Innovations for Supply Reliability: Role of Inter-jurisdictional Agreements

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Introduction

Rapid growth of western cities, full appropriation of dependable river flows, declining groundwater levels, and growing concern for the environment all lead to competition for water and pressure to resolve uncertainties and disputes. The frequent recurrence and the costs associated with water disputes are well documented and significant (Wolf, 2002, D'Estrée and Colby, 2004). Less recognized are the windows of opportunity to create more flexibility in water management. Negotiations to resolve conflicts have given groups who are traditionally marginalized in state level water policy making, such as environmental organizations and tribes, an opportunity to exert levels of influence they are unable to wield with state legislatures. The outcomes of these negotiations have broadened equity, in the form of access to water for interests were not awarded water rights when the region was being settled.

In this article, several innovations in western U.S. water management arising through inter-jurisdictional agreements are reviewed, highlighting provisions relevant to maintain water supply reliability under climate change. This article highlights opportunities that conflicts present to introduce new supply reliability tools into western water policy.

Economists evaluate changes in policies on the basis of efficiency and equity considerations. Efficiency (defined simply for this brief article) considers whether the stream of benefits over time outweighs the stream of costs associated with a particular policy change (benefits and costs measured in present value terms) . Equity considers how the distribution of benefits and costs shifts among different interest groups as a result of the policy change under consideration. For the policy innovations described in this article, a brief commentary is provided for each on their potential efficiency and equity implications.

Western water law tends to evolve slowly in the absence of the pressures for policy change that such conflicts produce. Although innovations become increasingly urgent as the western U.S. grapples with challenges presented by a changing regional climate, water policies tend to be resistant to fundamental change, an inertia which provides security to water right holders but also limits adaptability. This limited adaptability is primarily a consequence of resistance to change from established right holders under the prior appropriation water rights framework.

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Under the doctrine of prior appropriation, water entitlements are sequentially conferred upon water appropriators, meaning that appropriators who are first-in-time have the highest seniority and greatest security against future shortage. Later appropriators have junior rights in this system and in times of drought their entitlements might not be delivered. Additionally, the prior appropriation doctrine developed such that water entitlements could be lost if not beneficially used. This was done to encourage development in the arid west as well as to minimize the incentive to speculate in water. Currently, however, an appropriators' fear of losing access to water by not beneficially using it encourages inefficient use of the resource.[2] While the doctrines of prior appropriation and beneficial use were consistent with the developmental goals as the West was being settled, policymakers of that era could not anticipate the modern challenges of providing water for ecosystem services or facilitating climate change adaptation.

While water management has always been carried out amidst uncertainty, climate change requires adding new strategies to old approaches. Climate change and climate variability are associated not only with a projected increase in average temperature, but also increased frequency and severity of droughts and floods and an increasing portion of precipitation falling as rain rather than as snow – reducing the length of the snow storage season (Natural Resources Defense Council, 2008). These supply-side changes pose a daunting challenge to western water managers when combined with increased water demand for agricultural crops, growing populations, energy generation and urban landscape uses as temperatures rise. Aridity and increasing demand for water resources make the region's water supplies highly vulnerable (Colby and Frisvold, 2011). While a century of investment in dams and reservoirs means that many parts of the West are not much affected by year to year changes in precipitation, extended drought cycles and higher temperatures will exacerbate already intense competition for water (Colby and Bark, 2011). Innovations introduced through crafting inter-jurisdictional water agreements provide valuable tools to maintain supply reliability in the face of climate change.

Interstate water compacts and tribal water settlement are the two categories of inter-jurisdictional agreements discussed in this article. Both of these become legally binding agreements, once ratified by the necessary federal and state authorities (including the US Congress), and have the full force of federal, state and tribal law.

Native American tribes control large amounts of land in the western states, and significant entitlements to water can be associated with these land reservations. Efforts to clarify and quantify Native American water entitlements often result in protracted, costly litigation. However, in a number of cases government-to-government negotiations (tribes, states and federal agencies) or Native American water rights settlements, have generated creative solutions to seemingly intractable problems and more integrated management of regional water resources. Starting in the 1970s, tribal and non-Indian water users pioneered workable negotiation procedures and substantive approaches (Colby, Thorson and Britton, 2006). Over two dozen tribal water settlements have been ratified by Congress over the past quarter century, and dozens of settlement processes are underway.

[2] The term beneficial use is broad and often includes uses such as domestic, municipal, recreation, agricultural, mining, power and others. Some states also allow wildlife uses to be considered beneficial (For example, *see* Arizona Revised Statutes, California Water Code)

Interstate compact disputes are the second class of inter-jurisdictional conflict discussed here. Most of the rivers of the United States flow across one or more state boundaries and many are governed by interstate water compacts. The over two dozen interstate water compacts in the United States vary tremendously in their complexity. Interstate compacts evolved first in the West during the 1920s and focused on dividing up water in a shared river among the relevant states. States found to be in violation of compact provisions are subject to significant enforcement action (Hall, 2010). Nevertheless, it is not uncommon for one state to claim another has violated compact provisions, resulting in lengthy litigation and/or negotiations. Schlager and Heikkila (2009) examine 14 interstate water compacts in the western U.S. They find a regular pattern of disputes arising over compact interpretation and compliance, as well as resolution of these disputes through various mechanisms, including negotiated agreements between the compact member states.

Inter-jurisdictional agreements to address tribal and interstate water disputes shape the economies and futures of communities throughout the western United States. The costs of such conflicts, and of implementing agreements to resolve them, appear in the form of higher water costs, increases in property taxes and shifting of government spending away from other programs. Along with these costs, some agreements have introduced new ways of managing water that are proving valuable as the region adapts to climate change.

Water Management Innovations for Supply Reliability

In this section a number of innovative water management tools are discussed. Some of these are now actively used in multiple locations throughout the western United States, yet were first introduced through inter-jurisdictional agreements created to resolve interstate and tribal-state water conflicts. Here we discuss regional water banks, groundwater protection zones and shortage-sharing arrangements.

Regional Water Banks

A water bank is an institutional mechanism to create a more reliable water supply during dry years through voluntary trading and water storage (O'Donnell and Colby, 2009, Clifford, et al. 2004). Water banks are administered by federal and state agencies and private firms, and range in geographic scale from a specific urban area to several states. Water banks can make water available for future use through storage in either a reservoir or an aquifer. Water accounts are then maintained in which water is banked and withdrawn at varying locations and time periods (Howe and Weiner 2002). Provided that the appropriate legal structure exists, water banks can allow an appropriator to bank water without the fear losing access under the use-it-or-lose-it provision of the prior appropriation doctrine. In a setting where the bank facilitates trades between willing suppliers and willing demanders, it can also provide efficiencies in trade by reducing search costs of demanders as well as promotional/advertisement costs of suppliers. The centralized framework can operate as a clearinghouse that reduces the costs of bringing a trade to fruition.

Colorado River Interstate Conflicts and Water Bank Development

The Arizona Water Banking Authority, developed as a response to conflicts over the waters of the Colorado River, stores excess water for: higher priority subcontractors of the Central Arizona Project (CAP); Native American water rights settlements; and for interstate contractors. This recharged water will be recovered in times of shortage.

The Colorado River is sourced in the Rocky Mountains and flows through Colorado, Utah, Arizona, Nevada, and California south into northern Mexico. Wyoming and New Mexico also contain portions of the river's watershed and are parties to the Colorado River Compact. Major southwestern cities depend on water from the Colorado and large dams provide reliable municipal and agricultural supplies and generate hydropower. About 90 percent of water diverted from the river is used for irrigation. The seven basin states developed the Colorado River Compact after a 1922 U.S. Supreme Court decision (*Wyoming v. Colorado,* 259 U.S. 419) caused concern among the slower developing states that fast growing California would quickly divert (and thus gain rights to) most of the unclaimed water of the basin. The Compact divides the Colorado River Basin into an upper and lower basin at Lees Ferry; with Colorado, New Mexico, Utah and Wyoming as upper division states, and Arizona, California, and Nevada as the lower division states. The Compact apportions the waters of the Colorado River between the two basins, with each basin allocated 7,500,000 acre-feet of water per year (*Colorado River Compact*, Articles II and III). The Compact's apportionment has proven flawed as it was based on water supply measurements taken during an unusually wet period. This results in the lower division states having larger and more reliable water supplies in dry years than the upper division states. This is a source of ongoing conflict that is being partially addressed through water banking and new shortage sharing mechanisms.

As a consequence of the Colorado River Compact of 1922, water entitlements to the Colorado are divided into pre-1922 rights (senior rights) and post-1922 rights (junior rights). The junior water rights are the ones to be curtailed in the event of extended drought and a compact call by the lower division states (*Colorado River Compact*, Article 3(d)). The impacts of such a call are widely held to be widespread and damaging to Colorado. To provide flexibility in addressing such a situation, a water bank has been proposed to facilitate temporary water transfers and provide post-1922 water users with supply reliability (Iseman, 2009). If they purchase and store water under the bank, they can access that water in times when their allocations would otherwise be curtailed. This proposed bank would proactively assess future supply shortfalls and manage the threat of water use curtailment under the Compact (Water Information Program, 2008). Meetings to discuss this proposal are ongoing.

The Arizona Water Bank Authority (AWBA) has been operating for a number of years, also in response to conflicts involving interstate water sharing and the compact. The CAP, a key component of Arizona's water supply, delivers approximately 1.5 million acre-feet of Colorado River water annually to municipal, agricultural, and Native American interests in central Arizona. California's reluctant support of the project was contingent on Arizona accepting a junior CAP priority status, meaning CAP water users would be among the first to experience reduced deliveries in the event of shortage on the Colorado River system. The AWBA was established in 1996 to protect Arizona against Colorado River shortage and CAP supply disruptions by storing unused apportionment in underground aquifers within the state (Arizona Water Banking Authority, 2008). The AWBA purchases excess CAP water and effluent and stores it as accrued long-term storage credits. AWBA also participates in an interstate water management function with Nevada and California. Arizona is storing available portions of Nevada's Colorado River entitlement (up to 1.25 million acre feet) underground in Arizona. Nevada receives credits for this banked water and can use these storage credits to withdraw a portion of Arizona's Colorado River entitlement directly from Lake Mead. Arizona, in turn, withdraws the banked water from its groundwater aquifers (Garrick and Jacobs, 2006). Nevada paid Arizona $100 million in 2005, and is making 10 annual installments of $23 million until the entire 1.25 million acre-feet allowable is used (Southern Nevada 2009). California also can participate with similar arrangements.

Klamath Basin Tribal and Interstate Conflicts and Development of Water Banking

The Klamath River flows through southern Oregon and northern California before reaching the Pacific Ocean. Agriculture accounts for most of the water demand and the river also is used for hydropower generation and recreation. The basin is prime habitat for federally listed salmon species. California and Oregon entered into the Klamath River Basin Compact to divide the Basin's water among the two states and various tribal and federal water needs in the basin.

Many parties, including the Klamath Tribes, had long been concerned about precipitous declines in salmon populations. In 2001, the Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) issued Biological Opinions that required maintaining higher instream flows for fish recovery. As a consequence, Reclamation was unable to release normal volumes of irrigation water to farmers and a widely publicized crisis of fish versus farmers ensued. In response, Reclamation issued a new Operating Plan and a finalized 2002 NOAA-Fisheries Biological Opinion was issued which established specific flow requirements and directed Reclamation to develop a water bank to meet seasonal flow requirements.

The Klamath Pilot Water Bank, created in 2003, does not store water for later use but rather allows for transfer of forborne irrigation water to instream flows without jeopardizing irrigators' water rights. Banking operations evolved over time to include not only "crop idling" but also "groundwater substitution" and contingency contracts for "groundwater pumping." Groundwater substitution occurs when irrigators use well water instead of river water for farm irrigation and groundwater pumping is a program in which irrigators pump well water and divert the water into irrigation canals for use by others. The Klamath Water Bank also switched from a fixed offer price to a bidding system and was able to obtain water from irrigators more cost effectively.

There also is a seasonal aspect to the program. Instream flow requirements are high in spring and early summer while fallowing generates the most conserved water later in the summer. The bank allows Reclamation to "borrow" water from short-term storage supplies in the late spring and replace that water later with foregone irrigation water (GAO, 2005). While the program creates environmental benefit through stream flow restoration, there is a concern that farmers have unsustainably increased their use of groundwater to offset their reduced surface water use (USGS, 2005). Implementation of the functions served by the Bank was transferred from the U.S. Bureau of Reclamation to the Klamath Water and Power Authority in 2009.

Water Banks As A Supply Reliability Strategy

While only a few water banks are reviewed here, there are over a dozen now operating in the western U.S., most of which originated as a response to an inter-jurisdictional water conflict. Water banks allow for adaptability that is difficult to achieve in the traditional state water law framework for transferring water to other users or uses. The flexibility to transfer water quickly, and at low transaction costs, to locations and purposes that otherwise would suffer losses due to the variability climate change brings, makes water banks, in various forms, an important adaptation mechanism. Water banks, can reduce the transaction costs of participating in water trading as compared the costs of individuals negotiating trades on their own without the services provided by bank. This can enhance efficiency, by facilitating trades that produce positive net benefits but otherwise would not occur due to higher transaction costs. A bank which succeeds in reducing transaction costs also would allow a broader array of interest groups to participate in trades, parties who otherwise might be barred from trading due to higher transaction costs.

Groundwater Protection Zones

While surface water is more obviously susceptible to climate change impacts, more prolonged and severe droughts will also affect groundwater supplies as appropriators switch away from the more variable surface flows. Below are highlighted several innovative arrangements for protecting groundwater levels on behalf of cultural resources and to preserve groundwater as a buffer supply when surface water is limited. In the cases below groundwater has been protected by regulation (Taylor, Contor and Hamilton, 2010).

Groundwater Regulation to Restore Cultural Resources – the Zuni Heaven Settlement

The Pueblo of Zuni is located in New Mexico but members of the Zuni Tribe undertake a regular pilgrimage over 110 miles to perform religious ceremonies in "Zuni Heaven," a marshy riparian area of the Little Colorado River in Arizona. Congress passed a law in 1984 to acquire lands around the religious site for Zuni Pueblo. However, the site was much altered due to construction of an upstream dam which trapped sediment and caused the river to abandon its historical floodplain with rapid destruction of the wetlands. Groundwater pumping by nearby non-Indians exacerbated the destruction, along with introduction of non-native plants and cattle grazing.

The dominant focus of four-years of settlement negotiations was assuring adequate water to restore the cultural site. The cornerstone of the negotiated settlement, ratified by Congress in 2003, is a voluntary acquisition of water rights so the Zuni can irrigate the site and restore its original wetland habitat (Act Approving Settlement of the Water Rights Claims of the Zuni Indian Tribe, Pub. L. No. 108-34, June 23, 2003). To further protect the wetlands, two large utility companies agreed to "non-interference" groundwater compacts with the tribe and smaller parties to the settlement also agreed to limit their nearby groundwater pumping. These "Pumping Protection Agreements" effectively create buffer zones surrounding the religious site based on limiting groundwater use by non-Indians in that area (Williams, 2001).

Groundwater Protection Zones in Arizona Water Settlements Act

The Arizona Water Settlements Act, 2004, (AWSA, Pub. L. 108-451) has 35 signatories and over 85 side agreements, with several innovative features, see Bark and Jacobs, 2009. The AWSA created groundwater protection zones around the Gila River Indian Community (GRIC) Reservation, within which groundwater pumping by non-Indians is limited and must be replenished. This protection zone protects the groundwater water rights of GRIC from over pumping by neighboring water users. In addition to compensate for past excessive pumping around the boundaries of the reservation, which has drawn down groundwater supplies on the Reservation, the State must replenish groundwater on the southern border of the reservation and implement ongoing rules to restrict and replenish groundwater pumping in five protection zones (AWSA, Title II, Sec 207(c)(1)(i). Southside Replenishment Program, A.R.S. §45-2602 (A) as amended by HB 2728).

Maintaining Groundwater Levels As A Supply Reliability Strategy

These two examples are policy instruments designed to address the impacts of pumping on groundwater reserves for the environment and as a backup water supply when surface water supplies are curtailed during drought. While neither of these cases had climate change as their primary consideration, groundwater protection zones will likely become a more important management tool as water users seek to diversify their supply portfolios and spread their supply risks across multiple water sources and concurrently seek protection from the pumping of those outside of these arrangements.

The issue of efficiency as related to policies that seek to maintain groundwater levels is complex and has been usefully modeled by economists as a dynamic optimization problem over time (Brozovic et al, 2010, Shaw, 2005).The efficiency question of whether the present value of benefits from maintaining groundwater levels by restricting pumping outweighs the costs can only be answered by looking at site-specific information. However, it is clear that the groundwater protection policies can play an important equity role. In the two cases summarized here, maintaining the groundwater table at levels higher than would occurred without the policy intervention serves to protect specific tribal values against diminishment by neighboring non-Indian pumping.

Shortage-sharing Arrangements

Shortage-sharing agreements are voluntary negotiated arrangements in which a senior entitlements holder agrees to forgo their senior position so that another water user will have more reliable supplies during a time of shortage. For instance, in some basins, a tribe's full use of its senior rights during regional drought would cut off junior non-Indian water users. In these instances, shortage sharing agreements have proven to be attractive to both tribes and junior non-Indian water users. Under such agreements, a tribe consents to share shortages with non-Indian water users rather than to exercise the full seniority of the tribal right, thereby protecting non-Indian water users during dry years. A similar reasoning applies to agreements whereby a senior non-Indian water entitlement holder, such as an irrigations district, agrees to share shortages in some manner other than straight application of the priority system. This section discusses one example involving a tribe, another involving a shortage sharing mechanism established among the Colorado River Lower Basin States and a third example (AWSA) that includes exchanging water sources of varying quality and reliability levels.

Exchanges among water sources can provide improved reliability, efficiency, and a better match of water quality with water user needs. Trades involving water from rivers with differing drought cycles and between groundwater, surface water and treated wastewater are becoming more common around the West. Many of the policy mechanisms that facilitate such exchanges originated as a response to entered jurisdictional conflicts.

Navajo Nation and San Juan Chama Project

The water supply arrangements associated with the Navajo Indian Irrigation Project (NIIP), negotiated in the 1960s, provides water storage for the Navajo Reservation and other nearby water users and also laid the framework for the San Juan-Chama Project (CJCP), a trans-basin diversion which supplies the Rio Grande Basin of New Mexico. The Navajo Nation, which holds the most senior water rights on the San Juan River, agreed to share shortages proportionally with the SJCP during times of drought in order to obtain federal authorization for the NIIP. While not a comprehensive water rights settlement, this is an early example of a negotiated arrangement between an Indian nation and non-Indian water users (Colby, Thorson and Britton, 2005). In return for federal funding commitments to build a large new irrigation project on their reservation, the Navajo Nation agreed not to oppose New Mexico's 110,000 acre-foot annual diversion through the SJCP for the Rio Grande Basin.

Intentionally Created Surplus – Lower Colorado River Basin

The Secretary of the Interior must annually evaluate the water supply situation on the Colorado River for the Lower Division States and declare each year to be either surplus, normal, or shortage. Regulations and operating criteria had been defined for normal and surplus conditions, but shortage criteria and consequences were not explicitly defined until the culmination of formal process to develop shortage sharing guidelines for the Lower Basin (Department of Interior, 2007).

Increasing pressure on supply, drought, and the corresponding drawdown of the Colorado River system's two main storage reservoirs (Lake Powell and Lake Mead) prompted the negotiation of a new agreements and federal rules for how shortage conditions will be declared, managed, and shared. The new rules include coordinated management guidelines for the major system reservoirs under low reservoir conditions; allow more flexibility in storage and delivery of water and formalize a mechanism called "Intentionally Created Surplus" (Department of Interior, 2007).

The Intentionally Created Surplus (ICS) program provides a way for Colorado River water users in the Lower Basin to generate ICS credits to be stored in Lake Mead by engaging in four types of activities, of interest here, are extraordinary conservation and system conservation. The chief methods of extraordinary conservation are irrigation forbearance agreements, canal lining, and desalination programs. Each year when annual water orders are placed for the following year, states with ICS credits can request the recovery of those credits in addition to their water order for the year. Various ICS projects are underway in each of the three Lower Division States. ICS creates flexibility in the time of use and can serve to defer or lessen the severity of involuntary curtailment of water supplies under the more frequent and severe drought scenarios anticipated with climate change, by augmenting storage and thus Lake Mead elevations (Department of Interior, 2007).

Arizona Water Settlements Act

The AWSA includes and strengthens an important supply resilience mechanism: diversifying portfolios of water types and priorities. While long-term (99 years) water leases between the Gila River Indian Community (GRIC) and central Arizona cities are key to the AWSA, the innovation feature highlighted here is a complex array of exchanges among water sources. GRIC negotiated lease and exchange agreements with a large mining company to enable tribal CAP water to be used and exchanged in lieu of alternative surface and groundwater supplies (Bark, 2009). This set of exchanges gives GRIC, the mining company and other water users in the watershed more drought proof supplies and reduced supply costs compared to the original allocation of water sources.

Another AWSA side agreement exchanges reclaimed urban wastewater for CAP water between cities and GRIC, with the tribe receiving reclaimed urban water. These exchanges are implemented on a 4-to-5 ratio: the cities receive 20% less CAP water for their reclaimed water (Bark, 2009; Bark and Jacobs, 2009). However, the economic benefit to the cities lies in exchanging reclaimed water for potable water, and the tribe receives reclaimed water as a drought-proof supply for their agricultural and golf resort businesses.

Shortage-sharing Agreements As a Supply Reliability Strategy

Traditional state water law relies on the priority system to determine which users are cut off in times of shortage. The more flexible types of arrangements just discussed allow adaptation with less bureaucratic procedures and lower transaction costs than the primary flexibility provided in traditional water right systems - which is to go out and purchase more senior water rights if one desires increased supply reliability. In principle, voluntary shortage sharing arrangements can promote efficiency by allowing the most reliable supplies to be available to those water users that value supply reliability most highly and are able and willing to pay for access to more reliable supplies. Any type of voluntary trading can raise the equity concern that certain parties, such as those interested in acquiring supplies to support habitat, have less financial resources with which to bid for more reliable supplies. In recognition of this concern, public agency dollars are sometimes dedicated to acquiring water for environmental purposes along with funds raised by nonprofit groups (Berrens et al, 1996, Colby, 1990).

Conclusions

A number of valuable innovations, now becoming widespread, were first introduced into western water management as a part of negotiations to resolve inter-jurisdictional conflicts. These new arrangements would have been difficult to insert into traditional state water policies, absent the urgency to settle pressing disputes with tribes and other states. The inter-jurisdictional water agreements discussed are remarkable in many important respects. Through these arrangements, states, tribes and federal agencies collaborate on management of their region's water resources. Such policy innovations also raise both equity and efficiency issues, which need to be evaluated within the site-specific context in which the policy is being implemented.

Over a century of western U.S. experience with addressing interstate and tribal-state conflicts demonstrates that innovative approaches can be employed to settle disputes and to plan for the future. Fundamentally, inter-jurisdictional water agreements are an ongoing process. Rather than providing finality, such agreements typically need to be modified over time, adding new strategies to meet unexpected circumstances and changing needs. Flexibility to address unanticipated problems and conflicts becomes even more essential in the face of climate change. Policy innovations originally developed for other purposes are likely to be an important part of regional strategies to adapt to increased water supply variability under climate change.

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