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The Return to the River Basin: The Increasing Costs of "Jurisdictional Externalities"

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There is a long history of recognition of the river basin as the natural unit for river development, planning and management. In the U.S. and internationally, there is also a long history of breaking up river basins among many jurisdictions, most having nothing to do with water. At present because of the failure to focus development, planning and management on the river basin "jurisdictional externalities" are rising rapidly. Can we move back toward the river basin from the current splintered framework to achieve "win-win" improvements? It is suggested that "virtual river basins" can be created using current satellite technologies and through the extension of water markets to an interstate (if not international) basis.

Historical Background

Over past millenia, the river basin has been used as the entity for river planning and management. The origins of irrigation development in the Tigris and Euphrates Valleys go back to 6000 B.C. involving interdependent diversions from both rivers (Christensen 1993; Postel 1999). China's attempts to control the Yellow River go back to 4000 B.C. The Indus Basin was settled and managed by 2300 B.C. (Postel 1999), while the ingenious Dujianyang irrigation and flood control project on the Min River in Sezchwan Province of China was designed and built around 1600 B.C. by the still revered engineer Li Bao (Van Slyke 1988). Given the technologies available in those eras, these large undertakings required huge work forces and centralized control over the entire effort. These undertakings were the subject of Wittfogel's (1957) arguments about the importance of "hydraulic societies" and the historical existence of "oriental despotism" (Wittfogel 1957).

An exception to this pattern of centralized control was Egypt's use of the Nile River, based on its decentralized system of small basin irrigation that continued for more than 5,000 years, in spite of vast changes in Egypt's political fortunes. The Nile, in flood stage, was much too large to control with known technologies, so the irrigation works were localized and small scale (Butzer 1976; Drower 1954).

In the mid-nineteenth century, the faculty of the Ecole National de Ponts et Chaussees (ENPC) in Paris was one of the most prominent promoters of the river basin approach. The "Agences de Basin" proposed by ENPC are still the planning and management agencies in France. ENPC (especially engineer and economist Jules Dupuis) developed not only engineering techniques but also important tools of economic analysis including use of demand curves for transportation modes and the concept of the area under a demand curve as a measure of user benefits (Ekrlund and Hebert 1973).

In the U.S., the Inland Waterway Commission appointed by President Theodore Roosevelt in 1907 during the early era of "scientific management and the gospel of efficiency" of natural resources (Hays 1958) strongly promoted centralized control of the major rivers and multi-purpose river development. During the depression of the 1930s, expanded roles and authority of the federal government allowed for tight coordination between the various government water agencies–a condition not seen since. The federal government also developed the Tennessee Valley Project, the U.S.'s only attempt at basin-wide comprehensive development. This vast enterprise—including flood control, irrigation, power generation, fertilizer production and

assistance in urban development—was undertaken without even consulting the states involved (Trelease 1971).

The 1965 federal Water Resources Planning Act created the Water Resources Council to coordinate federal water development and management activities (Rogers 1993). The Council, consisting of the Secretaries of the departments involved with water, was to provide rational, coordinated planning. The Act also authorized the establishment of new river basin commissions to coordinate federal and state efforts for basin-wide planning. Membership consisted of the riparian states in each basin, plus federal agencies with programs in the basin. The New England, Great Lakes, Ohio, Pacific Northwest, Upper Mississippi and Missouri Commissions showed substantial achievements but were hampered by a unanimity rule for major decisions, along with upstream and downstream conflicts and "turf protection" by the federal agencies (Ingram 1971).

In the 1968–1973 period, the U.S. National Water Commission carried out an extensive set of studies leading to a landmark report, *Water Policies for the Future* (1973). The report strongly emphasized the importance of the basin approach., Under the Commission sponsorship, a group chaired by Gary Hart produced a major study, *Institutions for Water Planning-Institutional Arrangements: River Basin Commissions, Inter-Agency Committees and Ad Hoc Coordinating Committees (1971)* that emphasized the need for a whole basin approach. More recently in 1998, the U.S. Western Water Policy Review Advisory Commission issued an incisive report, *Water in the West: Challenge for the Next Century* that emphasized the need to coordinate increasingly popular watershed initiatives with river basin goals. Just how this was to be achieved was not made clear.

Technological developments have made basin-wide and real time modes of river management much more practical. Tele-monitoring of streamflows has been in use for more than 20 years, while satellite imagery of weather and flood events now makes it possible to allocate water on a basin-wide, real time basis rather than in terms of monthly or yearly average flows. Rain storm events are forecasted so that streamflows and storage capacities can be managed to greater advantage. Lynne Bennett and colleagues (Bennett, Howe and Shope 2000) have shown that the economically optimal compact allocations of river flow between upper and lower basin states are, generally, neither fixed quantity allocations (like the Colorado Compact) nor percentage-of-flow allocations (like the Arkansas Compact). Instead economic optimality usually requires more complex allocative formulae. Kilgour and Dinar (2001) have shown that real time basin-wide river management is superior to periodic accounting combined with simpler allocation formulae. These new technologies have opened up new possibilities for real time, basin wide administration.

Breaking Up the River Basin

When Ohio was admitted as a state in 1802, the federal government retained title to all public lands and associated water bodies, thus retaining the possibility of federal water management in a river basin context. However, many federal policies since the mid-19th century have had the effect of reducing federal control over water resources, reducing possibilities for basin-wide management (Trelease 1971). The 1877 Desert Land Act required that settlers make water claims under state law. The 1897 National Forest Act required those using forest lands to claim water under state laws. The 1902 Reclamation Act required authorized projects to proceed in conformity with state laws for claiming water, as did the Federal Power Act of 1920. The McCarren Amendment[1] requires all federal agencies to pursue claims for needed water under state laws, in spite of the "Winters Doctrine" of 1912 that implicitly accorded to federal reserved lands (e.g., forests, BLM lands, national parks) waters necessary for intended purposes of the reservation. While the Winters Doctrine has been narrowed by several court cases for federal water claims, it is still the major factor in the water claims of Native American reservations.

In 1982, the Reagan administration down-graded the Water Resources Council to a non-policy status and abolished the river basin commissions that had been established under the 1965 Act. This has left a very mixed picture, especially across the western states:

1. states have wide jurisdiction over water administration;
2. federal agencies must abide by state water laws in acquiring water rights;

3. the federal government retains control over navigable rivers and their major tributaries for purposes of navigation and power generation;
4. international treaties and interstate compacts relating to water over-ride all state laws;
5. the programs of the Army Corps of Engineers (mostly flood control and navigation) have never been subject to state control;
6. the 1974 Endangered Species Act can over-ride state water administration;
7. as a result of the U.S. Supreme Court decision in Arizona vs. California in 1963, the Secretary of Interior was given control over major water allocation issues in the Lower Basin of the Colorado River; and
8. in 2004, the Secretary of Interior stated that states must find the solutions to water problems (U.S. Department of Interior, 2004).

As a well known water planner stated, "U.S, water management has been transformed into an *ad hoc* problem-solving enterprise that neglects basic principles."

Increasing Costs of Failure to Focus on the River Basin: "Jurisdictional Externalities"

It must be recognized that many of the institutional developments that stand as impediments to comprehensive river basin planning were intended to achieve water and non-water related objectives. Examples include:

1. the recognition of national sovereignty in the case of international rivers;
2. the federalist goal of stronger roles for the states in the case of interstate rivers, such as "maximization of the use of water" made in the Colorado State Constitution;
3. keep water rights simple and subject to transfer without consideration of water quality impacts of transfers;
4. prohibitions of inter-basin and/or interstate transfers to safeguard basins of origin and the state's water supply; and
5. reluctance to issue water rights for instream flows for fear of monopolization of the river.

Thus there are trade-offs between the economic efficiency that might be achieved through system-wide management and other public policy objectives. In some cases, these trade-offs may have been planned but, I suspect, in most cases the efficiency losses were ignored.

Many efficiency losses result from the lack of congruence of administrative and river basin boundaries. This class can be called "jurisdictional externalities." There is evidence that economic efficiency losses are increasing as demands on our river systems increase. Trade-offs among objectives that once may have been appropriate are now likely to be out-dated. The Colorado River Compact of 1922 provides a clear example (Meyers 1966; Water Education Foundation 1997; 1999), involving seven riparian U.S. states and Mexico. The compact was agreed upon to relieve uncertainties about future water availability between the Upper and Lower Basins. Mexico was not considered at all. Once the Compact was signed and under existing institutional arrangements (e.g., no interstate water markets), the Upper Basin had no incentive to take into account the value of additional water in the Lower Basin. Nonetheless, supplemented by the construction of Glen Canyon Dam and the Central Arizona Project, the Compact has worked reasonably well for the riparian states. However, the current five year drought has introduced new threats. Since Lake Powell has been reduced to a very low level, power production and existing uses in the Upper Basin are threatened.

At the time the Compact was designed, there was little or no concern about the maintenance of instream flows and values such as power, recreation, and ecosystems. The studies by Young and Booker (1995) of severe, extended drought in the Colorado Basin clearly showed that, under current institutional arrangements (the "law of the river"), very large losses to both basins are likely to occur, 72% of which will be instream values. Interestingly, it was estimated that 85% of the losses to consumptive uses (agriculture and M&I) could be reduced by more efficient intra-state allocations. This study was largely ignored for a decade by water officials but is now being widely cited as evidence of the need to reconsider the "law of the river" in the U.S. In addition to current and future losses in the U.S., there have been severe losses to Mexican agriculture and the unique riparian eco-

systems of the River Delta in Mexico (Getches 2003; Luecke et al. 1999).

The Rio Grande River, involving Colorado, New Mexico, Texas, and Mexico has been a source of conflict since the turn of the 20th century when the initial treaty between the U.S. and Mexico was signed. Allocation of the U.S. share among the three states is also controlled by inter-state treaty. Current drought conditions have stressed this river, pitting endangered species issues (the "silvery minnow" in the Middle Rio Grande) against agriculture, ecosystems against recreation use. Under the drought, Mexico has been unable to deliver the river water agreed upon in the 1944 treaty. Steps toward integrated management of the river could reduce the magnitude of these problems (Texas Center for Policy Studies 2002).

The well watered eastern U.S. river basins face similar problems. Georgia, Alabama, and Florida have been unable to agree (after 13 years of negotiations) on joint management of the Apalachicola, Chattahoochee, and Flint (ACF) Rivers that they share. Alabama and Florida claim large losses of hydro-electric, recreation, navigation, fisheries, and environmental benefits (Lipford 2004; see also Ruhl 2005 in this issue). It has been suggested that development of interstate water markets would be an effective way of optimizing water use among the states, but it is not clear that agreement can be reached. The threat of judicial apportionment by the U.S. Supreme Court may be required to motivate an acceptable compact.

Internationally, conflict is in prospect for several major river basins. The Nile River has been managed by a compact between Egypt and the Sudan, but the other upstream riparian countries are now planning large consumptive diversions with no coordination with Egypt and the Sudan. Most advanced are Ethiopia's plans for large irrigation projects out of the Blue Nile. Political uncertainties surround the White Nile, making international agreement unlikely.

The Ganges is another case where upstream development by India has adversely affected Bangladesh's water supply. The Mekong is vital to transport, power, fisheries and agriculture for Myanmar, Laos, Thailand, Cambodia, and Vietnam. The international Mekong Commission has been successful in mediating the growing demands of the downstream countries and effecting some ecosystem protection. However, China is not party to the Commission and China has plans for a series of dams on the upper river. It is unlikely that consideration will be given to downstream effects. In Southwest Africa, the Okavango River faces similar challenges. Originating in long war-torn Angola and comprises the boundary with Namibia and empties in the great Okavango Swamp in Botswana, one of the world's most unique ecosystems, critical to Botswana's tourism. With calm prevailing in Angola and with increasing demands on the river by Namibia, the future of the Okavango system is in question. Thus across many international river basins, benefits lost through lack of coordination will grow unless ways are found to manage the rivers in a comprehensive way.

Can We Build "Virtual River Basins"?

It seems unlikely that nations, states, and all the special districts that currently have a say in water planning and management will surrender their prerogatives to unified river basin initiatives. Steps towards basin-wide integration will have to be gradual with rewards to all parties involved. Since institutional change always involves losers, as well as winners, progress depends in part on devising ways of compensating the losers in ways consistent with their long-run aspirations. In the face of climate change, cherished institutional arrangements will have to be revisited as we have seen in the Colorado Basin. Several currently feasible steps could take us toward what we might call "virtual river basins," i.e. not politically nor jurisdictionally unified regions but basin-wide water allocation principles and mechanisms that can result in "win-win" efficiency improvements.

A first step could be the adoption of the principle of "benefit sharing" in place of just water sharing. This was described by John Krutilla in his analysis of the negotiations of the Columbia River treaty between the United States and Canada (Krutilla 1967). Since the Columbia originates in the U.S., sweeps into the canyons of Canada and then returns to the U.S., efficient development required large reservoir storage in Canada to support power generation, navigation and fisheries downstream in the U.S. The Treaty solution was to arrange regular monetary payments to Canada, along with sharing of electric power from the lower river with British Columbia. Similar arrangements can be envisioned

on other rivers. Benefit sharing really consists of inducing cooperation through equitable compensation, not necessarily in terms of water.

Extra-market compensation frequently accompanies agricultural-to-urban water transfers in the western U.S. The State of Colorado requires "compensatory storage" for any project exporting water from the Colorado River Basin to other basins in the State (Grigg 2003). This storage is intended to provide insurance against the possibility of future shortages for the exporting area. However, compensatory storage may not be efficient if the exporting basin has other, higher priority needs, or if the probability of shortage is close to zero. Green Mountain Reservoir on the Blue River (tributary to the Colorado) was built by the Bureau of Reclamation as compensatory storage for the Colorado-Big Thompson Project (C-BT) that diverts water from the Upper Colorado to the (eastern slope) Big Thompson River. The reservoir was not needed for flow augmentation for its first 50 years, although it did generate electric power and provide recreation.

The Windy Gap Project, an extension of the C-BT trans-mountain diversions, provided various forms of compensation including added storage and other infrastructure to western slope irrigation districts whose costs increased as a result of the added water exports (Northern Colorado Water Conservancy District website u.d.) Colorado cities that buy agricultural water rights are often required by the water courts to provide for the re-vegetation of the dried-up farmland and frequently voluntarily offer extra-market compensation to local governments of the area of origin.

A second step is to take full advantage of newly developed optimization and surveillance technologies that facilitate basin-wide real time management using more efficient but complicated allocation rules. Bennett et al. (2000) has demonstrated the superiority of general allocation rules (i.e., neither fixed delivery nor percentage rules) for interstate compacts, while Kilgour and Dinar (2001) have shown the potential gains from real time allocation. Maximum gains from these innovations would require the use of "real time benefit functions" to direct water to its most valuable uses at all points in time. Increasing the time resolution of benefit (demand) functions requires further study but is approached in irrigation optimization models that distinguish different stages of crop growth and yield responsiveness. The potential gains may be sufficient to overcome the reluctance of states and water agencies to enter into more comprehensive river management arrangements.

A third step would be to expand the geographical scope of water leasing or sale markets to an interstate (or even international) basis. Selling or even leasing water out-of-state has not been permitted because of state fears of "losing the water" forever. These fears can be overcome by the establishment of continuous, low transaction cost water markets. At least two reasonable proposals have been made in Colorado. In 1984, the Galloway Group, Ltd. proposed construction of a dam on the Yampa River to store unused peak flows to which Colorado was entitled and for which Galloway held water rights with the intent of leasing the water to Lower Basin States (Gross 1985). There was severe opposition by the Upper Basin States on the basis of inferred Compact territorial use limitations and by environmental groups since the river had no major dams. In 1990, a group of investors called the Resource Conservation Group developed a plan for annually drying up irrigated acreage in southwestern Colorado on a rotating basis among cooperating farms with the reduced consumptive use being made available for downstream leasing. The State would not license the scheme in spite of detailed economic studies that showed substantial gains to the exporting region and to the State as a whole (Viscoli 1991).

In 1994, the Colorado River Board of California convened a workshop to propose an interstate lease market (water bank) among the Colorado Basin states (Colorado River Board of California 1994). The idea was that those having water available for lease under state laws or wanting to acquire water would post their offers with their own state engineer office which would check "no-injury" issues and forward approved offers to an interstate banking authority that could match offers to buy and sell. Contracts would be for one year only. Colorado quickly shot down the proposal even though the Colorado State Engineer, as a workshop participant, expressed enthusiasm for the idea (for which he was fired!).

Recently the States of Arizona and Nevada have entered into an interstate agreement, with the guidance of the Bureau of Reclamation and the assent

of the Secretary of Interior. Arizona has agreed to "bank" for 30 years 40,000 acre-feet per year from the currently unused portion of its Colorado River allocation. This water will be provided to Nevada as needed in the future (though the delivery mechanism has not been made clear). Nevada will pay $23 million per year to cover Arizona's costs of groundwater recharge, plus $100 million "up front". Nevada has also pledged political support for a change in the federal law that places Arizona's priority to Colorado River water behind those of California and Nevada (Arizona Daily Star 2004). It is widely agreed that water markets of all types must be supervised to avoid third party injury (Howe 2002). Each of the interstate proposals noted above adheres to the exporting state's rules, including no instate injury. However, water markets are limited in their ability to protect non-consumptive instream benefits such as recreation, ecosystem maintenance, and even hydro-power that are not represented by water rights in many cases. The Booker study cited above found that the greatest losses from extended drought were to recreation, power and environmental values, values generated by flows not represented by water rights.

Another question is whether or not the rapidly expanding number of watershed initiatives is likely to be consistent with broader river basin objectives. A survey of 118 "watershed initiatives" in the western U.S. by the Natural Resources Law Center at the University of Colorado (Kenney et al. 2000) showed that the objectives generally sought by these organizations are compatible with the objectives that would apply to the basin as a whole: flow regimes, water quality, sedimentation control, fish and wildlife preservation, endangered species, land use management, and general environmental concerns. It seems clear that these actions complement broader river basin concerns. Within most of the western states, these watershed initiatives are organizing umbrella groups for the exchange of ideas and experience and to promote cooperation in larger watersheds.

In summary, "benefit sharing" and the interstate extension of water markets should take us a significant distance towards integrated river basin management.

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He has served as consultant on interstate river compacts for the States of New Mexico and Texas and on water planning in Africa, Central and Latin America and Southeast Asia. He is a Fellow of the American Geophysical Union, recipient of the American Water Resources Association Icko Iben Award and the Warren A. Hall Medal from the Universities Council on Water Resources.

His books include *Benefit-Cost Analysis for Water System Planning* (AGU, 1971), *Natural Resource Economics* (John-Wiley, 1979) and *Management of Water Projects* (OECD, 1985). Recent articles include "Water Transfers & their Impacts: Lessons from Three Colorado Water Markets" (with Christopher Goemans, Jour. of the American Water Resources Association, 2003), "Water Transfers and Their Impacts" (*Journal of the American Water Resources Association),* and "Protecting Public Values in a Water Market Setting…" (*University of Denver Water Law Review, 2000*).

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Notes

1. The McCarren Amendment can be found at 43 U.S.C. §666 (1988).

However, the externality also increases the aggregate cost to the economy and society making it a negative externality. Externalities are negative when the social costs outweigh the private costs. Some externalities are positive. Positive externalities occur when there is a positive gain on both the private level and social level.Â R&D increases the private profits of a company but also has the added benefit of increasing the general level of knowledge within a society. So, while a company such as Google profits off of its Maps application, society as a whole greatly benefits in the form of a GPS tool. Positive externalities have publicâ€"or socialâ€"returns that are higher than the private returns. Similarly, the emphasis on education is also a positive externality. The concept of increasing returns has had a long but uneasy presence in economic analysis. The opening chapters of Adam Smithâ€™sWealth of Nationsput great emphasis on increasing returns to explain both specialization and economic growth. Yet the object of study moves quickly to a competitive system and a cost-of-production theory of value, which cannot be made rigorous except by assuming constant returns.Â To a great degree, cities form around and depend upon clusters of industry, so that without doing too much injustice to the question we can ask whether the patterns of location of industry follow paths that depend upon history. The German Industry Location School debated this question in the earlier part of this century, but it was never Transboundary situations create these â€œjurisdictional externalitiesâ€ almost by definition and range from international and interstate scope to local issues. In the water sector, jurisdictional externalities are especially difficult to modify because of the unidirectional nature of the resource flow.Â Many transboundary problems would be solved by a return to the river basin as the unit of management, while the expansion of water markets within the river basin context would serve to provide for the internalization of many current externalities. Flexible allocation rules that reflect real-time hydrologic conditions can greatly improve on the fixed rules that are incorporated in most interstate and international river compacts.