INTERNATIONAL WATER RIGHTS AND 21ST CENTURY TECHNOLOGY

Rhett B. Larson
Associate Professor of Law, Arizona State University
Senior Research Fellow, Kyle Center for Water Policy

Introduction

The Convention on the Non-Navigational Uses of International Watercourses (the "Watercourse Convention") was adopted by the UN in 1997 for the purpose of protecting and managing fresh water lakes and rivers shared across international borders. (UN Watercourse Convention, 1997). The Watercourse Convention entered into force on August 17, 2014 after Vietnam became the necessary thirty-fifth nation to ratify. (McCaffrey 2014). The entry into force of the Watercourse Convention is significant because it embodies customary international law on apportioning internationally-shared waters and will serve as a framework for regional transboundary water treaties. (Eckstein and Salman 2014). Nevertheless, important questions remain on how the Watercourse Convention will be interpreted and implemented. It is unknown, for example, how Watercourse Convention will be interpreted and its principles implemented with respect to technological innovation impacting the sharing of transboundary waters, including in particular desalination and cloud seeding.

The Watercourse Convention does not explicitly reference technological innovation. Yet new technologies have the potential to either aggravate or mitigate conflict over international watercourses. Desalination is rapidly developing into a cost-effective means of augmenting fresh water supplies and remediating saline contamination in existing supplies. (Tsiourtis, 2001). Cloud seeding, while less broadly implemented, also holds promise for increasing stream flow. (Xueliang et al. 2006). As these technologies evolve and expand in use, they will change how nations share water resources, particularly where one riparian state has the resources to avail itself of new technologies which allow it to increase or improve its water supply, while externalizing costs to co-riparian states lacking those same resources. (Larson, 2014).

This paper evaluates how the principles of the Watercourse Convention govern technological innovation, and proposes an interpretation of those principles to facilitate responsible development and equitable implementation of new or developing technologies in international watercourses. Part I describes how technological innovation can impact the sustainable and equitable allocation of international watercourses between co-riparian states. Part II evaluates how the principles of the Watercourse Convention can be interpreted to avoid conflict and encourage cooperation with respect to water augmentation technology in international basins. Part III proposes a basin-level governance approach under the Watercourse Convention aimed at managing technological innovation aimed at water supply augmentation.

I. The Impact of Innovation on International Watercourses

Technological innovation plays an essential role in water resource development. Innovation allows water to be stored, treated, transported, and used in new and more efficient ways. Technological innovation has improved irrigation efficiency, facilitated water recycling, advanced water storage, and lowered water consumption in industrial processes and domestic appliances. These technologies facilitate management of existing water sources. Other technologies have the potential to open up new sources of freshwater. This Part discusses the international implications of two such technologies – cloud seeding and desalination.

Desalination already features prominently in both contentious and cooperative efforts to share international watercourses. Desalination is an energy intensive process for removing salt from water, and generates potentially hazardous brine wastes. (Lattemann and Höpner). While brine waste disposal, thermal pollution, and saline water intake associated with the desalination process raise serious environmental concerns, the major obstacle to implementation of desalination has been energy costs and greenhouse gas emissions associated with energy consumption. (Craig, 2010). The energy costs associated with desalination have historically been so high as to limit its use in extremely water-poor but extremely energy-rich nations. (Abderrahman, 2010).

As the state of the art of desalination has advanced, however, the concerns and costs associated with its energy consumption may become increasingly muted. For example, photovoltaic solar cells and pressure transfer systems (recycling pressure from the waste stream to the production process) conserve energy, reduce greenhouse gas emissions, and lower costs. (El-Sayed, 2007). Additionally, when desalination plants are co-located with power plants or wastewater treatment plants, energy costs and consumption are further reduced. (Voutchkov, 2004). In combination, these innovations significantly reduce energy costs and environmental impacts associated with desalination, making it both an environmentally and financially feasible approach to water augmentation. (Yamada, et al., 1995). For example, the desalination plant on the Llobregat River in Barcelona, Spain relies on solar power, pressure transfer, and co-location, reducing energy consumption from the approximately 25 kwH/m^3 typical of desalination plants in the 1980s to approximately 2.5 kwH/ m^3 today in Barcelona. (Cazurra, 2008).

The advancing state of the art in desalination has made it an increasingly viable water supply tool. Nevertheless, its implementation in international basins raises serious and unresolved issues. In 2011, for example, the U.S. federal government explored the possibility of financially supporting two new desalination plants in Mexico to provide water to 300,000 homes on both sides of the U.S./Mexico border. (Spagat, 2011). The proposal sparked controversy due to concerns that the desalination plant developers were attempting to avoid U.S. environmental regulation of the facility. (Larson, 2012). The proposal also raised diplomatic concerns, because the U.S. government suggested that Mexico forego some of its rights to the Colorado River in exchange for U.S. support in developing desalination. (Spagat, 2011).

This proposal is only one of the most recent in a longstanding tension associated with desalination in the Colorado River basin. The salinity levels in the Colorado River are less than 50 parts per million (ppm) at its headwaters, yet began to exceed 1200 ppm at the U.S./Mexico border in the 1960s due to contamination from agricultural runoff. (Lohman, 2003). Mexico argued that salt pollution in the Colorado River violated U.S. obligations under the 1944 Rivers Treaty governing international rights to the river. (Judkins, 2010). After negotiations, the U.S. agreed to maintain salinity levels in the Colorado River at the Mexican border at just over the salinity levels behind the U.S. Imperial Dam. (Minute 242, 1973). To maintain this salinity level, the U.S. federal government authorized the construction (at a cost of $245 million in 1974) and operation of a desalination plant in Yuma, Arizona. (Colorado River Basin Salinity Control Act, 1974). However, the operation of the Yuma desalination plant has been sporadic. (Judkins, 2010). When in operation, the Yuma desalination plant reduces the salinity concentration in the Colorado River before it reaches Mexico, but the plant also reduces overall flow to the Colorado River Delta and discharges brine waste to environmentally-sensitive wetlands. (Tarlock, 2006). When not in operation, the U.S. attempts to comply with its obligations by diverting agricultural runoff away from the Colorado River to the Cienega de la Santa Clara in Sonora, Mexico, which depend upon this diversion to remain a viable wildlife habitat. (Carrillo-Guerrero, et al., 2013).

The nations of the Colorado River basin now find themselves with an intractable problem, where the use or the failure to use desalination present serious environmental, economic, and diplomatic challenges. Jordan and Israel face similar issues arising from the decision whether to implement desalination within the Jordan River Basin. (Dreizin, et al.,2008). Under the Peace Treaty between Israel and Jordan, Israel agreed to desalinate springs in the Jordan River basin to produce potable water for Jordan. (Treaty of Peace Between Israel and Jordan, 1995). Until Israel has installed desalination facilities for these springs, Israel supplies Jordan with water from the Jordan River. (Treaty of Peace

Between Israel and Jordan, 1995). The Peace Treaty expressly provides for desalination as a means to increase water supply and apportion rights in the Jordan River. Yet so far Israel has not engaged in desalination on behalf of Jordan, instead opting for continued ad hoc allocation measures on the Jordan River, in part due to environmental concerns as well as energy costs. (Mohsen, 2007).

Desalination presents similar issues to cloud seeding. Like desalination, cloud seeding represents a technological innovation with the potential to augment water supply in an international river basin. (Sharon, 1977). Cloud seeding involves dispersing charged particles like silver iodide or frozen carbon dioxide to act as condensation nuclei for the development of rain drops. (Rangno and Hobbs, 1995). More fresh water is held in the atmosphere at any given moment than in all rivers combined, and that holding capacity will only increase as global temperatures increase. (Karl and Trenberth, 2003). As such, a technology that makes atmospheric water accessible for potable use is comparable in many ways to technology that makes salt water accessible for potable uses.

Cloud seeding, however, remains a less widely-implemented technology relative to desalination, and its impacts on water supply, environmental quality, and climate are less well-understood compared to desalination. (McCaffrey, 2010). Even where increased rainfall has been correlated with cloud seeding operations, the causal effect of cloudseeding on precipitation is difficult to establish. (Levin, 2009). Despite these uncertainties and limitations, at least twenty-seven nations currently have some cloud seeding operations, ranging from small-scale commercial operations to large-scale, state-supported water augmentation projects. (Simms, 2015). The international implications of cloudseeding have been addressed largely in the context of its role in military operations. (Majzoub, et al., 2009). The United States conducted "Operation Popeye" during the Vietnam conflict, which included cloud seeding to stimulate monsoon events to impede Vietcong transportation. (Hauser, 2013). This led to 1977 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques. (Jensen, 2005). International law has not yet developed to specifically address non-hostile uses of weather modification technology.

But international law, and specifically the principles of the Watercourse Convention, must ultimately account for the potential impact of cloud seeding on transboundary water apportionment. Cloud seeding operations have been conducted for decades within the states of the Colorado River Basin. (Simms, 2015). Similarly, cloud seeding operations have been conducted in the Jordan River Basin. (Sharon, 1977). Unlike desalination, cloud seeding has not yet been directly addressed in bilateral treaties governing the management of these shared watercourses. In the case of both desalination and cloud seeding, one riparian state with greater economic resources can potentially avail itself of new technologies to a degree unavailable to its co-riparian, with both potential positive and negative externalities experienced by the co-riparian. International law must equitably allocate the costs and benefits of these technologies in a way that encourages responsible innovation and implementation of water augmentation technology. Given its recent entry into force, and its role as a framework for transboundary river management, the Watercourse Convention provides the best currently-available foundation upon which to build international laws governing these kinds of technological innovation.

II. Governing Innovation under the Watercourse Convention

The silence of the Watercourse Convention on governing technological innovation requires careful interpretation of the convention's main to facilitate responsible implementation of new or developing technologies in international river basins. The intent of the Watercourse Convention was to establish universal principles to guide states in equitably apportioning the benefits of internationally-shared waters, not necessarily the waters themselves. (Helal, 2007). The three main principles of the Watercourse Convention are: (1) equitable and reasonable use of shared resources; (2) the duty to avoid extraterritorial harms; and (3) the duty to cooperate in the management of shared international watercourses. (Tarlock, 2010). As the Watercourse Convention has entered into force, these principles are likely to be considered binding customary international law, and would be inapplicable to international watercourses only to the extent that a treaty governing the shared watercourse adopts different principles. (Watercourse Convention, 1997).

Under the first principle, riparian states have a right to the "equitable and reasonable" use of an international watercourse, with equity and reasonableness determined based on several factors, including population, hydrology, social and economic needs, and conservation. (Watercourse Convention, 1997). The Watercourse Convention does not prioritize uses in determining equity and reasonableness; however, "special regard" is to be given to concerns of "vital human needs." (Watercourse Convention, 1997). The second principle requires riparian nations to avoid causing "significant harm" to co-riparians in their use of international watercourses. (Watercourse Convention, 1997). The Watercourse Convention provides that riparian states avoid significant harm with "due regard" to equitable and reasonable utilization rights, and requires that states compensate or mitigate significant harm. (Watercourse Convention, 1997). Because of this "due regard" and the allowance of compensation for harm to co-riparians, the Watercourse Convention arguably subordinates the principle of avoiding significant harm to the right to equitable and reasonable utilization. (Salman, 2007). The third principle requires good faith cooperation between co-riparians in the development of water resources in an international basin. (Watercourse Convention, 2007). This is consistent with the customary international environmental law principle of "good neighborliness." (Larson, 2012).

Nations sharing international watercourses may assert claims of liability against co-riparians for the violation of these principles in the implementation of new or developing technologies. (Larson, 2014). For example, if Turkey developed an advanced run-of-the-river hydroelectric dam on the Euphrates River that impeded flow to Iraq without any consultation, Iraq could claim that Turkey had violated all three principles of the Watercourse Convention by inequitably and unreasonably using the river, causing significant extraterritorial harm, and failing to cooperate in good faith with its co-riparian.

This example illustrates a straightforward application of the principles of the Watercourse Convention to technological innovation. However, water augmentation technologies like desalination and cloud seeding may defy such straightforward analysis for several reasons. First, these technologies may effectively import new water to the basin, raising the issue of whether the principles of the Watercourse Convention should apply to the augmented supply at all. Second, negative externalities may be suffered by non-riparian states. For example, cloud seeding may interfere with weather patterns in ways that impact states that do not share a river with the cloud seeding state. (Rangno and Hobbs, 1995). Or desalination may result in pollution to the marine environment, impacting coastlines of nations not sharing freshwater sources with the desalinating state. (Larson, 2012). The Watercourse Convention contemplates basin-level cooperative management, but water augmentation technology is not limited inherently to intra-basin impacts. Third, water augmentation technologies can create significant harms that might not be the type contemplated by the Watercourse Convention's second principle. Arguably, the Watercourse Convention establishes an apportionment regime, and thus does not directly address issues of contamination, expansion of disease vector habitats, or flooding – all of which could be consequences of desalination or cloud seeding.

Furthermore, the question remains whether the use of water augmentation technologies by one riparian requires that state to forego appropriations from the shared watercourse in order for utilization to be equitable. If the Watercourse Convention is interpreted to require reapportionment of shared watercourses where one state has technologically augmented its supply, such an interpretation could prove a disincentive to invest in and develop new technologies where they most needed. (Larson, 2014). For example, the U.S. would arguably be discouraged from investing in research, development, and implementation of augmentation technologies if by doing so it must forego rights to shared international watercourses like the Colorado. On the other hand, if reapportionment is not required to achieve "reasonable and equitable utilization," existing inequities will be aggravated where wealthier riparian states augment supplies by technological means, and less developed co-riparians lack the means to take a similar approach but suffer potential negative impacts from desalination or cloud seeding. For example, Israel could access additional water supplies through desalination or cloud seeding, externalize environmental and energy costs to Jordan, and maintain its current allocation on the Jordan River. (Larson, 2014). Of course, both the Jordan River Basin and the Colorado River Basin are governed, at least in party, by existing treaty regimes. As such, these examples are illustrative only, as these treaties would preempt the application of Watercourse Convention principles, to the extent those principles would be inconsistent with treaty provisions.

The adjudication of water disputes in U.S. courts provides some guidance on how the Watercourse Convention principles could be interpreted to encourage responsible and equitable implementation of water augmentation technologies. These cases illustrate three factors international tribunals and river basin treaty commissions could consider in interpreting and implementing the principles of the Watercourse Convention in the context of water supply augmentation technology. These three principles include: (1) the relevancy of technology to the dispute over water resources; (2) the reasonableness of the use of the technology given the character of the watercourse; and (3) balancing the interest between encouraging innovation and efficiency against protecting established water rights. (Larson, 2014).

The 19th Century case of *Mason v. Hoyle* illustrates the first two factors. (14 A. 786, 1888). In that case, both parties operated mills on the same stream. The upstream mill owner, Hoyle, purchased a steam-boiler and engine. The new technology allowed Hoyle to close gates on the stream to divert water to fill his reservoir while still running the mill with the steam engine. When Hoyle closed his gates, stream flow was impaired to his downstream neighbor, Mason. Mason sued Hoyle, claiming his riparian water rights were impaired because Hoyle's use was not reasonable. The principles of U.S. riparian water rights, including in particular the concept of reasonable use, are arguably comparable to the reasonable and equitable utilization principle of international water rights law. (Vick, 2012). Hoyle used a new technology that allowed him to make better use of his water rights, but that innovation adversely impacted his downstream co-riparian. The court in *Mason v. Hoyle* concluded that the use of the steam engine was relevant to determining water rights, and that Hoyle's use was not reasonable under the circumstances. This illustrates the first factor for adjudicating claims involving technological innovation under the Watercourse Convention – technological innovation that impacts the relative rights to an international watercourse is a relevant consideration in determining reasonable and equitable utilization. Technological innovation is relevant where the technology is a central issue in resolving an international dispute over a transboundary watercourse. (Larson, 2014). As such, even where water supply augmentation technology does not directly impact the shared river itself, and even if it has impacts external to the basin, it is a relevant consideration in determining reasonable and equitable utilization rights in international watercourses if the technology is claimed by either party to potentially aggravate or mitigate disputes over the shared watercourse.

The *Mason* case also illustrates the second factor to consider in interpreting the principles of the Watercourse Convention in the context of technological innovation – the reasonableness of the use of technology given the characteristics of the watercourse. (Larson, 2014). The court in *Mason* drew a connection between reasonableness and fairness. This same connection between reasonableness and fairness is reflected in Article 6 of the Watercourse Convention. That article lays out what factors tribunals and commissions should consider when determining reasonable and equitable utilization. These factors include water conservation, the social and economic needs of the riparian states, the geography, climate, ecology, and hydrology of the basin, existing and potential uses of the watercourse, and the availability of alternatives to any planned or existing uses. (Watercourse Convention, 1997). These considerations mirror the language used by the court in *Mason*, which required that water uses, including implementation of new technology, be "adapted to the character and capacity of the stream." As such, implementation of water augmentation technology in an international basin is reasonable and equitable if that use is effectively adapted to the hydrologic, ecologic, economic, and sociocultural conditions of the basin, and if that technology is implemented with a cost-benefit analysis comparing it to alternative approaches. Evaluating the character and capacity of the stream should also include the need for water augmentation, which would mean an evaluation of population growth, changing consumption and climate patterns, and the extent to which effective conservation or water recycling alternatives have been implemented that might obviate the need for augmentation.

The third factor to consider in applying the Watercourse Convention to the implementation of water augmentation technology is balancing the competing interests in the watercourse. The competing interests are often promoting innovation and efficiency weighed against the need to satisfy existing interests in the allocation of benefits, rights, and obligations associated with the international watercourse. The case of *Wayman v. Murray City Corp*. illustrates how this factor can be considered in the context of technological innovation on a shared watercourse. (458 P.2d 861, 1969). In that case, Murray City installed an advanced and powerful pump to its existing well. Despite the increased pumping capacity, Murray City did not appropriate any more water than it had allocated to it. Nevertheless, neighboring well owners sued Murray City, arguing that the more powerful pump decreased pressure in their wells. Essentially, Murray City implemented a new technology to make more efficient use of its existing water right, but that new technology impaired the rights of its neighbors who shared the water source. (Larson, 2014).

The court in *Wayman* applied a "reasonableness" standard in holding in favor of Murray City, noting that holding a right to water does not mean an assurance of the status quo. The court in *Wayman* weighed the general interest in promoting innovation and efficiency against the interests of water rights holders to maintain existing conditions. As in *Wayman*, assessing the reasonableness of implementing water augmentation technology under the Watercourse Convention should require a balancing of interests. The interests of riparian states negatively impacted by technological innovation should be weighed against the interests of the user of the technology to not assume sweeping obligations to insure co-riparians against changes in the status quo. (Larson, 2014). This should not mean an automatic preference for encouraging investment and innovation in water augmentation. Instead, it should be seen as an attempt to achieve Pareto-optimal outcomes. (Larson, 2012). Furthermore, this balancing of interests will not always be similar to that in *Wayman*, where the general interest in innovation outweighed individual interests in predictability and reliability. International tribunals and river basin commissions must also weigh the individual benefits to riparian states increasing water supplies through technological means against the general interest of clearly assigned and predictable water rights and duties. Preserving the status quo may unfairly privilege existing users in some instances, but it may also serve to create an efficient market by preserving clearly assigned rights. And an effective water market may play an essential role in facilitating the efficient and equitable implementation of water augmentation technology. (Chau, 2014). This may mean that some issues associated with water augmentation technology are best left to resolution through customary international environmental law or through international trade and investment law, when appropriate. These alternative legal approaches may help resolve disputes involving water augmentation technology simply by lowering transaction costs and encouraging nations to facilitate water markets.

The principles of reasonable and equitable utilization under the Watercourse Convention should thus be applied to disputes between riparian states involving technological innovation by considering the following three factors: (1) the relevancy of technology to the dispute over water resources (i.e., the extent to which technology plays a central role in the transboundary water dispute); (2) the reasonableness of the use of the technology (i.e., the extent to which the implementation of technology is adapted to the character and capacity of the stream); and (3) balancing the interest between encouraging innovation and efficiency against protecting established water rights (i.e., attempting to achieve Pareto-optimal outcomes).

Central to the consideration of each of these factors is the question of whether, or at what point, water generated or made useable by technological means becomes part of the international basin, and thus subject to the Watercourse Convention. (Larson, 2014). Again, U.S. water rights principles are illustrative of one interpretive approach to this issue. Under prior appropriation water rights in the U.S. (i.e., water rights based on a priority system of "first in time, first in right"), the law distinguishes between "developed water" and "salvaged water." (Larson, 2012). Developed water is new water imported into, and not previously part of, the basin. Salvaged water is water that originated within a basin but was otherwise unusable due to inaccessibility or contamination. In the case of *Southeastern Colorado Water Conservancy District v. Shelton Farms, Inc*., the court held that increased stream flow achieved by removing invasive species from the river bank was salvaged water. (529 P.2d 1321, 1974). Under prior appropriation law, a party that generates developed water through technological means has a right superior to all other users in the basin to that developed water. However, a party that makes salvaged water accessible by technological means does not have a superior right, but uses the water within the priority system.

Desalination could generate "developed water" by introducing desalinated sea water to a river basin. It could generate "salvaged water" by remediating saline-contaminated river water or brackish groundwater. (Larson, 2012). Drawing this distinction in the context of cloud seeding is more complicated. Water vapor moves between basins, and cloud seeding could capture water that came from one basin and would have fallen in another but for technological intervention. The distinction between developed water and salvaged water, while difficult to draw in some cases of water augmentation technology, may still be useful in evaluating how to apply the principles of the Watercourse Convention in that context. For developed water in prior appropriation states, there is an incentive to invest in augmentation, because the investor will reap the benefits by having a superior right. For salvaged water, there is less incentive to remediate contamination or make new sources accessible, because the investor's rights are subordinate to existing rights. The Watercourse Convention should be interpreted and applied in a way that encourages responsible importation of developed water where the character and capacity of the stream require such importation, and facilitate the equitable sharing of that imported water. The Watercourse Convention should also be interpreted to provide incentives for implementing technology to salvage water.

Where the water generated by technological innovation is "developed water," and absent any treaty provision to the contrary, the presumption under the Watercourse Convention should be that the riparian state implementing the technology has full rights to developed water with no obligation to forego rights to the shared water source. This presumption is rebuttable in cases implicating "vital human needs" under Article 10 of the Watercourse Convention. (Watercourse Convention, 1997). In that case, the state claiming vital human needs must demonstrate an inability to meet certain water security benchmarks. (Molle and Mollinga, 2003). What those benchmarks should be, how failure to achieve them should be demonstrated, what reasons for that failure are acceptable, and the amount of water required to meet those benchmarks will be the subject of future papers.

Where technological innovation generates salvaged water, the riparian state making use of the technology cannot make a superior claim to any more than the reasonable and equitable use of the shared water source. In this case, the principles of the Watercourse Convention should be applied in accordance with the three factors discussed above (relevance, the character of the stream, and efficiency) to determine reasonable and equitable use given the presence of the new technology. However, any salvage efforts to make existing sources accessible or useable in the shared watercourse could be used to create a water quality credits trading market, to encourage investment in water salvaging technology. (Larson, 2013). The line between salvaged water and developed water can be problematic (particularly for cloud seeding), as can establishing an equitable evaluation of when offsets are required in the augmentation context to meet vital human needs. It is therefore essential that these interpretive factors under the Watercourse Convention be coupled with improved cooperative transboundary water resource governance, another essential principle of the convention itself.

III. Implementing New or Developing Technologies in International Watercourses.

The Watercourse Convention not only incorporates principles of reasonable and equitable utilization, but establishes a framework for cooperative water governance between co-riparian states. The principle of cooperation, or "good neighborliness," lies at the center of this governance framework. In the case of water augmentation technology, this principle should be interpreted and applied with three governance goals in mind: (1) adaptive management, (2) collaborative basin-level governance; and (3) legitimacy through shared benefits. (Larson, 2014).

The first goal is adaptive management of water augmentation technology within an international basin. Adaptive management is "a systematic process for continually improving management policies and practices by learning from the outcomes of implemented management strategies." (Paul-Wostl, 2007). Because the ability to predict future events, and in particular technological innovation, is inherently limited, collaborative institutions must periodically reevaluate management decisions to adapt to changing circumstances. Adaptive management is an iterative approach to problem solving that extends from daily management decisions to overall regulatory, legal, and political strategies. (Larson, 2012). The Watercourse Convention implicitly calls for adaptive management, because determinations of reasonableness and equity under Article 6 require consideration of dynamic systems, including population, climate, and potential future uses of the watercourse, that necessitate adaptation. (Watercourse Convention, 2007). Adaptive management works best when regulatory, legal and political regimes adequately fund the approach and provide for accountability and enforceability. (Larson, 2014). As such, successful adaptive management depends upon governance structures embodied in transparent and inclusive international river basin commissions.

The second element, therefore, involves appropriate governance structures. Under what is called the "internalization prescription for government jurisdiction," power should be assigned over resources, like water, "to the smallest unit of government that internalizes the effects of its exercise." (Cooter, 2000). Spillover goods are those like water and air, which move between jurisdictions. Jurisdictional boundaries should correspond to the geographic contours of such spillover goods. (Larson, 2015). Earth is like a golf ball – a sphere covered in divots. Each divot is a river basin. Often, jurisdictional boundaries overlap with or share multiple basins. As these goods move between jurisdictions, assigning the appropriate level of governance is difficult, particularly as governments can externalize costs, like pollution originating in one jurisdiction and flowing downstream to another or externalizing water scarcity by damming rivers and cutting off flow to downstream riparians. To achieve internalization of costs, when effects of resource management spill over jurisdictions, a cooperative inter-governmental commission should regulate such externalities. (Cooter, 2000). Its boundaries should correspond to the basin itself. The model for this type of approach is the multi-state river basin commission, which is a common feature of inter-jurisdictional water resource management under the Watercourse Convention framework. (Hall, 2010). Such commissions are explicitly referenced in the Watercourse Convention, which provides that riparian states "consider the establishment of joint mechanisms or commissions… to facilitate cooperation." (Watercourse Convention, 1997). When international basin commissions are sufficiently empowered and funded, they avoid externalities and facilitate adaptive management in desalination development. The challenge for these commissions to secure and maintain such power and funds is their perceived legitimacy by member states.

The third element, therefore, involves legitimacy. Legitimacy allows the international basin commission to secure sufficient funding and authority to implement adaptive management and govern technology at the basin level. (Larson, 2014). The basin-level governance institution must be perceived by all riparian states, and by all stakeholders in in the basin, as legitimate. Legitimacy depends upon full participation and transparency between collaborating riparians and their respective non-state stakeholders; the evidence of such legitimacy is adoption of the concept of shared benefits. (Sadoff and Grey, 2002). The concept of "shared benefits" is derived from welfare economics, which posits that water is simply a valuable, scarce commodity with multiple possible alternative uses. (Tarlock and Wouters, 2007). For example, water can generate hydroelectric power in upstream areas, but irrigate crops in downstream areas. Rather than each state attempting to fully develop the resource for energy and food, co-riparian states should engage in water resource development in accordance with their comparative hydrologic advantages, and then share benefits across the basin. The shared benefits approach ensures that uses occur in the most appropriate hydrogeologic, cultural, and economic setting, regardless of jurisdiction, and then distribute benefits equitably across the entire basin. (Larson, 2012). The shared benefits concept is arguably implied in the Watercourse Convention, which speaks not only of reasonableness and equity of water uses, but also the reasonableness and equity of deriving the "benefits" of the watercourse. (Larson, 2014).

One way to integrate these considerations to govern technological innovation in an international watercourse would be for an international river basin commission to have permitting authority over water augmentation technologies within the basin. (Larson, 2012). The commission should be regarded as holding a fiduciary obligation to manage the shared resource for the benefit of all member states, with a breach of that duty giving rise to a cause of action by member states against the commission under treaty provisions. (Larson, 2015). This fiduciary duty should help address concerns associated with sacrificing sovereignty to the river basin commission. So long as the commission regulates technology in accordance with its fiduciary duty, the permitting regime for water augmentation technology will be overseen and enforceable by the commission itself. So long as the riparian state implementing water augmentation technology complies with permit requirements, including effluent limits, reporting, insurance, and adaptive management, that riparian state is immune from liability under international law for the use of the technology. Permitting requirements can establish, wherever appropriate, offsets from the shared watercourse to account for augmented supplies, or to require transboundary benefit sharing from water resource development. Such a permitting scheme would ideally facilitate responsible implementation of new or developing technologies in river basins without sacrificing oversight and accountability. (Larson, 2014).

Conclusion

Water resource management requires adaptation, as it involves governing a dynamic system that integrates virtually all sectors of the economy, as well as significant ecological and cultural resources. Water resource management must also adapt to the dynamic technological environment, where innovation will allow previously inaccessible water resources to be developed. Such innovation has the potential to either aggravate or mitigate international water resource conflict, which could grow as water variability is impacted by global climate change. Climate change, along with population growth and economic development, may strain water resources in some regions to the point that conservation alone will an insufficient management strategy. Augmentation of water supply by technological means may be necessary in some settings. In those cases, the Watercourse Convention, as the framework for international water rights, should be interpreted to account for the relevancy of the technology to transboundary water disputes, the reasonableness of the technology given the character of the watercourse, and the efficiencies gained from implementing the technology. This interpretive approach should be taken under a cooperative and adaptive basin-level governance structure that is appropriately empowered to encourage sustainable and equitable implementation of new and developing technologies in international river basins.

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