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Sharing waters: Post-Rio international water management

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Abstract

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, significant efforts are underway to promote greater cooperation in the world's international river basins, with notable achievements in the past decade following the Dublin and Rio conferences.[1] *Over the past ten years, the international community has adopted conventions, declarations, and legal statements concerning the management of international waters, while basin communities have established numerous new basin institutions. Despite these developments, significant vulnerabilities remain. Many international basins still lack any type of joint management structure, and certain fundamental management components are noticeably absent from those that do. An understanding of these weaknesses, however, offers an opportunity for both the international and basin communities to better respond to the specific institution-building needs of basin communities and thereby foster broader cooperation over the world's international water resources.*

Keywords: International waters; Earth Summit; International water law; Water treaties.

1. Introduction

During the latter part of the 20th century, freshwater resources and their management 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 conflicting demands, depleting groundwater resources, and degrading water stocks worldwide, prompted regular calls for action to improve the state of this life-sustaining resource. The integrated management of water resources, however, is inherently complex. Freshwater systems ignore most political and administrative boundaries and consequently confound the creation of resilient basin-wide management institutions, particularly where multiple countries are involved.

A total of 145 countries are riparian to one or more of the world's 263 international basins. These basins, in which approximately 40% of the world's population live, cover nearly half of the earth's surface area and account for an estimated 60% of global freshwater flow (Wolf et al., 1999, 2002). In addition, there is an as yet unknown number of transboundary aquifers. For international basins, regional politics can exacerbate the already formidable task of understanding and managing complex natural systems, and disparities between riparian states — whether in terms of economic development levels, infrastructural capacity, political orientation, or cultural values — can complicate the development of joint management frameworks.

These challenges, coupled with a concern that a lack of coordination over shared water supplies might stimulate interstate conflict, have prompted the international community to step up its efforts to promote greater co-riparian cooperation. While the international community has long advocated the joint management of international river basins, the past decade has witnessed a perhaps unprecedented number of declarations as well as organizational and legal developments to further this objective. The decade began with the International Conference on Water and the Environment (Dublin, January 1992) in the lead-up to the 1992 UN Conference on Environment and Development

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[1] The International Conference on Water and the Environment (Dublin), 1992 and the United Nations Conference on Environment and Development (Rio de Janeiro), 1992.

(UNCED) in Rio,[2] which prompted the establishment of several international water resource institutions and programmes. Complementing these institutional changes was the United Nations General Assembly's adoption of the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses in 1997.

This article presents an assessment of the past decade's developments in international transboundary water management. Steps taken by the international community, both substantive and symbolic, are reviewed together with institutional developments at the regional and basin scales. The findings from the study highlight both important progress as well as continuing weaknesses in the management of internationally shared river basins. By placing these findings within the broader historical context of international water cooperation and conflict, the article concludes with suggested policy options for the international community to further support the integrated management of international waters.

2. The setting

Population and development pressures are placing increasing strains on world water supplies. Population growth alone has resulted in a near 80% decline in per capita water availability over the past century,[3] and sufficient potable drinking supplies still elude more than a billion people. As demand for the scarce resource continues to grow, competition over both the quantity and quality of shared water supplies will likely expand, which could result in tensions and, indeed, conflict between users and across political boundaries.

Where water supplies are shared by multiple countries, the risk of conflict is viewed as being especially high. The Middle East, for example, is often cited as a particularly vulnerable region due to climate conditions and political tensions. Over the years several Middle Eastern statesmen, including Egypt's Anwar Sadat and Boutros Boutros-Ghali as well as King Hussein of Jordan have warned of potential regional conflicts over water (Postel, 1999). Broader geographic concerns have been voiced by international leaders such as Ismail Serageldin, former World Bank Vice President for Environmentally and Socially Sustainable Development, who stated that "many wars in this [the 20th] century were over oil, but wars of the next will be over water" (quoted in Crossette, 1995). According to Serageldin, water has been raised to the "top of the international political agenda" and is a global concern, extending beyond "historically conflicted or dry areas" (quoted in McCaffrey, 1997).[4]

A closer look at the world's international basins provides a better understanding of the nature and potential magnitude of international water conflict. Perhaps one reason that international water issues have gained increasing attention is the fact that the number of international river basins has increased substantially in recent decades. In 1978, the last time any official body attempted to delineate them, there were 214 international basins (United Nations, 1978). By 2002, a total of 263 basins had been identified (Figure 1) (Wolf et al., 1999, 2002). The increase in recorded basins is largely the result of the "internationalization" of national basins through political changes, such as the break up of the Soviet Union and the Balkan states, as well as access to better mapping sources and technology.

Even more striking than the total number of basins is the number of countries with territory within these watersheds. Of the 145 nations sharing international watercourses, 21 lie entirely within the hydrologic boundaries of one or more international basins. Including these, a total of 33 countries have greater than 95% of their territory within one or more international basins. Notably, these nations are not limited to smaller countries, such as Liechtenstein and Andorra, but also include such sizeable countries as Hungary, Bangladesh, Belarus and Zambia.

Beyond their importance in terms of surface and political area, a look at the number of countries that share individual watercourses highlights the precarious setting of many international basins. Approximately one-third of the 263 international basins are shared by more than two countries, and 19 involve five or more sovereign states. Of these 19, one basin, the Danube, has 17 riparian nations. Five basins — the Congo, Niger, Nile, Rhine and Zambezi — are shared by between nine and 11 countries. 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, 2002).

3. Conflict and cooperation and the importance of resilient institutions

The complex dynamics of managing international waters can be seen through a review of co-riparian relations. The largest empirical study of water conflict and cooperation, completed in 2001 at Oregon State University, documents a total of 1,831 interactions, both conflictive and cooperative,

[2] The UN Conference on Environment and Development is often referred to as the Rio Earth Summit.

[3] Measured in terms of average runoff, "water availability" was approximately 30,000m^3/person in 1900 and declined to 7,000 m^3/person in 2000 (Gleick, 2000).

[4] Kofi Annan, UN Secretary-General, similarly warns of broader geographic risks of water conflicts. In a 2001 speech at the Annual Conference of the Association of American Geographers, Annan (2001) stated that "fierce competition over fresh water may well become a source of conflict and wars in the future".

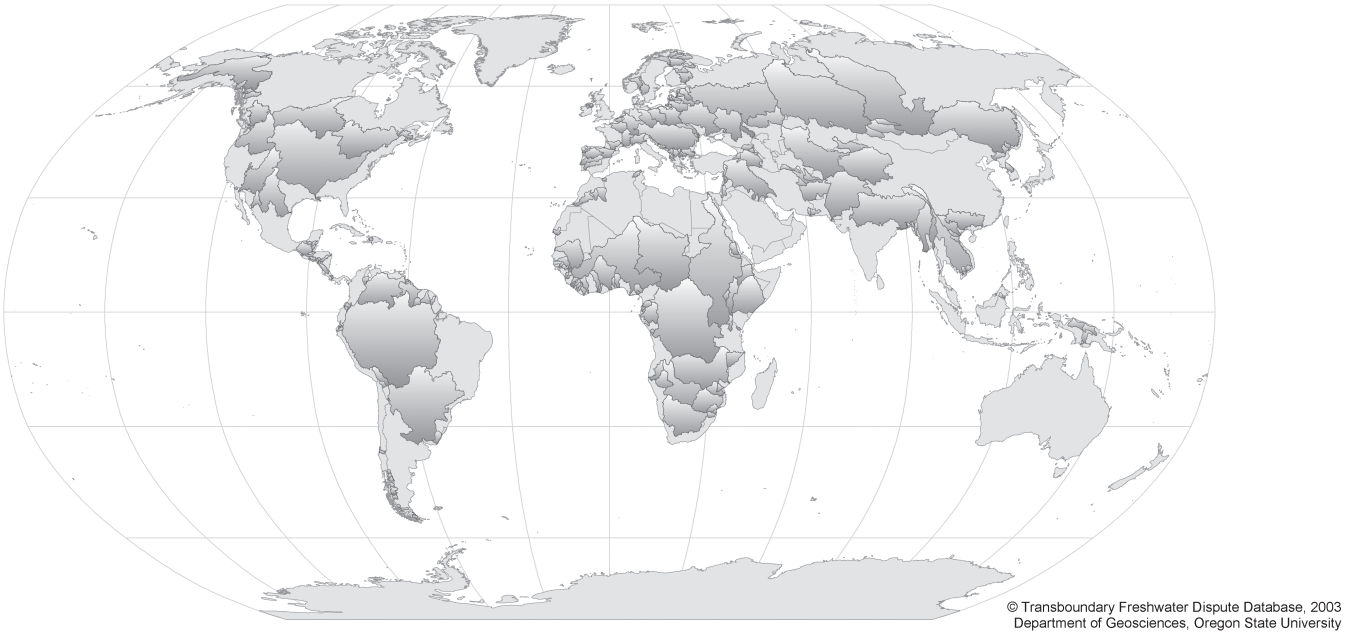

Figure 1. International river basins of the World

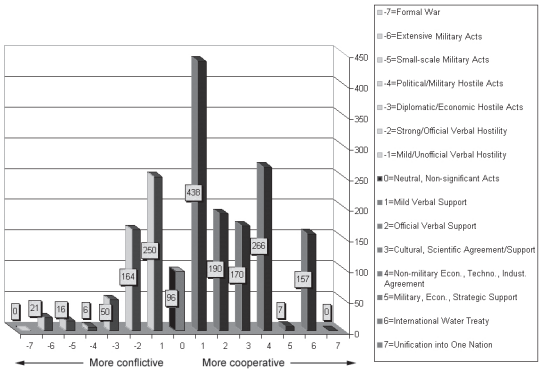

Figure 2. Number of water-related interactions by level of intensity, 1948–99

between two or more nations over water during the past 50 years.[5] An analysis of the data yields the following general findings. First, despite the potential for dispute in international basins, the record of acute conflict over international water resources is historically overwhelmed by the record of cooperation (Figure 2). The last 50 years have seen only 37 acute disputes (those involving violence) while, during the same period, over 150 water treaties were negotiated and signed. The total number of water-related events between nations of any magnitude is likewise weighted towards cooperation: 507 conflict-related events, versus 1,228 cooperative (Wolf et al., 2003). These data show that cooperation, rather than conflict, has been the rule in international water relations and that violence over water is in fact rare.

Second, nations find many more issues of cooperation than of conflict. Riparian nations cooperate over a broad spectrum of issues including management, quantity, quality, infrastructure, hydropower, and economic development. In contrast, almost 90% of all conflictive events relate to quantity or infrastructure. Furthermore, the 21 incidents of extensive military acts, the most extreme cases of water conflict identified, fall almost exclusively within these two categories (Wolf et al., 2003).

Third, at the sub-acute level, water acts as both an irritant and as a unifier. As an irritant, water can make good relations bad and bad relations worse. Threats and disputes over water have raged between neighbouring states with relationships as diverse as those between India and Pakistan and America and Canada. Water was the last and most contentious issue resolved in negotiations leading to a 1994 peace treaty between Israel and Jordan, and was relegated to "final status" negotiations — along with other of the most difficult issues such as Jerusalem and refugees — between Israel and the Palestinians (Lonergan, 2000).

Equally, international waters, despite their complexities, can also act as a unifier in basins where relatively strong institutions are in place. The historical record shows that international water disputes do get resolved, even among bitter enemies, and even as conflicts erupt over other issues. Some of the most vociferous enemies around the world have negotiated water agreements or are in the process of

[5] Included in the study are interactions that involved 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. Excluded are events where water is incidental to the dispute, such as those concerning fishing rights, access to ports, transportation, or river boundaries or where it is a tool, target, or victim of armed conflict.

doing so, and the institutions they have created frequently prove to be resilient over time, even during periods of otherwise strained relations. The Mekong Committee, for example, has functioned since 1957, exchanging water-related data throughout the Vietnam War.

Secret "picnic table" talks have been held between Israel and Jordan since the unsuccessful Johnston negotiations of 1953–55, even as these riparians until only recently were in a legal state of war. The Indus River Commission survived two wars as well as more recent threats to stability between India and Pakistan, and all ten Nile riparians are currently involved in negotiations over cooperative development of their shared basin as part of the Nile Basin Initiative (Wolf, 1998).

In the absence of institutions, however, changes within a basin can lead to conflict. To avoid the political intricacies of negotiating use of shared water resources, for example, a riparian, generally the regional power,[6] may unilaterally implement a project that impacts at least one of its neighbours. Such a project might involve a plan to meet existing uses in the face of decreasing relative water availability — as for example Egypt's plans to build a high dam on the Nile or India's diversions of the Ganges to protect the port of Calcutta — or to meet new or changing needs such as with Turkey's GAP project on the Euphrates. When projects proceed without collaboration within a basin, they can become a flashpoint, heightening tensions and regional instability, and requiring years or, more commonly, decades to resolve.

Evidence of how institutions can serve to defuse tensions is seen in basins with large numbers of water infrastructure projects. A review of international basins with high dam densities reveals that co-riparian relations are significantly more cooperative in those basins with established water treaties than in similarly developed basins without treaties. In fact, the presence or absence of institutions has proven to be one of the most important factors influencing co-riparian relations, exceeding such traditionally cited variables as climate, water availability, population density, political orientation, and levels of economic development (Wolf et al., 2003). Thus, the history of international water relations suggests that institutions seem to ameliorate water's conflict-inducing characteristics.[7]

[6] "Power" in regional hydropolitics can include riparian position, with an upstream riparian having more relative strength *vis-à-vis* the water resources than its downstream riparian, in addition to the more conventional measures of military, political and economic strength. Nevertheless, when a project is implemented that impacts one's neighbours, it is generally undertaken by the regional power, as defined by traditional terms, regardless of its riparian position.

[7] It is important to understand there is a history of water-related violence — but it is a history of incidents at the sub-national level, generally between tribes, water-use sectors, or states/provinces. There seems, in fact, to be an inverse relationship between geographic scale and intensity of conflict.

4. Recent developments in international transboundary water — contributions from the international community

Acknowledging the benefits of cooperative water management, the international community has long advocated institutional development in the world's international waterways, and has focused considerable attention in the 20th century on developing and refining principles of shared management. In 1911, the Institute of International Law published the Madrid Declaration on the International Regulation regarding the Use of International Watercourses for Purposes other than Navigation. The Madrid Declaration outlined certain basic principles of shared water management, recommending that co-riparian states establish permanent joint commissions and discouraging unilateral basin alterations and harmful modifications of international rivers. Expanding on these guidelines, the International Law Association developed the Helsinki Rules of 1966 on the Uses of Waters of International Rivers. Since then international freshwater law has matured through the work of these two organizations as well as the United Nations and other governmental and non-governmental bodies.

The past decade, however, has witnessed a perhaps unprecedented number of declarations as well as organizational and legal developments to further the international community's objective of promoting cooperative river basin management. The decade began with the International Conference on Water and the Environment in the lead-up to the 1992 Rio Earth Summit. Subsequently, actions taken by the international community have included the pronouncement of non-binding conventions and declarations, the creation of global water institutions, and the codification of international water principles. While clearly more work is required, these initiatives have not only raised awareness of the myriad issues related to international water resource management, but have also led to the creation of frameworks in which the issues can be addressed.

4.1. Conventions, declarations, and organizational developments

The 1992 Earth Summit served as a forum for world policy-makers to discuss problems of the environment and development. As such, management of the world's water resources was only one of several topics addressed. Water was, however, the primary focus of the International Conference on Water and the Environment (ICWE), a preparatory conference held in Dublin, before the Rio Earth Summit. The ICWE participants, representing governmental and non-governmental organizations, developed a set of policy recommendations outlined in the Conference's Dublin Statement on Water and Sustainable Development, which the drafters entrusted to the world leaders gathering in Rio for translation into a plan of action. While covering a range of water resource management issues, the Dublin Statement

specifically highlights the growing importance of international transboundary water management and encourages greater attention to the creation and implementation of integrated water management institutions endorsed by all affected basin states. Moreover, the drafters outlined certain essential functions of international water institutions including "reconciling and harmonizing the interests of riparian countries, monitoring water quantity and quality, development of concerted action programmes, exchange of information, and enforcing agreements."[8]

At the Rio Conference, water resource management was specifically addressed in Chapter 18 of Agenda 21, a non-binding action plan for improving the state of the world's natural resources in the 21st century adopted by UNCED participants. The overall goal of Chapter 18 is to ensure that the supply and quality of water are sufficient to meet both human and ecological needs worldwide, and the chapter provides details on this objective in its ambitious, seven-part action plan. Although transboundary water resource management is mentioned in Chapter 18, few specific and substantive references are made to water resource issues at the international scale. The Rio Conference did, however, generate a number of activities concerning freshwater management in general, with implications for international transboundary water management.

One result of the Rio Conference and Agenda 21 has been an expansion of international freshwater resource institutions and programmes. The World Water Council, a self-described "think tank" for world water resource issues, for example, was created in 1996 in response to recommendations from the Rio Conference. The World Water Council hosted two World Water Forums in 1997 and 2000.[9] These involved gatherings of government, non-government, and private sector representatives to discuss and collectively determine a vision for the management of water resources over the next quarter century. These forums have led to the creation of the World Water Vision, a forward-looking declaration of philosophical and institutional water management needs, as well as the creation of coordinating and implementing agencies such as the World Commission on Water for the 21st Century and the Global Water Partnership. The Second World Water Forum in the Hague also served as the venue for a Ministerial Conference in which the leaders of participating countries signed a declaration concerning water security in the 21st century. The World Summit on Sustainable Development (Johannesburg, September 2002) helped to sustain the momentum of these recent global water initiatives. In the Johannesburg Ministerial Declaration, delegates reaffirmed a commitment to the principles contained in Agenda 21 and called upon the United Nations to review, evaluate, and promote further implementation of this global action plan (United Nations, 2002a).

Through these meetings the international community has reinforced its commitment to satisfy the water quality and quantity requirements of the global population and its surrounding environment and has identified attendant tasks and policy measures needed to fulfil its pledge. While many of the strategies in Agenda 21 and subsequent statements are directed primarily at national water resources, their relevance extends to international transboundary waters. In fact, the Ministerial Declaration at the Second World Water Forum in the Hague in 2000 included "sharing water" (among different users and states) as one of its seven major challenges to achieving water security in the 21st century. Many of the other six challenges, which include meeting basic needs, securing the food supply, protecting the ecosystem, managing risks, valuing water, and governing water wisely, are also applicable to waters in an international setting. Furthermore, policy measures prescribed by the international community to build greater institutional capacity, such as integrated water resource management, expanded stakeholder participation, and improved monitoring and evaluation schemes, are likewise important components of international watercourse management.

Like Agenda 21, however, none of these post-Rio statements or declarations focuses exclusively on international freshwater sources. Additionally, despite the efforts over the past decade to expand global institutional capacity over freshwater resources, no supranational agency exists to manage transboundary resources globally. Thus, while many of the principles of national water management apply to international waters, the political, social, and economic dynamics associated with waters shared between sovereign states can require special consideration.

4.2. Legal principles

United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Convention), adopted in 1997 by the UN General Assembly, is one post-Rio accomplishment that specifically focuses on international transboundary water resources.[10] The UN Convention codifies many of the principles deemed essential by the international community for the management of shared water resources, such as equitable and reasonable utilization of waters with specific attention to vital human needs; protection of the aquatic environment; and the promotion of cooperative management mechanisms. The document also incorporates provisions concerning data and information exchange and mechanisms for conflict resolution. Once ratified, the UN Convention will provide a legally binding framework, at least upon its signatories, for managing international watercourses. Even without ratification, its guidelines are being increasingly invoked in international forums.

[8] Partial text of Dublin Statement available in FAO, 1998.

[9] The third World Water Forum will be held in March 2003 in Japan.

[10] UN General Assembly document A/RES/51/229 of 8 July 1997.

The approval of the Convention by UN member States, however, does not entirely resolve many legal questions concerning the management of internationally shared waters. First, the Convention would technically be binding only on those nations that have ratified or consented to be bound by the agreement. To date, five years after its adoption by the UN General Assembly, only 12 countries are party to the UN Convention, well below the requisite 35 instruments of ratification, acceptance, accession, or approval needed to bring the Convention into force (United Nations, 2002b).[11] Second, international law only guides conduct between sovereign nations. Thus, grievances of political units or ethnic groups within nations over the domestic management of international waterways would not be addressed. Third, while the Convention offers general guidance to co-riparian states, its vague, and occasionally contradictory, language can result in varied, and indeed conflicting, interpretations of the principles contained therein. As stated by Biswas (1999), the "vague, broad, and general terms" incorporated in the UN Convention "can be defined, and in certain cases quantified, in a variety of different ways."

Fourth, there is no practical enforcement mechanism to back up the Convention's guidance. The International Court of Justice (ICJ), for example, hears cases only with the consent of the parties involved and only on very specific legal points. Moreover, in its 55-year history, the Court has decided only one case, apart from those related to boundary definitional disputes, pertinent to international waters — that of the Gabçikovo-Nagymaros Project on the Danube between Hungary and Slovakia in 1997.[12] Finally, the Convention only addresses those groundwater bodies that are connected to surface water systems (i.e., unconfined aquifers), yet several nations are already beginning to tap into confined groundwater systems, many of which are shared across international boundaries.

5. Developments in basin-level transboundary water management

In addition to the efforts of the international community, riparian states have developed a rich history of treaties concerning the management of shared watercourses. In contrast with the vague and sometimes contradictory global declarations and principles, the institutions developed by co-riparian nations have been able to focus on specific basin-level conditions and concerns. An evaluation of these institutions over the past half-century, with particular attention to treaties signed since the Rio Conference, offers insights into how appropriately the emphasis areas highlighted in Agenda 21 and subsequent declarations and conventions on freshwater resource management in general address the needs of international transboundary waters specifically.

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 concerning the Tigris River ending the only true "water war" in history. Since then, a large body of water treaties has emerged. The Food and Agricultural Organization of the United Nations has identified more than 3,600 treaties dating from AD 805 to 1984 (FAO, 1978, 1984). While the majority of these relate to some aspect of navigation, a growing number address non-navigational issues of water management, including flood control, hydropower projects, or allocations for consumptive or non-consumptive uses in international basins. Since 1820 more than 400 water treaties and other water-related agreements have been signed, more than half of which were concluded in just the past 50 years.[13]

Despite their growth in numbers, however, a review of treaties from the last half-century reveals an overall lack of robustness. Water allocations, for example, the most conflictive issue area between co-riparian states, are seldom clearly delineated in water accords. Moreover, in the treaties that do specify quantities, allocations are often in fixed amounts, thus ignoring hydrologic variation and changing values and needs. Likewise, water quality provisions have played only a minor role in co-riparian agreements historically. Enforcement mechanisms are also absent in a large percentage of the treaties. Finally, international basins with water agreements remain in the minority. Formal management institutions have been established in only 117 of the 263 international basins (see Figure 3), and even within these, few include all nations riparian to the affected basins, which precludes the integrated basin management advocated by the international community.

More encouraging characteristics are the inclusion of information sharing, monitoring, and conflict resolution provisions in many of the past half-century's treaties. In addition, there has been a broadening in the definition and measurement of basin benefits. Traditionally, co-riparians have focused on water as a commodity to be divided — a zero-sum, rights-based approach. Precedents now exist for determining formulas that equitably allocate the benefits derived from water, not the water itself — a positive-sum, integrative approach. For example, as part of the 1961 Columbia River Treaty, the United States paid Canada for the benefits of flood control and Canada was granted rights to divert water between the Columbia and Kootenai for hydropower purposes. Similarly, a 1975 Mekong River

[11] As of March 2003, Finland, Hungary, Iraq, Jordan, Lebanon, Namibia, Netherlands, Norway, Qatar, South Africa, Sweden, and Syria were party to the Convention.

[12] The ICJ was established in 1946 with the dissolution of its predecessor agency, the Permanent Court of International Justice. This earlier body did rule on four international water disputes during its existence from 1922 to 1946.

[13] Statistics obtained from the Transboundary Freshwater Dispute Database (TFDD) maintained at Oregon State University. The TFDD is available on-line at: http://www.transboundarywaters.orst.edu/

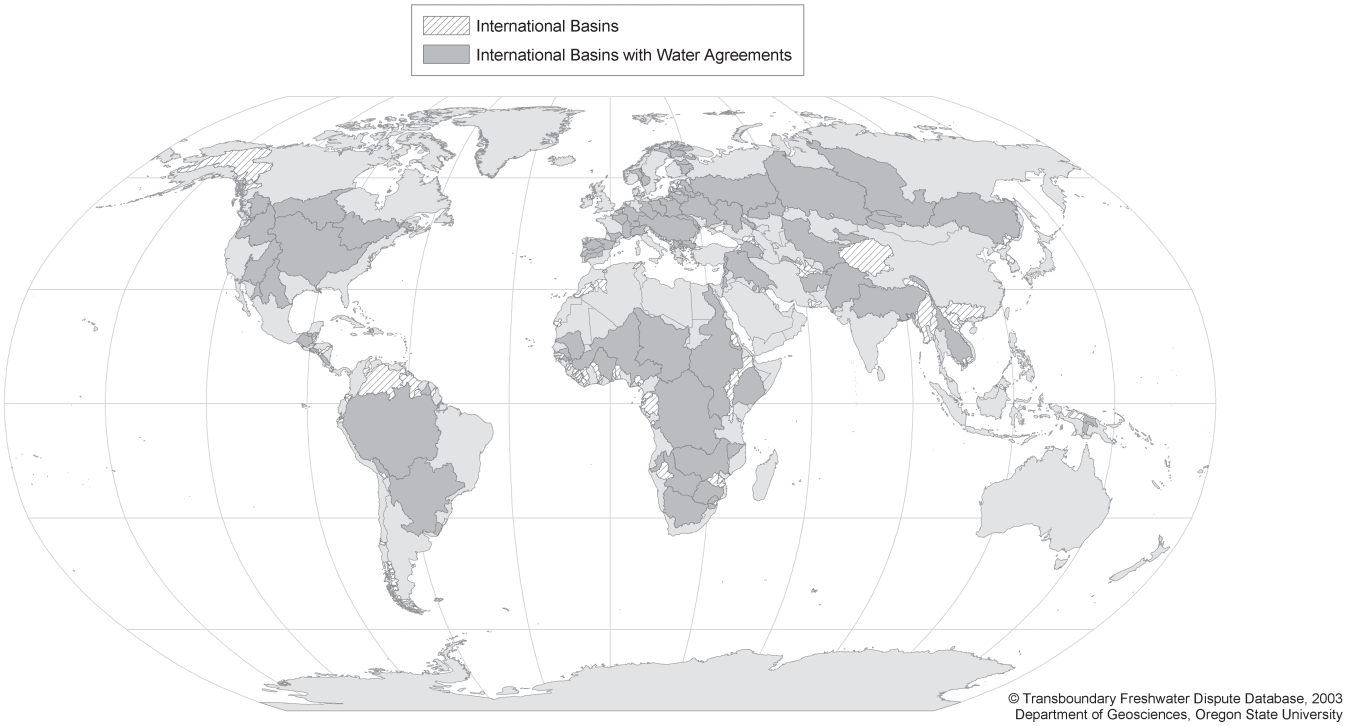

Figure 3. International river basins with existing or historical water agreements

agreement among the four lower riparian states of Laos, Vietnam, Cambodia, and Thailand defined 'equality of right' not as equal shares of water, but as equal rights to use water on the basis of each riparian's economic and social needs (Wolf, 1999).[14]

A review of treaties signed within the last ten years also reveals some encouraging developments. At least 54 new bilateral and multilateral water agreements have been concluded since the Rio Conference, representing basins in Asia, Africa, Europe, North America, and South America. As in the past 50 years as a whole, European water accords continue to dominate. However, agreements from other regions, in particular Asia, have grown disproportionately.[15] In addition to greater geographic representation, a number of improvements can be seen in this more recent set of treaties compared with the last half-century as a whole. First, a growing percentage of treaties address some aspect of water quality, a finding consistent with Rio's goal of both managing and protecting freshwater resources. Second, provisions concerning monitoring and evaluation, data exchange, and conflict resolution are included in many of the post-Rio treaties. Third, a number of agreements establish joint water commissions with decision-making and/or enforcement powers, a significant departure from the traditional advisory standing of basin commissions. Fourth, country participation in basin-level accords appears to be expanding. Although few of the agreements incorporate all basin states, a greater proportion of treaties are multilateral and many incorporate all major hydraulic contributors. Finally, although the exception, a 1998 agreement on the Syr Darya Basin, in which water management is exchanged for fossil fuels, provides a post-Rio example of basin states broadly capitalizing on their shared resource interests.

Institutional vulnerabilities still exist, however, in a number of key areas. Many treaties, for example, ignore issues of allocation, and of those that do few possess the flexibility to handle changes in the hydrologic regime or in regional values. References to water quality, related groundwater systems, monitoring and evaluation, and conflict resolution mechanisms, while growing in numbers, are often weak in actual substance. Furthermore, enforcement measures and public participation, two elements that can greatly enhance the resiliency of institutions, are largely overlooked.

6. Lessons for the international community

A review of international water relations and institutional development over the past 50 years provides important

[14] In the context of navigation, the 1995 Mekong River agreement, which superseded the 1975 agreement, again referenced, but in this case did not define, the concept of 'equality of right'.

[15] The fact that agreements representing European basins dominate the treaty record is not surprising given that Europe has the largest number of international basins (69) followed by Africa (59), Asia (57), North America (40), and South America (38) (Wolf et al., 1999, 2002).

insights into water conflict and the role of institutions. The historical record of water conflict and cooperation suggests that while international watercourses can cause tensions between co-riparian states, acute violence is the exception rather than the rule. A much more likely scenario is that a gradual decline in water quantity or quality, or both, affects the internal stability of a nation or region, which may in turn impact the international arena. Early coordination among riparian states, however, can serve to ameliorate these sources of friction.

The centrality of institutions both in preventive hydrodiplomacy and in effective transboundary water management cannot be over-emphasized. Yet, while progress is indeed apparent, the past 50 years of treaty writing suggests that capacity-building opportunities still remain. Many international basins are without any type of cooperative management framework, and even where institutions do exist, the post-Rio treaty record highlights a number of remaining weaknesses. Thus in combination with its existing efforts, the international community might consider focusing more attention on the specific institutional needs of individual basin communities by assisting riparian states in the development of cooperative management networks that take into account the following key factors:

1) *Adaptable management structure*. Effective institutional management structures incorporate a certain level of flexibility, allowing for public input, changing basin priorities, and new information and monitoring technologies. The adaptability of management structures must also extend to non-signatory riparians, by incorporating provisions addressing their needs, rights, and potential accession.
2) *Clear and flexible criteria for water allocations and water quality management*. Allocations, which are at the heart of most water disputes, are a function of water quantity and quality, as well as political fiat. Thus, effective institutions must identify clear allocation schedules and water quality standards that simultaneously provide for extreme hydrological events; new understanding of basin dynamics, including groundwater reserves; and changing societal values. Additionally, riparian states may consider prioritizing uses throughout the basin. Establishing catchment-wide water precedents may not only help to avert inter-riparian conflicts over water use, but also protect the environmental health of the basin as a whole.
3) *Equitable distribution of benefits*. Distributing water benefits, a concept that is subtly yet powerfully different from pure water allocation, is at the root of some of the world's most successful institutions. The idea concerns the distribution of benefits from water use — whether from hydropower, agriculture, economic development, aesthetics, or the preservation of healthy aquatic ecosystems — not the water itself. Distributing benefits allows for positive-sum agreements, occasionally including even non-water-related gains in a "basket of benefits", whereas dividing the water itself only allows for winners and losers.
4) *Concrete mechanisms to enforce treaty provisions*. Once a treaty is signed, successful implementation is dependent not only on the actual terms of the agreement but also on an ability to enforce those terms. Appointing oversight bodies with decision-making and enforcement authority is one important step towards maintaining cooperative management institutions.
5) *Detailed conflict resolution mechanisms*. Many basins continue to experience disputes even after a treaty is negotiated and signed. Thus, incorporating clear mechanisms for resolving conflicts is a prerequisite for effective, long-term basin management.

7. Conclusions

Over the next several decades competition for the world's water supplies will likely continue to intensify, making institutional frameworks all the more important for avoiding or alleviating transboundary water conflicts. Significant progress in international transboundary water management has already been made in the ten years since the Rio Earth Summit. The international community has launched a number of new policies, organizational, and legal initiatives while basin communities have continued to build upon a rich history of water-related agreements. Despite these positive developments, however, substantial vulnerabilities remain. Many international basins still lack official cooperative management frameworks, and even where such structures are in place key components crucial for long-term success are frequently absent. With a knowledge of these weaknesses, however, the international community together with basin states have an opportunity to better focus on the specific institution building needs within the world's international river basins and thereby promote stronger, more resilient water management networks.

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