The Effectiveness of Treaty Design in Addressing Water Disputes

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Abstract: Drawing on the neoliberal institutionist literature, we examine the design features of treaties governing international river basins and empirically test their effectiveness. We expect peaceful conflict management to be more frequent and successful and militarized conflict to be less likely in dyadic river claims when the claimants share membership in treaties with mechanisms for river basin organizations, information exchange, monitoring, enforcement, and conflict resolution. Analyzing data from the Issue Correlates of War (ICOW) and Transboundary Freshwater Dispute Database (TFDD) projects, we find that information exchange and enforcement provisions in river treaties are most effective for preventing militarization of contentious river claims and increase the chances that negotiations over river claims successfully resolve the issues at stake. Enforcement provisions also promote third party dispute settlement attempts and increase the likelihood of compliance with agreements reached. States that share membership in river treaties that establish river basin commissions are more likely to reach agreements in peaceful negotiations over river claims, although such dyads are also more likely to experience militarized disputes and they are less amenable to third party dispute settlement.

A previous version of this paper was presented at the 2012 International Studies Association conference, San Diego, CA. We thank David Victor for comments.
Despite the fact that more than two thirds of our “blue planet” is covered with water, only 2.5 percent is freshwater. As populations have grown and nations industrialized, the demand on freshwater has increased at an unsustainable rate (United Nations, 2006). Climate change is projected to aggravate the shortage of freshwater in water stressed regions, such as the Middle East and North Africa (IPCC 2007). These existing and future shortages have resulted in warnings of increasing potential for interstate conflict and tensions over international basins (United Nations, 2006; Verner, 2012).

In response to these warnings, experts have been analyzing attempts at cooperation through treaty formation to govern international basins, such as the Mekong, La Plata, and Jordan (Song and Whittington, 2004; Tir and Ackerman, 2009; Zawahri and Mitchell, 2011). Although signing a treaty does not guarantee a future of stable cooperation (Downs et al., 1996), it nevertheless provides states with a structured means to organize their affairs and manage disputes in attempt to avoid conflict (Jacobson and Weiss, 1998). In fact, riparians with treaties or commissions are more likely to manage their water crises through negotiations than riparians without institutionalized systems (Hensel et al., 2006; Odom and Wolf, 2011).

Some understandings exist about the forces contributing to treaty formation governing international basins (Tir and Ackerman, 2009; Zawahri and Mitchell, 2011) and the factors influencing treaty design (Conca et al., 2006; Tir and Stinnett, 2009, 2011, 2012; Zawahri et al., 2012). However, we have little knowledge about the effectiveness of treaty design. We remain uncertain about which design features can help to manage water disputes and which are simply ineffective (Bernauer and Kalbenn, 2010).

The objective of this paper is to empirically examine the effectiveness of different design features in order to assess their ability to facilitate cooperation or their failure to prevent conflict.
In negotiating treaties, riparian states can include several mechanisms that are generally perceived as facilitators of cooperation, such as establishing river basin organizations, enabling states to monitor developments of the basin, conflict resolution mechanisms to address disputes, enforcement to increase the cost of cheating, and exchange of hydrological data to improve the ability to manage a basin. We analyze the performance of these various institutional design features to see which provisions are best suited to promote cooperation between riparians.

The paper is organized as follows. We begin by summarizing arguments about the rise, role, and function of institutional design in river treaties. Existing arguments about institutional effectiveness are then considered in order to identify how we can classify successful design attributes. Drawing on the neoliberal institutionalist literature, the next section generates hypotheses about specific design features. After presenting the research design, the paper discusses the empirical findings and their contribution to the literature. We close with an examination of the implications for future research.

*The Rise, Role, and Function of Institutions*

As they follow nature’s rules and disregard man-made borders, rivers impose complex relationships on riparians because some upstream activities influence the quality and quantity of water available to the downstream state(s). Similarly, some downstream activities can influence the upstream state’s ability to develop the river within its territory. To minimize the potential losses from these relationships, states need to communicate in order to exchange hydrological and meteorological data, maintain drainage systems, dredge silt deposits, and distribute their water budget. The more dependent states are on their international river, the more interest they have in cooperation (Zawahri and Mitchell, 2011). Even when riparian states are adversaries
with a rich history of conflict, such as India and Pakistan, they have some interest in cooperating to minimize the potential losses from sharing an international river. In fact, after eight years of negotiations, India and Pakistan signed the Indus Waters Treaty in 1960.

To collaborate, minimize losses, and maintain future cooperation with contracts, states need to reduce their uncertainty about riparian neighbors’ compliance and incentives to cheat on any agreements reached. To overcome this collective action problem, states need an institution to monitor members’ activities, make commitments more credible, sanction defectors, establish the focal points for coordination, lower transaction costs, and gather information (Keohane, 1984 and 1989; Axelrod and Keohane, 1985; Keohane and Martin, 1995).

An institution’s ability to perform these functions is dependent on its capabilities (Koremenos et al., 2001; Haftel and Thompson, 2006). In other words, institutional design determines whether an institution can overcome the collective action problems states confront. Existing arguments are inconclusive as to which institutional design features are most critical.1 Stein (1990: 40) argues that states need an institution that can define cheating “quite explicitly, ensure that it be observable, and specify verification and monitoring procedures.” Mitchell (1994) suggests that an institution needs to monitor and sanction cheaters to be effective. Chayes and Chayes (1993) contend that conflict resolution mechanisms, technical and financial assistance, and transparency are most important for cooperation. Young (1999) argues that decision-making rules, monitoring, conflict resolution mechanisms, and clarity of the expected behavior from states are needed. Botcheva and Martin (2002) argue that strong monitoring power is important. While the literature identifies a series of institutional design features that promote cooperation, we have little knowledge about the relative importance of these different types of mechanisms for promoting interstate cooperation. It is also unclear if design features

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1 This point is made by Bernauer, 1995; Young, 1999; and Koremenos et al., 2001.
that are most critical for successful cooperation vary depending on the issues at stake (e.g. river cooperation vs. economic cooperation).

The literature on managing international rivers has also considered the design of institutions for regulating states’ interactions in developing this scarce natural resource that lacks property rights. The presence of institutions, or river commissions, appears to help states peacefully manage their water disputes (Priscoli, 1996; Bernauer, 1997; Marty, 2001; Yoffe, Wolf, and Giordano, 2003; Giordano, Giordano, and Wolf, 2005; Zawahri, 2009). Although these arguments have been made in predominantly qualitative case studies, quantitative empirical examination of a large number of river treaties supports these conclusions (Hensel et al., 2006; Tir and Stinnett, 2012).

As with the neoliberal institutional literature, the qualitative literature on managing international rivers also lacks consensus on which features of institutions enable riparians to peacefully address their disputes. Giordano, Giordano, and Wolf (2005) argue that if a river commission has conflict resolution mechanisms, is flexible and capable of adjusting to change, and is clear in its resource distribution and quality control, then it can successfully facilitate cooperation. Priscoli (1996) posits that an institution needs flexibility to respond to change, conflict resolution mechanisms, and an efficient and equitable allocation of water, but it also should oversee the multipurpose use of water and permit the involvement of local users to facilitate collaboration.² Bernauer (1997) provides a framework for future research, calling for an examination of such things as the type of property rights, issues covered, legal framework, financial transfers, monitoring, and openness of the institution.

²This is similar to Elinor Ostrom’s (1990) argument that cooperation is enhanced when local stake holders have a greater stake in the institutions governing common property resources.
The few empirical analyses of institutional design tend to focus on the factors influencing states’ interests in investing in institutional design (Stinnett and Tir, 2009; Tir and Stinnett 2011; Gerlak et al., 2011). Tir and Stinnett (2012) consider the effectiveness of institutional design, but their dependent variable (militarized conflict) is distinct from the peaceful management of international rivers, which weakens their capacity to generate broad conclusions. Missing in the literature, therefore, is an-depth examination, with sufficient empirical evidence, that relate institutional attributes of river treaties to states’ ability to manage their water disputes. That is, we lack an empirical examination of the effectiveness of institutional design. This paper fills in the gap by identifying the primary design features in river treaties and providing the data to demonstrate their function as managers of conflict. This is an important contribution since researchers discovered that treaties and agreements signed over international rivers tend to establish river commissions that can draw on conflict resolution mechanisms (Wolf, 1998; Conca et al., 2006).

**Institutional Effectiveness**

Existing explanations in the neoliberal institutionalist literature about the effectiveness of institutions tend to define it in terms of problem solving. In other words, an institution is effective when it succeeds in solving the problem that led to its creation. This understanding of effectiveness, when applied to environmental issues, such as ozone depletion, acid rain, over-harvesting of fish stocks, or protection of endangered species, contains two underlying assumptions. First, given sufficient knowledge, accurate policies, and an effective institution,
the problem that led to the creation of the institution can be solved. Secondly, there is a terminal point at which the solution is reached—i.e., species will no longer be endangered, production of harmful chemicals such as chlorofluorocarbons will be contained, and fish stocks will not be over harvested.5

Yet, sometimes states are confronted with complex relationships that must be managed because they lack a solution or the solution is prohibitively expensive. International rivers represent such a dilemma. Unless a state is able to control the entire river—i.e., upstream India invading downstream Pakistan to control the Indus River system; or, downstream Iraq invading upstream Syria and Turkey to secure access to the Euphrates and Tigris Rivers—a state’s reliance on its riparian neighbor cannot be solved, but must be managed. In other words, as long as an international border remains constant, the problem has no solution and states are likely to face continuous disputes or conflicts of interests, all of which require constant negotiations. Disputes between riparian states are likely to arise over the design, construction, and operation of dams or barrages along the shared river; the construction of industry or irrigation systems along the river; the quality and quantity of water carried by the river; maintaining drainage systems; and managing floods and droughts. Under these conditions, an institution is effective when it is able to assist states in managing a problem that has no solution, but rather continuous conflicts of interests. Therefore, institutional effectiveness is defined in terms of “process management.”6

Measuring Effectiveness

5 Young (1999: 13) concedes that some problems are “difficult or even impossible to solve within any reasonable time frame,” but he accepts that a solution still exists. We acknowledge the possibility that a solved problem, such as over-fishing, can possibly resurface at a future date if states decide to withdraw their compliance from institutional dictates. A state’s decision against compliance is a reflection of the institution’s effectiveness.

6 The idea of process management comes from Young (1999: 13), who notes that “Although there is a natural tendency to think in terms of problem solving in evaluating the performance of regimes [institutions], the idea of process management deserves greater attention in future analyses of institutional effectiveness.”
Several operational measures are available to test an institution’s effectiveness. Some studies propose considering the extent to which member states comply with institutional dictates (Chayes and Chayes, 1993; Mitchell, 1995). Others suggest process-tracing states’ implementation of treaty commitments (Victor et al., 1998). Jacobson and Brown (1998) focus on measuring implementation and compliance with an agreement. Keohane et al. (1993) look at the domestic political process of member states to see whether they embraced appropriate agendas and policies.

Consistent with our attempt to understand the relationship between institutional design and collaboration over complex relationships that lack a feasible single solution but rather must be managed continuously, we consider an institution’s ability to manage disputes and facilitate cooperation over a long-term period, which can possible include deterioration in political relations between member states. If the institution’s ability to perform its function varies over a long-period, then this institution is considered weak. If the institution is able to peacefully address riparian states’ disputes, then one may draw a conclusion that specific design features embedded in the institution are effective in facilitating interstate cooperation.

The Effectiveness of Institutional Design

Although we are certain that institutional design matters (Young, 1999; Mitchell, 1994; Koremenos et al., 2001; Andresen and Hey 2005; Breitmeier et al., 2006), there is little consensus as to which attributes are most important for collaboration when states are confronted with a collective action problem (Bernauer, 1995; Young, 1999; Koremenos et al., 2001). This lack of consensus produces several potential problems. First, it minimizes our ability to generate causal mechanisms connecting the existence and operation of institutions to cooperation.
Second, if specific design elements serve as the source of institutional effectiveness, then we need to understand which institutional attributes have the greatest impact on success and why. Finally, our ability to generate policy prescriptions for practitioners negotiating or bargaining over institutional creation or the modification of existing institutions is weakened by the absence of knowledge about which institutional attributes are important under which conditions (Bernauer, 1995; Young, 1999).

As a small step towards contributing to remedy some of these shortcomings, we argue that when states are attempting to collaborate in the management of complex relationships, the following institutional attributes may be important for long-term cooperation: the presence of a river basin commission, conflict resolution mechanisms, monitoring, enforcement, and exchange of hydrological data.

River Basin Organization or Commission

River basin organizations, such the Mekong River Commission or the International Commission for the Protection of the Rhine, are interstate institutions. These commissions provide member states with the ability to draw on an institutionalized structure that enables them to meet and communicate directly with one another. Direct communication between members—by phone, fax, email, cable, or letters—is necessary in order to schedule meetings, compile the agenda, exchange information, and schedule or complete maintenance work covering the basin. Without this institutionalized form of direct communication between members, the ability to perform necessary tasks for managing the shared river system is likely to be compromised or complicated. These institutionalized meetings permit the commissioners to coordinate their activities to dredge the river, install new metering stations, or fix an existing metering station.

Another value of river commissions is their ability to provide technical experts, engineers, water resources managers, or an epistemic community an institutionalized mechanism to operate within. The advantage of an epistemic community is its ability to use technical knowledge and shared assumptions to address hydrologically complex problems by identifying negotiating points that can facilitate the resolution of a dispute (Haas 1992). Examples include the Indus Water Commission and the Israeli-Jordanian Joint Water Commission, both of which are institutions that are operated by engineers with substantial knowledge of the basin (Zawahri, 2009).

Hypothesis 1: If a pair of states shares membership in one or more treaties that establish a River Basin Commission, this should increase the chances for peaceful and successful management of interstate river claims and reduce the chances for militarized disputes.

Monitoring

According to neoliberal institutionalists, states concerned with their self-interest and behaving rationally, must have some interest in cooperation and overcome their mutual fear of cheating in order to collaborate. To cooperate and minimize losses, states need to reduce their uncertainty about riparian neighbors’ compliance and decrease their incentive to cheat. To overcome this collective action problem, states need the capacity to monitor members’ activities to gather information (Keohane, 1984 and 1989; Keohane and Martin, 1995). The ability to monitor is important not only for gathering information but also improving transparency and assisting states in overcoming their fear of cheating (Bernauer, 1997; Dai, 2007). Monitoring is the capacity to travel throughout the river system to gather pertinent information on member states’ activities along the shared hydrological system. The ability to ask for and be granted permission to inspect any site along the river permits riparian states to confirm the accuracy of

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8A river claim occurs when two or more states’ official representatives make statements claiming sovereignty over a specific river that is claimed or administered by another state or contest the use or abuse of a specific international river (Hensel et al., 2008).
exchanged data or detect potential cheating. Inspections also provide members with assurances that the necessary maintenance work is completed, such as cleaning drainage systems or dredging the river. These inspections permit states to collect information on the intentions, preferences, and actions of their riparian neighbors in developing the international river. Such information can involve a neighbor’s desire to build additional hydrological infrastructure or expand irrigation systems, which may increase their consumption or control of the river. Finally, inspections permit states to assure that their riparian neighbor’s consumption of the river complies with their agreement. Thus, the ability to travel throughout the shared river system is essential for an institution to monitor the river’s development in order to gather important information and assist states in overcoming their collective action problem. The 1945 treaty between Paraguay and Argentina over the La Plata included monitoring capacity as did the multilateral 1976 treaty covering the Rhine basin. The 1987 agreement between Jordan and Syria over the Yarmouk River and the 1985 protocol between Syria and Turkey over the Euphrates River both failed to include monitoring mechanisms. The combination of increased upstream consumption by Syrian farmers and climate change substantially decreased the flow of the Yarmouk River, preventing Jordan from filling its 2008 Unity dam and resulting in tensions between the riparians. As upstream Turkey built many dams along the Euphrates River that enabled it to control the river’s flow, Syria lacked the capacity to draw on monitoring mechanisms to enable it to learn about Turkey’s progress. This fear of continued upstream construction contributed to conflict. In 1996 and 1998, Turkey and Syria confronted a militarized interstate dispute over upstream Turkey’s construction of the Birecik dam, which is located near their international border.
The ability to draw on monitoring mechanisms enables states to stabilize their expectations about one another’s future behavior, overcome their fear of cheating, and maintain long-term cooperation. This institutional attribute can also change states’ incentives to cheat and reduce uncertainty about riparian states’ intentions.

**Hypothesis 2:** If a pair of states shares membership in one or more treaties that establish monitoring mechanisms, this should increase the chances for peaceful and successful management of interstate river claims and reduce the chances for militarized disputes.

**Conflict Resolution**

To maintain cooperation, states need conflict resolution mechanisms to manage disputes that inevitably arise when they are confronted with managing complex relationships (Giordano et al., 2005). For instance, if Canada decides to construct a multipurpose dam along a tributary it shares with the United States, the project can affect the quality and quantity of water and potentially produce a conflict of interest between the states. Canada’s interest is to construct the project and generate the most benefits from the dam, while the United States’ interest may be set against constructing the project due to the potential harm it can impose. Without a set procedure on steps to be taken to negotiate a settlement to such disputes, states might opt to defect from cooperation when conflict of interests arise, which could reduce the level of interstate cooperation along the river. However, the existence of mechanisms for conflict resolution can guide member states through periods of high tension and assist them to maintain cooperation. The 1948 multilateral treaty over the Danube Basin included conflict resolution mechanisms. The 1960 Indus Waters Treaty between India and Pakistan had elaborate conflict resolution mechanisms that have been used successfully to manage the riparians’ water disputes (Salman, 2008). The 1994 Israeli-Jordanian Peace Treaty covered their shared water systems and provided for a commission to coordinate and share these hydrological systems. The treaty failed
to provide for conflict resolution mechanisms and as the riparians were implementing treaty provisions they often had to draw on their national leaders to address disputes and avert conflict.

**Hypothesis 3:** If a pair of states shares membership in one or more treaties that contains provisions for conflict resolution, this should increase the chances for peaceful and successful management of interstate river claims and reduce the chances for militarized disputes.

**Enforcement**

The problems confronting states attempting to collaborate can be divided into two phases—bargaining and enforcement (Fearon, 1998). According to Koremenos et al., (2001: 776): “Enforcement problems refers to the strength of individual actors’ incentives to cheat on a potential given agreement or set of rules.” As the number of collaborating states increases, it becomes more difficult to identify defection from an agreement and to punish defectors, raising the for free-riding and the desire for rent-seeking, all of which could lead to the collapse of cooperation (Axelrod and Keohane, 1985). Thus, sustaining future cooperation is complicated by the enforcement problem. In the case of Iran and Iraq, they confronted a militarized interstate water dispute in 1980 because their treaty lacked any enforcement mechanism.

Treaties that contain provisions for enforcement against cheating can improve the compliance rate by reducing states’ incentives to cheat or decrease the possible rents from cheating. The 1967 treaty between Italy and France over the Roya and the 1984 treaty between Canada and the United States both included enforcement mechanisms that involved financial compensation for the harmed party. Cognizant of the possibility of punishment from cheating and the associated reputational consequences that decrease the prospects for future cooperation should combine to decrease states’ incentive to cheat (Henkin, 1979). As a result, we expect the presence of enforcement mechanisms in treaties regulating use of international rivers to increase the potential for peacefully addressing water disputes.
Hypothesis 4: If a pair of states shares membership in one or more treaties that contains mechanisms for enforcement, this should increase the chances for peaceful and successful management of interstate river claims and reduce the chances for militarized disputes.

Exchange of Hydrological Data

In developing more stable cooperation in the basin’s management, states require hydrological data. The downstream state depends on its upstream neighbor for collecting and delivering hydrological data; otherwise, it cannot prepare for floods and droughts or generate hydropower, which can lead to social, economic, and political losses. Consider the case of floods. Although they are predictable and essential natural events needed for preserving the soil’s fertility, replenishing aquifers, and sustaining a river’s ecosystem, floods can inflict substantial losses. The downstream state may minimize the impact of these natural hazards if it receives flood warnings from its upstream neighbors. Flood warnings can provide a grace period — 2 to 14 days depending on the river’s size — between upstream rainfall and the augmentation in a river’s flow downstream. This grace period enables the state to make the necessary adjustments — releasing dams’ reservoir water, evacuating residents, and transporting food, water, and medicine to the region. Pakistan depends on India for flood warnings and the Indus Waters Treaty assures the delivery of the data.

The downstream state also depends on its upstream neighbor for hydrological data warning of below average precipitation or a drought. As with floods, droughts are normal and regular features of nature, but as people increasingly migrate into drought-prone areas, the potential losses increase (Wilhite, 2004). These losses may be minimized if the downstream state receives warnings of insufficient rains, which enable it to implement the necessary policies — drilling new wells, reallocating water away from irrigation, and initiating water conservation policies. Without these policy adjustments, states may incur economic and political costs.
In addition to managing natural hazards, the downstream state depends on its upstream neighbor for hydrological data and a regular discharge of the river to generate hydropower. Syria has three dams along the Euphrates River, which provide 45 percent of the country’s electricity (Elver, 2002: 370). Due to the lack of hydrological data and the variability in the river’s flow, Syria’s ability to operate these dams has decreased tremendously (Japan International Cooperation Agency, 2000). Syrian officials noted that they are only able to operate their Euphrates’ dams at one third of their capacity (Ka’ddam, 2000). The 1963 treaty over the Rhine covered the sharing of hydrological data, as did the multilateral 1978 accord over the Amazon and the 1982 bilateral treaty between France and Belgium over the Scheldt basin.

Despite the benefits of sharing hydrological data amongst riparian states, some governments may perceive hydrological data on their shared rivers as integral to national security (Falkenmark, 1990; Waterbury, 1994; Warner, 2004). When hydrological data, such as a river’s discharge, is seen as a tightly guarded secret, it is unlikely that states will reveal sufficient information to decrease the costs associated with managing complex relationships or permit for an integrated approach. The failure to exchange hydrological data can contribute increasing tensions between riparian states.

Hypothesis 5: If a pair of states shares membership in one or more treaties that establishes a provision for sharing hydrological data, this should increase the chances for peaceful and successful management of interstate river claims and reduce the chances for militarized disputes.

Drawing on the neoliberal institutionalist literature, we propose that treaties are more likely to be effective in mitigating riparian conflict if they have river basin organizations, monitoring, exchange of hydrological data, conflict resolution mechanisms, and enforcement of treaty commitments. The lack of these provisions is likely to contribute to conflict because of the lack of means to address disputes and maintain cooperation.
Research Design

To evaluate our hypotheses, we begin with a set of diplomatic disagreements over cross-border rivers as coded by the Issue Correlates of War (ICOW) project (Hensel et al. 2008). River claims involve disagreements between two or more nation-states over access to or usage of a shared river (Hensel et al., 2006; Brochmann and Hensel 2009). Typical grounds for the disagreement include a downstream state's objection to pollution, excessive irrigation, or the construction of dams by an upstream state, which will decrease or degrade the quantity and quality of water available to the downstream state. Several notable cases have led to militarized conflict, such as numerous incidents between Israel, Syria, and Jordan in the 1950s and 1960s surrounding attempts by each side to divert water from the Jordan River, and more recent threats between Turkey, Syria, and Iraq over the construction of dams on the Euphrates River. Other disagreements have been managed more peacefully, such as Mexican-American disagreements over pollution, damming, and water diversion in the Rio Grande, the Colorado River, and their tributaries. We focus only on river claims in our analysis in the regions for which ICOW data is currently available: North and South America, Western Europe, and the Middle East. We have a total of 64 dyadic river claims in these regions in these years, generating 538 claim dyad years for analysis. For example, the Rio Grande dyadic river claim includes the years of contention between the United States and Mexico over the Upper Rio Grande (1900-1906) and the Lower Rio Grande (1924-1944), contributing a total of 28 cases to the claim dyad year dataset. The United States and Canada had a diplomatic disagreement over the High Ross Dam (1972-1984), adding a total of thirteen cases to the claim dyad year dataset.

Each of the ICOW river claims is identified based on extensive searches through general and more specific historical news sources and diplomatic histories. This includes a variety of
sources such as the *New York Times*, *Facts on File*, *Keesings*, the *London Times*, Lexis-Nexis Academic Universe, academic journals, and books on the history of the disputed area. Potential river claims are generated by creating a list of all rivers that cross borders of lengths greater than 100 miles. For each potential claim, the ICOW project uses the news sources listed above to construct a chronology of events. Based on this chronology, ICOW codes every attempt to peacefully settle the claim, indicating *inter alia* the years of each settlement attempt, the type of settlement (bilateral negotiations, good offices, inquiry and conciliation, mediation, arbitration, adjudication, and multilateral negotiations), information about third party actors involved, and the outcome of each settlement attempt (such as the signing of a treaty resolving the claim and whether the parties comply with agreements reached). Our analyses below employ this additional data from the ICOW dataset, using each peaceful settlement attempt as a unit of analysis. For North and South America, Western Europe, and the Middle East, there are a total of 140 peaceful settlement attempts to manage the ongoing river claims from 1945-2001. The ICOW river claims dataset goes back to 1900 but we include only 1945-2001 cases due to temporal limitations of our institutional dataset.

Militarized attempts to settle river issue claims are identified by the ICOW dataset with version 3 of the Correlates of War Project's Militarized Interstate Dispute (MID) data set (Ghosn, Palmer, and Bremer 2004). A militarized dispute involves the threat, display or use of military force between two or more states, including confrontations that reach the level of interstate war (over 1,000 battle deaths). Each militarized dispute that occurred between two adversaries involved in an ongoing river claim was examined by the ICOW coders to determine whether the dispute involved an attempt to change the river status quo with respect to that specific claim. This determination was based on standard news sources and diplomatic histories, as well as on
the chronologies of each ICOW claim. Only militarized conflicts that are directly related to the specific river issue at stake are included. We utilize a dummy variable that equals one if two riparian states experienced a militarized dispute in a given dyad claim year (2.97 percent) and zero otherwise (97.03 percent).

To collect data on river treaty commitments and institutional design provisions, we constructed a dyadic river treaty dataset that includes information on treaty content, river, and signature states. The treaty data comes from the Transboundary Freshwater Dispute Database (TFDD), originally presented in Wolf (1998), but updated since.9 We excluded treaties signed before 1945 because they included colonial signatories. Of the post-1945 treaties, we eliminated treaties between a sovereign state and colonial state on behalf of its colony. We excluded international conventions, but retained treaties between sovereign states and political entities in transition to statehood, because they were signatories to the treaty and they participated as self-governing entities in the negotiations (i.e., Palestinian Authority, Eritrea). The data we use in the three regions for which ICOW river claim data is coded consists of around 100 dyads and over 8,800 treaty dyad years.

We are interested in five particular design features described in the theoretical section of the paper: river basin organization, information exchange, monitoring, enforcement, and conflict resolution. These treaty features are coded from the TFDD database using dummy variables for each possible dyad-treaty case. We then expanded the dyadic treaty data into dyad-year format and summed this information by dyad year, creating a sum of the treaties two states belong to that contain each of the specific provisions. For example, the United States and Canada have up to 12 different treaties that contained information exchange provisions for hydrological data, up

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9 http://www.transboundarywaters.orst.edu/database/interfreshtreatdata.html. We used Zawahri et al. (2012) dyadic format of the database that includes information on treaty design.
to 9 treaties with monitoring provisions, and as many as 6 treaties with conflict resolution mechanisms. It is possible for a pair of states to belong to one or more river treaties that do not contain the specified design mechanisms. We did not want to lose the basic information about their joint membership in a river treaty, thus we created a summed measure that adds one to the original collapsed dyad-year measure and then treats years with treaty obligations but not the specific mechanism as a value of one. A value of zero on our summed indicators suggests that the two states have no river treaties between them in a given year.\(^{10}\) The mean dyadic value and range for each of our treaty design variables in the ICOW river claim dyad year dataset is as follows: river basin organizations (0.58; 0 to 3), information exchange (1.85; 0 to 14), monitoring (1.36, 0 to 10), enforcement (0.65; 0 to 3), and conflict resolution (1.21; 0 to 10).

We include three control variables in our analyses drawing upon previous analyses of the ICOW issue claim dataset (Hensel et al., 2008). The first measure, issue salience, captures the importance of the contested river and ranges from 0 to 12 (mean = 6.67). This includes information about use of the river for navigation, population and fishing on the river, as well as the use of the river for irrigation and hydroelectric power generation. Previous ICOW research has demonstrated that peaceful and militarized settlement attempts are more likely to occur as the salience of a river issue claim increases (Hensel et al., 2008). The second measure captures the relative capabilities between the two states in the dyad and records the strongest state’s dyadic share of the two states’ summed CINC scores (ranging from 0.5 for parity to close to one for preponderance).\(^ {11}\) Hensel et al. (2008) find that militarized and peaceful settlement attempts are

\(^{10}\) We also tried two different measurement strategies. In one case, we kept only positive values on the treaty count variables if the treaties contained the specific provisions. In the other case, we created a dummy variable if the dyad has one or more treaties with the specific provisions. Our results are similar to those reported in the paper.

\(^{11}\)CINC stands for the Composite Index of National Capabilities and captures a state’s total global share of demographic, military, and economic power. See http://www.correlatesofwar.org/.
less likely in dyads where the stronger state is much more powerful than the weaker side. In our river dyad claim year dataset, the mean value is 0.78 and the range is 0.50 to 0.987. The final control variable captures the history of militarized conflict in the dyad. Hensel et al (2008) find that militarized and peaceful settlement attempts are more likely in dyads that have a history of militarized conflict in the dyad. We use a weighted measure that treats a militarized dispute in the previous year as 1.0 and then drops the weight by 10 percent going back to ten years prior to the current dyad year. The average for our sample is 0.17 with a range of 0 to 3.2.

_Empirical Analyses_

We begin by analyzing the river claim dyad year dataset. As noted earlier, this dataset creates one case for every year a diplomatic issue claim over a cross-border river is ongoing. Table 1 presents three models: 1) Model 1 has a dependent variable equal to one if the states in the dyad experienced a militarized dispute over the river in question in a given year and zero otherwise;\(^{12}\) 2) Model 2 has a dependent variable equal to one if the states in the dyad engaged in one or more bilateral negotiations over the river issue in question and zero otherwise;\(^ {13}\) 3) Model 3 has a dependent variable equal to one if the states in the dyad sought out third party assistance on one or more occasions including mediation, arbitration, and adjudication; zero otherwise.\(^ {14}\) Given that we have a reasonably sized sample, we are able to include all treaty variables together in the same logit model.

In Table 1, Model 1, we see that states who share membership in river treaties with information exchange (p<.05) and enforcement provisions (p<.10) are significantly less likely to

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\(^{12}\)Only 16 of 538 dyad years (2.97%) experience militarized disputes. Rivers are the least militarized issue claim in the ICOW Project, compared to territorial and maritime issues (Hensel et al 2008).

\(^{13}\)78 of 538 dyad years (13.38%) experience bilateral negotiations.

\(^{14}\)44 of 538 dyad years (8.18 percent) experience third party settlement attempts.
experience militarized conflict over their contested river issues relative to states without such treaty commitments. These results are consistent with our expectations and they support the need to encourage riparian states to invest in establishing these design mechanisms in river agreements. The more information that states exchange, the fewer social, economic, and political losses that they incur, which can decrease the prospects for tensions in interstate relations. The findings on the positive contribution of enforcement mechanisms are consistent with the general expectation that these mechanisms increase the prospects for maintaining cooperation by decreasing the incentives to cheat (Michell, 1994; Koremenos et al., 2001). The pacifying effect of enforcement mechanisms can also result from increasing states’ faith in compliance.

On the other hand, dyads with treaty memberships that establish one or more river basin commissions (p<.01) are more likely to experience militarized conflict. This finding contradicts our expectation and the general belief within the literature on managing international rivers that commissions have a positive pacifying impact that can mitigate conflict. One possible explanation is that states might select not to use the commissions to manage their international water disputes. Or, if they allow commissions to operate, riparian states might not permit them to meet regularly, which can decrease the positive contribution of these institutions. The bilateral accords between Jordan and Syria illustrate this possibility. Although the 1953 and 1987 accords both supported the establishment of a commission, this commission was extremely weak. It depended on upper rank government officials to operate and only held meetings when required. The sporadic meetings of these commissioners weakened their ability to manage water disputes between the riparians (Zawahri 2010). Our findings on the role of commissions are consistent with the expectation of Fausett and Volgy (2010) and Mitchell (2006), who also find that IGOs
can increase the chances for low level dyadic militarized conflict. Thus while such treaties can stop high levels of violence (e.g. war), because they are often signed between states that have reasons to disagree, commissions have difficulty in completely averting conflict.

More highly salient (p<.04) river claims with a history of militarized conflict (p<.01) are more likely to experience militarized disputes as expected. This finding is consistent with the general expectation of the literature about issues of high salience, such as construction of dams (Hensel 2001; Hensel et al, 2008). Wolf et al. (2003) find that the construction of hydrological infrastructures can increase the prospects for militarized conflict between riparians. This is the experience along the Jordan basin, when the upstream riparians attempted to divert a tributary and they were confronted by military conflict. The significant influence of a history of militarized conflict on the experience of militarized disputes is consistent with findings by Hensel 2001; Hensel et al 2008). Recent interactions over a contested issue appear to exert substantial influence on later issue management; in this case a history of militarized conflict tends to increase chances for future militarized conflict.

Power asymmetry (p<.01) in the dyad reduces the chances for militarization. This result can be a consequence of effective deterrence as the weaker riparian is less likely to resort to military means against a hydro-hegemonic neighbor. Consider the Colorado or Rio Grande basins, as they flow from the United States into Mexico. Under this highly asymmetric structure, Mexico lacks the incentive to resort to militarized means to manage water disputes with its much stronger riparian neighbor.

In Table 1, Model 2, we find that the only treaty design feature that promotes bilateral negotiations between states in river claims are those with monitoring provisions (p<.10). Information exchange provision treaties actually discourage bilateral negotiation attempts
(p<.10). However, both effects are fairly weak. Despite their weakness, these results suggest that monitoring provisions are important in facilitating cooperation between riparians.

In Model 3, we examine the factors that promote third party settlement attempts of disputes. Here we see that enforcement provisions (p<.01) have a strong, positive effect on third party attempts. States attempting to avoid paying the costs incurred with lack of compliance that are included in the enforcement provisions might draw on third parties to mediate their disputes. Riparian states belonging to treaties with river basin organizations (p<.05) are less likely to submit to third party settlement, which makes some sense if the established organization has a strong mechanism for handling disputes that arise. This finding supports existing expectations that river basin commissions can help states to address their water disputes (Tir and Stinnett, 2012) and riparians are less likely to need third parties to address their disputes. Highly salient river claims are less likely to be managed through third party attempts (p<0.1).

In Tables 2-4, we utilize each peaceful settlement attempt as the unit of analysis. This allows us to capture other aspects of negotiation success including 1) whether the parties reached an agreement over the river issue claim (Table 2), 15 2) whether the parties complied with any agreement reached (Table 3), 16 and 3) whether the specific agreement reached resolved the overall river issue claim (Table 4). 17 There is a high degree of multicollinearity among the river treaty variables in these smaller samples, thus we evaluate the effect of each treaty provision type

15 Agreements were reached in 72 of the 140 (51.4%) settlement attempts in the 1945-2001 dataset.
16 Out of the 72 agreements reached, both states complied with the terms of the agreement in 54 cases (75%).
17 The river issue claim ended in 25 of the 72 agreement cases (34.7%).
We see in Table 2 that the only variable that improves the chances for two states to reach an agreement in a given negotiation is the presence of a river basin organization (p<.10). This finding is consistent with existing arguments about the role of commissions in facilitating negotiations over river disputes (Bernauer 1995; Zawahri 2009; Marty 2001).

In terms of compliance (Table 3), only enforcement treaty provisions improve the chances for both sides to carry out the terms of the agreement (p<.10). This finding contradicts the arguments of Chayes and Chayes (1993) that states do not need enforcement mechanisms to comply with treaties. On the other hand, we see in Table 4 that both information exchange (p<.10) and enforcement provisions (p<.10) improve the chances that an agreement will resolve the contested river issue. While these results are fairly weak, they nevertheless provide us with a glimpse into the importance of enforcement and information exchange to resolving water disputes.

We also tried estimating models with a summed measure across all treaty variables, something similar to Tir and Stinnett’s (2012) analysis. We find a negative and significant effect on militarized disputes for this institution variable, which is similar to Tir and Stinnett’s results whereby a higher density of institutionalized shared river treaty membership reduces militarized conflict in a dyad. This summed measure also has a positive and significant effect on most of the negotiation attempt and successful outcome variables, suggesting that these rational design features reinforce riparian cooperation.

Conclusion

Drawing on the neoliberal institutionalist literature, we examine the design features of treaties governing international river basins and empirically test their effectiveness in facilitating

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18There is also a relatively high correlation between relative capabilities and treaty provisions, thus we exclude the capabilities control variable in these analyses. We see a higher density of treaty memberships with more rational design features in more asymmetric dyads.
cooperation and averting conflict. We argue that peaceful conflict management over diplomatic river issues is more frequent and successful and that militarized conflict is less likely to occur in dyadic river claims when the claimants share membership in treaties with mechanisms for river basin organizations, information exchange, monitoring, enforcement, and conflict resolution mechanisms. Analyzing data from the Issue Correlates of War (ICOW) and Transboundary Freshwater Dispute Database (TFDD) projects, we find that information exchange and enforcement provisions in river treaties are most effective for preventing militarization of contentious river claims and increase the chances that negotiations over river claims successfully resolve the issues at stake. Enforcement provisions have a particularly strong effect on peaceful and militarized management of river claims and improve the success of negotiations, which is quite interesting given that these provisions are not commonly used in river treaties. This finding is similar to what we see in adjudication in other issue areas (e.g. Mitchell and Hensel 2007). When states go to adjudication, they settle the issues in almost every instance, but adjudication is used in less than 10% of over 2,000 total peaceful settlement attempts in the ICOW project. These treaty provisions generally specify a council that handles sanctions for non-compliance, such as the 1946 agreement struck between Argentina and Uruguay over the La Plata River. Information exchange is also shown to be an effective rational design strategy. States that share membership in river treaties that establish river basin commissions are more likely to reach agreements in peaceful negotiations over river claims, although such dyads are also more likely to experience militarized disputes and they are less amenable to third party dispute settlement.

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19Tir and Stinnett (2011) find that only 7% of TFDD treaties signed between 1950 and 2002 contain enforcement provisions.
Our next step involves the addition of treaty data from the TFDD database from the years 1900 to 1944. We were initially skeptical of including such years given the density of colonial agreements, but we plan to examine this period in greater detail to see if this gives us more leverage for testing our rational design hypotheses. The ICOW project is also coding additional regions of river claim data, which will give us additional cases from Eastern Europe, Asia, Africa, and Oceania to examine in the future.
References


Table 1: River Treaty Commitments and Management of River Claims, Dyadic Claim Data (1945-2001)

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
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<td>Third Party Settlement Attempts</td>
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Note: Numbers in parentheses are standard errors; $p$-values: *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Table 2: Reaching Agreements in Negotiations over River Issue Claims, 1945-2001

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<th>Model 1 All Types</th>
<th>Model 2 River Basin Organization</th>
<th>Model 3 Information Exchange</th>
<th>Model 4 Monitoring</th>
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Note: Numbers in parentheses are standard errors; p-values: *** p<0.01, ** p<0.05, * p<0.1
Table 3: Compliance with Agreements Reached in Negotiations over River Issue Claims, 1945-2001

<table>
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<th>River Treaty Design Features</th>
<th>Model 1</th>
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<th>Model 5</th>
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N 71  71  71  71  71
Wald $\chi^2$ 1.47 2.94 3.87 5.47 2.74

Note: Numbers in parentheses are standard errors; $p$-values: *** $p<0.01$, ** $p<0.05$, * $p<0.1$
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Note: Numbers in parentheses are standard errors; $p$-values: *** $p<0.01$, ** $p<0.05$, * $p<0.1$