PII: S0165–0203(96)00046–3

Natural Resources Forum, Vol. 21, No. 2, pp. 85–90, 1997

0165–0203/97 $17.00 + 0.00

Changing the course of transboundary water management

Sandra Postel

It is no small coincidence that the Latin word *rivalis*, from which we derive 'rival', originally referred to a person living on the opposite bank of a river. Indeed, the growing number of rivalries over river water is among the signature features of geopolitics today. As farms and cities, states and provinces, and neighbouring countries compete for a limited or shrinking water supply, a new politics of scarcity is beginning to shape world affairs.

Worldwide, at least 214 rivers flow through two or more countries, yet no enforceable law governs the allocation and use of international waters. As demand for water approaches the limit of the available supply, nations in shared river basins can fall into a zero-sum game—in which increasing the water supply to one user means taking some away from another. Among today's hot spots of international water dispute are the Ganges basin in South Asia, the Aral Sea basin in Central Asia, and all three of the major river basins in the Middle East—the Nile, the Jordan, and the Tigris-Euphrates. In none of these locations is there yet a treaty recognized by all parties that allocates the basin's waters among them.

The challenge of formalizing agreements for sharing water among nations grows more urgent each year. Equally pressing, but less well recognized, is the challenge of developing strategies for sharing water with nature. Rivers, lakes, and wetlands are in declining health because the traditional approach to water development has failed to protect their vital ecological functions—including flood protection, water purification, habitat maintenance, and sustenance of fisheries. The delta regions of many international rivers are undergoing serious deterioration as a result of large-scale dams and water diversions upstream.

For all its impressive engineering, modern water development has adhered to a fairly simple formula: estimate the demand for water and then build new supply projects to meet it. It is an approach that largely ignores concerns about equity, the health of ecosystems, other species, and the welfare of future generations. In a world of resource abundance, it may have served humanity adequately. But in the new world of scarcity, it is fueling conflict and degradation.

As the world's population expands by a projected 2.6 billion over the next 30 years, and as consumption levels spiral upward, water problems are bound to intensify and heighten the potential for conflict (Postel *et al.*, 1996). With the best dam sites already developed and many groundwater reserves overtapped, opportunities to meet new water needs by exploiting new sources are clearly limited. A new and more promising blueprint is needed, one with goals of using and allocating water more efficiently, sharing international waters equitably, and explicitly reserving water for the protection of aquatic ecosystems.

Depleted rivers

Among the most disturbing signs of increasing water shortage and competition for scarce supplies is the severe depletion of flow that has occurred in many of the world's rivers. Globally, the tripling of water use since 1950 has led to the building of more and bigger water supply projects. Around the world, the number of large dams (those more than 15 meters high) built for water supply, hydropower, and flood control has climbed from just over 5000 in 1950 to roughly 38 000 today. Along with thousands of kilometers of diversion canals, these structures have brought about a massive change in the global aquatic environment in a very short period of time.

The mighty Ganges in South Asia is one of several major rivers that no longer reach the sea for all or part of the year. India's heavy diversions upstream during the dry season have left almost no water in the river for Bangladesh, much less to reach the river's natural outlet in the Bay of Bengal. The lack of fresh water flowing out to sea has caused the rapid advance of a saline front across the western portion of the river delta, which is damaging valuable mangroves and fish habitats, important resources for local inhabitants. Unless more water is allowed to flow into the delta during the dry season, damage to vegetation and fisheries will continue, spreading disruption to the local economy (Frederiksen *et al.*, 1993).

In the Nile River basin, the High Dam at Aswan was constructed during the 1960s to provide virtually complete control over the Nile's waters and a crucial hedge against drought. Lake Nassar is able to store a full two years' worth of the Nile's average annual flow. Not surprisingly, however, the High Dam has greatly altered the river system. Out of 47 commercial fish

The author is Director of the Global Water Policy Project in Amherst, Massachusetts.

species available in the Nile prior to the dam's construction, only 17 were still harvested a decade after its completion. The annual sardine harvest in the eastern Mediterranean dropped by 83%, which is likely a side-effect of the reduction in nutrient-rich silt entering that part of the sea.

One of the most worrisome long-term consequences of the disruption of the Nile ecosystem is that the river delta, so essential to Egypt's economy, is slowly falling into the sea. The Nile transports an average of 110 million tons of silt each year, much of it fertile soil washed down from the Ethiopian highlands. Since the completion of the High Dam at Aswan, and the trapping of virtually all of this silt in Lake Nassar, the delta has been losing ground to the sea—a process that may quicken with global warming and the anticipated rise in sea level that higher temperatures will bring. Researchers at the Woods Hole Oceanographic Institution in Massachusetts calculate that Egypt could lose up to 19% of its habitable land within about 60 years, displacing up to 16% of its population—which by then would likely total well over 120 million—and wiping out some 15% of its economic activity (Milliman *et al.*, 1989).

In North America, the Colorado River—shared by seven U. S. states and the Republic of Mexico—ranks among the most heavily plumbed waterways on the planet. Virtually its entire flow is now captured and used—which has caused desiccation of the river's delta, shrinkage of wetlands, the disappearance of once-abundant wildlife, and the cutoff of nutrients to northwest Mexico's Sea of Cortez. Fisheries in the sea have declined dramatically, partly as a result of heavy overfishing, but likely also because of the loss of nutrients and critical habitat. The native Cocopa people, who have fished and farmed in the Colorado Delta for perhaps 2000 years, are now a culture at risk of extinction.

No region better illustrates the consequences of neglecting ecosystem health in water management decisions than the Aral Sea basin in Central Asia. Some four decades ago, Soviet central planners calculated that using central Asian rivers for irrigation of cotton would produce more economic value than letting the majority of their flow empty into the Aral Sea, which was then the planet's fourth largest lake. Irrigated area in the region expanded greatly during the ensuing decades, and now totals 7.9 million hectares. This places the Aral Sea basin among the world's largest irrigation systems, with an area more than double that of Egypt's and half that of the vast Indus system in Pakistan.

Prior to 1960, the Amu Dar'ya and Syr Dar'ya poured 55 billion cubic meters of water a year into the Aral. As river diversions for irrigation increased, however, this flow diminished. Between 1981 and 1990, the rivers' combined flow into the sea dropped to an average of 7 billion cubic meters, 13% of the pre-1960 inflow. With replenishment well below evaporation rates, the sea has been shrinking. Between 1960 and 1992, the Aral lost half its area and three-fourths of its volume (Micklin, 1992). Unusually heavy rains in the Aral watershed between 1990 and 1994 increased annual river inflow to an average of 23 billion cubic meters; but even this was not enough to stop the sea's shrinkage.

The still-unfolding chain of ecological destruction ranks the Aral Sea's demise as one of the planet's greatest environmental tragedies. Twenty of the 24 fish species there have disappeared, and the fish catch, which totalled 44 000 tons a year in the 1950s and supported 60 000 jobs, has dropped to zero. Abandoned fishing villages dot the sea's former coastline. Each year, winds pick up some 100 million tons of a toxic dust-salt mixture from the dry sea bed and dump them on the surrounding farmland, harming or killing crops. The low river flows have concentrated salts and toxic chemicals, making water supplies hazardous to drink and contributing to high rates of many diseases. The population of Muynak, a former fishing town, is down from 40 000 several decades ago to just 12 000 today (Micklin, 1991).

What has happened in the Aral Sea basin shows vividly how damage to economy, community, and human health can follow close on the heels of ecological destruction. It is a pattern poised to repeat itself in many international river basins if nations do not succeed in devising strategies for ecosystem protection.

Rising tensions

Unique among strategic resources, water flows easily across political boundaries. Many countries depend on river water from upstream neighbours for a substantial portion of their surface supplies. Particularly in the face of population growth and rising water demands, tensions over water are increasing. Indeed, the Project on Environmental Change and Acute Conflict, based at the University of Toronto, finds that 'the renewable resource most likely to stimulate interstate resource war is river water' (Homer-Dixon, 1994). River basins in which hostilities are most likely to erupt are those in which the river is shared by at least two countries, where water is insufficient to meet all projected demands, and where there is no recognized treaty governing the allocation of water among all basin countries.

Egypt, with its very scant annual rainfall, is perhaps more vulnerable than any other country to a reduction in water supplies. The nation depends on the Nile River flowing into its territory for 97% of its surface water. With a population of 60 million, climbing by 1 million every nine months, some 3.2 million hectares of cropland totally dependent on irrigation, and a current water demand that is very near the limits of the supply, any cutoff of the Nile's flow would be highly disruptive, if not disastrous.

Until recently, Egypt was at minimal risk of suffering such reductions, except, of course, from drought. But Ethiopia, where 86% of the Nile's total flow originates, now has the political stability and capacity to mobilize resources to store and use water for agricultural and economic advancement. An estimated 3.7 million hectares of Ethiopia's land is potentially irrigable. Using Nile water to irrigate even half this area could reduce downstream flows by some 9 billion cubic meters per year—equal to 16% of Egypt's current annual Nile supply. Moreover, Ethiopia plans to expand hydropower production, with some 80% of future hydro schemes located on Nile tributaries (Abate, 1994). Similarly, studies of Uganda, in the upper White Nile basin, suggest that on the order of 2 billion cubic meters per year of additional water consumption might occur there if its irrigation potential were fully developed (Falkenmark and Lundqvist, 1995). Thus Egypt seems increasingly vulnerable to a loss of Nile water.

When downstream countries are relatively less powerful than water-controlling upstream countries, conflict may be less likely, but social and economic insecurity—which in turn can lead to political instability—can be great. For example, as the weaker riparian, Bangladesh would almost certainly not choose to go to war with India. But as the nation last in line to receive water from the Ganges—which rises in the Himalaya of Nepal and then flows through India and Bangladesh before emptying into the Bay of Bengal—Bangladesh has lost out, and the failure to meet its needs has for years had a destabilizing effect on relations with its more powerful neighbour.

In the early 1970s, India completed the Farakka Barrage to divert Ganges water to the port city of Calcutta, which reduced the flow into Bangladesh. The two nations agreed in 1977 to a short-term solution for sharing the dry-season flow, and also guaranteed Bangladesh a minimum amount of water during periods of extremely low flow. That agreement expired in 1982 and was replaced with an informal accord that did not include the guarantee clause for Bangladesh. A follow-up agreement expired in 1988.

Tensions between the two countries worsened during the nineties. In 1993, the dry-season flow into Bangladesh was the lowest ever recorded. The Ganges Kobadak project, one of this poor nation's largest agricultural schemes, reportedly suffered an estimated $25 million in losses. Irrigation pumps on the Gorai River, the Ganges' main tributary in Bangladesh, were idle again in 1994. And in October 1995, then Prime Minister Begum Khaleda Zia stated before the United Nations that more than 40 million Bangladeshis were facing poverty and suffering because of India's diversions of Ganges River water. She called India's actions 'a gross violation of human rights and justice,' and said the Farakka Barrage had become for Bangladeshis 'an issue of life and death' (Platt, 1995).

Syria and Iraq are in a similar situation with regard to Turkey, the eastern mountains of which give rise to both the Tigris and Euphrates rivers. Turkey is undertaking a huge hydropower and irrigation scheme known as the GAP (after the Turkish acronym), which could reduce the Euphrates flow into Syria by 35% in normal years and substantially more in dry years, besides polluting the river with irrigation drainage. Iraq, third in line for Euphrates water, would see a reduction as well.

Turkey and Syria signed a protocol in 1987 that guarantees the latter nation a minimum flow of 500 cubic meters per second, about half of the Euphrates' volume at the border, but Syria wants more—a request Turkey so far has denied. In 1992, then Turkish Prime Minister Suleyman Demirel remarked about Syrian requests for more Euphrates water: 'We do not say we should share their oil resources. They cannot say they should share our water resources.' Although the government may have a more compromising position than this hard-line language would suggest, the parties have not yet reached a water-sharing agreement.

From conflict to cooperation

Historically, rivers have often been used to delineate political boundaries, and have thus divided nations. Ecologically, however, rivers join nations. Any river that forms a border between two countries courses through the middle of a watershed that spans those two countries. And any river that flows through two or more nations is supported by ecosystems that cut across political boundaries. Cooperation is thus essential not only to avert conflict but to protect the natural systems that underpin regional economies.

Although no enforceable law as yet governs the allocation and use of international waters, a code of conduct and legal framework for shared watercourses has steadily been evolving. Efforts by both the United Nations International Law Commission and the private International Law Association have established (albeit with varying emphases) equity and reasonableness as overriding water-sharing principles for international river basins. While useful as general guidelines, these principles are subject to widely differing interpretations, and thus are minimally helpful in practice. Water-sharing and the prevention of conflict thus depend on the affected parties hammering out and abiding by treaties. Unfortunately, in none of today's potential hot spots of water dispute does a treaty exist that includes all of the parties within the river basin.

The 1994 treaty signed by Israel and Jordan, for example, resolves some of the water issues between these two countries, and hopeful early signs of a peaceful resolution of water disputes are evident in the 1995 interim Israeli–Palestinian agreement as well. But until water rights or allocations are clarified and agreed to by all parties in the Jordan River basin—which include Israel, Jordan, Lebanon, the Palestinians, and Syria—tensions will likely persist. In an April 1996 speech, U. S. Secretary of State Warren Christopher spotlighted the Middle East as a region 'where the struggle for water has a direct impact on security and stability' (Christopher, 1996).

In the Nile basin, a 1959 treaty between Egypt and Sudan allocates an amount of Nile water between them that adds up to nearly 90% of the river's average annual flow—even though 86% of that flow originates in Ethiopia. Ethiopia is not party to the treaty and, not surprisingly, feels no obligation to respect it. Fortunately, now that Ethiopia is in a position to begin tapping upper Nile waters for its own use, the affected nations are beginning to cooperate. At a February 1995 meeting in Tanzania, the water affairs ministers of most of the Nile basin countries—including Egypt and Ethiopia—agreed to form a panel of experts that would be charged with developing a basinwide framework for water sharing aimed at 'equitable allocation of the Nile waters' (Extracts, 1995). Especially given Egypt's historic position, this is a striking development.

Certainly, the most notable recent development is the December 1996 signing of a treaty between India and Bangladesh to share the waters of the Ganges River at Farakka. The agreement, which is to remain in force for 30 years, not only sets out a clear water sharing formula between the two countries, but establishes a guaranteed minimum flow for Bangladesh, sets forth emergency procedures in the event of extremely low flows, calls for the establishment of a joint committee to observe and record the daily flows at Farakka and generally to implement the treaty arrangements (Republic of India and People's Republic of Bangladesh, 1996). Apparently the product of a 'good-neighbor' policy of Indian Prime minister H.D. Deve Gowda's coalition government, the agreement should greatly relieve the tensions that had persisted for so long over the Ganges water. What the treaty does not address, however, is the need for minimum flows to protect the Ganges delta.

Finally, in the Aral Sea basin, the presidents of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan met in January 1994 and approved an action plan for addressing the basin's dire situation and for broader social and economic development over the next three to five years. The centrepiece of the plan is a regional water management strategy, completed in draft form in May 1996, which has been agreed to by all five countries. In several key respects, this strategy document is a milestone for basin-wide water management worldwide, because it recognizes the Aral Sea and the Amu Dar'ya and Syr Dar'ya delta ecosystems as 'water users' in their own right, deserving of water allocations (Aral Sea Basin Program—Group 1 *et al.*, 1996).

A number of lessons emerge from past and ongoing efforts to arrive at international water-sharing agreements. First, some third-party involvement is often key to resolving water disputes, and this involvement may need to be backed by financial support. For example, the World Bank played a key intermediary role in resolving the 12-year dispute between India and Pakistan over the Indus River that erupted in 1947 with the partitioning of the subcontinent. In addition, the Bank's mobilization of financing for carrying out technical aspects of the agreement was integral to the success of the Indus Waters Treaty, which was signed by the two countries in 1960.

Second, water agreements may be easier to achieve, and economically more efficient, if they include resources or assets other than water. A natural trade in many river basins, for example, is that between water supply and energy. Equity would dictate, however, that a certain minimum amount of water be provided to all parties in a given river basin, and that no party should have to trade other assets to receive this minimum amount.

Third, progress toward water-sharing agreements is sometimes made when the negotiations shift from discussions of water rights to water needs. How much water each party has a 'right' to is subjective, emotionally charged, and varies with the criteria used, but how much each 'needs' or can beneficially use can more easily be quantified objectively. For example, the Johnston Accord for the Jordan River basin, which was orchestrated in the 1950s but never ratified for political reasons, was based on estimates of how much water was needed for all the potentially irrigable land within the basin that could receive water by gravity flow. National water allocations were then determined by the location of this land within the basin. Although irrigable area was the basis for determining the allocation, each country could use its share of water any way it pleased (Bingham *et al.*, 1994). The Johnston water-sharing formula was acceptable to all parties at the time and still has validity today.

The inevitability of droughts and the prospect of climate change must also figure into water-sharing agreements. It may no longer make sense for treaties to specify the absolute quantity of water each nation, state, or province receives, since in many years there may not be enough water to meet all treaty requirements. A more sensible approach is for agreements to specify each party's respective share of river runoff, with the absolute amount each gets tied to how much is available in a particular year. To protect a river's ecological functions, treaties would need to specify an absolute quantity and quality of water that is reserved for the environment, and this minimum flow would need to be provided in dry years or wet. The Murray-Darling river basin in Australia is now managed under such an approach (Blackmore, 1994).

Finally, creating institutions and procedures that allow for joint, integrated management of water that crosses political boundaries is critical. When countries in the same river basin are cooperating and managing the basin's water in an integrated, holistic manner, a host of mutually beneficial strategies become feasible. It is the promise of such win-win possibilities that may ultimately transform water scarcity from a source of conflict into a motivation for peace.

Policies and strategies for sustainable river management

Sharing water equitably is only one part of the challenge of transboundary water resources: using and managing the water optimally, and protecting the ecological integrity of river systems are other key prerequisites for sustainability. A critical first step is for countries to recognize the value of water left instream for ecosystem protection. The flow levels needed will vary with the time of year, the habitat requirements of riverine life, the system's sediment and salt balances, the value local residents place on fisheries and recreation, and other factors specific to each river basin. But setting even preliminary minimum flows for both average and low-flow periods would provide some needed assurance of ecosystem protection. These levels can then be refined as more knowledge is gained about river system functioning.

In the many regions where rivers are already overtapped, meeting such minimum requirements will involve shifting some water away from farms and cities over to the environment. This process has begun in California, for example, where a 1992 federal law called for dedicating 800 000 acre-feet (987 million cubic meters) of water annually from the Central Valley Project, one of the nation's largest irrigation projects, to maintaining fish and wildlife habitat and other ecosystem needs. Efforts are also underway to limit the amount of fresh water that can be diverted from the San Francisco Bay delta-estuary, a highly productive aquatic ecosystem that is home to more than 120 species of fish.

Allocating water to the aquatic environment is more difficult in developing countries and in international river basins, where cooperation among several countries may be needed. Part of the ongoing effort in the Aral Sea basin involves constructing wetlands and artificial lakes in the Amu Dar'ya Delta in order to restore aquatic vegetation, fisheries, and wildlife. But the Aral Sea ecosystem would need a substantial allocation of water just to stop the spiral of decline, much less reverse it. Stabilizing the sea even at its present level would require an annual inflow of some 35 billion cubic meters (Glazovskiy, 1991)—five times greater than the average annual inflow registered during the 1980s. Although the basin countries have recognized the need to dedicate river flows to the Aral Sea ecosystem, their national economic goals—which in several cases include irrigation expansion—are not entirely consistent with substantially increasing river inflow (Aral Sea Basin Program—Group 1 *et al.*, 1996).

In rich and poor countries alike, meeting irrigation, industrial, and household water demands while also protecting the aquatic environment requires much greater incentive to use and allocate water more efficiently. Stretching existing water supplies can help satisfy new water needs within countries as well as relieve tensions between countries. Moreover, when compared on an equal footing with conventional water supply projects, measures to reduce the demand for water through investments in conservation, recycling, and increased efficiency are typically the most economic alternatives for balancing water budgets. At 5–50¢ per cubic meter, nearly the entire spectrum of conservation and efficiency options—including leak repair, the adoption of more efficient technologies, and water recycling—cost less than the development of new water sources in most regions. Even the most expensive conservation options cost half as much as the least expensive seawater desalination projects (World Bank, 1995; Postel, 1992).

Unfortunately, large subsidies to water users continue unchecked, discouraging efficiency investments and conveying a false message about water's scarcity and value. Farmers rarely pay more than 15% of the real cost of water from government irrigation schemes. As a result, they have little incentive to adopt water-saving measures—such as switching from sugar cane or rice to less water-intensive crops, investing in drip irrigation lines or low-pressure sprinklers to reduce evaporation losses, or optimizing the timing and frequency of irrigations, to name a few.

Along with more effective water pricing, water marketing can create incentives both to encourage efficiency and reuse, and to allocate water more productively. Marketing is not appropriate or workable everywhere, since it requires well-defined property rights to water. And if unregulated or monopolistic, it can lead to overexploitation of water sources, inequalities in water distribution, and exploitative prices (Rosegrant and Schleyer, 1994). Under proper conditions, however, markets offer substantial benefits. Instead of looking to a new dam or river diversion to get additional water, cities and farmers can purchase supplies from others who are willing to sell, trade, or lease their water or water rights. The Metropolitan Water District of Los Angeles, for example, is investing in conservation measures in southern California's Imperial Irrigation District in exchange for the water those investments will save. The annual cost of the conserved water is estimated at about 10¢ per cubic meter, far lower than the water district's best new-supply option.

Efficiency standards round out the package of policy tools for stretching water sources. In the United States, a 1992 law requires manufacturers of toilets, faucets, and showerheads to meet specified standards of efficiency. The average U. S. resident's water use with these fixtures is expected to drop by more than half within 30 years as the more efficient models replace the existing stock (Vickers, 1993). A number of other governments, including Mexico and the Canadian province of Ontario, have adopted standards for household plumbing fixtures (Postel, 1992). The National Community Water Conservation Program in Cairo is currently working with the Egyptian government in attempts to introduce water conservation standards to the plumbing code there. Although efficiency standards have so far mainly been applied to household fixtures, they offer potential for water savings in agriculture, industry, and other municipal uses as well.

For the foreseeable future, using water more efficiently and distributing it more equitably—between people and nations as well as between people and nature—offers the best hope for preventing political and social instability and more widespread ecological decline in international river basins. To the extent policymakers see and seize the mutual gains possible through cooperation, international rivers may yet become bridges to peace rather than sources of strife.

Acknowledgements

Much of the material for this article is drawn from *Dividing the Waters: Food Security, Ecosystem Health, and the New Politics of Scarcity* by the author (Worldwatch Institute, Washington, D.C., 1996).

References

Abate, Z. (1994) The integrated development of Nile Basin Waters. In *The Nile: Sharing a Scarce Resource*, eds P. P. Howell and J. A. Allan. Cambridge University Press, Cambridge.

Aral Sea Basin Program—Group 1, Interstate Commission for Water Coordination, and World Bank (1996) Developing a regional water management strategy: issues and work plan. Draft prepared for the Executive Committee of the Interstate Council for the Aral Sea.

Bingham, G., Wolf, A. and Wohlgenant, T. (1994) *Resolving Water Disputes: Conflict and Cooperation in the United States, the Near East, and Asia.* U.S. Agency for International Development, Washington, D.C.

Blackmore, D. J. (1994) Integrated catchment management—the Murray-Darling Basin experience. Paper presented at *Water Down Under '94*, Adelaide, Australia.

Christopher, W. (1996) American Diplomacy and the Global Environmental Challenges of the 21st Century. Text of speech given at Stanford University, Stanford, Calif., 9 April 1996.

Extracts from the Minutes of the 3rd Meeting of the Ministers of Water Affairs in the Nile Basin on Tecconile, and Annex Z, Project on the Nile Basin Cooperative Framework. Draft Terms of Reference for a Panel of Experts Constituted by the Tecconile Council of Ministers, Arusha, Tanzania, 9–11 February 1995.

Falkenmark, M. and Lundqvist, J. (1995) Looming water crisis: new approaches are inevitable. In *Hydropolitics: Conflicts Over Water as a Development Constraint*, ed. L. Ohlsson. Zed Books, London; based on estimated additional withdrawals of 11 million cubic meters per day to satisfy full irrigation potential.

Frederiksen, H. *et al.* (1993) *Water Resources Management in Asia.* World Bank, Washington, D.C.

Glazovskiy, N. F. (1991) Ideas on an escape from the 'Aral Crisis' *Soviet Geography* **32**(2), 73–89.

Homer-Dixon, T. F. (1994) Environmental scarcities and violent conflict. *International Security* **19**(1), 5–40.

Micklin, P. (1991) Touring the Aral: visit to an ecological disaster zone. *Soviet Geography* 32(2), 90–105.

Micklin, P. (1992) The Aral crisis: introduction to the special issue. *Post-Soviet Geography* 33(5), 269–282.

Milliman, J. D. *et al.* (1989) Environmental and economic implications of rising sea levels. *Ambio* 18(6).

Platt, G. (1995) India's control of Ganges river flow a 'life and death' issue for Bangladesh. *Journal of Commerce* 26 October 1995.

Postel, S. (1992) *Last Oasis: Facing Water Scarcity.* Norton, New York.

Postel, S. L., Daily, G. C. and Ehrlich, P. R. (1996) Human appropriation of renewable fresh water. *Science* **271**, 785–788.

Republic of India and People's Republic of Bangladesh (1996) Treaty Between the Government of the Republic of India and the Government of the People's Republic of Bangladesh on Sharing of the Ganga/Ganges Waters at Farakka.

Rosegrant, M. W. and Schleyer, R. G. (eds) (1994) *Tradable Water Rights: Experiences in Reforming Water Allocation Policy.* Irrigation Support Project for Asia and the Near East, Arlington, Va.

Vickers, A. (1993) The Energy Policy Act: assessing its impact on utilities. *Journal of the American Water Works Association*, August 1993.

World Bank (1995) *From Scarcity to Security: Averting a Water Crisis in the Middle East and North Africa.* Washington, D.C.