CHAPTER ONE

Introduction

The dire effects of water scarcity are quite clear. Over 1.5 billion people lack access to drinking water and if current projections continue, at least 3.5 billion people will live in water-stressed basins in just twenty years. Furthermore, 3.3 billion people have access to water, but much of it is contaminated and 2.5 billion people have no water sanitation services. In developing countries, an estimated 90 percent of waste is discharged without treatment into rivers and streams. Consequently, there are about 250 million cases of water-related diseases that result in 5–10 million deaths each year (World Wildlife Fund, 2003).

The problem is not just a developing nation phenomenon. Freshwater conflict has been documented in Europe and in North America. In the United States, 400 million cubic meters of groundwater is removed annually from aquifers in Arizona, double the amount of recharge. In Spain, nearly half of the 100 aquifers are overexploited (Mayell, 2003).

Population increase, industrial pollution, drought, and inefficient governmental responses all contribute to water scarcity. While each factor is integrally related, there is no "one size fits all" approach for mitigating regional water scarcity. Yet it is possible to evaluate interstate water accords. Nation states have been overwhelmingly successful in sharing freshwater resources even if other strident political concerns remain. Of the 152 water conflicts documented in the twentieth century, only 7 have resulted in skirmishes (Wolf, 1998). Still it is an open question as to whether this form of collective action is sufficient to meet a recent United Nations goal of providing 95 percent of human beings with safe drinking water and sanitation by 2025 (Asian Development Bank, 2004).

While empirical data from interstate water accords offers hope, comprehensive research has not been conducted on the underlying motivations for creating interstate water accords nor has there been a thorough assessment in understanding the level of cooperation within water accords. Therefore, two central questions are addressed in this study: (1) How are nation states able to overcome collective action problems and achieve measurable accords? and (2) What factors make accords so resilient?

In order to address these questions, it is important to understand that water scarcity impacts nation states in multiple ways. Levy (1995); T. Homer-Dixon (1993); S. Postel (1993); and P. H. Gleick (1993, 1998, 2000) viewed it in terms of conflict. Furthermore, M. Nakayama (1997), Homer-Dixon and Percival (1995), D. Ward (2002), and Bennet (1995) provided detailed cases studies depicting freshwater scarcity and its impact on various societies. However, aggregate analysis of 1,831 international water related events over the last 50 years revealed that two-thirds of these encounters were cooperative. Nations agreed to implement joint scientific or technological work and signed 157 water treaties (Postel & Wolf, 2001). According to figure 1.1 (see appendix B), nations are very reluctant to engage in violent conflict over water.

Aaron Wolf (2000, 2002) provided initial insight toward understanding and evaluating how water accords reduce freshwater scarcity. His central finding was that nation states have been able to negotiate successfully over water quantity, quality, and non-water linkages such as pollution reduction. While these are important findings, it was uncertain why this occurs or how it applies collectively to interstate water accords. Few authors have conducted systematic analyses on international water treaties as a whole (Wolf, 1999). However, there is a growing need for global environmental scholars and for international security experts to evaluate the early signs and likely locations of water-related disputes, as well as to understand what governments and international agents can do to prevent the eruption of violence and political instability (Wolf, 2002).

The reality is that one-fourth of water-related interactions during the last half of the twentieth century were hostile. Albeit, much of the hostility was simply verbal antagonism; there were thirty-seven occasions where rival countries either fired shots, engaged in dam destruction, or undertook some other form of military action (Postel & Wolf, 2001).

While acute instances of water conflict may be dismissed as outliers, much of the world is experiencing freshwater shortages. The amount of available water today is the same as it was during the times of ancient Mesopotamia (approximately 4,000 years ago). Since 1950, the renewable supply per person has fallen 58 percent as the world population swelled

from 2.5 billion to 6 billion (Postel, 2000). Unlike oil and other strategic resources, freshwater has no substitute. Clearly, forward-thinking policies must be developed in order to manage this global crisis.

Recognizing a Global Environmental Problem

Freshwater scarcity[1] is a complex geopolitical phenomenon with multiple dimensions. Therefore, it needs to be addressed in an incremental manner. This entails issue overview, causal factor evaluation, alternative policy solutions, and interstate water accord evaluation.

Background

Water[2] is endemic to any society. "From water we have created every living thing (Qur'an, Sura 21, Verse 30); . . . if you touch water, you touch everything" (Cassuto quoting Gunther, 2002). Water has significant symbolic value because it is viewed as a cleansing and healing agent and in many cultures it is associated with rebirth (Abrams, 2001). It also is the only limited natural resource that absolutely is essential to human life.[3] Unlike energy, where technological advancements offer solar panels, wind turbines, and fuel cells to replace coal, oil, and gasoline, there is no alternative to water (Graffy, 1998).

Population increase, pollution, drought, and myopic governmental solutions have increased freshwater competition. While a Malthusian[4] perspective has never been proven, water management needs to improve greatly in order to meet current and future population needs. If current practices remain unchecked, Benjamin Franklin's statement, "when the well's dry, we know the price of water" (Postel, 1993) may soon be felt in massive proportions.

An excellent starting point that will help evaluate freshwater scarcity is the seminal study, *Water Scarcity in the Twenty-First Century* (International Water Management Institute [IWMI,] 1999). It projected water supply and demand for 118 countries from 1990 to 2025 based on water consumption patterns in agriculture, industry, households, and the environment. The study indicated that the Middle East, South Africa, and portions of China and India will face absolute water scarcity issues by 2025. This means that these countries will not be able to meet their basic water consumption demands. Population growth is the central factor for explaining water scarcity in each of the four previously mentioned categories. Table 1.1 depicts countries facing water scarcity.

According to table 1.1 (see appendix A) there are four types of water scarce categories. Countries that are labeled categories one and two are of immediate concern. Countries in the first category face absolute water scarcity since daily water requirements are threatened. One billion people (projected to reach 1.8 billion by 2025) predominantly located in the Middle East, South Africa, and portions of China and India are affected. More ominously, these people will not have enough water to maintain 1990 per capita levels by 2025 (IWMI, 1999).

The second category are countries that have sufficient water resources to meet projected 2025 requirements, but that will require greater efforts to extract water. Currently, 350 million people live under these conditions but 900 million people could be affected by 2025 (IWMI, 1999). The problem is further pronounced because many of these countries lack the financial resources to offset impending water shortages (i.e., dam construction and irrigation development).

In 1980 only about 40 percent of the world's population had access to a safe and adequate supply of drinking water. Access was lower in rural areas and in suburban areas and for low-income people wherever they lived. It is now clear that despite immense efforts during the UN-declared Decade for International Drinking Water Supply and Sanitation, by 1990 only a few countries had reached the Decade's goal of providing a safe water supply to all of their citizens (Nickum, 1994).

Water shortages have different impacts depending on how they are exhibited and how the metropolis responds. Scarcity may show up as low water pressure in the delivery system, as restrictions on a supply for short periods during the day, as cutbacks in service to certain areas of the city, or as quantity restrictions on each household or on certain activities. The biggest economic losses occur in extended periods of scarcity if industry does not get enough water. In agriculture an entire crop may be lost if water is unavailable during brief critical periods (Nickum, 1994).

Freshwater scarcity will remain a serious issue even if better irrigation methods are implemented. According to the IWMI, improved irrigation will require 60 percent more water in order to meet basic food supplies by 2025. This means that 2.7 billion people will still remain without adequate freshwater supplies. Figure 1.2 (see appendix B) illustrates how increasing agricultural demands impact water consumption.

It is perplexing that while major diseases have been eradicated, humanity has not effectively managed natural resources. Nature's conflict with neoliberal ideology is part of the problem.[5] Natural resources have been viewed simply as a means for creating greater economic growth without concern for current or future generations.

This is a serious problem for developing countries who are under pressure to meet the basic needs of the people: food and clothing, shelter,

and economic growth. In some cases, developing countries believed that environmental destruction was an inherent by-product of the development process and thus environmental measures meant less economic growth. For example, Indian prime minister Indira Gandhi asked at the 1972 Stockholm Conference on the Human Environment, "How can we speak to those who live in the villages and in the slums about keeping the oceans, the rivers, and the air clean, when their own lives are contaminated? Are not poverty and need the greatest polluters?" (Andreen, 2000).

Whether it is from socioeconomic factors or from other factors, nation states are reluctant to recognize the full impact of water scarcity. Water should be valued as a natural resource independent of socioeconomic considerations. However, nonbinding international law and pressing economic demands have enabled it to remain ill-governed and severely underpriced (Economist, 2003). Consequently, there has been limited domestic and international support in solving freshwater scarcity issues.

This in turn has led to substantial, unnecessary, and preventable human suffering. An estimated 14,000 to 30,000 people, mostly young children and the elderly, die every day from water-related diseases. At any given moment, approximately half of the people in the developing world suffer from diseases caused by drinking contaminated water or from eating contaminated food (United Nations, 2008).

Water quality and quantity are both at issue. In many developing countries, the effort to extend water supply services to new neighborhoods has far outweighed the commitment to treat and safely dispose of waste in the past decade. The bias may have been an unintentional result of the United Nations International Drinking and Water Supply and Sanitation Decade, which set ambitious goals for the extension of sanitation services in the 1980s. In 1988, 78% of urban populations in developing countries were provided with water supply, but only 66% had access to sanitation services. Increasing levels of developing urban water supply facilities may, ironically, adversely affect the urban environment because increased water supply may lead to a larger discharge of untreated wastewater (Nickum, 1994).

"Adequate" water supplies are often contaminated. Inefficient Water Sanitation Systems (WSS), often result in negative environmental and public health externalities due to unsanitary potable water supplies and inadequate wastewater collection and treatment. Waterborne diseases include diarrhea, cholera, and typhoid. Significant reductions in morbidity and mortality, especially among children can be achieved with adequate access to safe and potable water as well as with proper removal, treatment, and disposal of wastewater and effluent (Johnstone, 2001).

Other studies corroborate IWMI findings. According to a recent UN World Water Development Report, freshwater demand has tripled

in the past 50 years. More than 2.3 billion people (17% of the global population) lack access to safe drinking water. Two million die each year from water-related diseases and half of the developing world population suffers from water related maladies (Wertheim, 2004).

The UN and the National Intelligence Council project that at least 40% of the world's population, or about 3 billion people, will live in water scarce countries by 2015 (Jehl, 2002). Additionally, as many as 7 billion people in 60 countries will face water scarcity within the next half century (UNDR, 2003).

By 2015, nearly 3 billion people—40% of the projected world population, are expected to live in countries that find it difficult or impossible to mobilize enough water to satisfy the food, industrial, and domestic needs of its citizens. This scarcity will translate into heightened competition for water between neighboring states and provinces. Maps 1.2 and 1.3 highlights the regions where water stress is evident (see appendix C).

Two continents exhibiting serious acute water shortages are Africa and the Middle East. By 2010, freshwater scarcity will affect 450 million people, approximately 37% of Africa's projected population (Farley, 2001). The Middle East is another stressed region. Nine of the fourteen Middle East countries face water scarce conditions. The population in several other countries is expected to double over the next twenty-five years, exacerbating pressure on already scarce water supplies (Postel, 1997). The Middle East is another region where war has been waged due to water scarcity.[6]

Other problem areas include China, Mexico, India, the southwestern region of the United States. The Chinese government is redirecting rivers (1,000 miles to the north) from the Yangtzee Basin to the water-parched cities of Beijing and Tianjin. This could have serious environmental implications because much of the water is untreated and nearly 300,000 people will be uprooted (Eckholm, 2002). In the western part of the United States water scarcity has impacted negatively local U.S. and Mexican border economies and strained interstate relations over access to the Colorado River. Water riots have occurred in New Delhi, India (2002), and in Monterey, Mexico (1995). While water conflict varies in size and location, it is evident in both hemispheres, including central Asia,[7] Europe, and South America.

Causal Factors

Freshwater scarcity is caused by population growth, industrial pollution, drought, and ineffective governing policies. In 1830, 1 billion people

inhabited the earth. Despite wars, famine, and disease, human population increased 500% over the last 150 years. Today, 6 billion people inhabit the earth with a population equivalent of New York City added each month (90 million people a year). Even if terrorism or war claims 1 million lives, those numbers are replaced within four days (Ward, 2002).

Unprecedented population growth has increased water use sixfold (Jehl, 2002). Half of the world's available freshwater is depleted each year. This figure could reach as high as 74% by 2025. Water tables have fallen on every continent and the situation is expected to worsen. Greater food production is required to meet expanding population needs. However, this entails increased agricultural output. Over-pumping and agricultural runoff have reduced water quantity and quality in many regions. Groundwater mismanagement is now widespread in parts of China, India, Mexico, Thailand, the western United States, North Africa, and the Middle East (Postel, 1993).

The largest and most combustible imbalance between population and available water supplies is Asia, where crop production depends heavily on irrigation. Asia today has roughly 60% of the world's people but only 36% of the world's renewable freshwater (Postel & Wolf, 2001). China, India, Iran, and Pakistan are among the countries where a significant share of the irrigated land is now jeopardized by groundwater depletion, scarce river water, a fertility-sapping buildup of salts in the soil, or some combination of these factors. Groundwater depletion alone places 10 to 20% of grain production in both China and India at risk. Water tables are falling steadily in the North China Plain, as well as in India's northwest Punjab region.

Water scarcity has forced many farmers to move to overcrowded cities. This is the case in Pakistan, where falling agricultural output has prompted a massive rural migration to large urban centers, contributing to renewed outbreaks of ethnic violence.

Internal water stresses also shifts international political alliances, which in turn adds to the humanitarian crises. Many countries commonly adapt to water stress by importing their food (provided they have the foreign exchange to do so). It takes about 1,000 cubic meters of water to grow 1 ton of grain. By importing wheat and other staples, water stressed countries can allocate more of their scarce freshwater to cities and industries, which generate far more economic value per liter than agriculture does. Currently water-stressed countries in Asia, Africa, and the Middle East account for 26% of global grain imports (Postel & Wolf, 2001). This trend is projected to increase over the next fifteen years, in such countries as China, India, and Pakistan. These countries are grain self-sufficient, but are unlikely to remain so considering the

fact that 80% of the available freshwater in Asia is used for irrigation, and 90% of irrigation water is used for rice.[8]

Pollution

Humanity's callous treatment of natural resources has led to global warming as well as to river and stream pollution. Waterways are contaminated with human, industrial, and agricultural wastes. Fertilizers, pesticides, and overgrazing have reduced water quantity and quality. Now, more than half of the world's major rivers are either polluted or have reduced water levels. Additionally, half of the planet's wetlands have been lost in the twentieth century, and freshwater systems all over the world are losing their ability to support human, animal, and plant life (Ward, 2002). The problem is compounded further because natural freshwater is distributed unevenly, with too much water in some areas and far too little in others (Jehl, 2002). Maps 1.2, 1.3 and 1.4 (see appendix C) depict regions facing varying water scarcity problems.

In many developing countries water quality indicators have deteriorated or are not even measured. For example, ambient water quality for Chinese rivers shows substantial degradation since 1990 (Gleick, 2003). Even in developed countries, water quality improvements have been modest (Gleick, 2000).[9] Since 1980, water per capita use in the United States declined substantially due to greater efficiency by farmers and by industrial users. However, these gains could be lost by the increasing water demand of American cities and suburbs, especially in the arid West.

There are many serious sociopolitical issues that permeate the world. Civil war, famine, AIDS, and malaria are prominent social issues that impact life quality and longevity. Still, these issues pale in comparison to global freshwater scarcity problems. No society can survive without adequate freshwater supplies. Modern society must refocus and sustain existing water supplies.[10] However, achieving sustainability is a difficult process. Goodland and Daly (1996) believed that sustainability must incorporate both human and ecological needs. They divided the legacy left to future generations into natural, manufactured, and human or social capital. Natural capital is defined as our natural environment. Manufactured capital is the human-created infrastructure. Finally, human or social capital reflects people, institutions, information, knowledge, and culture. These categories are not interchangeable and sustainability must be applied to each category (Cousins, 2003). This means that people need to develop a comprehensive (economic, political, social, and scientific) understanding of water sources. Only then will society be able to adapt

effective water management policies to resolve future disputes. Even then, policies must be pragmatic for effective implementation to occur (Cosens, 2003). This strategy could entail a combination of philosophical approaches. According to western thought, God made an imperfect world; it is the responsibility of men and women to make it perfect. In the Eastern mind, God made a perfect world; people were to learn how to live in harmony with it. In their own ways, both philosophies are correct in addressing regional water scarcity and in developing effective measures for mitigating the crisis.

International Recognition

Freshwater scarcity has been recognized as a major problem at the international level. The Dublin Principles (1992) declared that every human has the right to "sustain life and meet basic sanitation needs" and elucidated that each person is entitled to 50 liters of water per day[11] (Asian Development Bank, 2003). The 1992 Rio Earth Summit reaffirmed this point by expanding human rights to include environmental water needs. In 1997, the UN declared that water planning must address both human needs and ecosystem preservation (Asian Development Bank, 2003). The Johannesburg Earth Summit (2002) agreed to reduce by half the number of people without safe access to clean water and basic sanitation by 2015. The UN declared 2003 to be the year of freshwater (Economist, 2003).

However, there is a significant discrepancy between declaring goals and achieving them. First, the Dublin Principles delineated that each person is entitled access to safe drinking water, but more than a decade later, nearly 20% of the global population remains at risk. Second, the UN's 2015 goal to reduce freshwater scarcity by 50% is formidable. This means that the UN or other institutions will have to provide viable freshwater resources for 630 million people in ten years. The sanitation challenge is even more daunting: Over the next decade, 1.4 billion people will require this service. The year 2025 is the target date for 100% global access to equitable water supplies (Wertheim, 2004).

Challenges for Mitigating Water Scarcity

Freshwater scarcity is complex because it affects societies in various ways. Its impact is felt locally, nationally, and internationally. Regional water shortages have raised the specter of armed conflict, forced relatively affluent societies to finance huge water projects, and left some of the world's

most impoverished nations in a deepening crisis (Jehl, 2002). While each case requires different methods to alleviate freshwater scarcity, it is illusory to believe that freshwater scarcity can be reduced without a global commitment. Actions must take into account a wide range of social, ecological, and economic factors and needs. Governments need to enhance ongoing dialogues in order to achieve a global consensus (Dowedswell, 1998).

However, current water policies are developed in a fragmented fashion. Distrust between competing institutions prevents effective collective action. Interagency cooperation fails because each power is too decentralized. In some countries, irrigation is managed by ministries of irrigation, water supply by municipalities, hydroelectric power by ministries of energy, navigation by ministries of transport, environment by ministries of environment, and health by ministries of health. Lack of coordination exhibited by intense rivalries has resulted in suboptimal water policies.[12] Without institutional rationalization and strengthening, water management simply will not become effective (Dowedswell 1998). Equitable water management is also complicated because each river basin has its own peculiar ecosystem. Attention must be given to each river basin's hydrology in terms of inflows and outflows.

Regardless of perspective, governments, international aid agencies, water agencies, non-governmental organizations, and local communities must work together to provide everyone with a basic water requirement and to guarantee water as a human right (Gleick, 2000).

Alternative Policy Solutions

Privatization has been suggested as a method to reduce freshwater scarcity. This perspective is based on the Washington Consensus, which is an economic model that links effective resource allocation to liberal market economics. However, this is a deceptive practice. First, it means that a few transnational corporations, backed by the World Bank and the International Monetary Fund (IMF), institutions that are supposed to provide economic well-being, have taken over public water services. The results are uneven because many Third World societies do not have sufficient resources to pay for water price increases (Barlow & Clark, 2002). In turn, this weakens local economies, further destabilizing water scarce regions.

Recent events in Cochabamba, Bolivia, underscore these risks. In June 1999, the World Bank issued a report on Bolivia discussing the water situation in Cochabamba. The World Bank, which along with the International Development Bank had made privatization a condition for loans, recommended that there be "no public subsidies" to hold down

water service price increases. However, a $30 monthly water bill increase was destabilizing for many Cochabamban families.[13] The Bolivian government agreed with the "one size fits all approach" of the World Bank and privatized Cochabamba's water system. The key provision was Law 2029, which in turn eliminated any guarantee of water distribution to rural areas. This resulted in only half of Cochabamba's population being connected to the central water system. The law also prohibited the peasants from constructing collection tanks to gather rainwater. Law 2029 required people to ask the water superintendent for permission to collect rainwater. The superintendent gave private companies a concession for forty years of general water use while only conceding five years to the irrigators and peasants in the outlying communities (Olivera, 2004).

Following the privatization of Cochabamba's water system, water rates skyrocketed. This resulted in water bills that was equal to more than a quarter of residents' income. While Cochabama is extreme, it is not an isolated case.[14] Activists in Colombia and South Africa likewise have opposed the privatization of water and of other municipal services. Meanwhile, last year IMF loan agreements with at least half a dozen countries called for some degree of water system privatization. The number of urban dwellers is projected to double to 5 billion by 2025. Unless governments and lenders strengthen municipal water agencies toward equity as well as toward efficiency, more violence like that in Cochabamba may be forthcoming.[15]

One cannot predict how water scarcity will impact future societies, but the IWMI and UN agency reports must be taken seriously. Water is a vital resource for sustaining human life, growing crops, and serving industrial needs. However, freshwater demand is rising faster than the supply and clearly delineated conservation practices are needed to reduce the current 1 billion people who lack sufficient water supplies every day of their lives.

One area where this has occurred is within the framework of interstate water accords. The International Environmental Agreements (IEAs) have proven to be remarkably successful in the twentieth century. Of the 152 documented water disputes, 145 or 95.3% were resolved (Wolf, 2002). Figure 1.1 (see appendix B) illustrates the likelihood that nation states are willing to cooperate over water. However, it is perplexing that even with such success, freshwater scarcity remains a growing global concern.

Therefore, this study provides a comprehensive assessment of interstate water accords as a means of mitigating regional freshwater scarcity. It also contributes to the development of a new intergenerational water ethic[16] where the needs of the present are met "without compromising

the ability of future generations to meet their needs" (Graffy, 1998). Specifically, this means a fair share of water for both developing and developed riparian nations. It also includes a fair share of water for the poor, most notably women and children. They spend long hours collecting water and suffer the most from water quality and from water-related diseases. Finally, there must be a fair share of water among competing users that includes aquatic species, habitats, and ecosystems.

Heraclitus, the ancient Greek philosopher, stated that one never steps in the same river twice. Heraclitus' observation indicated the ever-changing flow of water and life. The world's freshwater systems are in a constant state of natural flux. Undoubtedly, these changes have influenced the direction of civilization. However, human activities and population growth have accelerated and altered natural hydrologic processes. Today, freshwater quantity and quality are serious global issues. Arid and semi-arid regions face increasing stress from water scarcity and much of the world faces growing pollution problems resulting from environmental change and inefficient management.

The potential for freshwater conflict is enormous, given its importance for basic survival, industry, energy production, and for other fundamental societal components. Many freshwater basins (approximately 300) lie on or across international borders. Several conflicts linked to freshwater scarcity are apparent already at both the local and international levels. In many cases, little preventive action has been taken and even less definitive planning has been implemented systematically to analyze and to propose integrated management solutions (Gorbachev, 2000). Therefore, it is imperative to evaluate measures that have been successful and analyze them in greater detail.

Water Basins

River basins[17] have existed throughout history. They have influenced human settlement and interaction long before the establishment of interstate accords. River location and flow determined how societies developed. They provided transportation and communication that contributed to the formation of political units. River basins should not be viewed as a mere function of society. In some instances, the physical unity of the basin has often proved to be stronger than the various political divisions (World Bank, 2005). Yet the river basin has unified communities and stimulated trade by creating large political and economic units. Agriculture, navigation, and human settlement location are all directly influenced by river basins.

Commercial unity and non-navigational use has enabled the water basin to evolve into a complex and multi-purposed entity. By the twentieth century, water appropriators emphasized a systems wide integration approach of river water. Nations, in turn, valued water basins even more, which created greater dependency on them in terms of social organization and administration (World Bank, 2005).

Interstate Water Accords

Currently, there are 263 rivers that either cross or demarcate international political boundaries. Geographically, Europe has the largest number of international basins (69), followed by Africa (59), Asia (57), North America (40), and South America (38) (Wolf & Giordano, 2003). The absolute number of international basins, as well as the nations through which they traverse, change over time due to political changes. Map 1.4 (see appendix C) reflects worldwide basin distribution and water stress levela. For example, in the 1990s, the breakup of the Soviet Union and Yugoslavia led to the internationalization of several basins as well as to changes in the political composition of existing international basins (i.e., Danube and Aral Sea basins). In contrast, the unification of Germany and Yemen in 1990 resulted in the "nationalization" of the Weser and Tiban water basins (Wolf & Giordano, 2003).

The geographic structure of the world's international waterways is also significant. The world's 263 international river basins accounts for nearly half of the earth's land surface, generate 60% of global freshwater flow, and are home to approximately 40% of the world's population. It is the political composition of these shared water systems that highlights their vulnerabilities. A total of 145 countries contribute territory to international basins. Thirty-three nations, including sizable countries such as Bolivia, Chad, the Democratic Republic of the Congo, Niger, and Zambia have more than 95% of their territory within the hydrologic boundaries of one or more of the international basins. Even more significant is the number of countries that share individual basins. The Danube has seventeen riparian states. The Congo, Niger, Nile, Rhine, and Zambezi are shared by more than nine countries while the Amazon, Aral Sea, Gagnes-Brahmaputra-Meghna, Jordan, Kura-Araks, La Plata, Lake Chad, Mekong, Neman, Tarim, Tigris-Euphrates, Shatt al Arab, Vistula, and Volga basin each contain territory of at least five sovereign nations (Wolf et al., 1999).

The complex physical, political, and human interactions within international river basins makes the management of these shared water

systems especially difficult. Issues of increasing water scarcity, quantity, rapid population growth, unilateral water development, and uneven levels of economic development are potentially disruptive factors in co-riparian water relations (Wolf, 2003).

Yet, despite these formidable obstacles, co-riparians have demonstrated a remarkable ability to cooperate over their shared water supplies. In the largest quantitative study of water conflict and cooperation, Oregon State University researchers found that cooperative interactions between riparian states over the past fifty years have outnumbered conflictive interactions by more than two to one. Since 1948, the historical record documents only 37 incidents of acute conflict (i.e., those involving violence) over water (30 of these events were between Israel and its neighbors, the last of which occurred in 1970). At the same time, approximately 295 water agreements were negotiated and signed (Wolf, 2003).

At the sub-acute level, which defines most water interactions, cooperative relations dominate the history of international water relations. This does not imply that water cannot act as a source of discord. Water was the last and most contentious issue resolved in negotiations over the 1994 Treaty of Peace between Israel and Jordan, and in the Israeli-Palestinian context discussions concerning the resource were relegated to the "final status" negotiations along with other controversial issues such as the status of Jerusalem, and the right of return for Palestinian refugees (Wolf & Giordano, 2003).

However, water cooperation is far more prevalent especially where strong institutions are present. The establishment of the Indus Water Commission in 1960 between India and Pakistan fostered remarkably resilient bilateral cooperation over water, notwithstanding two wars and continued political turmoil between the two states. The Mekong River Committee, established in 1957 among the four lower riparian states of Thailand, Cambodia, Vietnam, and Laos also weathered extreme political conditions and viable water cooperation even during the Vietnam War (Wolf & Giordano, 2003).

Thus, the creation and maintenance of effective international water institutions offer hope that current freshwater scarcity problems can be managed. In fact, the presence or absence of institutions has proven to be one of the most important factors influencing co-riparian water relations, exceeding traditional variables such as climate, water availability, population density, political orientation, and levels of economic development (Wolf, 2003). Furthermore, the historical record indicates an increased likelihood of basin conflict where institutions are unable to accommodate to changing political and hydrologic needs. Yet where international water

institutions exist, relations among riparian states are generally more cooperative than in basins without treaties or other cooperative management mechanisms (Wolf, Yoffe, & Giordano, 2003).

Regional Accords

Regional organizational initiatives have served further to encourage co-riparian cooperation. Through the creation of region-specific guidelines, multinational bodies such as the Organization for Economic Cooperation and Development (OECD), the European Union (EU), and the Southern African Development Community (SADC) have formulated agreements and protocols supporting collaborative water resource initiatives. In the 1970s, the OECD Council recommended the management and protection of trans-boundary resources relevant to international rivers. European governments have addressed regional water issues through such agreements as the Convention on Environmental Impact Assessment in a Trans-boundary Context (1991) and the Convention on the Protection and Use of Trans-boundary Water Courses and International Lakes (1992). In 2000, the SADC member states established the Protocol on Shared Watercourses in the Southern African Development Community (Wolf & Giordano, 2003). (Map 1.5 [see appendix C] shows the correlation between number of international water basins and interstate accords.)

Basin Treaties

The highest levels of cooperative water management are located within water basins with corresponding treaties extending back to 2500 B.C. The Food and Agricultural Organization of the United Nations has documented more than 3,600 international water treaties from AD 805 to 1984. Although a vast majority of these agreements concern navigational issues, a growing number address water scarcity.

There are three distinguishing characteristics in developing interstate water accords. They are: shared values, creativity, and adaptability. First, co-riparians share several hydrologic linkages. Agriculture, industry, recreation, hydropower, flood control, environmental integrity, and human health are connected. While individual sectors and countries have exploited their riparian position or dominance, basin states have demonstrated a remarkable ability to cooperate upon their shared interests. For example, the 1986 Lesotho Highlands Water Project Agreement in South

Africa, supports the financing of hydroelectric/water diversion facility and in turn, receives the rights to drinking water for its industrial use in Guateng Province.

Second, basin states have illustrated a great deal of creativity in formulating treaty provisions that meet the unique hydrologic, political, and cultural settings of their individual basins. As part of 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 upstream in Nepal to protect its own downstream water supplies (Wolf, 1999).

Third, effective accords require adaptability. Precedents exist for incorporating provisions into basin accords to accommodate changing needs and values. The 1987 Agreements on the Action Plan for the Environmentally Sound Management of the Common Zambezi River System allows for additional riparian states to sign the treaty. Other flexible treaties include the 1996 treaty between India and Bangladesh on the Sharing of the Ganga/Ganges Waters at Farakka, the 1986 Lesotho Highlands Water Project Agreement, and the 1992 Komati River Basin Treaty between South Africa and Swaziland (Wolf & Giordano, 2003).

The Transboundary Freshwater Data Base offers the most comprehensive source for interpreting interstate freshwater accords.[18] One hundred forty-five water-related treaties were signed in the twentieth century. Of these, 124 (86%) are bilateral and conversely 21 are multilateral. It is unclear why an overwhelming number of treaties are bilateral. One possibility is that only two states share a majority of international watersheds. Yet, according to negotiation theory, the number of disputing parties reduces the chance for conflict resolution. This is problematic because in basins with more than two riparians, preference for bilateral agreements can preclude the comprehensive regional management long advocated by water resource managers (Wolf, 2003).

Most treaties focus on hydropower and water supplies: 57 (39%) discuss hydroelectric generation, 53 (37%) distribute water for consumption, 9 (6%) mention industrial uses, 6 (4%) deal with navigation, 6 (4%) discuss pollution, 13 (9%) focus on flood control.

However, few treaties allocate water. Clearly defined allocations account for 54 (37%) of the agreements. Of that number, 15 (28%) specify equal proportions, and 39 (72%) provide a specific means of allocation. All but 3 multilateral agreements lack definite allotments, although a few establish advisory and governing bodies among states (Wolf, 2003). Fifty-seven of the treaties (39%) focus on hydropower. Power-generating facilities bring development, and hydropower provides a cheap source of electricity to spur developing economies.

Groundwater is only addressed in three interstate accords. The most recent is the 1995 Israeli-Palestinian agreements. However, there are serious limitations, because this accord does not provide a quantitative measure for water sharing. The 1989 Bellagio Draft Treaty between the United States and Mexico provides a legal framework for groundwater negotiations. The Draft requires the joint management of shared aquifers and describes principles based on mutual respect, good neighborliness, and reciprocity. While this framework is useful for future groundwater diplomacy, data collection is expensive and hence, difficult to obtain (Wolf, 2000).

Water and non-water linkages are often negotiated together. For example, if pollution causes trouble in a downstream country, an upstream riparian may compensate a downstream neighbor by paying for a treatment plant in lieu of reduced inputs or reduced withdrawals. Here, water quality is of greater importance than water quantity. If successful, this method has the capacity to increase water quantity benefiting all nations at risk. Increasing the scope of negotiations is reflected clearly in interstate water accords. Financial compensation is most evident in interstate accords; 44 cases (30%) addressed capital exchange, territorial or political consideration were much smaller with just 6 land transfer cases (4%), and 2 cases concerned political concession (1%). There are an additional 10 cases (7%) that address non-water linkages. While many prominent accords exhibit creativity and adaptability, the reality is that over half of the existing accords are quite limited; 83 cases (57%) of total interstate water accords do not have any non-water linkages. This means that a simple treaty is more vulnerable to collective action breakdown because a nation could default on its commitment without being concerned with reprisal.

Treaties encompass support from technical and basin commissions as well as from government officials. Fifty-two (36%) of the treaties provide for an advisory council or conflict-addressing body within the parties' governments, 14 treaties (10%) refer disputes to a third party or to the UN, 32 treaties (22%) make no provisions for dispute resolution, and 47 treaties (32%) of the texts are either incomplete or uncertain as to dispute resolution mechanisms (Wolf, 2000).

Lack of unified guidelines (as indicated by the available data) suggests that interstate water accords (which govern the world's international watersheds and predominantly are based on international law) are in their respective infancies. More than half of these treaties have no monitoring provisions, two-thirds do not delineate specific water allocation mechanisms, and four-fifths have no enforcement mechanism (Wolf, 2000). Therefore, interstate water accords offer cautious hope. Empirical

evidence states that nations can overcome strident political and social obstacles and cooperate over water resources. Yet, it is uncertain how effective these accords will be in addressing current and future freshwater scarcity problems.

Looking forward, there are four key components that can be used for developing future interstate water accords. First, adaptable management structures incorporate a certain level of flexibility, allowing for public input, changing basin priorities, and providing for new information and monitoring technologies. The adaptability of management structures must also extend to non-signatory riparian nations by incorporating provisions addressing their needs, rights, and potential accession.

Second, there should be clear and flexible criteria for allocations and quality. Allocations, which are at the heart of most water disputes, are a function of water quantity and quality. Therefore, effective institutions must identify clear allocation schedules and water quality standards that simultaneously provide for extreme hydrologic events, a new understanding of basin dynamics, and changing societal values. Additionally, riparian states should consider prioritizing uses throughout the basin.

Third, there needs to be an equitable distribution of benefits. This subtle concept differs from equitable use or allocation. It involves the distribution of benefits from water use from hydropower, agriculture, economic development, or the preservation of aquatic ecosystems rather than simply the benefit of water itself. These benefits allow for greater positive sum-agreements, whereas dividing the water itself allows only for winners and losers.

Fourth, many basins must continue to experience disputes even after a treaty is ratified or signed. Therefore, incorporating clear mechanisms for resolving conflicts is an inelastic prerequisite for long-term effective management. Negotiation theory contains suggestions on how this might accomplished.

Freshwater scarcity is a serious geopolitical phenomenon that affects all societies and cultures. While natural ecological factors contribute to scarcity conditions, current data reveal that it is more human induced. Freshwater scarcity cannot be shared evenly by all disputing nations because many water poor countries do not have the institutional capacity to effect such positive change. Therefore, comprehensive international cooperation is essential for mitigating freshwater scarcity problems (Danilav-Danilan, 2003).

There is much hope for the future success of interstate water accords. They are resilient even as other strident sociopolitical considerations remain. This axiom will be tested with increasing levels of freshwater scarcity. Freshwater scarcity impacts water quantity, quality, and

pollution levels. If unmitigated, water reduction will affect the internal stability of nations as well as serve as a catalyst to increase tensions among various social and ethnic groups. If the current projected models are accurate, water will be the major political issue for many nations as the twenty-first century progresses. Interstate water accords offer a measure of hope to mitigate this crisis, but greater study is required especially in understanding how riparian states engage in early coordination strategies to reduce water conflict.

Conclusion

The following reflects some of the key outstanding issues regarding interstate water management:

- Water resources are under critical stress.
- Water quantity issues affect both developing and developed states.
- Severe problems exist in Asia because of the large agricultural water demands.
- Sub-Sahara Africa is the region most vulnerable to acute water scarcity.
- Forty percent of the global population lack access to vital resources.
- Population growth, industrial pollution, natural climatic conditions, and ineffective interstate responses all contribute to water scarcity.
- Nations have been able to share freshwater resources provided through the development of interstate water accords.

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