relations, are related to bilateral, rather than regional, issues.

As described above, the national level analysis involved a comparison of each primary country's internal WFH and external WFH levels for the years for which the two data sets overlapped. In the case of Israel, internal and external water relations were correlated. A mild correlation was found between the two datasets for India and no correlation for South Africa. For Israel, and to a lesser extent India, the results suggest a relationship between national water policies and external water relations. For both India and South Africa, a comparison of internal and external WFH levels at the international basin level may have offered insights into more localized water dynamics. However, insufficient internal basin-specific data precluded an analysis at this scale.

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[40] Note that the especially high correlation coefficient cited for South Africa in Table 2 and Table 3.2 are

In addition to the analyses just described, we examined a large set of variables hypothesized to be correlated with overall FH and WFH levels such as precipitation patterns by basin,[41] trends in Gross National Product (GNP), population and change in government structure. No correlation was found between any of these variables and FH or WFH levels in the three-country sample. These findings are consistent with the results of the Wolf et al.'s study, which found through cross-sectional time series analysis of all the world's international basins a mild, at best, correlation between these variables and WFH.

Table 3: Summary of Correlation Co-efficients

Relationship Type	Israel	India	South Africa
1. FH between primary/secondary political units	Mildly Correlated	No Correlation	Mildly Correlated
2. FH and International WFH			
a) in aggregate	Correlated	No Correlation	Insufficient Data
b) bilaterally	None to Mildly Correlated	No Correlation	Insufficient Data
3. International WFH between primary/secondary political units	Mildly Correlated	No Correlation	Mildly Correlated
4. International WFH and Domestic WFH			
a) at national level	Correlated	Mildly Correlated	No Correlation
b) at basin level	Not Applicable*	Insufficient Data	Insufficient Data

* Only one basin involved.

In summary, the framework as applied to the three case study countries found that for Israel overarching regional issues drive the overall friendship/hostility level.

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largely a function of the low number of observations.

Friendship/Hostility in turn appears to be connected in some manner to Israel's external water relations. Israel's external water affairs are also likely associated in some manner with the country's national water policies. Whether water issues, either internal or external, drive the country's overall relations cannot be clearly determined from this analysis. As with Israel, the results for South Africa suggest that overarching regional issues drive international relations in general and over water. However, because of a lack of data it is not possible to make a connection between non-water and water related events for South Africa. For India, the results suggested that bilateral relations drive India's foreign affairs both overall and as related to water, but that water and non-water relations appear to move independently of one another. This conclusion is slightly obscured by the fact that internal and external water relations were mildly correlated, which suggests some connection between India's national water policies and water relations with its neighbors in general.

Placing the Quantitative Findings in Context

While data constraints limited a full analysis of all the potential spatial and political relationships, the application of the framework to the three case study countries and surrounding regions did offer insights into possible linkages between water and non-water events and between international and domestic water relations. To ascertain the effectiveness of the analytical framework and associated event data, the results of the

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[41] Analysis included the Indus, Ganges and Jordan basins. Adequate precipitation data was not available for

quantitative analysis must be placed within their regional contexts. Drawing from the case study descriptions presented above, the following section compares the quantitative results with the general qualitative understanding of the three selected primary countries.

Israel

For the Israel case study, a substantial degree of conformity can be found between the quantitative results and conventional understanding of the country specifically and the Middle East region in general. The correlation between Israel's Friendship Hostility (FH) and International Water Friendship Hostility (WFH), for example, is supported by the explicit linkages that exist between regional water issues and broader political conflict and cooperation in the Middle East. Furthermore, until the peace agreements of the 1990s, Israel's Arab neighbors have generally been in alliance against the Jewish state, a finding consistent with the mild correlation between Israel's FH and WFH with each of its neighbors. Finally, the relationship found between Israel's internal and external water events conforms with the fact that water resources within the country are controlled at the national scale and that the internationally shared Jordan River also serves as the primary water source for Israeli citizens as well as for many of Israel's neighbors.

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other basins.

India

In the case of India, the regionalized character of water and non-water relations is at least in part evident in the results of the statistical analysis. For example, that fact that no correlation was found in any of the statistical analyses of FH and International WFH between India and its neighbors in the aggregate is consistent with the general picture of India's diverse geographic conditions, post-independence international history, and government structure. The lack of a relationship between water and non-water related events is also consistent with India's relationship with Pakistan on the Indus, exemplified in the resiliency of the bilateral water treaty despite continued hostilities in other realms between the two countries. Furthermore, when Pakistan was riparian to both the Ganges and the Indus prior to 1971, India and Pakistan demonstrated an ability to differentiate between basin-distinct issues, when, for example, bilateral negotiations continued on the Indus despite Pakistan's disagreements over the Farakka Barrage on the Ganges (Salman 1998).

A correlation between water and non-water events would have been expected, however, between India and Bangladesh given the elevation of the Farakka Barrage issue to the realm of high politics from the 1970s up until the 1996 treaty between the two countries. Additionally, the mild correlation found between external and internal water events appears dis-synchronous with the South Asia regional setting. Given the decentralized nature of India's water regime and the dissimilarities between India's bilateral relations

with Pakistan and with Bangladesh and Nepal, no relationship between India's domestic and aggregate international water affairs would have been expected.

South Africa

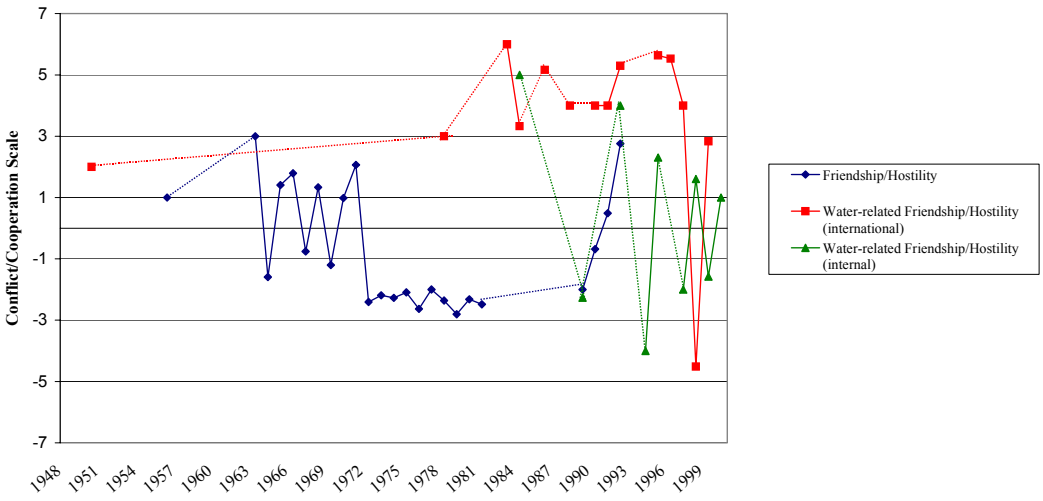
The South African case study likewise demonstrates a general correspondence between the statistical results and the qualitative description of the country and Southern African region. South Africa's shifting political conditions in its post-World War II history, for example, supports the correlation found in the country's bilateral Friendship-Hostility levels. While the bilateral FH relations were found to be only mildly correlated, a closer analysis of the data indicates collective oscillations in regional relationships consistent with the dominancy of the apartheid government and its recent downfall. For the years in which event data were available, Figure 6 demonstrates generally positive overall relations between South Africa and its colonized neighbors from 1963-1971, a decline in relations in the succeeding ten years as South Africa's neighboring states gained independence,[42] and an improvement in relations in the early 1990s as South Africa moved closer to abolishing apartheid.

The mild correlation of bilateral international WFH levels is also supported by the region's resource relationships. Unlike FH, however, generally positive relations are

[42] Independence for the region's countries are as follows: Malawi (1964); Zambia (1964); Botswana (1966); Lesotho (1966); Swaziland (1968); Angola (1975); Mozambique (1975); Zimbabwe (1980); and Namibia (1990).

apparent from the mid-1980s onward, as illustrated in Figure 6, a finding consistent with South Africa's conclusion of water treaties while still in the midst of general apartheid-based political isolation. While insufficient overlap between FH and international WFH data precluded a comparison of these two data sets, a strong relationship would not have been expected due to divergent FH and WFH levels in the latter apartheid years. Since 1994, however, a correlation between FH and international WFH would be likely.

Figure 6: South Africa's Average Friendship/Hostility and Water Friendship/Hostility (1948-2000)



Consistent with its apartheid history, South Africa's bilateral Friendship Hostility (FH) levels collectively oscillated from generally positive in the post-World War II colonial period, to more conflictive as its neighbor's gained independence, to a return to more positive relations as South Africa moved closer to abolishing apartheid. Water relationships, in contrast, improved at a noticeably earlier stage, as South Africa began concluding water agreements with its riparian neighbors while still in the midst of general apartheid-based political isolation.

Finally, the lack of correlation between international and domestic WFH also corresponds with South Africa's recent history. The two data sets were compared over the years 1989-2000, which encompasses both apartheid and post-apartheid years. As described above, the discriminatory practices of the apartheid years extended to the provision of water sanitation services to the majority, black population. It was not until the dramatic political changes of 1994 that the South Africa central government assumed the responsibility for the country's water resources, both national and international, for the benefit of South Africa's *entire* population. With additional data, further analysis of the

domestic and international water events might indeed reveal correlation between domestic and international water events in the recent post-apartheid years.

Conclusions

This paper presented a methodology for systematically examining the geographic complexities of water conflict and cooperation. The framework developed for the study—which involved data collection, statistical analysis, and contextual evaluation techniques—sought to answer four specific questions related to the existence and nature of water relationships. The framework was applied to three regional case studies focused on Israel, India and South Africa, and while certain limitations were present, the framework provided valuable insights into the study of water conflict and cooperation.

The findings from the quantitative analysis, supported by qualitative description, indicated that water-related events at the national level are related to both water and non-water events at the international scale. The nature of these relationships and the extent to which they are present, however, appear to vary considerably by country and region. This result highlights not only the intricacies of hydro-political dynamics and their variation across geographic space, but also the need to consider the often distinct historical and political conditions within a region or basin if water relations are to be well understood. As Gilbert White stated almost a half century ago: "[i]f there is any conclusion that

springs from a comparative study of river systems, it is that no two are the same" (White 1957, 43).

Chapter Four: Managing the Quality of International Rivers: Global Principles and Basin Practice

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Abstract

Population and development pressures combined with changing regional values have intensified competition for global freshwater stocks, raising concerns of expanded conflicts over scarce water resources. At the international scale, analyses of the issues surrounding water conflict have largely focused on water supply and allocation while water quality, an equally important element of water management, has received rather limited attention. To assess the potential vulnerabilities of international transboundary water quality management, this paper examines the extent to which co-riparian states have addressed water quality issues in basin accords. Based on an analysis of over 200 bilateral and multilateral water treaties, this study found that although water quality provisions are incorporated into basin accords with increasing frequency, riparian states appear reluctant to commit themselves to comprehensive water quality management programs and standards. Furthermore the failure of basin states, in general, to proactively address water quality issues has occurred despite the international community's efforts to devise legal principles encouraging greater co-riparian cooperation. In light of these findings, the paper concludes with suggested policy options for improving international transboundary water quality management.

Introduction

Population increases, economic development, and changing regional values have intensified competition over scarce water resources worldwide leading to predictions of greater future conflicts over shared water supplies (Biswas 1991; Gleick 1993; McCaffrey 1993; Homer-Dixon 1994).[43] Of particular concern to the international community is the potential for conflict within the world's 263[44] international basins.[45] River basins that cross or delineate international political boundaries are home to approximately 40 percent of the world's population, account for nearly half of the earth's surface (Wolf et al. 1999), and generate an estimated 60 percent of global freshwater flow.[46]

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[43] Numerous international leaders have likewise made references to the role of water in future international disputes. In 1995, for example, Ismail Serageldin, the World Bank vice president for Environmentally Sustainable Development stated that "[m]any of the wars in this century were about oil, but wars of the next century will be over water" (quoted in Crossette 1995, 13). More recently, Kofi Annan, the present UN Secretary General announced in a speech to the Association of American Geographers that "fierce competition for fresh water may well become a source of conflict and wars in the future" (Annan 2001, 10). Several other leaders, such as Egyptian President Anwar Sadat, Egyptian foreign secretary (and later UN Secretary General) Boutros Boutros-Ghali, and King Hussein of Jordan have proclaimed water to be the only resource that would incite regional conflict (Postel 1999).

[44] Delineation of international river basins is from the Transboundary Freshwater Dispute Database (TFDD), Department of Geosciences, Oregon State University, February 2002.

[45] Utilizing the definition and corresponding basin delineations in Wolf et al. (1999), a 'river basin' is "the area that contributes hydrologically (including both surface- and groundwater) to a first-order stream, which, in turn, is defined by its outlet to the ocean or to a terminal (closed) lake or inland sea." A river basin is defined as 'international' "if any perennial tributary crosses the political boundaries of two or more nations" (389).

[46] Population and discharge estimates based on data contained in the Transboundary Freshwater Dispute Database, Department of Geosciences, Oregon State University, February 2002.

In assessing the sources of tension between co-riparian states over shared water systems, the hydropolitical literature has largely focused on the issues of scarcity and inequitable allocation of available water stocks (see, for example, Duda and La Roche 1997; Wolf 1999; Wouters 2000). Another closely related factor, yet one that is often overlooked in the context of international freshwater management, is that of water quality. Changes in water quality can not only infringe upon human health,[47] economic well-being, and the environment but can also effectively reduce the overall availability of the resource itself (Postel 1999) thereby integrally linking this particular element of the water resource equation to the more commonly emphasized supply and allocation components.

Many of the world's international basins, along with the human and ecological communities dependent upon them, have already experienced or are currently plagued by severe water quality problems. The development of joint water management frameworks is one possible means for addressing such transboundary environmental issues. Yet, research on international water management institutions, like the hydropolitical studies, has largely focused on water allocation (see, for example, Karan 1961; Dellapena 1995; Beaumont 1997; Waterbury 1997; Wolf 1999). The treatment of water quality institutions in the international water literature is much more limited. Existing analyses include Utton's (1973) survey on the evolution of international water quality law; Ando's (1981)

[47] Estimates of water quality and health in the developing world indicate that more than 1 million people lack access to safe drinking supplies and that 80% of all diseases and more than 30% of all deaths are a consequence of consuming contaminated water (United Nations 1992 and Gleick 2000).

assessment of the existence of freshwater pollution prevention obligations within international laws and declarations; and Shmueli's (1999) comparative analysis of internal and external influences on the institutionalization of transboundary water quality management. Building from these existing studies, this paper seeks to examine the manner in which water quality has been addressed as a *fundamental* component of transboundary water management, presenting an historical and spatial assessment of the international community's and co-riparian efforts to preserve and protect the quality of shared water resources worldwide. The paper begins with a discussion of the complexities of water quality management in an international setting followed by a review of the historical evolution of transboundary water quality management principles established by the international community. The practices of water quality management in international basins are then assessed through an examination of over 200 international treaties that concern water *per se*. Based on the findings from the study, the paper concludes with lessons learned from existing management principles and practices and suggests options available for streamlining the efforts of the international and basin communities.

Complexities of Transboundary Water Quality Management

Managing water quality at any scale involves a number of complex issues, not least of which stems from the fact that water is a common resource. Protecting the quality of shared, mobile resources such as water is dependent upon the actions of all users. In the

case of river systems, where water typically moves uni-directionally,[48] waste disposal or agricultural runoff upstream can seriously impair the quality of downstream waters, thereby diminishing the effective supply of the resource. Activities in which one party imposes uncompensated costs on another result in what are known as 'negative externalities' and in the case of water quality increase the likelihood of degraded water supplies and reductions in overall human welfare and environmental destruction. To correct (or 'internalize') these externalities within a single political unit, government agencies can intervene by imposing quality standards, taxing users (e.g., the "polluter pays" principle), or establishing legally enforceable use rights.

At the international scale, the application of such solutions is made difficult by the fact that no overarching legal body exists to set and enforce rules and conduct between nations over water.[49] Instead, solutions to international water quality problems must be voluntarily negotiated between sets of sovereign nations. Negotiating positions taken by co-riparian states concerning the issue of water quality can vary greatly depending on such factors as a country's position along a river (upstream versus downstream states), predominate water uses (e.g., agricultural, industrial, hydropower, navigation, human consumption), access to other domestic or international freshwater sources, level of

[48] Some rivers, however, such as the Tonle Sap, a tributary of the Mekong River in Cambodia, reverse their course on a regular basis.

[49] As will be argued below, while principles of international water quality do exist, the generalized language, limited scope, and lack of resolute commitment and practical enforcement mechanisms all serve to limit the efficacy of existing global water quality principles.

economic development, membership in a regional cooperative body (e.g., the European Union or the Southern African Development Community), political ideology, and environmental values. Designing a comprehensive, basin-wide water quality plan can therefore involve a number of politically difficult compromises. A further disincentive for cooperation at the international level relates to the scope of any solution. Unlike issues of water quantity or navigation, which typically concern only the watercourse itself, water quality management ideally involves coordinated efforts extending throughout the broader topographic boundaries of a basin with consideration for both water and land use practices. As a result, creating an effective transboundary water quality management plan can entail substantial concessions of political sovereignty.

Principles of International Water Quality Management

In light of these complexities and recognizing the potential for water quality related conflicts within transboundary river basins, the international community has tried to encourage co-riparian states to implement more cooperative water quality practices. One of the primary means of encouragement has been through the development of international laws concerning the management of shared water resources. International water quality law can be traced back to at least the early 20th century, the sources of which include generalized principles, judicial decisions, international declarations, and intergovernmental conventions.

The body of international water quality law that has evolved over the 20th century builds upon the principle of limited territorial sovereignty. Applied to international freshwater management, the principle of territorial sovereignty reflects the right of a state to the reasonable and equitable use of an international water body provided that no significant harm is inflicted upon any other co-riparian state. One of the earliest applications of this principle to water quality can be found in the Institute of International Law's 1911 Madrid Declaration concerning the regulation of international watercourses, which forbid "all alterations injurious to the water [and] the emptying therein of injurious matter (from factories, etc.)…" and the consumption of "so much water" such that the "utilizable or essential character of the stream shall, when it reaches the territory downstream, become seriously modified."[50] Since then, the principle of limited territorial sovereignty in international water quality law has been reinforced through the work of international tribunals, such as in the 1941 *Trail Smelter* decision[51] and 1957 Lake Lanoux case,[52] the International Law Association's refinement of water quality principles in the 1966

[50] Partial text available in Food and Agricultural Organization of the United Nations 1998, 269-270.

[51] As noted by Utton (1973), the *Trail Smelter* case dealt with transboundary air pollution between the United States and Canada. However, due to a lack of previous case histories concerning air pollution across sovereign boundaries, the Tribunal utilized several US Supreme Court cases concerning water quality due to the similarities between the two issues.

[52] In resolving a dispute between France and Spain over the diversion of water for hydropower purposes from Lake Lanoux, the Tribunal ruled in favor of France stating that the country had in fact upheld its obligation to consider other territorial interests since the water delivered downstream to Spain remained unaltered in terms of both quantity and quality (Utton 1973).

Helsinki Rules, [53] and United Nations resolutions including the 1972 Declarations of the United Nations Conference on the Human Environment, the 1977 Mar del Plata Action Plan, and Agenda 21, adopted at the 1992 United Nations Conference on Environment and Development.

Most recently, the principles of international freshwater management, including water quality management, were codified in the 1997 UN Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Convention). References to water quality can be found in several sections of the agreement. For example, the UN Convention *requires* co-riparian states to regularly exchange water quality data, to "individually, and, where appropriate, jointly, prevent, reduce and control the pollution of an international watercourse that may cause significant harm to other watercourse States or to their environment… [and] take steps to harmonize their policies in this connection" (Articles 9 and 21). Furthermore, watercourse states are *encouraged* to jointly set water quality objectives and criteria, establish methods to address various types of pollution, and develop lists of substances to be controlled or investigated (Article 21).[54]

[53] Other International Law Association declarations referencing water quality include the Statement of Principles – Resolution of Dubvronik, 1956; Resolution on the Use of the Waters of International Rivers – New York, 1958; and Recommendation on Pollution Control – Hamburg, 1960.

[54] Full text available in Food and Agricultural Organization of the United Nations 1998, 29-44.

While the UN Convention, as well as previous declarations of universal water management principles, offers general guidance to co-riparian states, actual implementation of broad-based principles can prove difficult for a number of reasons. First, any set of principles devised to encompass the diverse geographic needs and conditions of the world's international river basins must inherently be generalized, which in turn can detract from their intended use (Giordano and Wolf 2001). As stated by Biswas (1999), the "vague, broad, and general terms" incorporated in the UN Convention do not provide "any practical guidance to the negotiators and no operational assistance to the technical experts…." (439).[55]

Second, the geographic scope of the UN Convention further weakens the applicability of the water quality principles contained therein. In its final form the UN Convention applies the spatial framework of the "watercourse" defined as "a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus" (Article 2).[56] As water quality can be affected by natural and anthropogenic processes throughout the entire river basin, as noted above,

[55] Adopting mutually agreeable language concerning transboundary waters can prove difficult even in non-binding agreements, such as Agenda 21. For example, McCaffrey (1994) notes that Agenda 21 fails "to include a *comprehensive* treatment of the international, or transboundary aspects of the protection and management of fresh water" and that the "meagre treatment afforded them [references to transboundary waters] suggests that they are not of great importance" (158).

[56] See Wescoat (1992) for a detailed discussion concerning the debate over the geographic scope of the UN Convention.

the effectiveness of the UN Convention on water quality factors outside of the watercourse itself is greatly diminished.

Finally, lack of widespread commitment to the agreement diminishes the UN Convention's ultimate ability to promote improved water management practices. While 103 countries approved the 1997 resolution[57] to adopt the UN Convention, ratifications remain insufficient to bring the document into force,[58] suggesting a reluctance among countries to firmly commit themselves to the UN Convention's broad principles. Furthermore, although the UN Convention serves as international customary law whether ratified or not, enforcement of its principles may be problematic given the lack of a single oversight body. While international conflict resolution mechanisms such as the International Court of Justice (ICJ) exist, resolving disputes over interpretations of or conformance with international water laws requires the consent of all parties involved, and, under certain circumstances, a state can even disclaim rulings of the ICJ (Wolf 1999).

Thus while providing general guidance for co-riparian states, the effectiveness of international water quality law is ultimately limited by its naturally vague language and

[57] UN General Assembly Resolution 51/229 dated May 21, 1997 (United Nations General Assembly Plenary Press Release GA/9248).

[58] For the Convention to enter into force, thirty-five instruments of ratification, acceptance, accession or approval are required. As of April 11, 2002, the Convention was not yet in force as only twelve countries had become party to the agreement (United Nations 2002).

narrow scope as well as by the lack of commitment and practical enforcement mechanisms. In fact, the ILA reported in 1964 that of all the subjects of international law with which it had experience, the issue of pollution created the most difficulties. The complexities and conflicts of interest associated with pollution, the ILA noted, make it problematic to establish laws that are fully satisfying to the states involved (Wolman 1968).

Practice of International Water Quality Management

In addition to the efforts of the international community, basin states have long utilized treaties and related agreements to manage shared watercourses. The history of international water treaties dates as far back as 2500 BC, when the two Sumerian city-states of Lagash and Umma crafted an agreement ending a water dispute along the Tigris River (Wolf 1998). Since then, a rich body of water treaties has evolved. The Food and Agricultural Organization of the United Nations has documented more than 3600 international water treaties dating from AD 805 to 1984 (Wolf 1998). Although the vast majority of these agreements concern navigational issues, a growing number address water as a limited and consumable resource apart from navigational, boundary definitional or resource extraction purposes.[59] However, while numerous studies have been conducted on international freshwater treaties, as noted above, few have tried to quantify the role of

[59] Based on treaty collection contained in the Transboundary Freshwater Dispute Database, Department of Geosciences, Oregon State University.

water quality in international basin accords, particularly as it relates to non-navigational water treaties.

To assess the extent to which water quality has been addressed in international basin accords, a survey was undertaken of 227 international freshwater treaties that explicitly deal with water *per se*.[60] The primary data source for the survey was the Oregon State University Transboundary Freshwater Dispute Database (TFDD), which contains the largest known collection of international water treaties that deal with water as a scarce and/or consumable resource or as quantity to be managed.[61] The following sections outline both the research methodology and findings from the international water treaty survey.

Survey Methodology

From the TFDD document collection, a total of 227 water treaties[62] were reviewed for the survey. Each of the treaties was examined to identify "water quality" provisions. A document was considered to have a "water quality" provision if the treaty directly mentioned water quality and/or if it addressed one or more of the following water quality

[60] Thus excluded from the study are treaties in which water is incidental to the agreement, such as those concerning fishing rights, access to ports, transportation, or river boundaries.

[61] Transboundary Freshwater Dispute Database is available on the worldwide web at: http://www.transboundarywaters.orst.edu/.

[62] All available treaty amendments were also reviewed, in conjunction with the original treaty documents, for the existence of water quality provisions.

related issues: pollution, contamination, sanitation, waste discharge, harmful development, salinity, or sedimentation. References to bank or riverbed cleaning or to water quality related activities *solely* for navigational, fishing, or other economic activities were not considered as "water quality" provisions for this survey.

Once the treaties containing water quality provisions were identified, the agreements were classified into one of three categories according to the terms of the relevant provisions. Agreements with the most detailed water quality provisions specifying standards, action plans, and/or comprehensive management frameworks were classified as Category One. Agreements that defined water quality related actions but lacked specific standards or a comprehensive management framework were separately grouped as Category Two. A final classification, Category Three, was established to account for agreements that simply outlined an indefinite commitment to some aspect of water quality management.

Survey Findings

Of the 227 agreements, 62 treaties (or 27 percent of the total treaties reviewed) were found to contain references to water quality.[63] The 62 "water quality" treaties span nearly the entire 20th century, with the earliest agreement, the Treaty between the US and Great Britain Relating to the Boundary Waters and Boundary Questions, signed in 1909.

[63] See Appendix II for listing of all "water quality" treaties identified.

Apart from this treaty, however, only seven other agreements concluded prior to 1950 were found to reference water quality, representing only 10 percent of all the pre-1950 agreements reviewed. In contrast, 35 percent of the treaties signed in the latter half of the century incorporated water quality provisions, and for the 1990s alone, more than 60 percent of the agreements referenced some aspect water quality as defined above.

Spatially, attention to water quality issues appears also to have expanded during the 20th century. Prior to 1950 water quality provisions were found only in treaties relating to North American and European basins. Since the 1950s, however, water quality provisions were found in agreements from Asia/Middle East, Africa, Europe, North America and South America. Overall, the European region accounted for the greatest overall number of "water quality" treaties.

Further institutional developments are apparent in terms of the substance of water quality provisions. Earlier treaties focused primarily on pollution prevention and control. In contrast, treaties from the latter half of the 20th century describe a range of water quality related issues from pollution control measures to broader social and environmental aspects of transboundary water quality management, a finding evident to a greater or lesser extent across all geographic regions and across all three category types discussed in greater detail below.

While the numbers, spatial representation, and substance of "water quality" provisions suggest an expanded practice of water quality management, as with the international principles described above water quality treaties are still in many aspects institutionally immature. First, while the 227 treaties as a whole represent approximately 40% of the world's international basins, the 62 water quality treaties represent less than 15% of the world's international basins, and, in general, apply to only a particular tributary or section thereof. The greatest coverage is in the Asia/Middle East area, in which the "water quality" treaties represent just over one-fifth of that region's 57 international basins. Conversely, of South America's 39 international basins, only one, the La Plata, has had any type of water quality management arrangement.[64]

Second, the potential value of existing water quality cooperation efforts is lessened by a general absence of all-inclusive basin membership. The vast majority of the 62 "water quality" agreements are bilateral despite the fact that the majority of the treaty basins contain more than two riparian nations. More significantly, with the exception of international basins with only two riparian countries (e.g., the Colorado, Columbia, St. Lawrence, Fly, and Sepik), no treaty addressing water quality was found to include all affected riparian states.

[64] According to the Transboundary Freshwater Dispute Database at Oregon State University, the regional breakdown of the world's 263 international basins is as follows: Europe—69 basins, Africa—59, Asia and the Middle East—57, North America—40, and South America—38.

Finally, a review of the categories in which the treaties were classified further illustrates important institutional weaknesses. Nearly one-half of the "water quality" treaties fit within the parameters of Category Three (indefinite commitments), the least specific of the treaty groupings. In general the references to water quality in these agreements are brief and relatively vague in terms of riparian obligations and primarily express a desire to improve the water quality conditions of shared basins with some incorporating pledges for future action. The 30 agreements in this category span the entire the 20th century and represent all geographic regions (e.g., Europe, Asia/Middle East, Africa, North America and South America), and although treaties from the other two categories have grown proportionally in the past fifty years, indefinite commitments have generally dominated the treaty record throughout the 20th century.

The more specific Category Two (defined activities) grouping included 24 agreements. These agreements were concluded primarily in the latter half of the 20th century and have representation in all regions except South America. The water quality provisions in this treaty category require signatory states to assume some defined responsibility, such as independently monitoring water quality or cooperatively instituting regulatory measures. However, none of the Category Two agreements require the institution of specific water quality standards or comprehensive management frameworks.

Category One (explicit standards) treaties are a more recent addition and represent the smallest of the three treaty groupings defined for this survey. Treaties meeting the criteria of this category were all established within the past thirty years and relate only to basins in Europe and North America. Of the eight Category One treaties, the 1978 Great Lakes Water Quality Agreement, which renewed and expanded upon a 1972 treaty by the same name, and the 1976 Convention on the Protection of the Rhine against Chemical Pollution provide the most detailed water quality standards. The 1972 and 1973 agreements between the US and Mexico, while much narrower in extent, contain specific guidelines to reduce the salinity of the Colorado River water that enters Mexican territory. The remaining three Category One treaties—the 1992 Helsinki Convention, the 1994 Danube Convention, and 1994 Lake Victoria Agreement—cover a range of issues related to water quality and its management, and, while they do not define specific standards, the agreements do provide a framework to guide in the development of more detailed water quality criteria.

In summary, the results of this study illustrate a number of notable trends in the management of international riverine water quality. Attention to water quality in international basin accords has expanded both temporally and spatially during the 20th century. Additionally, the scope of water quality provisions has broadened, in general, from a focus on pollution to a greater number of treaties addressing human and environmental health concerns. Nevertheless important institution building opportunities

clearly continue exist. Treaties with water quality provisions remain a significant minority of the total number of international water treaties as well as the international basins they represent. Moreover, the fact that the majority of water quality treaties that have been signed lack substantive details and full basin membership places into question the ultimate effectiveness of many existing institutions.

Policy Lessons

An analysis of both the principles and practice of international water quality management offer important insights for future policy making. As described above, international water quality principles have offered suggestions to co-riparian states concerning standards of community conduct and model treaty guidelines. The inherently generalized nature of the principles and lack of commitment and practical enforcement mechanisms, however, suggest that water quality practices are more likely to be shaped by the often unique social, economic and physical conditions within individual river basins. While a survey of international water treaties suggests a growing commitment to address water quality issues at the basin level, comprehensive institutional response mechanisms remain rare. Thus the future challenge is to encourage greater co-riparian commitment to substantive, basin-wide management regimes before degraded water conditions ultimately force a response—a scenario reminiscent of the damaging experiences in the Colorado and Rhine rivers. Crafting agreements in advance of a problem is far more likely to be effective and beneficial to all concerned.

To expand and strengthen basin-level water management institutions, the international community has many other tools beyond the construct of generalized principles that could likely facilitate the process. Organizations such as the United Nations, for example, might utilize its ability to organize broad participatory meetings to further general understanding of water quality issues and management strategies such as through the regularly held World Water Forums. Similarly, the academic community, by expanding water quality analyses from the technical and scientific spheres to the hydropolitical can provide important policy insights. Through comparative case studies and policy evaluations, for example, the experiences in basins with existing water quality institutions may offer lessons for policy-makers and resource managers elsewhere.

Finally, the international community can help facilitate basin-level water quality negotiations. Active engagement can be particularly valuable in regions where political and/or economic issues confound the establishment of joint water management programs. Nakayama (1997), for example, cites the successful involvement of the World Bank and United Nations in establishing the Indus and Mekong river accords, both of which weathered extreme political strain.[65] International mediation efforts might additionally entail the mobilization of resources, a technique proven successful in the Indus Waters Treaty negotiations (Nakayama 1997). With appropriate donor coordination, pledges of

[65] Members of the Mekong Committee, for example, continued to exchange water-related data throughout the Vietnam War (Wolf 1998). Similarly, India continued to make payments to Pakistan as part of its obligation under the 1960 Indus Waters Treaty in the midst of a war between the co-riparian states (Giordano and Wolf, 2001).

financial and technical assistance can serve as strong incentives for co-riparian cooperation. In the Nile basin, for instance, the promise of funding from the World Bank and other prospective donors is prompting the river's ten historically conflictive riparian states to begin making positive moves towards cooperative basin management (Postel 1999).

Conclusions

The quality of the world's freshwater resources is critical for human and environmental health as well as for the sustained yield of water as a consumable resource. Despite this obvious importance, the research presented here suggests that regimes to manage the quality of international freshwater systems remain weak. In particular, the effectiveness of the international community's generalized rules for the management of water quality in transboundary settings has been hindered in large part by a lack of resolute commitment on the part of riparian states, and basin-level institutions, though expanding, remain limited both in actual number and substance. While the economic, political, and legal complexities associated with transboundary water quality management may complicate institutional development, existing comprehensive water quality management frameworks in a small number of European, African and North American river basins suggest that such obstacles may be overcome.

To encourage the development and strengthening of water quality institutions elsewhere, several research and policy suggestions were presented which could more closely focus the international community's attention on the specific needs and conditions of individual river basins. Included in these suggestions was not only the organization of broad participatory forums and comparative studies to collect and disseminate general information on water quality issues and management techniques but also more basin specific policy options such as the provision of direct technical and financial assistance. While the effectiveness of any transboundary water institution is ultimately dependent upon the commitment of the states directly involved, greater participation of the international community in basin level institution building activities, rather than a focus on generalized rules, may foster stronger cooperation in the realm of transboundary water quality management.

Chapter Five: Conclusions

As competition for the world's freshwater resources have intensified over the past century, appeals for greater cooperative management networks in the world's international basins have grown. Co-riparian states have created literally hundreds of water sharing agreements, yet, as has been demonstrated here, significant institutional weakness remain. Many of the world's international basins lack any type of cooperative management framework, and of those that have been developed, few clearly define specific management practices concerning either water allocation or water quality. While the international community has sought to encourage greater cooperative water networks through the development of generalized international water management principles, surveys of both water allocation and water quality treaties indicate that those principles have rarely been applied. Given this apparent divergence between principle and practice, the primary purposes of the present work were to explore the underlying reasons for the dichotomy and, by examining more fully the dynamics of water relationships and management practices, to offer possible policy alternatives to promote greater cooperation over internationally shared water resources.

To meet this objective, global, regional, and functional approaches were utilized to assess whether generalized rules for basin management might be successful or if the unique characteristics of each basin require customized regimes. The findings from each of the

analyses suggest that international freshwater management institutions are shaped more by the conditions present within a basin, both water and non-water related, than by externally devised, generalized principles. This conclusion should perhaps not be surprising, since, as shown, no global theory of freshwater management currently exists. Rather, intellectual thought on freshwater management has largely focused on the basin as a discreet spatial and managerial construct encompassing unique physical and anthropogenic characteristics. The failure to develop a global theory of river basin management may stem from the fact, as put by Gilbert White, that "no two [rivers] are found to be the same" (1957, 43), a finding supported by the regional analysis presented here which revealed substantial variation in the nature of co-riparian relations, as well as the factors that influence those relations, for basins in Southern Africa, the Middle East, and South Asia. Further supporting the notion that local conditions are of primary importance in the development of international water institutions, the specific examination of water quality management revealed irregular patterns of development, an outgrowth perhaps of the complex factors that shape water quality negotiations and management regimes.

The research and conclusions presented here represent only a beginning to a much needed expansion in comparative basin analysis. Future studies of international river basin histories and treaty practice are not only necessary to clarify the nature and dynamics of international water relations, but may also reveal important patterns of co-

riparian interactions not readily apparent from the scale of the analyses selected for this study. Accordingly, to remedy the "primitive state of comparative water resources research" (Wescoat 1992, 304), a number of possible research paths are envisioned. The analytical framework introduced in Chapter Three, for example, might serve as a model for other comparative basin studies. Researchers might select other regions of the world to apply the framework, comparing the results with those presented here. In selecting case study basins or regions, consideration might be given to areas with similar social characteristics (e.g., economic, political, religious) or physical settings (e.g., climate conditions, topographic characteristics). By concentrating on basins with certain shared characteristics, it might be possible to isolate factors that influence riparian relationships in particular social or physical settings, which in turn may lead to the formation of regional or functional theories of international river basin management. Additionally, future research on relationships within international river basin should consider the relative importance of a shared river on its individual basin states. The dependence on any particular river basin can vary substantially among the riparian states, in terms of both riparian position as well as usage of water resources, and thereby influence the stake a country has in any type of cooperative management arrangement. Thus, an ability to capture this international water dependency factor in intra- and inter- basin analyses would help to further refine and improve comparative water resources research.

While additional studies are needed to further clarify the dynamics of water relationships across regions, a number of significant policy lessons are already apparent from the research findings presented here. For example, it is clear that scale should be considered by the international community when developing recommendations for international freshwater policy. While water treaties were shown to be shaped largely by local conditions, the international community has typically attempted to influence those treaties by creating generalized principles meant for application on a global scale. To meet its objective of fostering and strengthening cooperative water management networks, the international community might instead consider focusing its attention on local institution-building efforts that take into account the physical and social settings of individual basins. Methods of local engagement already proven successful include mediation, provision of technical expertise, and application of financial incentives that both foster negotiations and support the creation of resilient management frameworks. Additionally, international and basin communities alike might consider the potential benefits of multi-resource linkages in basin negotiations. Given the relationships found between water and non-water events, multi-resource linkages might serve as another productive means to encourage co-riparian cooperation and increase the possibility of developing positive sum solutions to water and other international resource problems. In summary, then, the three sections of this dissertation together suggest that a more focused, customized approach to international freshwater management, perhaps drawing

upon the support and expertise of the international community, has a greater potential to foster cooperative institutions than does the current emphasis on global protocols.

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Appendices

Appendix I: Statistical Summary of Water Relationships

Table 1.1a. Israeli Bilateral Friendship/Hostility Correlation Coefficients

	Egypt	*Jordan*	*Lebanon*	*Syria*
Egypt	1.00			
Jordan	0.79	1.00		
Lebanon	0.42	0.75	1.00	
Syria	0.77	0.64	-0.15	1.00
Average	0.54			

Table 1.1b. Israeli Bilateral Friendship/Hostility Observations (number)

	Egypt	*Jordan*	*Lebanon*
Jordan	44		
Lebanon	11	10	
Syria	44	43	10

Table 1.2a. South African Bilateral Friendship/Hostility Correlation Coefficients

	Botswana	*Lesotho*	*Mozambique*	*Namibia*	*Swaziland*	*Zimbabwe*
Botswana	1.00					
Lesotho	0.48	1.00				
Mozambique	0.72	0.66	1.00			
Namibia	0.43	0.55	0.63	1.00		
Swaziland	0.69	0.63	0.64	0.52	1.00	
Zimbabwe	0.52	0.50	0.48	-0.07	0.23	1.00
Average	0.51					

Table 1.2b. South African Bilateral Friendship/Hostility Observations (number)

	Botswana	*Lesotho*	*Mozambique*	*Namibia*	*Swaziland*
Lesotho	17				
Mozambique	15	15			
Namibia	16	17	16		
Swaziland	15	15	16	16	
Zimbabwe	17	18	16	17	15

Table 1.3a. Indian Bilateral Friendship/Hostility Correlation Coefficients

	Bangladesh	*China*	*Myanmar*	*Nepal*	*Pakistan*
Bangladesh	1.00				
China	-0.28	1.00			
Myanmar	0.48	-0.04	1.00		
Nepal	0.43	-0.16	0.31	1.00	
Pakistan	-0.06	0.04	-0.04	0.22	1.00
Average	0.09				

Table 1.3b. Indian Bilateral Friendship/Hostility Observations (number)

	Bangladesh	*China*	*Myanmar*	*Nepal*
China	10			
Myanmar	8	31		
Nepal	9	30	28	
Pakistan	10	34	32	30

Table 2. Correlation of Aggregate Friendship/Hostility (excluding water) with Aggregate Water-related Friendship Hostility by Primary Country

	Correlation Coefficient	*Number of Observations*
Israel	0.76	27
South Africa	0.97	4
India	0.29	32

Table 3.1. Israeli Bilateral Friendship/Hostility (excluding water) and Water-related Friendship/Hostility Correlation Coefficients

	Correlation Coefficient	*Number of Observations*
Egypt	0.37	6
Jordan	0.49	28
Lebanon	N/A	0
Syria	0.25	20
Average	0.37	14

Table 3.2. South African Bilateral Friendship/Hostility (excluding water) and Water-related Friendship/Hostility Correlation Coefficients

	Correlation Coefficient	*Number of Observations*
Botswana	N/A	0
Lesotho	0.67	3
Mozambiqu	N/A	0
Namibia	N/A	1
Swaziland	N/A	1
Zimbabwe	N/A	0
Average	0.67	1

Table 3.3. Indian Bilateral Friendship/Hostility (excluding water) and Water-related Friendship/Hostility Correlation Coefficients

	Correlation Coefficient	*Number of Observations*
Bangladesl	-0.02	8
Nepal	0.32	10
Pakistan	0.21	23
Average	0.17	14

Table 4.1a. Israeli Bilateral Water-related Friendship/Hostility Correlation Coefficients

	Egypt	*Jordan*	*Lebanon*	*Syria*
Egypt	1.00			
Jordan	0.36	1.00		
Lebanon	N/A	0.22	1.00	
Syria	1.00	-0.05	0.57	1.00
Average	0.42			

Table 4.1b. Israeli Bilateral Water-related Friendship/Hostility Observations (number)

	Egypt	*Jordan*	*Lebanon*
Jordan	6		
Lebanon	2	9	
Syria	2	17	9

Table 4.2a. South African Bilateral Water-related Friendship/Hostility Correlation Coefficients

	Botswana	*Lesotho*	*Mozambique*	*Namibia*	*Swaziland*	*Zimbabwe*
Botswana	1.00					
Lesotho	N/A	1.00				
Mozambique	-1.00	N/A	1.00			
Namibia	N/A	N/A	N/A	1.00		
Swaziland	N/A	1.00	0.88	N/A	1.00	
Zimbabwe	N/A	N/A	1.00	N/A	1.00	1.00
Average	0.58					

Table 4.2b. South African Bilateral Water-related Friendship/Hostility Observations (number)

	Botswana	*Lesotho*	*Mozambique*	*Namibia*	*Swaziland*
Lesotho	1				
Mozambique	2	1			
Namibia	1	2	1		
Swaziland	1	2	3	2	
Zimbabwe	1	1	2	1	2

Table 4.3a. Indian Bilateral Water-related Friendship/Hostility Correlations

	Bangladesh	*China*	*Myanmar*	*Nepal*	*Pakistan*
Bangladesh	1.00				
China	N/A	1.00			
Myanmar	N/A	N/A	1.00		
Nepal	0.03	N/A	N/A	1.00	
Pakistan	0.31	N/A	N/A	0.32	1.00
Average	0.22				

Table 4.3b. Indian Bilateral Water-related Friendship/Hostility Observations (number)

	Bangladesh	*China*	*Myanmar*	*Nepal*
China	2			
Myanmar	1	0		
Nepal	8	1	0	
Pakistan	3	0	0	10

Table 5. Correlation of Aggregate External and Internal Water-related Friendship Hostility by Primary Country

	Correlation Coefficient	*Number of Observations*
Israel	0.65	9
South Africa	0.10	6
India	0.56	9

Appendix II: Bilateral and Multilateral Water Agreements Containing Water Quality Provisions

	Category	AGREEMENT TITLE	DATE	PARTIES	WATER QUALITY REFERENCE
1	One	Agreement to Initiate Program to Strengthen Regional Coordination in Management of Resources of Lake Victoria	August 5, 1994	Kenya, Tanzania, Uganda	Articles 2, Attachment 1 (Component 2)
2	One	Convention on cooperation for the sustainable use of the Danube River	June 29, 1994	Albania, Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Moldavia, Poland, Romania, Slovakia, Slovenia, Switzerland, Ukraine, Yugoslavia	Entire Document
3	One	Convention on the protection and use of transboundary watercourses and international lakes, Helsinki	March 18, 1992	Albania, Austria, Belgium, Bulgaria, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Spain, Sweden, Switzerland, United Kingdom	Entire Agreement
4	One	Agreement between the United States and Canada on Great Lakes water quality (as amended)	November 22, 1978	US, Canada	Entire Document
5	One	Convention on the Protection of the Rhine against chemical pollution	December 3, 1976	Germany (FRG), France, Luxembourg, Netherlands, Switzerland, European Economic Community	Entire Agreement
6	One	Mexico-US Agreement on the permanent and definitive solution to the salinity of the Colorado River Basin (International Boundary and Water Commission Minute No. 242)	August 30, 1973	US, Mexico	Entire Document
7	One	Colorado River salinity agreement effected by minute no. 241 of the International Boundary and Water Commission, United States and Mexico (as amended)	July 14, 1972	US, Mexico	Entire Document
8	One	Agreement on Great Lakes Water Quality with Annexes (as amended)	April 15, 1972	US, Canada	Entire Document
9	Two	Convention on the Protection of the Rhine	January 22, 1998	Germany, France, Luxembourg, Netherlands, Switzerland, European Union	Entire Document
10	Two	The Israeli-Palestinian interim agreement on the West Bank and Gaza Strip	September 28, 1995	Israel, Palestinian Authority	Annex III (Protocol concerning Civil Affairs) Article 40 and Schedules 8-11
11	Two	Protocol on shared watercourse systems	August 28, 1995	Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe	Articles 2, 3, 5
12	Two	Agreement on the cooperation for the sustainable development of the Mekong River Basin	April 5, 1995	Cambodia, Laos, Thailand, Vietnam	Chapter 3: Articles 1, 3, 7, 8 and Chapter 4: Articles 18, 24
13	Two	Treaty of peace between the state of Israel and the Hashemite Kingdom of Jordan, done at Arava/Araba crossing point	October 26, 1994	Israel, Jordan	Article 6 and Annex III
14	Two	Agreement on joint activities in addressing the Aral Sea and the zone around the Sea crisis, improving the environment, and enduring the social and economic development of the Aral Sea region	March 26, 1993	Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan	Articles 1, 3
15	Two	Convention on environmental impact assessment in a transboundary context, Espoo	February 25, 1991	Albania, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, United States	Implicit references to water quality throughout document
16	Two	Convention between Germany and the Czech and Slovak Republic and the European Economic Community on the International Commission for the Protection of the Elbe	October 8, 1990	Federal Republic of Germany, Czech and Slovak Federative Republic, European Economic Commission	Entire Document

	Category	AGREEMENT TITLE	DATE	PARTIES	WATER QUALITY REFERENCE
17	Two	Agreement Between The Government Of Canada And The Government Of The United States Of America For Water Supply And Flood Control In The Souris River Basin	November 15, 1989	US, Canada	Article VI
18	Two	Agreement on co-operation on management of water resources in the Danube Basin	December 1, 1987	Austria, Germany (FRG)	Articles 1-7
19	Two	Agreement on the action plan for the environmentally sound management of the common Zambezi River system	May 28, 1987	Botswana, Mozambique, Tanzania, Zambia, Zimbabwe	References made throughout the document
20	Two	Convention creating the Niger Basin Authority	January 21, 1980	Benin, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Upper Volta	Article 4
21	Two	Agreement Relating to the Establishment of a Canada-United States Committee on Water Quality in the St. John River and its Tributary Rivers and Streams which Cross the Canada-United States Bounder, With Annex (As amended)	September 21, 1972	US, Canada	Entire Document
22	Two	Agreement between Romania and the USSR on the joint construction of the Stinca-Costesti Hydraulic Engineering Scheme on the River Prut and the establishment of the conditions for its operation (with Protocol)	December 16, 1971	USSR, Romania	Main Agreement: Article 16, Protocol: Articles 5, 8
23	Two	Agreement Between Finland and Sweden Concerning Frontier Waters	December 15, 1971	Finland, Sweden	Chapter 1: Article 3; Chapter 3: Articles 3, 9, 10, 13
24	Two	Treaty between Austria and Czechoslovakia concerning the regulation of water management questions relating to frontier waters	December 7, 1967	Czechoslovakia, Austria	Article 3 and Annex 1 (Article 2)
25	Two	Agreement concerning the River Niger commission and the navigation and transport on the River Niger	November 25, 1964	Benin, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Upper Volta	Article 12
26	Two	Agreement between Poland and the USSR concerning the use of water resources in frontier waters	July 17, 1964	Poland, USSR	Articles 3, 4, 9, 10, 11
27	Two	Convention and statutes relating to the development of the Lake Chad Basin	May 22, 1964	Cameroon, Chad, Niger, Nigeria	Chapter II Article 5 (second paragraph)
28	Two	Indus Waters Treaty	September 19, 1960	India, Pakistan	Article IV
29	Two	Agreement between Czechoslovakia and Poland concerning the use of water resources in frontier waters	March 21, 1958	Czechoslovakia, Poland	Articles 2, 3, 8, 9
30	Two	Treaty between the Hungary and Austria concerning the regulation of water economy questions in the frontier region	April 9, 1956	Hungary, Austria	Article 2
31	Two	Agreement between Yugoslavia and Romania concerning questions of water control on water control systems and watercourses on or intersected by the state frontier, together with the statute of the Yugoslav-Romanian water control commission	April 7, 1955	Romania, Yugoslavia	Articles 1, 2. (Article 2 of attached Statute of the Water Control Commission reiterates objectives noted in Article 1 of the overall Agreement)
32	Two	Convention between Germany and Lithuania regarding the maintenance and administration of the frontier waterways	January 29, 1928	Germany, Lithuania	Articles 15, 17, 19, 21, 22, 24

	Category	AGREEMENT TITLE	DATE	PARTIES	WATER QUALITY REFERENCE
33	Three	Agreement Between Kazakhstan, Kyrgyz, Uzbekistan on cooperation in the area of environment and rational nature use	March 17, 1998	Kazakhstan, Kyrgyz, Uzbekistan	Article 2
34	Three	Agreement Between Kazakhstan, Kyrgyz, Uzbekistan on use of water and energy resources of Syr Darya Basin	March 17, 1998	Kazakhstan, Kyrgyz, Uzbekistan	Article X
35	Three	Joint Water Commission terms of reference	January 1, 1996	South Africa, Mozambique	Article 3
36	Three	Agreement between Angola, Botswana and Namibia on the establishment of a Permanent Okavango River Basin Water Commission (OKACOM)	September 16, 1994	Angola, Botswana, Namibia	Article 4
37	Three	Agreement Between the Government of the People's Republic of China and the Government of Mongolia on the Protection and Utilization of Transboundary Waters	April 29, 1994	China, Mongolia	Articles 2, 3, 6, 10
38	Three	Agreement between Namibia and South Africa on the establishment of a Permanent Water Commission	September 14, 1992	Namibia, South Africa	Article 3
39	Three	Treaty on the establishment and functioning of the Joint Water Commission between South Africa and Swaziland	March 13, 1992	South Africa, Swaziland	Article 3
40	Three	Treaty on the development and utilization of the water resources of the Komati River Basin between South Africa and Swaziland	March 13, 1992	South Africa, Swaziland	Articles 13, 14
41	Three	Treaty on the Lesotho Highlands Water Project between South Africa and Lesotho (as amended)	October 24, 1986	South Africa, Lesotho	Articles 6, 7, 8, 15
42	Three	Agreement on Paraná river projects	October 19, 1979	Argentina, Brazil, Paraguay	Section 5
43	Three	Agreement between Iran and Iraq Concerning Frontier Commissioners	December 26, 1975	Iran, Iraq	Article 6 (VIII, (l))
44	Three	Protocol concerning the delimitation of the river frontier between Iran and Iraq	June 13, 1975	Iran, Iraq	Article 8
45	Three	Joint declaration of principles for utilization of the waters of the lower Mekong basin, signed by Cambodia, Laos, Thailand, and Vietnam to the Committee for Coordination of Investigations of the Lower Mekong Basin	January 31, 1975	Cambodia, Laos, Thailand, Vietnam	Chapter III: Articles III, IV, VIII, XIX, XXV, XXIII
46	Three	Agreement between Australia (acting on its own behalf and on behalf of Papua New Guinea) and Indonesia concerning administrative border arrangements as to the border between Papua New Guinea and Indonesia	November 13, 1973	Papua New Guinea, Indonesia	Article 12
47	Three	African Convention on the conservation of nature and natural resources	September 15, 1968	Algeria, Cameroon, Central African Republic, Congo, Cote D'Ivoire, Djibouti, Egypt, Ghana, Kenya Liberia, Madagascar, Malawi, Mali, Morocco, Mozambique, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sudan, Swaziland, Togo, Tunisia, Uganda, Tanzania, Zaire, Zambia	Article 5
48	Three	Act regarding navigation and economic co-operation between the states of the Niger Basin	October 26, 1963	Benin, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Upper Volta	Article 4
49	Three	Treaty Between the Argentine Republic and the Eastern Republic of Uruguay on the Boundary Constituted by the Uruguay River	April 7, 1961	Argentina, Uruguay	Article 7
50	Three	Treaty between the Netherlands and Germany concerning the course of the common frontier, the boundary waters, real property situated near the frontier, traffic crossing the frontier on land and via inland waters, and other frontier questions (Frontier Treaty)	April 8, 1960	Netherlands, Germany (FRG)	Article 58
51	Three	Agreement concerning water economy questions between the government of Yugoslavia and Bulgaria	April 4, 1958	Bulgaria, Yugoslavia	Article 1
52	Three	Treaty between the USSR and Iran concerning the regime of the Soviet-Iranian frontier and the procedure for the settlement of frontier disputes	May 14, 1957	USSR, Iran	Article 10
53	Three	Agreement between Yugoslavia and Albania concerning water economy questions, together with the statute of the Yugoslav-Albanian water economy questions and with the protocol concerning fishing in Frontier lakes and rivers.	December 5, 1956	Yugoslavia, Albania	Article 1

	Category	AGREEMENT TITLE	DATE	PARTIES	WATER QUALITY REFERENCE
54	Three	Agreement between Yugoslavia and Hungary together with the statute of the Yugoslav-Hungarian water economy commission	August 8, 1955	Hungary, Yugoslavia	Articles 1, 2
55	Three	Agreement between Syria and Jordan concerning the utilization of the Yarmuk waters	June 4, 1953	Jordan, Syria	Article 10
56	Three	Treaty between the USSR and Hungary concerning the regime of the Soviet-Hungarian state frontier and final protocol	February 24, 1950	USSR, Hungary	Articles 16, 17
57	Three	Treaty between the USSR and Romania concerning the regime of the Soviet-Romanian state frontier and final protocol	November 25, 1949	USSR, Romania	Article 17
58	Three	Agreement between the Government of the Polish Republic and the Government of the Union of Soviet Socialist Republics Concerning the Regime on the Soviet-Polish State Frontier	July 8, 1948	Poland, USSR	Article 17
59	Three	Exchange of notes constituting an agreement between the United States of America and Canada relating to a study to be made by the International Joint Commission with respect to the Upper Columbia River Basin.	March 3, 1944	US, Canada	Paragraphs 2, 3
60	Three	Treaty between the United States of America and Mexico Relating to the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande	February 3, 1944	US, Mexico	Article 3
61	Three	Treaty between Germany and Poland for the settlement of frontier questions	January 27, 1926	Germany, Poland	Article 30
62	Three	Treaty between Great Britain and the United States relating to boundary waters and boundary questions	January 11, 1909	US, Great Britain	Article IV