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I. Introduction

Nature fashioned the river basin as an ecological system or unit. When water use intensified toward the end of the nineteenth century, it was perceived that the waters of the basin formed a unified system and that, for efficiency of use, they should be treated as such. Thus was born the concept of the integrated river basin as a unit for water management under an autonomous basinwide administration. In some instances, basin commissions acquired powers extending over other resources as well as water.

On the whole, autonomous basin administration has been more successfully and consistently applied to international rather than national drainage basins. This is because basin commissions have been less exposed to the rivalries of other forms of water administration internationally than within nations. Recently, the increasing likelihood of widespread and interrelated environmental impacts from global warming has focused attention on the possible advantages of treating the basin as a unit for multi-dimensional resource management. In this context, the river basin concept, though of general ap-

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plication, may be more readily adaptable to international river basins. However, the water administrations in these basins must be adequately improved and strengthened to meet the new challenge.

This article will discuss the development of the river basin concept and will assert that the ecosystem character of the river basin calls for management beyond water resources. The article will also suggest how river basin administrations can deal with such enlarged responsibilities.

II. The River Basin Concept

A. *Early Success and Expansion of the Basin Concept*

The concept of the river basin as a unit of water resource management was spurred at the beginning of this century by three factors: 1) improved technology in building concrete dams; 2) fear of the reckless depletion of many natural resources, including water; and 3) horrendous industrial pollution of rivers and lakes.[1] Construction of large dams permitted the harnessing of watercourses for several different purposes simultaneously. Power production, water supply, and irrigation utilized the natural interconnectedness of waters within a river basin more efficiently.[2]

In the United States, the nascent conservation movement feared that the nation's natural resources would be altogether exhausted under the impact of industrialization.[3] The conservationists saw in multipurpose uses for water the possibility of saving the resource and advocated the treatment of all the wa-

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1. For a comprehensive history of the river basin concept, see, L. TECLAFF, THE RIVER BASIN IN HISTORY AND LAW (1967) [hereinafter THE RIVER BASIN].

2. The claim that power production could pay the costs of engineering works for navigation and other purposes was clearly stated in the preliminary report of the Inland Waterways Commission in the United States in 1907. S. Doc. No. 325, 60th Cong., 1st Sess. 22 (1908). The Federal Bureau of Reclamation and some states had been building dams for multipurpose use of water since 1888. REGISTER OF DAMS IN THE UNITED STATES 22, 30, 174 & 188 (T. W. Mermel ed. 1958).

3. *See* THE RIVER BASIN, *supra* note 1, at 115 (citing the speech of President Theodore Roosevelt to the Governors' Conference in 1908. Conference of Governors, White House, Washington, D.C., May 13-15, 1908, Proceedings 6 (1909)).

ters of a river basin as a unit.[4] At the same time, in the Ruhr region of Germany, where industrial wastes had turned six small tributaries of the River Rhine into veritable sewers, it was decided that management of water resources ought to be on a sub-basin scale. Commissions were created to deal with water pollution and power generation.[5] Though they did not individually embrace an entire drainage basin, they already embodied the ideas of basin unity and basin administration.

As the quest and the need for efficient use of water grew, plans for basinwide development of water resources multiplied. In the late 1920s and 1930s the U.S. Army Corps of Engineers, responding to Congress' authorization of a comprehensive study of the country's navigable streams, prepared about 200 separate studies of important river basins in the United States.[6] The Corps' studies addressed the suitability of coordinated development of navigation, flood control, irrigation, and power.[7] During the same period, plans for multipurpose development were authorized in France and Spain.[8] After World War II, basinwide planning spread outside the United States and Europe[9] and acceptance of the concept be-

4. REPORT OF NATIONAL CONSERVATION COMMISSION, S. Doc. No. 676, 60th Cong., 2d Sess., v. I, 27 (1909).

5. Fair, *Pollution Abatement in the Ruhr District*, in COMPARISONS IN RESOURCE MANAGEMENT 142, 149 (H. Jarrett 1961); Gieseke, *River Basin Authorities on the Ruhr and on Other Rivers in Germany*, 2 U.N. ECONOMIC COMM'N FOR EUROPE, CONFERENCE ON WATER POLLUTION PROBLEMS IN EUROPE, Documents, Geneva, Switzerland, Feb. 22-Mar. 3, 1961, at 276-77 (U.N. Doc. Water Poll./Conf. 4) (1961).

6. The studies were authorized by Act of Mar. 3, 1925, ch. 467, § 3, 43 Stat. 1190. They were known as "308 Reports" from the number of the House document in which the basins to be surveyed were listed. H.R. Doc. No. 308, 69th Cong., 1st Sess. (1926).

7. *Id.*

8. For France, see Law Approving the Plan of Works for Improvement of the Rhone from the Swiss Frontier to the Sea, from the Point of View of Power, Irrigation, Navigation, and Other Agricultural Uses, May 27, 1921, 21 Duvergier, Collection Complete des Lois 261, May 27, 1921. In Spain, there was the Plan Nacional de Obras Hidraulicas, cited in White, *A Perspective of River Basin Development*, 22 LAW & CONTEMP. PROBS. 157, 171 (1957).

9. *See, e.g.*, U.N. ECONOMIC COMM'N FOR ASIA AND THE FAR EAST, MULTIPLE-PURPOSE RIVER BASIN DEVELOPMENT, pt. 2D, at 7-13, U.N. Doc. ST./ECAFE/SER.F/18, U.N. Sales No. 61.II.F.8 (1961); U.N. ECONOMIC COMM'N FOR ASIA AND THE FAR EAST, DEVELOPMENT OF WATER RESOURCES IN THE LOWER MEKONG BASIN, (Flood Control Series No. 12), U.N. Doc. ST/ECAFE/SER.F/12, U.N. Sales No. 1957.II.F.8 (1957).

came so rapid and widespread that the Secretary-General of the United Nations saw fit to state that "river basin development is now recognized as an essential feature of economic development."[10] The very success of promoting the river basin unit for water management spurred advocates to assign it a more far-reaching role as a natural region for the development of *all* resources.[11] This view of the basin figured prominently in a 1937 proposal to divide the United States into seven regions roughly corresponding to major river basins.[12] The 1937 plan was never implemented, but the earlier established Tennessee Valley Authority (TVA) embodies the idea of the basin as an economic region.[13] After World War II, fears of a recession caused more valley authorities to be proposed, but when the expected slump did not materialize, these plans were shelved and the TVA remained the only entity of its kind in the United States.[14]

However, authorities similar to the TVA appeared elsewhere, for example, in India, Ceylon (now Sri Lanka), Colombia, Brazil, and Ghana.[15] Their common feature was a mandate which went far beyond water management, turning the river basin into an all-purpose unit of economic development. Such mandates were often found to be too broad. For example, in addition to tasks specifically related to water management, the commission for Brazil's huge Sao Francisco River

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10. 21 U.N. ECOSOC Annexes at 6, U.N. Doc. E/2827 (1956).

11. For example, Lilienthal saw the development of all resources within the river basin as following the dictates of nature. D. LILIENTHAL, DEMOCRACY ON THE MARCH 53 (1953).

12. 81 CONG. REC. 5280-81 (1937).

13. A broad mandate for the comprehensive basinwide economic development of the Tennessee Valley by an autonomous public authority was embodied in the Act of May 18, 1933, in which Congress authorized the formation of a government corporation "to improve the navigability and to provide for the flood control of the Tennessee River; to provide for the agricultural and industrial development of said valley." Act of May 18, 1933, ch. 32, § 2.

14. *See* THE RIVER BASIN, *supra* note 1, at 131, n. 134.

15. *See* (India) Damodar Valley Corporation, Act No. 14, Mar. 27, 1948, 6 INDIA CODE 13-33 (1956); (Ceylon) Gal Oya Development Board, Act No. 51, Nov. 24, 1949; (Colombia), Presidential Decree No. 3110, Oct. 22, 1954 (for the Cauca Valley); (Brazil) Law No. 541, Dec. 15, 1948, 7 ColeÇão 141 (1948) (for the Sao Francisco Valley); (Ghana) Act No. 46, Apr. 26, 1961 (establishing the Volta River Authority).

Basin was charged with agricultural and industrial development, modernization of transportation, colonization of land, social welfare, assistance to education, and exploitation of resources.[16] The valley authorities threatened the traditional units of government and, accordingly, they were limited in number.[17] Nevertheless, these bodies illustrate the administrative potential basinwide commissions could have in an appropriate context.

B. *Challenges to the Basin Concept*

In the meantime, strides in technology have permitted engineers to plan and construct huge projects encompassing parts of several basins. Since water is not uniformly distributed, transfers from basins with a surplus offer a solution to shortages in those with a deficit. One of the most ambitious and imaginative of these projects, which will illustrate the technical and administrative difficulties, is the North American Water and Power Alliance (NAWAPA).[18] NAWAPA was first proposed in the 1960s and revived in the drought of 1988.[19] It is international in scope and would require an agency created by treaty. It envisages the transfer of surface water from Alaska and northern Canada to the western United States and even as far as the five northern states of Mexico, almost the entire length of the North American continent.[20] Those who believe it to be the only feasible, effective solution to the continent's pressing water needs are confident that it could be built within a decade.[21]

Water transfers, however, create as many problems as they solve, no matter what the scale is. Even if the basins

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16. (Brazil) Law No. 541, 7 ColeÇão 141 (1948), *supra* note 15.

17. THE RIVER BASIN, *supra* note 1, at 143 & 200.

18. On the original NAWAPA proposal, see SENATE COMMITTEE ON PUBLIC WORKS, SPECIAL SUBCOMMITTEE ON WESTERN WATER DEVELOPMENT, 88th Cong., 2d Sess. (1964).

19. On the reconsideration of the project and its advancement by the National Democratic Policy Committee, see 5 U.S. WATER NEWS 11 (No. 2, Jan. 1989).

20. *See id.*, for the map of the proposed engineering works, canals, and aqueducts.

21. *See id.*

from which water is diverted have a surplus now, future requirements must always be taken into consideration. Whereas separate river basins correspond to organic units and have internal cohesion, units created through interbasin diversion and long-distance transfer are artificial, and implicitly or explicitly, proclaim a preference for areas of need over areas of origin.

In the United States, resistance to transfer has several times led to legislative enactments or litigation restricting or prohibiting out-of-basin diversions. For instance, the Flood Control Act of 1962, authorizing the New Melones Project in California, required the Secretary of the Interior to determine the quantity of water needed to satisfy all existing and future requirements within the Stanislaus River Basin before initiating any diversion.[22] The Water Resources Planning Act of 1965 forbade the National Water Resources Council and the basin commissions it established to study plans for water transfer out of river basins.[23] In 1983, the State of Massachusetts passed the Inter-Basin Water Act which prohibits transfer from one river basin to another without approval of the state Water Resources Commission.[24] The following year, the State of Colorado was forbidden by the U.S. Supreme Court to divert out of basin.[25] In 1985, the eight American states and two Canadian provinces in the Great Lakes Basin entered into a non-binding agreement called the Great Lakes Charter, to

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22. Flood Control Act of 1962, Pub. L. No. 87-874, 76 Stat. 1180, 1191 (1962), *reprinted in* 1962 U.S. CODE CONG. & ADMIN. NEWS 1365, 1398-99.

23. Act of July 22, 1965, Pub. L. 89-80, 79 Stat. 244 (1965), *reprinted in* 1965 U.S. CODE CONG. & ADMIN. NEWS 259-70.

24. MASS. ANN. LAWS ch. 21, §§ 8B-8D (1981 & Supp. 1991). The Commission is required to establish criteria for approval or disapproval of the proposed transfer. These criteria are to include all reasonable efforts to identify and develop sources in the receiving area; all practical measures to conserve water in the receiving area; and maintenance of instream flows in the basin from which water is to be diverted. *Id.* § 8D.

25. In Colorado v. New Mexico, 467 U.S. 310, *reh'g denied*, 468 U.S. 1224 (1984), the U.S. Supreme Court rejected the recommendation of a Special Master in this interstate dispute that Colorado be permitted an out-of-basin diversion representing about one-third of the average annual flow of the Vermejo River, which rises in southern Colorado and flows into New Mexico. *See* XVII ROCKY MTN. MIN. L. FOUND. WATER NEWSLETTER 1 (No. 2, 1984).

guard against diversion to dry areas outside the watershed.[26]

Metropolitan water authorities, in particular, are prone to regard their own needs as paramount and use their economic power to secure distant water supplies at the expense of other users. This often meets with stiff resistance, leading to a re-evaluation of priorities, when water becomes scarcer or there is a perceived threat to the environment in the basin of origin. For example, the City of Los Angeles, which had been diverting water from the Mono Lake basin for several decades, recently became involved in lengthy law suits concerning the diversions which are drying out the lake.[27]

C. *The Resilience of the Basin Concept*

Because of the many different approaches to water management, it cannot be claimed, as some early writers insisted, that the drainage basin is the *only* efficient unit for development, regulation, and use of water resources.[28] Obviously, other units have flourished and multiplied. Nevertheless, in spite of some reverses, the basin concept of water exploitation and development showed remarkable tenacity. The basin concept was given expression almost simultaneously in the 1960s in France and in the United States, at the federal level. The U.S. Water Resources Planning Act of 1965 envisaged the establishment of commissions in major river basins to study, plan, and coordinate water resources development at a basin

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26. *See* COUNCIL OF GREAT LAKES GOVERNORS, WATER DIVERSIONS AND GREAT LAKES INSTITUTIONS (Final Report and Recommendations: Great Lakes Governors Task Force on Water Diversion and Great Lakes Institutions), Appendix III at 40 (Jan. 1985); *see also* T. COLBORN, A. DAVIDSON, S. GREEN, R. HODGE, C. JACKSON, AND R. LIROFF, GREAT LAKES, GREAT LEGACY? 212-13 (1990).

27. *See* California Trout Inc. v. State Water Resources Control Board, 207 Cal. App. 3d 585, 255 Cal. Rptr. 184 (1989); *and* National Audubon Society v. Department of Water, 858 F.2d 1409 (1988). In 1990, the California Court of Appeals, Third Appellate District, ordered that conditions be attached to the city's license immediately. California Trout Inc. v. Superior Court of the County of Sacramento, 218 Cal. App. 3d 187, 194, 266 Cal. Rptr. 788, 790-91 (1990). As a consequence, the State Water Resources Control Board ordered Los Angeles to release sufficient water into the streams feeding Mono Lake to re-establish and maintain the fisheries of the Lake as they existed prior to the diversion. XXIII ROCKY MTN. MIN. L. FOUND. WATER NEWSLETTER 5 (No. 1, 1990).

28. *See* LILIENTHAL, *supra* note 11, at xviii-xix.

level.[29] In France, the law of 1964 created river basin agencies and river basin committees with a mandate for pollution control and taxation of users.[30] The committees are composed of representatives of users, local communities, and the central administration.[31] They act as a water parliament and have consultative powers.[32] The river basin agencies have a similar composition and are concerned with taxes on water supply and on discharges into water.[33] Rates are established on the advice of the committees and are applied by the agencies.[34]

In Great Britain, the water basin authorities of England and Wales, created under the Water Act of 1973, were given responsibility for managing both the clean and dirty ends of the water cycle.[35] That is, they were to supply water, provide public sewers, and enforce regulatory controls over direct discharges into the waters.[36] In addition, they were empowered to "fix, and to demand, take and recover charges for services performed, facilities provided or rights made available . . . ."[37]

Even though the British river basins are small and water management does not encompass large-scale irrigation and hydropower production, the administration of water resources envisioned by the 1973 Water Act conformed admirably to the recommendation of the U.N. Interregional Seminar on Water Resources Administration. The seminar, held in New Delhi in 1973, recommended that water resources management be consolidated at two levels: local, or river basin, and national.[38]

When the inherent difficulties of apportioning functions

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29. Act of July 22, 1965, Pub. L. No. 89-80, 79 Stat. 244, (1965), *reprinted in* 1965 U.S. CODE CONG. & ADMIN. NEWS 259-70.

30. *See* (France), Law Concerning the Regime and Distribution of Waters and Protection Against Pollution, Dec. 16, 1964, 47 B.L.D. 674 (1964).

31. *Id.* at art. 13.

32. *Id.*

33. *Id.* at art. 14.

34. *Id.*

35. England and Wales, Water Act 1973, ch. 37.

36. *Id.* at arts. 11, 16, & 17; *see also* England and Wales, Control of Pollution Act 1974, ch. 40, art. 34.

37. England and Wales, Water Act 1973, ch. 37, art. 30.

38. PROCEEDINGS OF THE INTERREGIONAL SEMINAR ON WATER RESOURCES ADMINISTRATION, New Delhi, India, Jan. 22-Feb. 2, 1973, at 12, para. 86, U.N. Doc. DP/UN/INT-70-371 (1975).

between a central administration and river basin commissions became apparent, the power of the British river authorities was curtailed. The Water Act of 1989 transferred their water supply functions to private companies or corporations[39] and their regulatory functions to a new central regulatory body, the National Rivers Authority.[40]

In most countries, water supply is the responsibility of government agencies, local government units, or private distributors.[41] Through privatization, Britain simply reverted to the prevailing practice of not allotting this function to river basin bodies. What British water management may have gained in efficiency and in ability to conform to the pollution control directives of the European Economic Community, it has lost in public participation.[42] Users of water have more of a direct influence when they or their representatives actually form part of the administrative structure, as in the French basin committees, where local communities and different categories of users are represented.[43] The great appeal of decentralization along the watershed boundary, whether in unitary or federal states, is that it forces administration to be more responsive to local needs.

In 1989, the same year Britain somewhat retreated from its commitment to river basin administration of water resources, Italy adopted the concept of basinwide planning without, at that time, creating basin-level administration.[44]

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39. England and Wales, Water Act 1989, ch. 15, arts. 4 & 11.

40. *Id.* at arts. 1 & 4. See the analysis of the act in R. Burnett-Hall, *Environmental Regulation in the United Kingdom: Its Development to the Present Day and Trends for the Future, Analysis and Perspective*, 12 Int'l Envtl. Rep. (BNA) 461, 464-66 (1989).

41. *See* L. TECLAFF, ABSTRACTION AND USE OF WATER, at 102-16, U.N. Doc. ST/ECA/154, U.N. Sales No. E.72.II.A.10 (1972).

42. *See* Burnett-Hall, *supra* note 40. According to Parker and Sewell, however, public accountability of water management had been progressively dismantled within the past two decades and especially since 1983, when local government members ceased to be appointed to Water Authority boards. D. Parker and W. Derrick Sewell, *Evolving Water Institutions in England and Wales: An Assessment of Two Decades of Experience*, 28 NAT. RESOURCES J. 751, 782-83 & Table 2 (1988).

43. France, Law Concerning the Regime and Distribution of Waters, *supra* note 30.

44. Italy, Act. No. 183 of May 18, 1989, 149 Leg. Ital. I, 1368 (1989).

Basinwide planning, as in Italy, may be the first step to the full-fledged management of water resources which would also include basin-level administration. The crucial role of basin planning in management of water resources was already perceived in 1957 when a group of United Nations experts stated that "it is now widely recognized that individual water projects, whether single or multipurpose, cannot as a rule be undertaken with optimum benefit for the people affected before there is at least the broad outlines of a plan for the entire drainage area."[45] Three years before Italy, Spain gave basinwide planning an important role in its revamped water law.[46] It entrusted the planning to basin-level administration in the Confederaciones Hidrograficos (Hydrographic Confederations) composed of representatives of water users, local government and the central administration.[47] It directed these basin authorities to elaborate basinwide plans,[48] which it will coordinate with and adapt to the national plan.[49]

In the case of rivers running through two or more provinces or states within a federation, the basin unit is often seen as a means of reconciling the conflicting claims of regional versus federal government. Creating interprovincial entities with basinwide powers may be the easiest and perhaps the only way to get consensus for developing the water resources of a basin. The mandates of such entities vary considerably. In the United States, for example, the Delaware River Basin Commission composed of the governors of the states of New York, New Jersey, Pennsylvania, and Delaware, plus the Secretary of the Interior as representative of the federal government, can make decisions by majority vote.[50] It is empowered to develop plans, policies and projects related to water resources, as well as to allocate the basin's waters to signatory

45. U.N. DEP'T OF ECONOMIC AND SOCIAL AFFAIRS, INTEGRATED RIVER BASIN DEVELOPMENT, at 1, U.N. Doc. E/3066 (1958).

46. Spain, Act No. 29/1985 (Basic Water Act of Aug. 2, 1985) R.A.L., 1985, 1980.

47. *Id.* at art. 25(b)-(d).

48. *Id.* at art. 26.

49. *Id.* at art. 43.3.

50. Delaware River Basin Compact, Pub. L. No. 87-328, 75 Stat. 688 (1961), *reprinted in* 1961 U.S. CODE CONG. & ADMIN. NEWS 775-809.

states.[51] In Australia, a commission was established for the River Murray as the planning and coordinating body, but it had power only to supervise the construction of waterworks by agencies of the two basin states, New South Wales and Victoria.[52] In Argentina, interprovincial basin committees were set up in the 1970s for the Rio Bermejo and the Rio Colorado.[53] These committees are advisory and information-gathering bodies and can make recommendations.[54] Each province appoints a representative, but the chairman is nominated by the federal government.[55]

III. International River and Lake Basins

On an international plane, basinwide development of water resources has become a recurring theme in pronouncements by the United Nations and other international organizations. In 1956, for example, the U.N. Secretary-General declared that river basin development was now recognized as an essential feature of economic development.[56] In 1961, the Institute of International Law adopted a resolution that its existing rules on non-navigational uses of international inland waters were applicable to the utilization of waters which form part of a watercourse or hydrographic basin extending over the territory of two or more states.[57] Meanwhile, the International Law Association, at its New York conference in 1958, proclaimed, as one of the agreed principles of international

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51. *Id.* at art. 3. For other examples in the United States, see THE RIVER BASIN, *supra* note 1, at 146-48.

52. U.N. ECONOMIC COMM'N FOR ASIA AND THE FAR EAST, RIVER MURRAY COMMISSION, THE DEVELOPMENT OF CONTROL OF THE WATERS OF THE RIVER MURRAY UNDER THE RIVER MURRAY AGREEMENT, U.N. Doc. ST/ECAFE/SER.F/9, U.N. Sales No. 1956.II.F.3 (1956).

53. Valls, *Water Legislation in South American Countries*, FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS, (Legislative Study No. 19) (1983), 9-10.

54. *Id.* at 21-22.

55. *Id.*

56. U.N. ESCOR Council Off. Rec., 21st Sess., Annexes at 6, U.N. Doc. E/2827 (1956).

57. Institute of International Law, Resolutions Adopted at the 1961 Session (Salzburg), 49 (2) ANN. DE L'INSTITUT DE DROIT INT'L 370 (1961); English text in 56 AM. J. INT'L L. 737 (1962).

law, that a "system of rivers and lakes in a drainage basin should be treated as an integrated whole (and not piecemeal)."[58] It also recommended that basin states "constitute permanent or ad hoc agencies for continuous study of all problems arising out of the use, administration and control of waters of drainage basins."[59] Then in 1966, the Association adopted the so-called Helsinki Rules,[60] which hold that "[t]he general rules of international law as set forth in these chapters are applicable to the use of the waters of an international drainage basin except as may be provided otherwise by convention, agreement or binding custom among the basin States."[61] The Helsinki Rules further proclaim that "[e]ach basin state is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin."[62]

Similar endorsements of the basin concept, some modeled on the Helsinki Rules, were made at international meetings in the next two decades. For example, the United Nations Interregional Meeting on River and Lake Basin Development, held in 1988 at Addis Ababa, Ethiopia, explicitly recommended that governments recognize that the drainage basin provides the most useful context within which to achieve cooperation and agreement between or among the basin states for integrated development.[63] These endorsements by international organizations and conferences found practical expression in

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58. INTERNATIONAL LAW ASSOCIATION, REPORT OF THE FORTY-EIGHTH CONFERENCE (New York) 99 (1958).

59. *Id.* at 100.

60. INTERNATIONAL LAW ASSOCIATION, HELSINKI RULES ON THE USES OF THE WATERS OF INTERNATIONAL RIVERS, Report of the 52nd Conference (Helsinki) 484-532 (1967).

61. *Id.* at art. I.

62. *Id.* at art. IV.

63. U. N. DEP'T OF TECHNICAL CO-OPERATION FOR DEVELOPMENT, RIVER AND LAKE BASIN DEVELOPMENT, PROCEEDINGS OF THE UNITED NATIONS INTERREGIONAL MEETING ON RIVER AND LAKE BASIN DEVELOPMENT WITH EMPHASIS ON THE AFRICA REGION, Addis Ababa, Ethiopia, Oct. 10-15, 1988 (Natural Resources/Water Series No. 20), U.N. Doc. ST/TCD/13 (1990) at 17, B.1 [hereinafter RIVER AND LAKE BASIN DEVELOPMENT]. For earlier examples, see D. CAPONERA, THE LAW OF INTERNATIONAL WATER RESOURCES (FOOD AND AGRICULTURE ORGANIZATION LEGISLATIVE STUDY No. 23) 145, 150, 192-93, 201 & 210 (1980) [hereinafter CAPONERA].

basinwide planning and administration in all parts of the world.

Some of the agreements, plans, and commissions for international drainage basins are confined to water resources; others have much wider scope. Both the Indus Waters Agreement of 1960[64] and the Columbia River Basin Treaty of 1964[65] are limited to water resources. India and Pakistan agreed to divide the waters of the tributaries of the Indus River for exclusive use in each country and to cooperate in building the necessary waterworks.[66] They established a permanent commission with the duty to conduct studies, exchange information, carry out inspections, and serve as a tribunal of first instance for the settlement of disputes.[67] In the Columbia Basin, the United States and Canada agreed to cooperate in developing the river for power, with the United States building most of the necessary works and Canada providing storage facilities.[68] In accordance with the so-called downstream benefit theory,[69] the United States agreed to give Canada half the power generated in the United States with the help of the Canadian storage.[70] The two countries established a Permanent Engineering Board to supervise the operation of the facilities and see that the treaty objectives and standards were reached.[71]

Many of the agreements and plans for the huge river basins of Latin America and Africa encompass much more than water resources. In 1978, the eight states of the Amazon River Basin (Bolivia, Brazil, Colombia, Ecuador, Guiana, Peru, Surinam, and Venezuela) concluded a treaty for Amazonian coop-

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64. Indus Waters Treaty, Sept. 19, 1960, India-Pakistan, 419 U.N.T.S. 126.

65. Treaty Between the United States of America and Canada Relating to Cooperative Development of the Water Resources of the Columbia River Basin, Jan. 17, 1961, United States-Canada, 15 U.S.T. 1555, T.I.A.S. No. 5638, 542 U.N.T. 244.

66. Indus Waters Treaty, *supra* note 64, arts. 2, 3 & 4.

67. *Id.* arts. 8 & 9.

68. Columbia River Basin Treaty, *supra* note 65, arts. II, III & IV.

69. On the downstream benefit theory, see THE RIVER BASIN, *supra* note 1, at 165-70.

70. Columbia River Basin Treaty, *supra* note 65, at art. V.

71. *Id.* at art. XV.

eration.[72] Its purposes were to promote harmonious development of the Amazon region, to distribute the benefits equitably, and to continue to expand the joint efforts made for the ecological conservation of the region.[73] Implementation of the treaty is entrusted to the foreign ministers of the signatories, who meet as required, and to a council, comprised of high-level diplomatic representatives of the basin states, which meets once a year. The Council has the task of carrying out the decisions of the foreign ministers' meetings and agreeing on studies and plans to be executed by the Permanent National Commission.[74]

In Africa, where the major rivers and lakes are nearly all international, basin programs are considered vital to economic development. Basin authorities, whatever their actual level of performance, hold a special place in water resources administration.[75] The Nile Waters Agreement of 1959 between Egypt, then the United Arab Republic, and the Sudan was a narrowly conceived arrangement. The Agreement called for the building of the Aswan Dam and the allocation of the river's flow for irrigation.[76] Later agreements on African rivers, however, provide for much broader cooperation.

In 1963, the nine riparian states of the Niger River Basin, Guinea, Mali, Ivory Coast, Upper Volta (now Burkina Faso),

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72. Treaty for Amazonian Co-Operation, 17 I.L.M. 1045 (1978).

73. *Id.* at Preamble.

74. *Id.* at art. XXIII. *See also* U.N. ECONOMIC COMM'N FOR AFRICA, DEVELOPMENT IN CO-OPERATIVE ACTION CONCERNING SHARED WATER RESOURCES, Addis Ababa, Ethiopia, Oct. 10-15, 1988, U.N. Doc. No. ECA/NRD/IMRLBD/3 (Aug. 1988).

75. "Because river basin development programmes tend to involve the largest projects in national portfolios within African countries with sizable river and lake basins, and with special support from the Heads of State, *national and international river basin authorities have no substitute.*" RIVER AND LAKE BASIN DEVELOPMENT, *supra* note 63, at 21 (emphasis added).

76. Agreement for the Full Utilization of the Nile Waters, Nov. 8, 1959, United Arab Republic-Sudan, 453 U.N.T.S. 51. In part IV(1) of the treaty the parties agreed to constitute a Permanent Joint Technical Committee. On the functions of this body, which subsequently changed its title, see *The Permanent Joint Technical Commission for Nile Waters: Egypt-Sudan*, in EXPERIENCES IN THE DEVELOPMENT AND MANAGEMENT OF INTERNATIONAL RIVER AND LAKE BASINS, PROCEEDINGS OF THE UNITED NATIONS INTERREGIONAL MEETING OF INTERNATIONAL RIVER ORGANIZATIONS, 158-64, Dakar, Senegal, May 5-14, 1981, (1983) [hereinafter EXPERIENCES].

Dahomey (now Benin), Niger, Nigeria, Chad, and Cameroon, signed a treaty obligating themselves to cooperate closely regarding the construction of projects which might affect navigation, water quality, biological characteristics of the fauna and flora, and industrial and agricultural exploitation of the basin.[77] A year later, they established a commission composed of high officials[78] which was subsequently reorganized as the Niger Basin Authority.[79] The Authority was given responsibility for promoting cooperation among the member states to ensure an integrated development of the Niger Basin in all fields, particularly energy, water resources, agriculture, animal husbandry, fisheries, forestry, transport, communications, and industry.[80]

An even more ambitious program was outlined in the 1987 Agreement on the Action Plan for the Environmentally Sound Management of the Common Zambezi River System (ZACPLAN).[81] The ZACPLAN covers a huge spectrum of problems, such as deforestation, harmful land-use practices, soil erosion, siltation, unsafe drinking-water supply and poor sanitation, pollution, waterborne and insect-borne diseases, degradation of the natural resource base, degradation of flora and fauna, inadequate floodplain management, and inadequate protection of wetlands.[82] All these elements are to be

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77. Act Concerning Navigation and Economic Cooperation, 1963, text in Schreiber, *Vers un Nouveau Regime International du Fleuve Niger*, 9 ANN. FRANCAIS DE DROIT INT'L 866, 887 (1963).

78. Agreement Concerning the Commission of the River Niger and Navigation and Transportation on the River Niger (Niamey Agreement), Nov. 25, 1964, in Schreiber, *Accord Relatif à la Commission du Fleuve Niger et à la Navigation et aux Transports sur le Fleuve Niger*, 10 ANN. FRANCAIS DE DROIT INT'L 813, 815 (1964).

79. Convention Creating the Niger Basin Authority, Nov. 21, 1980, in U.N. DEP'T OF TECHNICAL CO-OPERATION FOR DEVELOPMENT, TREATIES CONCERNING THE UTILIZATION OF INTERNATIONAL WATER COURSES FOR OTHER PURPOSES THAN NAVIGATION: AFRICA (Natural Resources/Water Series No. 13), at 56, U.N. Doc. No. ST/ESA/141, U.N. Sales No. E/F.84.II.A.7 (1984).

80. *Id.* at arts. 3 & 4. The Authority encountered severe financial problems and has been hampered in its functions. *See* RIVER AND LAKE BASIN DEVELOPMENT, *supra* note 63, at 95.

81. Agreement on the Action Plan for the Environmentally Sound Management for the Common Zambezi River System, May 28, 1987, 27 I.L.M. 1109 (1988).

82. *Id.* at annex I, The Zambezi Action Plan (ZACPLAN).

assessed, taken into account, and dealt with in future plans for the development of this very large basin, which straddles almost the entire width of the continent. The Agreement calls for an Intergovernmental Monitoring and Coordinating Committee to guide development, together with a subordinate river-basin coordinating unit to administer the implementation of the Action Plan.[83] The powers of the small coordinating unit are limited to formulating project documents, negotiating execution of projects, collecting and disseminating information, and organizing expert and intergovernmental meetings.[84] The execution of the Plan, including field research, is to be left to the existing national institutions of the basin states.[85]

The ever-broadening scope of modern basin planning in an environmental context indicates progress toward a perception of the basin as an ecosystem. To look upon a river or lake basin as an ecosystem means to view it not merely as a unit in which water resources are interlinked, but as a unit in which many elements of the environment (fresh water, salt water, air, land, and all forms of life) interact within the confines of the drainage area. When the basin is so regarded, efficient management of water resources must take account of these interactions and, hence, requires a broader mandate for basin administration.

Explicit advocacy of the river basin as an ecosystem appears in the Great Lakes Water Quality Agreement of 1978.[86] The Agreement defined "ecosystem" as the "interacting components of air, land, water and living organisms, including man, within the drainage basin of the St. Lawrence River at or upstream from the point at which that river becomes the international boundary between Canada and the United States . . . ."[87] Since the 1978 Agreement, the International Joint Commission and its subordinate bodies have continued

83. *Id.* at annex II, para. 7.

84. *Id.* at annex II, para. 12.

85. *Id.*

86. Great Lakes Water Quality Agreement, Nov. 22, 1978, United States-Canada, 30 U.S.T. 1384, T.I.A.S. No. 9257.

87. *Id.* at art. I(g).

to develop ecosystem approaches to water management problems.[88] An ecosystem approach, as outlined by the Commission, means "adopting a basinwide, long-term perspective which includes taking into account the impacts of all of man's activities on the natural and socio-economic systems of the Great Lakes Basin."[89]

The concept of the river basin as ecosystem was discussed at the International Seminar on the Relevance of River Basin Approach for Coordinated Land and Water Conservation and Management, held in Sweden in 1984.[90] The Seminar addressed the potential use of the river basin as a basis for coordinated land and water conservation management.[91] The following year, the Cairo Programme for African Co-Operation gave priority to supporting and implementing integrated development plans for Lake Chad and the Niger and Cubango/Cuando rivers in order to use their waters and ecosystems rationally.[92]

IV. The Impact of Climate Change

The need to treat the river basin as an ecosystem, with all its implications for the mandates of basin authorities, becomes clear and urgent under the impact of threatened climate change. A global warming of the climate is widely pre-

88. For example, The Great Lakes International Surveillance Plan (GLISP), which antedated the 1978 Agreement and was not really geared to an ecosystem approach, had to be updated and refocussed to develop compatible methodologies for atmospheric monitoring applicable to the entire basin. *See* Teclaff & Teclaff, *International Control of Cross-Media Pollution — An Ecosystem Approach*, 27 NAT. RESOURCES J. 21, 38-39 (1987); *see also* Colborn, *supra* note 26, at 193-201, for an update on the International Joint Commission's role in implementing the ecosystem approach of the 1978 agreement.

89. INTERNATIONAL JOINT COMMISSION, REPORT, POLLUTION IN THE GREAT LAKES BASIN FROM LAND USE ACTIVITIES xii (March 1980).

90. Reynolds, *River Basin as an Ecosystem*, in RIVER BASIN STRATEGY, INTERNATIONAL SEMINAR ON THE RELEVANCE OF RIVER BASIN APPROACH FOR COORDINATED LAND AND WATER CONSERVATION AND MANAGEMENT, LINKÖPING, SWEDEN, 4-8 JUNE 1984, 217 (1984).

91. *Id.*

92. African Ministerial Conference on the Environment, Cairo Programme for African Co-Operation, 16-18 Dec. 1985, Sec. E. 1, *reprinted in* 16 ENVT'L POL'Y & L. 27, 28 (1986).

dicted to take place within the next century.[93] The literature on the subject is growing exponentially,[94] and governments all over the world have taken the issue so seriously that it is now at the top of the agenda for high-level conferences and summit meetings.[95]

The effects of climatic change upon water resources are difficult to forecast, but could be very severe in individual

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93. Despite widespread acceptance of the idea that human activities can change climate on a global scale, the subject remains controversial and there is considerable uncertainty among some climatologists and geophysicists as to whether a warming trend will actually take place in the manner and within the time-scale forecast. For a brief history of the development of climate change calculation and a discussion of the controversy, see White, *The Great Climate Debate*, 263 SCI. AM. 36 (July 1990). For a negative viewpoint, see Stevens, *Skeptics Are Challenging Dire 'Greenhouse' Views*, Special Report, New York Times, Dec. 13, 1989, at A1, col. 1.

94. For some authoritative studies and conclusions, see S. SCHNEIDER, GLOBAL WARMING (1989); CLIMATE INSTITUTE, PREPARING FOR CLIMATE CHANGE, PROCEEDINGS OF THE FIRST NORTH AMERICAN CONFERENCE ON PREPARING FOR CLIMATE CHANGE: A COOPERATIVE APPROACH, Oct. 27-29, 1987 (1988) [hereinafter PREPARING FOR CLIMATE CHANGE]; U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF POLICY, PLANNING AND EVALUATION, OFFICE OF RESEARCH AND DEVELOPMENT, THE POTENTIAL EFFECTS OF GLOBAL CLIMATE CHANGE IN THE UNITED STATES: REPORT TO CONGRESS (J. B. Smith and D. Tirpak, eds. 1989) [hereinafter THE POTENTIAL EFFECTS]; 261 SCI. AM. (No. 3, Sept. 1989) (an entire special issue devoted to climate change); and CLIMATE CHANGE AND U.S. WATER RESOURCES (Report of the American Association for the Advancement of Science Panel on Climatic Variability, Climate Change, and the Planning and Management of U.S. Water Resources) (P. Waggoner ed. 1990) [hereinafter Waggoner].

95. *See* INTERNATIONAL CONFERENCE ON GLOBAL WARMING AND CLIMATE CHANGE: PERSPECTIVE FROM DEVELOPING COUNTRIES, NEW DELHI, INDIA, Conference Statement, Feb. 21-23, 1989 (distributed by the Woods Hole Research Center, Woods Hole, Mass., 1989); DECLARATION OF NOORDWIJK, BY THE MINISTERIAL CONFERENCE ON ATMOSPHERIC POLLUTION AND CLIMATIC CHANGE, Noordwijk, Netherlands, Nov. 6-7, 1989, U.N. Doc. A/C.2./44/5 (1989), annex, *reprinted in* 12 Int'l Env't Rep. (BNA) 624 (Dec. 13, 1989); World Conference on Preparing for Climate Change, Cairo, Dec. 17-21, 1989, Cairo Compact and Panel Reports (1989); *and* The Interparliamentary Conference on the Global Environment Decisions, Washington, D.C., Apr. 29-May 2, 1990, *reprinted in* 20 ENVTL. POL'Y & L. 112 (No. 3, 1990).

Three United Nations teams of the Intergovernmental Panel on Climate Change have been working on the matter and are expected to produce a final report identifying elements of a framework global convention, which it is hoped will be negotiated prior to the upcoming 1992 U.N. Conference on Environment and Development. *See* Fitzgerald, *The Intergovernmental Panel on Climate Change: Taking the First Steps Towards a Global Response*, 14 S. ILL. U.L.J. 231 (1990); and *Intergovernmental Panel on Climate Change: Progress on Interim Assessment Report*, 20 ENVTL. POL'Y & L. 70.

river basins, especially when superimposed upon existing problems of population pressure, variability of water supply, increased demand for water, pollution, and conflicts of use.[96] A warming trend could drastically alter precipitation and streamflow regimes, producing floods or drought or both in succession (e.g., floods from unseasonably early snowmelt, followed by lower streamflow and faster evaporation as temperatures rise). Rising sea levels, one of the more readily calculable effects, would cause a loss of present coastal wetlands and river estuaries, as well as the contamination of fresh surface and ground waters through salt-water intrusion.[97] Damage to watershed forests from climate stress could have impacts throughout an entire river basin, causing soil erosion and altering the amount, timing, and succession of flows downstream.[98]

The consequences could be an overall reduction in water quantity, poorer water quality, and increased competition for dwindling supplies. Many ecosystems would die out, forest and crop belts would shift and under the strain of greater crop water needs, food acreage in existing grain-growing regions could fall drastically.[99] In coastal areas and low-lying

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96. For effects on water resources worldwide, see Maurits la Riviere, *Threats to the World's Water*, 261 SCI. AM. 80; Schneider, *supra* note 94, ch. 6, *Assessing the Impact*. For effects on water resources of the United States in particular, see PREPARING FOR CLIMATE CHANGE, *supra* note 94, ch. XIII; and THE POTENTIAL EFFECTS, *supra* note 94, ch. 9.

97. On sea-level rise and its consequences, see THE POTENTIAL EFFECTS, *supra* note 94, ch. 7; PREPARING FOR CLIMATE CHANGE, *supra* note 94, ch. VI; and Hekstra, *Global Warming and Rising Sea Levels: The Policy Implications*, 19 ECOLOGIST 4 (1989).

98. THE POTENTIAL EFFECTS, *supra* note 94, at 71.

99. The United Nations Environment Programme has drawn attention to the urgency of these problems in river and lake basins:

> Climate change can bring a totally new series of environmental impacts on river and lake basins. Should current estimates prove to be correct, global warming could radically alter precipitation patterns. New deserts could be created; lands which are now considered to be too arid for productive use may have to be relied on in the future to feed our successor generations. Evapotranspiration may assume a new dimension, given temperature rises. The uncertainties of today may become urgent issues in less than a decade from now, and water systems will, perforce, assume an even greater importance.

river valleys, where a great many of the world's major ports and larger cities are located, the dislocation of municipal water supply and sanitation systems might be enormous. Even nuclear power plants in river flood plains would be in danger from sea-level rises.[100]

Some recent studies have attempted a closer identification of potential problems for individual regions and river basins of the United States in the event of global warming.[101] By singling out certain characteristics of water availability, use, and management, they assess how vulnerable a river basin or the basins of a particular region would be to factors such as temperature increase and precipitation decrease, earlier than normal snowmelt, floods or drought, and reduced groundwater recharge. Among these characteristics are low water storage capacity relative to streamflow, high water consumption, highly variable streamflow, great reliance on irrigation for agriculture, and heavy dependence on hydroelectric power.[102] For example, any warming and drying trend would severely reduce the quantity and quality of water in the twenty-four western water resource regions where total water use already exceeds average streamflow.[103] Its effects would be particularly harsh in arid basins such as those of the Rio Grande, Colorado, and Missouri. The rainy Northwest would be very vulnerable to reduced flows because a large proportion of electricity produced there comes from hydropower.[104] The Northeast, too, is not immune to prolonged drought, because it has far less storage capacity in reservoirs than the big river basins of the West.[105] Rivers of the Southeast and those flow-

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RIVER AND LAKE BASIN DEVELOPMENT, *supra* note 63, at 110.

100. *See* Hatchwell, *Nuclear Power — A Victim of Greenhouse Warming?* 19 ECOLOGIST 14 (1989).

101. *See, e.g.*, PREPARING FOR CLIMATE CHANGE, *supra* note 94, chs. XIII and XV; THE POTENTIAL EFFECTS, *supra* note 94, ch. 9; *and* U.S. ENVIRONMENTAL PROTECTION AGENCY/DELAWARE RIVER BASIN COMMISSION, GREENHOUSE EFFECT, SEA LEVEL RISE, AND SALINITY IN THE DELAWARE ESTUARY (C. Hull and J. Titus eds. 1986) [hereinafter DELAWARE ESTUARY].

102. *See* SCHNEIDER, *supra* note 94, at 135-37.

103. THE POTENTIAL EFFECTS, *supra* note 94, at 176.

104. SCHNEIDER, *supra* note 94, at 136.

105. THE POTENTIAL EFFECTS, *supra* note 94, at 178.

ing to the Gulf of Mexico are endangered by sea-level rise, which would raise groundwater tables, increase the salinity of estuaries and lowland aquifers, and inundate large areas of coastal wetland.[106] The damage would be compounded if the climate became drier, for the reduced inflow of fresh water could alter the entire estuarine ecology of these rivers.[107]

Particularly illuminating are some of the problems foreseen for the great interstate and international river basins of North America because of existing large-scale water distribution programs and existing treaties, compacts, regulations, or judicial decrees. These programs and measures would very likely have to be modified and some are already under challenge. For example, the lower Mississippi River has been regulated since the last century by dams, navigation channels, canals, and flood protection levees.[108] These have interrupted the flow of sediment, freshwater, and nutrients to the Mississippi delta to such an extent that more than 100 square kilometers of wetlands convert to open water every year and saltwater intrusion is altering the vegetation of marshes and swamps.[109] Federal river management is a major cause of land loss here and it is estimated that under the present regime, most of the delta will be lost by 2100 even if no sea-level rise occurs.[110] If there is sea-level rise, half of the delta could be lost and its population centers threatened by 2030, and all of it lost by 2050.[111] To check the current loss and restore the natural process of sediment deposition would be expensive, take at least two decades, interfere with flood control and navigation maintenance, and require that remedial action begin *now*.[112] If authorities wait until the year 2000 to begin restoration and sea level rise accelerates, it is estimated that sixty to seventy percent of the delta might be lost before the

106. *Id.* at 125.

107. *Id.* at 178.

108. Titus, *Causes and Effects of Sea Level Rise*, PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 125, 128.

109. *Id.* at 129.

110. THE POTENTIAL EFFECTS, *supra* note 94, at 143, 395.

111. *Id.* at 395.

112. *Id.*

project could be completed.[113]

Problems of a very different sort face the Colorado River Basin, and some of them derive from an overly optimistic assessment of water availability made early in this century. The Interstate Compact of 1922[114] required the upper basin to provide a fixed amount of 7.5 million acre-feet of water annually to the lower basin, leaving an undetermined quantity of possible surplus to Mexico.[115] The allocation was unfortunately based on two decades of historic high flows which were several million acre-feet more than the long-term records.[116] Since then it has been challenged and reinterpreted several times in the courts[117] and in negotiations with Mexico,[118] but nothing can alter the fact that, despite huge reservoir storage, the basin is running out of water. Demand already exceeds supply in the lower part and the upper basin is expected to use all of its allocation by the year 2000.[119] In the event of a warming trend, water supply in the upper Colorado could be reduced by as much as forty percent.[120] This would further aggravate the problems of the lower basin and California and increase sectoral competition for dwindling supplies, especially between irrigation agriculture and municipalities.[121]

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113. *Id.* at 396.

114. Colorado River Compact, 1922 (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming), text in DOCUMENTS ON THE USE AND CONTROL OF INTERSTATE AND INTERNATIONAL STREAMS: COMPACTS, TREATIES AND ADJUDICATIONS 53 (T. Witmer 2d ed. 1968) [hereinafter Witmer].

115. *Id.* at art. III(a).

116. SCHNEIDER, *supra* note 94, at 9-10 & n. 4, citing B. Brown, *Climate Variability and the Colorado River Compact: Implications for Responding to Climate Change*, in M. GLANTZ, SOCIETAL RESPONSES TO REGIONAL CLIMATIC CHANGE: FORECASTING BY ANALOGY 279 (1988).

117. Arizona v. California, 283 U.S. 423 (1931); Arizona v. California, 292 U.S. 341 (1934); Arizona v. California, 298 U.S. 558 (1936); Arizona v. California, 373 U.S. 546 (1963).

118. Rio Grande, Colorado, and Tijuana Treaty, Feb. 3, 1944, United States-Mexico, 59 Stat. 1219, 1228, T.S. No. 994; Agreement on a Permanent and Definitive Solution to the International Problems of Salinity of the Colorado River, Aug. 30, 1973, United States-Mexico, Minute No. 242, International Boundary and Water Commission, in 69 DEP'T ST. BULL. 395 (1973).

119. THE POTENTIAL EFFECTS, *supra* note 94, at 177.

120. *Id.*

121. *Id. See also* Strock, *Adjusting Water Allocation Law to Meet Water Qual-*

Another scenario could arise in the interstate/international Great Lakes Basin. If the climate became warmer and drier, it could result in major changes to the hydrologic cycle and ecosystem of the Lakes.[122] A decline in forest cover would cause increased runoff and soil erosion, and watersheds now forested might be used for other purposes.[123] There would be more demand for water for irrigation and a loss in energy from hydropower production.[124] The biggest impact would be on the lake levels, which are projected to drop because of increased evaporation and decreased runoff. This would principally disrupt navigation by causing decreased channel depths and hence a need for more dredging. However, warmer temperatures could keep the lakes almost ice-free and permit a longer shipping season.[125] Water quality would also be affected by the diminished supply, lowered lake levels, and contaminated dredge from shipping channels.[126]

Many jurisdictional interests are involved in the huge Great Lakes drainage basin. Its waters and water uses, like those of the Colorado Basin, are regulated by an overlapping assemblage of treaties,[127] interstate agreements and adjudications,[128] and unilateral actions,[129] which would have to be ex-

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ity and Availability Concerns in a Warming World, PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 382, 383.

122. *See* Quinn, *Likely Effects of Climate Change on Water Levels in the Great Lakes*, PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 481. *See also* Cohen, *How Climate Change in the Great Lakes Region May Affect Energy, Hydrology, Shipping and Recreation*, PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 460; Goodwin and Raoul, *Climatic Changes — Impacts on Great Lakes Levels and Navigation*, PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 488; *and* Regier, Holmes & Meisner, *Likely Effects of Climate Change on Fisheries and Wetlands, With Emphasis on the Great Lakes*, PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 313.

123. THE POTENTIAL EFFECTS, *supra* note 94, at 71 & 86.

124. *Id.* at 109, 173.

125. Cohen, *supra* note 122, at 467.

126. Quinn, *supra* note 122, at 482, 485.

127. Boundary Waters Treaty, Jan. 11, 1909, United States-Gt. Britain, 36 Stat. 2448, T.S. No. 548; Treaty Relating to Uses of Waters of the Niagara River, Feb. 27, 1950, United States-Canada, 1 U.S.T. & O.I.A. 694, T.I.A.S. No. 2130; Great Lakes Water Quality Agreement, Apr. 15, 1972, United States-Canada, 23 U.S.T. 301, 24 U.S.T. 2268, T.I.A.S. No. 7312, 7747; Great Lakes Water Quality Agreement, Nov. 22, 1978, United States-Canada, 30 U.S.T. 1384, T.I.A.S. No. 9257.

128. Great Lakes Basin Compact, 1955 (Illinois, Indiana, Michigan, Minnesota,

tensively revised. The Great Lakes form a single, enormous unit of fresh water and it is expected that, in a period of climatic warming, other regions will cast envious eyes upon its water wealth. Since the beginning of the century, water has been diverted out of Lake Michigan at Chicago and in the summer of 1988, there was great pressure to augment this diversion for the benefit of the drought-stricken Mississippi River Basin.[130] Such demands, if intensified, would place a further strain on interstate and U.S.-Canadian relations and, according to one expert, "a major thrust will be on how to keep water in the system."[131]

It is not difficult to visualize problems like those foreseen for the Mississippi, Colorado, and Great Lakes Basins arising in many parts of the world, particularly in international river basins. Densely populated, agriculturally productive river deltas will be especially vulnerable to higher sea levels. The Netherlands, in the Rhine delta, may be able to cope, with the aid of diking and expensive hydraulic works, but Bangladesh stands to lose an enormous amount of land.[132] This flat deltaic country, formed by the Ganges and Brahmaputra Rivers, is threatened on two sides: by flooding from Nepal and India upriver and by storm surges from the sea whose effects are felt far inland.[133] Here the problems are too much water and a

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New York, Ohio, Pennsylvania, and Wisconsin), text in Witmer, *supra* note 114, at 177. The adjudications are: New York v. Illinois, 274 U.S. 488 (1927); Wisconsin v. Illinois, 278 U.S. 367 (1929); and Wisconsin v. Illinois, 281 U.S. 179 (1930).

129. The most controversial unilateral action was the opening by the State of Illinois in 1900 of the Chicago Diversion Canal, which completely reversed the flow of the Chicago River away from Lake Michigan into Mississippi basin drainage, withdrawing 8,500 cubic feet of water per second from Lake Michigan at Chicago. The diversion was the subject of the interstate adjudications cited above at note 128, and has been a thorny topic in U.S.-Canadian relations within the past half century. *See* J. CARROLL, ENVIRONMENTAL DIPLOMACY 126-29 (1983).

130. *See* Schmit, *Water Transfers are Inevitable*, 4 U.S. WATER NEWS 7 (July 1987).

131. Quinn, *supra* note 122, at 486.

132. *See* Goemans & Vellinga, *Low Countries and High Seas*, PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 147-49.

133. *See* Teclaff, *Treaty Practice Relating to Transboundary Flooding*, 31 NAT. RESOURCE J. 109, at 118, n. 66 (1991); *International Rivers: The Experience of Bangladesh*, in EXPERIENCES, *supra* note 76, at 270, 271.

lack of any basinwide organizational setup.[134] Contrariwise, too little water and inflexible treaty requirements are liable to afflict the already arid basins of international rivers such as the Indus, the Nile, and the Rio Grande.[135] Diversions, existing and projected, will probably be a source of strain, if not of strife, in Middle Eastern river basins.[136] Pollution, aggravated by diminished streamflows, would make an existing bad situation worse in rivers of eastern Europe, such as the Oder, the Vistula, and the Elbe.[137]

Obviously, it is not within the power of water management agencies, national or international, to control the emission of greenhouse gases, but the prospect of a warming trend

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134. India and Bangladesh established a joint rivers commission for the Ganges-Brahmaputra-Megna delta and entered into an interim agreement for sharing waters of the Ganges (Nov. 5, 1977). Agreement on Sharing of the Ganges Waters, Nov. 5, 1977, Bangladesh-India, 17 I.L.M. 103 (1978). However, this agreement is of limited scope. Cooperation between the two countries within the past two decades has been sporadic and there is no mechanism for extending it to a larger area of the basin. *See* U.N. ECONOMIC COMM'N FOR AFRICA, DEVELOPMENT IN CO-OPERATIVE ACTION CONCERNING SHARED WATER RESOURCES, *supra* note 74, at 41; *International Rivers: The Experience of Bangladesh*, *supra* note 133, at 273, 276, 361. Bangladesh apparently wanted a tripartite agreement, but India rejected the idea of including Nepal in the Indo-Bangladesh Joint Rivers Commission. *See International Rivers and Lakes* 4-5 (Newsletter of the U.N. Department of Technical Co-Operation for Development) (No. 3, May 1983).

135. Indus Waters Treaty, *supra* note 64. The three eastern branches of the Indus system were allotted to India, the three western branches to Pakistan, and the treaty was very specific as to the amounts that could be withdrawn from these branches during a "water-accounting period." *See* Indus Waters Treaty, *supra* note 64, art. 2(5) and Annex H. On the Nile, see Nile Waters Agreement, *supra* note 76, which allocates precise amounts of water to the two parties. On the Rio Grande, see Rio Grande, Colorado, and Tijuana Treaty, *supra* note 118, which allocates the waters of the river between the two countries partly by proportions of the flow from tributaries and in the main channel, but does specify to the United States a fixed amount to be made available by Mexico from certain Mexican tributaries (art. 4. B. (c) and (d)).

136. *See* Ghadban, *The Development of Euphrates River Basin: A Case Study*, in RIVER AND LAKE BASIN DEVELOPMENT, *supra* note 63, at 219; J. LAMMERS, POLLUTION OF INTERNATIONAL WATERCOURSES 302-07 (1984); *and International Rivers and Lakes* 15 (Newsletter of the U.N. Department of Technical Co-Operation for Development) (No. 14, May 1990).

137. See Simons, *Befouled to Its Romantic Depths, Danube Reaches a Turning Point*, N.Y. Times, May 7, 1990, at A1, col. 2, which despite the title, describes the pollution of Vistula, Oder-Neisse and Elbe River Basins as well; see also LAMMERS, *supra* note 136, at 254-55.

has already affected the planning and strategies of some entities. Britain's National Rivers Authority warns, in a study due to be completed in 1991, that large areas of coastline of the British Isles and thousands of acres of farmland risk being flooded by rising sea levels.[138]

The potential impact of rising sea levels is a major concern also of the Delaware River Basin Commission, which has explored the issue extensively in a joint study with the U.S. Environmental Protection Agency.[139] A special Delaware River Basin Climate Change Project, conducted by the U.S. Geological Service, has been underway since mid-1988 and, like the British study, is scheduled for completion in 1991.[140] The Delaware Commission has had decades of experience in managing reservoir releases to control saltwater intrusion up the estuary during drought periods, but rising sea levels or, worse still, a combination of sea-level rise and upstream drought would severely strain the Delaware Basin's capacity to provide sufficient flows to repel salinity. The Commission realizes the need for augmented flows and is actively pursuing the construction of an additional water storage project.[141]

The Mississippi River Commission is another entity that is beginning to factor various climate change impacts into its current and future planning and development activities.[142] Drought conditions, rather than sea-level rise, appear to be the major concern of some other river basin bodies. The Susquehanna River Basin Commission has not, as of this writing, developed any specific strategies, but believes that its existing regulation on consumptive use of water would be a powerful tool in combating the impacts of climate change. This regulation requires large users to replace their consumptive losses through the release of stored make-up water at or above the

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138. 37 WORLD PRESS REV. 6 (No. 6, June 1990), citing The Observer (London).

139. DELAWARE ESTUARY, *supra* note 101.

140. Letter from Gerald M. Hansler, Executive Director of the Delaware River Basin Commission (Jan. 17, 1990).

141. *Id.*

142. Letter from Col. John P. Carey, Corps of Engineers, Secretary, Mississippi River Commission (Jan. 31, 1990).

point of taking.[143] Like the Delaware Commission, the Susquehanna Commission is sponsoring the development of increased storage, and both of these strong commissions have the authority to make emergency drought declarations, issue special orders regarding water use and conservation, and even modify the terms of existing signatory state permits for the withdrawal of water.[144]

The potential effect of climate change on pollution, apart from the impact of saltwater intrusion on estuaries, is apparently not yet a major issue, despite the fact that a river's receiving water quality could be gravely impaired by drought. Few of the commissions with a particular mandate for water quality control appear to have developed advance planning against such an outcome. Some, including the Colorado River Basin Salinity Control Advisory Council, consider that climate-change effects can be accommodated under existing strategies.[145] Some are monitoring developments, but have not formulated any action plan.[146] The International Commission for the Protection of the Rhine does not expect to develop such strategies.[147]

V. Basin Administration in Time of Climate Change

When and if it comes, climate change will affect river basin ecosystems in all their interrelated elements. Commissions are already in place in many basins and, by default or design, will have the task of adapting to new conditions and managing basin ecosystems in an environment different from today's. A number of commissions, as we have seen, are already preparing to meet the challenge of climate change with their

143. Letter from Richard A. Cairo, Secretary to the Commission (Feb. 16, 1990). *See* proposed revisions to 18 C.F.R. § 803.61 in 54 Fed. Reg. 33,036, 33,037-38 (Aug. 11, 1989).

144. Susquehanna River Basin Compact, 1968, PA. STATS. ANN., tit. 32, § 820.1 (Purdon Supp. 1990), art. 11; Delaware River Basin Compact, *supra* note 50, at art. 10.

145. Letter from David W. Robbins, Council Chairman (Feb. 23, 1990).

146. One such commission is the Ohio River Valley Water Sanitation Commission. Letter from Alan H. Vicory, Jr., Executive Director (Jan. 9, 1990).

147. Letter from J. Goppel, Executive Secretary (Apr. 29, 1990).

existing mandates and powers.[148] But are these powers adequate? Some agencies, such as the Delaware Basin Commission,[149] perform their usual tasks very well; planning, advising, developing guidelines and standards, and even making decisions, at least within a water management context. But, when given a broader mandate, as in the case of some international basin administrations in Latin America and Africa,[150] the record and ability of basin entities to deal with problems under the cumbersome structure of their authority have been questioned and severely criticized.[151]

It is true that a basin administration composed of the highest officials in government can be rendered ineffective by political rivalry. Even so, this type of entity may be the best model for basin administration, because of its potential for reaching quick decisions when a crisis, such as climate change, makes cooperation at the highest level imperative and diminishes political differences. Thus, to strengthen decision-making capability and cut down delay in achieving final decisions, the possibility of creating a two-level basin administration should be considered. The upper level, as in some existing administrations, would consist of top officials acting on the proposals of the lower-level body, which would be a permanent entity carrying out day-to-day duties.[152] Members of the upper or ministerial level should be able to bind their governments in all treaty matters for which parliamentary approval is not necessary. Where possible, appropriate constitutional amendments could be negotiated. If legal impediments would prevent an upper-level body from making binding decisions speedily, it might be better to dispense with that level, so as not to make the basin administration as unwieldy as some ex-

148. *See supra* notes 140-145.

149. *See supra* notes 50 and 140.

150. *See supra* notes 72, 74-81.

151. *See* Cano, *Argentina, Brazil and the de la Plata River Basin: A Summary Review of Their Legal Relationship*, in WATER IN A DEVELOPING WORLD 127, 142 (A. Utton & L. Teclaff 1978); *see also* United Nations Development Programme, *The Multi-Donor Approach in Large River and Lake Basin Development in Africa*, in RIVER AND LAKE BASIN DEVELOPMENT, *supra* note 63, at 74, 95.

152. For an example of this type of administrative structure, see the Treaty for Amazonian Co-Operation, *supra* note 72.

isting two-tier entities. The single-tier basin administration should then be empowered to make decisions which would become final and binding if there were no objections by any of the basin states.[153]

In any case, the lower tier of a basin administration should have this kind of power in the event of an emergency. For that, it should prepare contingency plans, including measures to deal with droughts, floods, and severe pollution incidents threatening health. After proclaiming an emergency, the commission should be able to regulate water supply and consumption, establish zones of conservation, and modify pollution standards.[154] Lack of ability to take prompt and final decisions is probably the most difficult problem that faces the reconstruction of basin commissions at provincial and international levels, but may not be the most critical one.

Because there is a need for promptness and adequate knowledge, the powers that most commissions already possess should be strengthened and expanded to enable them to manage the basin as an ecosystem. The three tasks which stand out in this context are: conducting research, assessing impacts, and providing a forum for public participation. The most obvious among these functions is research. The processes of global warming and their effects upon the hydrologic cycle are still not well understood and may remain unclear until long after changes have taken place. Moreover, even if they can be slowed down by global effort, the changes will be ongoing and, probably, irreversible.[155]

Although the major climate modeling projects have been underway for some two decades, the hydrosphere component still needs considerable fine tuning.[156] As one study points out,

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153. The International Boundary and Water Commission, though not a basin entity, has such power and used it successfully in resolving the controversy concerning the salinity of the waters of the Colorado River which the United States was bound to deliver to Mexico. *See supra* note 118.

154. Such powers are envisaged for international commissions in a model treaty on transboundary groundwaters prepared by the U.S.-Mexico Transboundary Resources Study Group. *See Transboundary Groundwaters: The Bellagio Draft Treaty* (R. Hayton & A. Utton eds.), 29 NAT. RESOURCES J. 663 (1989).

155. *See* Maurits la Riviere, *supra* note 96, at 94.

156. The Corps of Engineers, for example, initiated studies on climate change in

hydrologists have had to work backwards in evaluating climate-change consequences by constructing a set of plausible scenarios without even being able to assign a reasonable set of probabilities to those scenarios.[157] Hydrologists want to know more about the sensitivity of individual river basins to climate change and the interrelationships of all the basin components.[158]

Research to fill this gap is already underway in some major international basins. In the Great Lakes system, conceptual models simulate moisture storage, runoff, precipitation, heat storage, and evaporation, for more than 100 watersheds. The figures are then coupled with different climate-change scenarios to gain some insight into future transformations of the hydrology and economy of that basin.[159] The Interim Committee for Co-ordination of Investigations of the Lower Mekong Basin is currently carrying out, in cooperation with the University of Colorado, a climate-change assessment which will include possible changes in temperature and precipitation generated by three selected global circulation models (GCMs).[160] The Committee is also including in its work program a project on the effects of sea-level rise on the Mekong delta. In Europe, the International Commission for the Hydrology of the Rhine Basin, which is specifically devoted to research, has completed an inventory of existing basin data and is studying how to improve hydrological forecasts. It is also investigating extreme hydrological periods of drought and high water, as well as changes in streamflow caused by human influence through engineering works carried out in the Rhine Basin since 1800.[161]

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the 1970s. *See* Hanchey, Schilling & Stakhiv, *Water Resources Planning Under Climate Uncertainty*, in PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 394, 398.

157. *Id.*

158. *Id.* at 403. *See also* Rogers & Fiering, *From Flow to Storage*, in Waggoner, *supra* note 94, at 207.

159. *See* Beston & Quinn, *Hydrologic Consequences of Climate Change in Region*, 6 U.S. WATER NEWS 9 (Sept. 1989).

160. Letter of P. Chomchai, Senior Economist and Assistant Executive Agent, Mekong Secretariat (May 23, 1990).

161. *See International Rivers and Lakes* (Newsletter of the U.N. Department of Technical Co-Operation for Development) 10-13 (No. 10, May 1988).

Water research laboratories throughout the developed world are using river-basin computer simulation for wastewater planning, flood warning networking, adjusting irrigation systems, identifying vulnerable groundwater supplies, and regulating water flow to save endangered wetlands.[162] Advanced technology of this type will undoubtedly be employed for climate change scenarios by the developed countries, but at great cost. It will not be available to basin entities in the developing countries except by technology transfer on a very large scale from international organizations and donor countries.[163]

After research comes impact assessment. In its climate-change study, the Environmental Protection Agency has advocated such assessments as "good investments for almost any organization whose activities are sensitive to climate or sea level and whose decisions have outcomes stretching over periods of 30 years or longer."[164] They may be of three types: 1) decision-oriented (for example, adding an estimate of the impact of sea-level rise to the evaluation of ongoing projects); 2) program-oriented (for agencies with many potentially vulnerable activities, such as the Tennessee Valley Authority); and 3) problem-oriented (for problems outside the responsibility of any single organization).[165]

Impact assessment and project evaluation are already mandated in the legislation of a number of countries[166] and

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162. 6 U.S. WATER NEWS 11-15 (Aug. 1989).

163. The problem of technology transfer was highlighted, for example, at the U.N. interregional meeting at Addis Ababa, Ethiopia, in 1988, in a discussion on the use of microcomputers in planning. *See Mathematical Models for Planning River Basin Development*, in RIVER AND LAKE BASIN DEVELOPMENT, *supra* note 63, at 415:

> Never underestimate the logistical difficulties of getting equipment and keeping it running. For example, equipment available in Africa costs about 50 to 200 percent more than similar items in Europe, Japan or North America. Finding those who can repair or maintain equipment is also a possible problem.

164. THE POTENTIAL EFFECTS, *supra* note 94, at 390.

165. *Id.*

166. *See* L. TECLAFF, WATER LAW IN HISTORICAL PERSPECTIVE 242-55, 473-77 (1985). For a discussion and analysis of environmental impact assessment methods and models, *see* United Nations Environment Programme, *Problems of Environmental Impact Assessment in River and Lake Basin Development*, in RIVER AND LAKE

are finding their way into international agreements. For instance, they are important elements of the Zambezi Action Plan, but it is not yet clear what institutional form they will take.[167] Perhaps the most outstanding example in recent years of such evaluation was the International Joint Commission's unanimous opposition, on environmental grounds, to the Garrison Diversion Project, which proposed to link Missouri Basin waters across the U.S.-Canadian border with waters flowing to Hudson's Bay.[168]

Providing a forum for public participation is particularly important in light of the increasing emphasis on community input to natural resource planning and management. For instance, at least two studies of global warming put behavior modification high on the list of policy approaches to future water resource problems.[169] Indeed, the U.S. Army Corps of Engineers candidly admits to a change in outlook stemming from this cause. One of its spokesmen has said that: "The Corps . . . traditionally has modified the behavior of water; now we also recommend nonstructural solutions — measures that modify human behavior."[170] If ordinary users are to participate fruitfully in water administration, they will need data and they will need a forum for expressing their views and working with water management agencies. A basin commission or some form of parallel users' organization affords the best means of identifying community interests with the natural resource unit.

Expanded public access to information and to administrative procedures is already being applied to transboundary

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BASIN DEVELOPMENT, *supra* note 63, at 311.

167. Zambezi Action Plan (ZACPLAN), *supra* note 81, part II.C. A draft convention on environmental impact assessment in a transboundary context is under preparation in the U.N. Economic Commission for Europe. 20 ENVTL. POL'Y & L. 181 (1990).

168. *See* CARROLL, *supra* note 129, at 175-84; M. Cohen, *River Basin Planning*, EXPERIENCES, *supra* note 75, at 107, 122.

169. THE POTENTIAL EFFECTS, *supra* note 94, at 165-66, 178; Dickey, *An Army Civil Works Perspective on Responding to Changing Water Availability*, in PREPARING FOR CLIMATE CHANGE, *supra* note 94, at 388. Dr. Dickey says that "our first possible line of defense should be prevention through behavior modification." *Id.* at 392.

170. Dickey, *supra* note 169, at 389.

matters, both in doctrine and in state practice. In frontier areas of western Europe, individuals have access to administrative authorities across the border.[171] Non-governmental organizations have had an acknowledged role in the development of the agreements for the Great Lakes Basin, and the International Joint Commission, which has long held public hearings, now seeks even more direct forms of discourse.[172] A non-governmental organization, The International Coalition (TIC), is working hard to get local people from both sides of the U.S.-Canadian border to take a basinwide perspective and participate actively in resolving land and water issues in the Red River Basin, which lies within three states (Minnesota, North Dakota, and South Dakota) and two Canadian provinces (Manitoba and Saskatchewan).[173] Realizing the importance of information as a decision-making tool, TIC has helped fund the establishment of comprehensive land-use data bases to enable citizen groups to test management decisions and assess the impact of land-use changes on water resources.[174]

Problems which may already indicate climate change, or at least give early warning of its impacts, have recently prompted a broader public participation. For example, the Missouri River Basin Assembly was formed in 1989 under sponsorship of a non-profit organization to discuss basin issues and promote public education regarding management of this drought-plagued ten-state river basin.[175] In developing countries, the participation of women in addressing issues relevant to resources and conservation is being sought at com-

171. *See* Teclaff & Teclaff, *supra* note 88, at 43-44.

172. For example, the 1989 biennial meeting on Great Lakes water quality afforded many citizens' groups, including native peoples, an opportunity to express their views. At this meeting, the Commission announced that it would organize a series of roundtable discussions on specific issues of concern. Also it was recommended that a binational regional pilot project be completed to anticipate and prevent climate change problems and serve as a model for other regions. *See* 14 FOCUS ON INTERNATIONAL JOINT COMMISSION ACTIVITIES, Nov.-Dec. 1989.

173. Lance Yohe, President of The International Coalition. *See The Red River Basin: An International Approach to Water Management*, 6 U.S. WATER NEWS 7 (June 1990).

174. *Id.*

175. *See* 6 U.S. WATER NEWS 4 (May 1990).

munity and international levels. The New Delhi Conference on Global Warming and Climate Change, held in February 1989,[176] emphasized the role of women both in the Conference Statement and in the Executive Summary, and the Zambezi River Basin Action Plan devotes a sub-paragraph of its environmental management section to encouraging women, as "end users" of water, to participate in management.[177]

VI. Conclusions

The history of the river basin concept shows persistence, but also variation, in its scope depending on circumstances. At some periods it has been narrowly construed to encompass only management of water resources, at others it has embraced other elements of the environment. Under the expected impact of climate changes the basin begins to be perceived as an ecosystem in which all elements of the environment are interrelated and should be managed, at least as a first stage, by basin commissions. This is especially relevant at a provincial and international level. The powers and means of the commissions to make final decisions, to conduct necessary research and investigations, to assess the impact of projects and to serve as a forum for public opinion should, therefore, be adequately expanded so as to be commensurable with their expanded tasks.

176. *See* INTERNATIONAL CONFERENCE ON GLOBAL WARMING AND CLIMATE CHANGE: PERSPECTIVE FROM DEVELOPING COUNTRIES, NEW DELHI, INDIA, Conference Statement, Feb. 21-23, 1989 (distributed by the Woods Hole Research Center, Woods Hole, Mass., 1989).

177. Zambezi Action Plan, *supra* note 81, § 29(d).