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

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, water supply and allocation are frequently cited as the primary sources of tension, yet significant vulnerabilities also exist in terms of water quality management. The vast majority of the world's international basins are without any type of water quality institution, and, even where such institutions do exist, a general lack of substantive language and full basin participation likely minimize their ultimate effectiveness. To foster greater co-riparian cooperation, the international community has concentrated on the development of generalized, global principles of water quality management. More attention to the specific institution building needs at the basin level, however, may be needed.

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.[1] Of particular concern to the international community is

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1. *See, e.g.*, Asit K. Biswas, *Water for Sustainable Development in the 21st Century: A Global Perspective*, 7 INT'L J. WATER RESOURCES DEV. 219 (1991); Peter H. Gleick, *An Introduction to Global Freshwater Issues*, *in* WATER IN CRISIS: A GUIDE TO THE WORLD'S FRESH WATER RESOURCES 3 (Peter H. Gleick ed., 1993); Stephen McCaffrey, *Water, Politics, and*

the potential for conflict within the world's 263[2] international basins.[3] River basins that cross or delineate international political boundaries are home to approximately 40 percent of the world's population, account for nearly one-half of the earth's surface area, and generate an estimated 60 percent of global freshwater flow.[4]

In assessing the sources of tension between co-riparian states over shared water systems, the hydro-political literature has largely focused on the issues of scarcity and inequitable allocation of available water stocks.[5] A closely related factor, yet one that is often overlooked in the context of international freshwater management, is water quality. Degrading water quality can not only infringe upon human health, economic well-being, and the environment but can also effectively reduce the overall availability of the resource itself, 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,

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International Law, in WATER IN CRISIS: A GUIDE TO THE WORLD'S FRESH WATER RESOURCES 92 (Peter H. Gleick ed., 1993); Thomas F. Homer-Dixon, *Environmental Scarcities and Violent Conflict: Evidence from Cases*, 19 INT'L SECURITY 5 (1994). Numerous international leaders have also made references to the role of water in international disputes. For example, Ismail Serageldin, former 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." *Severe Crisis Ahead for Poorest Nations in Next 2 Decades*, N.Y. TIMES, Aug. 10, 1995, at A13. More recently, Kofi Annan, the present UN Secretary-General announced that "fierce competition for fresh water may well become a source of conflict and wars in the future." *Address to the Association of American Geographers*, 36 AAG NEWSL. (Ass'n of Am. Geographers) Apr. 2001, at 10. Several other leaders, such as Egyptian President Anwar Sadat and King Hussein of Jordan, have proclaimed water to be the only resource that would incite regional conflict. SANDRA POSTEL, PILLAR OF SAND 133-34 (1999).

2. *See* Aaron T. Wolf et al., *International River Basins of the World*, 15 INT'L J. WATER RESOURCES DEV. 387 (1999), *available at* http://www.transboundarywaters.orst.edu/publications/register/ (last updated Oct. 2002).

3. According to Wolf et al., 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." *Id.* at 389

4. Estimates from the Transboundary Freshwater Dispute Database project, Oregon State Univ., *available at* http://www.transboundarywaters.orst.edu [hereinafter TFDD].

5. *See, e.g.*, Alfred M. Duda & David La Roche, *Sustainable Development of International Waters and Their Basins*, 13 INT'L J. WATER RESOURCES DEV. 383 (1997); Aaron T. Wolf, *Criteria for Equitable Allocations*, 23 NAT. RESOURCES FORUM 3 (1999); Patricia Wouters, *National and International Water Law*, 25 WATER INT'L 499 (2000).

research on international water management institutions, like the hydropolitical studies, has largely focused on water allocation.[6] The treatment of water quality institutions in the international water literature is much more limited. Existing analyses include Utton's survey on the evolution of international water quality law, Ando's assessment of the existence of freshwater pollution prevention obligations within international laws and declarations, and Shmueli's comparative analysis of internal and external influences on the institutionalization of transboundary water quality management.[7]

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 and basin communities' efforts to preserve and protect the quality of shared water resources worldwide. The article 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 water treaties. Based on the findings from the study, the article concludes with lessons learned from existing management principles and practices and suggests options available for better coordinating 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 often 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

6. *See, e.g.*, Pradyumna P. Karan, *Dividing the Water: A Problem in Political Geography*, 13 PROFESSIONAL GEOGRAPHER 6 (1961); Joseph Dellapena, *Building International Water Management Institutions*, *in* WATER IN THE MIDDLE EAST: LEGAL, POLITICAL AND COMMERCIAL IMPLICATIONS 55 (J.A. Allan & Chibli Mallat eds., 1995); Peter Beaumont, *Dividing the Waters of the River Jordan: An Analysis of the 1994 Israel-Jordan Peace Treaty*, 13 INT'L J. WATER RESOURCES DEV. 415 (1997); John Waterbury, *Between Unilateralism and Comprehensive Accords: Modest Steps toward Cooperation in International River Basins*, 13 INT'L J. WATER RESOURCES DEV. 279 (1997); Wolf, *Criteria for Equitable Allocations*, *supra* note 5.

7. *See generally* Albert E. Utton, *International Water Quality Law*, 13 NAT. RESOURCES J. 256 (1973); Nisuke Ando, *The Law of Pollution Prevention in International Rivers and Lakes*, *in* THE LEGAL REGIME OF INT'L RIVERS AND LAKES 331 (Ralph Zacklin & Lucius Caflisch eds. 1981); Deborah F. Shmueli, *Water Quality in International River Basins*, 18 POL. GEOGRAPHY 437 (1999).

river systems, where water typically moves uni-directionally,[8] 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 and environmental welfare. 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.[9] 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 (*i.e.*, 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 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.

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

9. 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.

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 twentieth 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 twentieth century largely builds upon the principle of limited territorial sovereignty. Applied to international freshwater management, this principle "reflects rights to reasonably use the waters of an international waterway, yet with the acknowledgement that one should not cause harm to any other riparian State."[10] 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."[11] 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[12] and the 1957 Lake Lanoux case;[13] the International Law Association's (ILA) refinement of water

10. Wolf, *Criteria for Equitable Allocations*, *supra* note 5, at 6.

11. International Regulation Regarding the Use of International Watercourses for Purposes Other Than Navigation, Art. II, partial text reprinted in FAO LEGISLATIVE STUDY 65: SOURCES OF INT'L WATER LAW 269, 269-70 (1998) [hereinafter SOURCES OF INT'L WATER LAW].

12. The *Trail Smelter* case, in fact, involved transboundary air pollution between the United States and Canada. Due to a lack of previous case history concerning the issue, however, the Tribunal drew from several U.S. Supreme Court cases dealing with transboundary water pollution. Utton, *supra* note 7, at 286-87.

13. 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, *supra* note 7, at 287-88.

quality principles in the 1966 Helsinki Rules; [14] 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.[15]

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).[16] References to water quality can be found in several sections of the agreement. For example, Articles 9 and 21 *require* 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."[17] 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.[18]

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.[19] As stated by Biswas, 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."[20]

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

14. Other International Law Association declarations referencing water quality include the Statement of Principles, Resolution of Dubrovnik, 1956; Resolution on the Use of the Waters of International Rivers, New York, 1958; and Recommendation on Pollution Control, Hamburg, 1960. *See* SOURCES OF INT'L WATER LAW, *supra* note 11, at 281-324.

15. *See* SOURCES OF INT'L WATER LAW, *supra* note 11, at 157-60, 171-76.

16. UN Doc. A/51/869, Arts. 9 & 21, *reprinted in* SOURCES OF INT'L WATER LAW, *supra* note 11, at 29-44.

17. *Id.* at 36.

18. *Id.*

19. Meredith A. Giordano & Aaron T. Wolf, *Incorporating Equity into International Water Agreements*, 14 SOCIAL JUST. RES. 349 (2001).

20. Asit T. Biswas, *Management of International Waters*, 15 WATER RESOURCES DEV. 429 (1999).

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."[21] However, factors influencing water quality often lie outside of the watercourse itself. Natural and anthropogenic processes throughout an entire river basin can affect water quality conditions. Thus, limiting the scope of the UN Convention to the "watercourse," while perhaps more politically expedient, impedes the practical effectiveness of the agreement on international water quality management.[22]

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[23] to adopt the UN Convention, ratifications remain insufficient to bring the document into force,[24] 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) do 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.[25]

Thus, while providing general guidance for co-riparian states, the effectiveness of international water quality law is ultimately limited

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21. UN Doc.A/51/869, *reprinted in* SOURCES OF INT'L WATER LAW *supra* note 11, at 30. For a detailed discussion concerning the debate over the geographic scope of the Convention, see James L. Wescoat, Jr., *Beyond the River Basin: The Changing Geography of International Water Problems and International Watercourse Law*, 3 COLO. J. INT'L ENVTL. L. & POL'Y 301 (1992).

22. An acknowledgement of the broader basin-wide factors influencing water quality management is evident in Article 20 of the UN Convention, which obliges watercourse states to "protect and preserve the *ecosystems* of international watercourses" [emphasis added]. UN Doc.A/51/869, *reprinted in* SOURCES OF INT'L WATER LAW, *supra* note 11, at 36; *discussed in* Stephen McCaffrey, *The Contribution of the UN Convention on the Law of the Non-Navigational Uses of International Watercourses*, 1 INT. J. GLOBAL ENV. ISSUES 250, 256-57 (2001). The UN Convention does not, however, define the geographic scope of an "ecosystem," nor is it clear as to the relevance of the Convention's terms outside its established "watercourse" scope.

23. Press Release, United Nations General Assembly, General Assembly Adopts Convention on Law of Non-Navigational Uses of International Watercourses (May 21, 1997) (on file with author).

24. Per Article 36 of the UN Convention, entry into force requires 35 instruments of ratification, acceptance, accession, or approval. As of July 2002, 12 countries were party to the Convention. United Nations, *United Nations Treaty Collection On-line, available at* http://www.untreaty.un.org/english/treaty.asp (available on a subscription basis only).

25. Wolf, *Criteria for Equitable Allocations*, *supra* note 5, at 5.

by its naturally vague language and 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.[26]

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.[27] 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.[28] 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. However, while numerous studies have been conducted on international freshwater treaties, few have tried to quantify the role of 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.[29] 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 a quantity to be managed.[30] The following sections outline both the research methodology and findings from the international water treaty survey.

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26. Abel Wolman, *Pollution as an International Issue*, 47 FOREIGN AFFAIRS 164 (1968).

27. Aaron T. Wolf, *Conflict and Cooperation along International Waterways*, 1 WATER POL'Y 251, 255 (1998).

28. *Id.*

29. 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.

30. TFDD, *supra* note 4.

SURVEY METHODOLOGY

From the TFDD document collection, a total of 227 water treaties[31] dating from 1864 to 2001 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 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, these "water quality" agreements were then classified into one of three categories. 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 treaties reviewed) were found to contain references to water quality.[32] These 62 "water quality" treaties span nearly the entire twentieth century, with the earliest agreement, the Treaty between the United States and Great Britain Relating to the Boundary Waters and Boundary Questions, dating back to 1909. Apart from this treaty, 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 of water quality as defined above.

Spatially, attention to water quality issues appears also to have expanded during the twentieth century. Prior to 1950, water quality

31. All available treaty amendments were also reviewed, in conjunction with the original treaty documents, for the presence of water quality provisions.

32. For a full listing of all "water quality" treaties identified, see Appendix.

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 Africa, Asia/Middle East, Europe, North America, and South America. Overall, the European region accounted for the greatest number of "water quality" treaties.

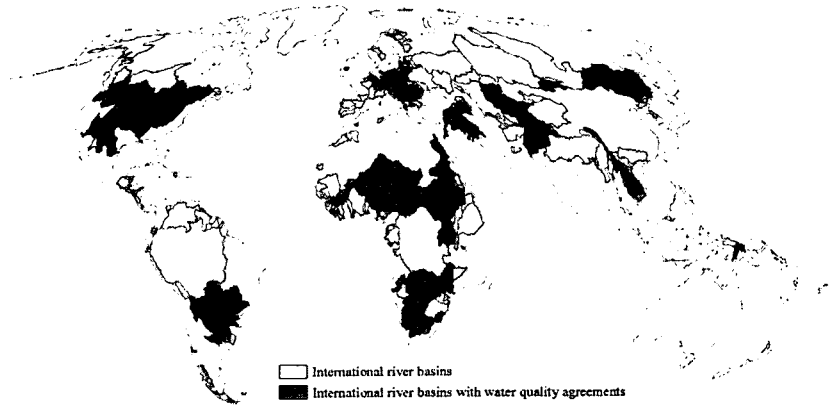
Further institutional developments are apparent in terms of the substance of water quality provisions. Earlier treaties focused primarily on pollution prevention and control. In contrast, treaties from the latter half of the twentieth century describe a host of water quality related issues ranging from 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, water quality treaties are still in many aspects institutionally immature. First, while water treaties in general have been concluded in at least 117 of the world's 263 international basins, the 62 "water quality" treaties represent only 38 international river basins or sections thereof (see Figure 1). 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 38 international basins, only one, the La Plata, was found to have had an official mechanism for managing water quality.[33]

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, St. Lawrence, Fly, and Sepik), no treaty addressing water quality was found to include all affected riparian states.

33. 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. *See* Wolf et al., *International River Basins of the World*, *supra* note 2.

Figure 1: International River Basins with Existing or Historical Water Quality Agreements



The 62 water quality agreements identified in this study represent 38 of the world's 263 international river basins or sections thereof.
Basil Data Anderson, cartographer

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 three 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 twentieth century and represent all geographic regions (*e.g.*, Africa, Asia/Middle East, Europe, North America, and South America). Moreover, although treaties from the other two categories have grown proportionally over the past 50 years, Category Three agreements continue to comprise a significant percentage of "water quality" treaties signed.

The more specific Category Two (defined activities) grouping includes 24 agreements. These agreements were concluded primarily in the latter half of the twentieth 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 to the treaty record 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 30 years and relate primarily 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 United States 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 the 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 international water quality management. Over the twentieth century, treaties addressing water quality issues expanded both in terms of absolute numbers and spatial coverage. Additionally, the scope of water quality provisions in general broadened to consider a range of social and environmental issues. Nevertheless, important institution building opportunities clearly continue to 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 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. 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.

Three areas in particular on which the international community might concentrate are information dissemination, comparative research, and resource mobilization. International organizations such as the United Nations, for example, might utilize their ability to organize broad participatory meetings to further general understanding of water quality issues and management strategies. Similarly, the academic community, by expanding water quality analyses from the technical and scientific spheres to the hydro-political 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 could be particularly valuable in regions where political and/or economic issues confound the establishment of joint water management programs. Nakayama, for example, cites the successful involvement of the World Bank and United Nations in establishing the Indus and Mekong river accords, respectively,[34] two institutions that subsequently weathered extreme political strain.[35] International mediation efforts might additionally entail the mobilization of resources, a technique proven successful in the Indus Waters Treaty negotiations.[36] With appropriate donor coordination, pledges of 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.[37]

CONCLUSIONS

The quality of the world's freshwater resources is critical for human and environmental health as well as for the sustained yield of

34. Mikiyasu Nakayama, *Successes and Failures of International Organizations Dealing with International Waters*, 13 WATER RESOURCES DEV. 367, 368-73 (1997).

35. The Indus Water Treaty between India and Pakistan endured two wars between the co-riparian states, and the members of the Mekong Committee continued to exchange water-related data throughout the Vietnam War. Wolf, *Conflict and Cooperation along International Waterways*, *supra* note 27, at 260.

36. Nakayama, *supra* note 34, at 368-70.

37. POSTEL, *supra* note 1, at 146-47.

water resources. Despite this obvious importance, the research presented here suggests that the institutional capacity to manage the quality of international freshwater systems remains 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; while basin-level institutions, though expanding, remain limited both in actual number and efficacy. 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 have been presented that 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.

APPENDIX

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	Aug. 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, United Kingdom	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)	Nov. 22, 1978	United States, Canada	Entire Document
5	One	Convention on the Protection of the Rhine Against Chemical Pollution	Dec. 3, 1976	Germany (FRG), France, Luxembourg, Netherlands, Switzerland, European Economic Community	Entire Agreement

	Category	Agreement Title	Date	Parties	Water Quality Reference
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)	Aug. 30, 1973	United States, 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	United States, Mexico	Entire Document
8	One	Agreement on Great Lakes Water Quality with Annexes (as amended)	April 15, 1972	United States, Canada	Entire Document
9	Two	Convention on the Protection of the Rhine	Jan. 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	Sept. 28, 1995	Israel, Palestinian Authority	Annex III (Protocol concerning Civil Affairs) Article 40 & Schedules 8–11
11	Two	Protocol on Shared Watercourse Systems	Aug. 28, 1995	Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe	Articles 2, 3, 5

	Category	Agreement Title	Date	Parties	Water Quality Reference
12	Two	Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin	April 5, 1995	Cambodia, Laos, Thailand, Vietnam	Chap. 3: Articles 1,3,7,8, & Chap. 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	Oct. 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	Kazahkstan, Kyrgzstan, Tajikstan, Turkmenistan, Uzbekistan	Articles 1, 3
15	Two	Convention on Environmental Impact Assessment in a Transboundary Context, Espoo	Feb. 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 the document

	Category	Agreement Title	Date	Parties	Water Quality Reference
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	Oct. 8, 1990	Federal Republic of Germany, Czech and Slovak Federative Republic, European Economic Commission	Entire Document
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	Nov. 15, 1989	United States, Canada	Article VI
18	Two	Agreement on Co-operation on Management of Water Resources in the Danube Basin	Dec. 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 entire document
20	Two	Convention Creating the Niger Basin Authority	Jan. 21, 1980	Benin, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Upper Volta	Article 4

	Category	Agreement Title	Date	Parties	Water Quality Reference
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 Boundary, with Annex (as amended)	Sept. 21, 1972	United States, 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)	Dec. 16, 1971	USSR, Romania	Main Agreement: Article 16, Protocol: Articles 5, 8
23	Two	Agreement Between Finland and Sweden Concerning Frontier Waters	Dec. 15, 1971	Finland, Sweden	Chap. 1: Article 3, Chap. 3: Articles 3,9,10,13
24	Two	Treaty Between Austria and Czechoslovakia Concerning the Regulation of Water Management Questions Relating to Frontier Waters	Dec. 7, 1967	Czechoslovakia, Austria	Article 3 & Annex 1 (Article 2)
25	Two	Agreement Concerning River Niger Commission and the Navigation and Transport on the River Niger	Nov. 25, 1964	Benin, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Upper Volta	Article 12

	Category	Agreement Title	Date	Parties	Water Quality Reference
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	Chap. II Article 5 (second paragraph)
28	Two	Indus Waters Treaty	Sept. 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 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 (Art. 2 of attached Statute of the Water Control Comm. reiterates objectives noted in Art. 1 of the overall agreement)

	Category	Agreement Title	Date	Parties	Water Quality Reference
32	Two	Convention Between Germany and Lithuania Regarding the Maintenance and Administration of the Frontier Waterways	Jan. 29, 1928	Germany, Lithuania	Articles 15,17,19, 21,22,24
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 the 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	Jan. 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)	Sept. 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

	Category	Agreement Title	Date	Parties	Water Quality Reference
38	Three	Agreement Between Namibia and South Africa on the Establishment of a Permanent Water Commission	Sept. 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)	Oct. 24, 1986	South Africa, Lesotho	Articles 6, 7, 8, 15
42	Three	Agreement on Paraná River Projects	Oct. 19. 1979	Argentina, Brazil, Paraguay	Section 5
43	Three	Agreement Between Iran and Iraq Concerning Frontier Commissioners	Dec. 26, 1975	Iran, Iraq	Article 6 (VIII (i))
44	Three	Protocol Concerning the Delimitation of the River Frontier Between Iran and Iraq	June 13, 1975	Iran, Iraq	Article 8

	Category	Agreement Title	Date	Parties	Water Quality Reference
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	Jan. 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	Nov. 13, 1973	Papua New Guinea, Indonesia	Article 12
47	Three	African Convention on the Conservation of Nature and Natural Resources	Sept. 15, 1968	Algeria, Cameroon, Central African Republic, Congo, Côte 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	Oct. 26, 1963	Benin, Cameroon, Chad, Côte D'Ivoire, Guinea, Mali, Niger, Nigeria, Upper Volta	Article 4

	Category	Agreement Title	Date	Parties	Water Quality Reference
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

	Category	Agreement Title	Date	Parties	Water Quality Reference
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	Dec. 5, 1956	Yugoslavia, Albania	Article 1
54	Three	Agreement Between Yugoslavia and Hungary Together with the Statute of the Yugoslav-Hungarian Water Economy Commission	Aug. 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	Feb. 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	Nov. 25, 1949	USSR, Romania	Article 17

	Category	Agreement Title	Date	Parties	Water Quality Reference
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	United States, 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 of the Rio Grande	Feb. 3, 1944	United States, Mexico	Article 3
61	Three	Treaty Between Germany and Poland for the Settlement of Frontier Questions	Jan. 27, 1926	Germany, Poland	Article 30
62	Three	Treaty Between Great Britain and the United States Relating to Boundary Waters and Boundary Questions	Jan. 11, 1909	United States, Great Britain	Article IV