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Relative Water Scarcity and Country Relations along Cross-Boundary Rivers: Evidence from the Aral Sea Basin

RESEARCH NOTE

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How do countries that share cross-border rivers respond to periods of abnormally low water availability? Existing research concerning water scarcity focuses on how cross-basin differences in absolute availability influence relations between countries. I argue that understanding whether countries react cooperatively or conflictually to within-basin shortages is important. I use the case of two major cross-boundary rivers in the Aral Sea basin of Central Asia to study the effects of within-basin relative scarcity. Employing original data on interactions among the Central Asian countries over the issue of water management, I find an association between, on the one hand, relative water scarcity and, on the other hand, an increased likelihood of both cooperative and conflictual interactions. By showing that relative scarcity affects when cooperative and conflictual events occur, my analysis highlights the fact that absolute scarcity is not the only type of water scarcity that influences international relations on cross-boundary rivers.

Securing access to international sources of freshwater, such as cross-boundary rivers, is a central concern for many countries. Each of the 276 international rivers in the world represents an unavoidable point of contact between countries and thus a potential source of political tension.[1] The likelihood of an international response increases dramatically when water is in short supply. States may engage in conflict to secure access to water resources. But they may also respond to water shortages by increasing cooperation to avoid the costs of military conflict. Indeed, scholars find evidence of both cooperative and conflictual responses to water scarcity.

However, existing research focuses on an absolute conceptualization of water scarcity. It examines the effects of cross-basin variation in factors like water-flow levels. Such measures capture the nominal level of water in a given country or basin unit. The focus on cross-national variation in absolute levels of availability downplays the role of scarcity relative to that normally found in specific water basins. This kind of scarcity also influences state behavior as times of unusual shortage create strong pressure on governments to obtain access to water. These periods typically do not last long enough for amelioration via long-term, unilateral solutions, such as planting less water-intensive crops or undertaking large infrastructure projects. Thus, increases in relative scarcity should make states more likely to turn outward and engage in either cooperation or conflict with their neighbors.

To assess this claim, I present evidence of how relative scarcity affects country relations within the Aral Sea basin of Central Asia. Using original data on cooperative and conflictual interactions among the five countries located within this basin, I find that periods of relative scarcity correlate positively with an increase in the likelihood of both cooperative and conflictual interactions. In other words, short-term water scarcity leads these countries to interact with their neighbors, although the nature of this interaction takes different forms.

The Central Asian case is useful for studying within-basin variation in water scarcity. First, focusing on the Aral Sea basin controls for structural and hydrological factors that might affect cooperation, while still allowing for comparisons between the two rivers in the basin. Second, the shared experiences of the countries themselves under the Soviet Union, and their similar trajectories since independence, control for country-level political and cultural factors that may affect their propensity for cooperative or conflictual interactions. Finally, these countries have developed a unique system of water management that involves frequent renegotiations of formal water agreements. This makes both cooperative and conflictual interactions more visible than in other instances of international water management.

Understanding the impact of water scarcity in Central Asia also matters in its own right. The resource management regime devised by the Soviets caused the rapid depletion of the Aral Sea and the environmental degradation of the surrounding region. The independent Central Asian countries must deal with this legacy; while it seems unlikely that they will ever be able to restore the Aral Sea, they may still prove able to mitigate the damage and its consequences (Micklin 2007, 62–67). In addition, as a 2007 Human Development Report notes, Central Asia is particularly vulnerable to climate change and related changes in water flow patterns (United Nations Development Programme 2007, 18). More broadly, resource management significantly shapes economic development in the region (United Nations Development Programme 2005, 84–111).

The scholarly bias toward an absolute conceptualization of water scarcity is particularly problematic in the face of climate change. Studies forecast a sharp increase in the

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[1] The number of international rivers comes from Wolf (2007, 242).

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variability of water flows in many parts of the world.[2] If these predictions prove correct, basins will experience increasingly large swings in the water available for consumption. Understanding how countries respond to extreme events of this kind will help policymakers develop long-term strategies for the management of international water resources.

Although my substantive findings are specific to the Aral Sea case, they have much broader implications for how we conceptualize water scarcity. It seems unlikely that the countries of the Aral Sea basin are uniquely responsive to short-term fluctuations in the availability of water. Thus, we should expect that changes in relative water scarcity also affect cooperative and conflictual interactions in other regions of the world.

Theory

In this section, I discuss the difference between absolute and relative conceptualizations of scarcity. Although absolute scarcity plays an important role in shaping how states behave, I identify compelling reasons to expect that relative scarcity also affects how countries interact with one another over water issues. I then draw on existing literature to generate testable hypotheses about the effect of relative scarcity on cooperation and conflict between countries.

The Case for Studying Relative Water Scarcity

There are two ways to conceptualize water scarcity: the absolute quantity of available water and the amount relative to a basin-specific baseline. To illustrate the first of these, consider two frequently used measures: the volume of water that passes through rivers in the basin (water discharge) and the amount of water flowing over land in that basin (water runoff). These measures capture how much water is available in a given basin. Some basins will, naturally, have much lower water discharge and runoff than others. For example, the average runoff of the Tigris-Euphrates/Shatt al Arab basin, which contains parts of Iran, Iraq, Jordan, Saudi Arabia, Turkey, and Syria, is 52,718 mm/year, and the average discharge is 11,200 km^3/year. In contrast, the Mississippi basin, which includes parts of Canada and the United States, has an average runoff of 252,264 mm/year and an average discharge of 801,010 km^3/year.[3] Absolute measures like these highlight the fact that the Mississippi basin simply contains more water than the Tigris-Euphrates/Shatt al Arab basin. Even in a year of severe drought, the Mississippi basin has a higher discharge and runoff than the Tigris-Euphrates/Shatt al Arab basin has in a year of supreme abundance.

Existing work on the relationship between water scarcity and international behavior focuses on absolute conceptualizations like those described above.[4] These studies test the hypothesis that countries in certain basins act differently than others when they generally have less water. I argue that countries also act differently when they have less water than usual. In other words, while comparing absolute scarcity between basins helps us understand how countries act, so too does comparing relative scarcity within basins. There are both theoretical and methodological reasons to believe this is the case.

First, the short-term nature of relative scarcity limits the range of noninternational alternatives available to countries. All else equal, countries might prefer unilateral solutions to water shortages. These responses circumvent the need for trust at the international level and do not require countries to cede sovereignty over the issue of water management.[5] However, relative scarcity comes on quickly and may last only a season or so. Unilateral solutions to water shortages take time to develop and implement. For example, desalination plants decrease the pressure on water supplies in the long term, but their construction takes too long to alleviate short-term relative scarcity. A similar argument can be made for infrastructure aimed at increasing the efficiency of water use in agriculture or other areas. Even financially modest solutions, like encouraging the judicious selection of crops with low water requirements, may face delays due to farmer reluctance. The range of unilateral solutions to short-term scarcity is therefore limited. Faced with few other options, the likelihood that countries engage with their neighbors increases during such times.

Second, measures of absolute scarcity implicitly assume that a given level of availability means the same thing in all basins. In reality, this is not the case. Some countries use water more efficiently than others. Consider the example of irrigation. The water requirement ratio measures the amount of water theoretically needed to irrigate the crops in a given country divided by actual water withdrawals. High values characterize efficient irrigation systems with little wasted water. In a recent study by Frenken and Gillet (2012, 27–29), the average country-level water requirement ratios ranged from 0.18 in Costa Rica, Guinnea-Bissau, and Timor-Leste to 0.85 in Turkey. This implies that the actual water used to meet the same agricultural demand is about 4.7 times higher in Costa Rica, Guinea-Bissau, and Timor-Leste than it is in Turkey. In other words, the same absolute quantity of water "goes further" in Turkey than it does elsewhere in the world. An absolute measure would overpredict the degree of scarcity in Turkey, leading researchers to surmise it is more prone to conflict and/or cooperation than its true level of scarcity implies.

Similarly, measures of absolute scarcity do not take into account the "virtual water" imported and exported through trade. As Allan (2001, chapters 5 and 6) describes, some countries grow crops that require less water and import those that require more. These countries can thrive with lower absolute quantities of water than those that do not import virtual water. In this way, crop decisions and trade profiles also alter the true level of long-term water scarcity.

Focusing on relative scarcity helps alleviate the concerns of cross-basin comparability. In a relative scarcity approach, water availability is defined in relation to some basin-specific baseline. This allows cross-basin comparisons of the size and scale of scarce (or abundant) periods, rather than comparing absolute quantities that may or may not mean the same thing in different contexts.

Relative scarcity measures also account for the "human element" of water management without needing to measure it directly. Human activity affects the seriousness of water scarcity, particularly through water usage patterns and changes to natural flows from reservoirs and dams. Recognizing this, environmental scientists often consider ratios of

[2] See Adler (2008, 732–38) for an overview of the scientific literature linking climate change and water scarcity/variability.

[3] These data are from the Transboundary Freshwater Spatial Database, Department of Geosciences, Oregon State University.

[4] For example, Hensel, Mitchell, and Sowers (2006), Wolf, Stahl, and Macomber (2003), Tir and Stinnett (2012), Tir and Ackerman (2009), Zawahri and Mitchell (2011), and Brochmann and Hensel (2009, 2011) all use absolute measures as their primary measures of water scarcity.

[5] Elhance (1999, 234) argues that countries generally look for unilateral solutions to water problems, before bilateral or multilateral ones are considered.

water withdrawal or use to discharge (Vorosmarty, Green, Salisbury, and Lammers 2000). Such measures attempt to account for water demand as well as supply. However, withdrawals are difficult to measure directly. Further, actual withdrawals are not always accurate measures of demand, especially during times of water shortage; at such moments, artificial restrictions on water use decrease withdrawals below the actual level of demand. This downplays the severity of scarcity and biases the measure. The relative scarcity approach avoids tricky calculations of demand by making the reasonable assumption that countries adapt their water usage to their "normal" level of water. When that normal level is not reached, supply and demand become mismatched, and incentives for behavior at the international level change. In this way, the idea of relative scarcity accounts for demand without needing to measure it directly.

Despite the theoretical and empirical reasons for studying relative scarcity, very little existing research addresses this issue. A few studies, such as those by Gleditsch, Furlong, Hegre, Lacina, and Owen (2006) and Brochmann and Hensel (2011), include measures of drought in the statistical models. Yet they define "drought" in terms of its consequences (for example, deaths, state of emergency declarations). Other factors potentially influence the consequences of drought, including international cooperation or conflict. Therefore, these measures do not directly capture the degree of relative water scarcity. Dinar, Dinar, and Kurukulasuriya (2011) take a slightly different approach. They model the average rate of decline in water availability per capita within different basins. This captures the idea of increasing water scarcity over time, but it does not account for actual year-to-year variation.

Finally, a few recent studies look at how an increase in the variability of water flows affects interstate relations. De Stefano, Duncah, Dinar, Stahl, Strzepek, and Wolf (2012) examine the institutions that river basins have in place to deal with the issue of variability, and Dinar, Blankespoor, Dinar, and Kulukurasuriya (2010) look at the relationship between water variability and treaty formation. However, these studies conceive of variability as an attribute of the basin, rather than focusing on country responses to extreme events. My approach complements these studies.

The Predicted Effect of Water Scarcity

It is widely accepted that water scarcity, broadly defined, affects the international behavior of countries that share cross-boundary rivers. However, the exact nature of this effect is less clear. The earliest theories originated with the eighteenth century writings of Reverend Thomas Malthus (2008, chapters 1 and 2). He argued that growing population pressure would inevitably result in violent competition over scarce natural resources. Technological innovation kept pace with population growth during the intervening centuries, alleviating some of the predicted pressure. However, innovation may eventually reach its limit, resulting in serious conflict over scarce resources. This argument applies particularly well to the case of water, which is critical for human life and has no substitute. The amount of available water also varies dramatically from region to region, with some areas of the world, such as the Middle East, already experiencing severe shortages. Considerations of this kind led Homer-Dixon (1994, 19–20) to conclude that water is the renewable resource most likely to cause interstate violence. Studies aimed at evaluating the "water wars" hypothesis have found some evidence that absolute scarcity leads to conflict between countries.[6] In essence, the valuable nature of water makes it a resource worth fighting for, and it is significantly more valuable when in short supply.

A similar relationship should exist between relative scarcity and conflict. Obtaining access to freshwater becomes dramatically more important during periods of shortage. At such times, water is especially valuable and, consequently, even more likely to be worth fighting for. This observation leads to the first hypothesis:

H1: *As relative water scarcity increases, countries are more likely to engage in conflictual behavior.*

Although conflict is one possible response to water shortages, it is not the only one. Since conflict is always ex post inefficient, an ex ante agreement should be possible under a wide range of conditions.[7] Water scarcity increases the stakes of reaching a mutually acceptable division of water. In line with this, a growing body of empirical research shows that absolute water scarcity increases the likelihood of cooperation.[8]

Similarly, I expect that relative scarcity may induce cooperation rather than conflict. Reducing the total amount of available water does not alter the costliness of conflict. The optimal division of water may be different under conditions of scarcity than it is in periods of abundance, but a mutually acceptable division should still exist. Relative scarcity increases the importance of obtaining access to water, making it even more likely that countries come together to determine new water allocations in a cooperative manner. The second hypothesis follows from this observation:

H2: *As relative water scarcity increases, countries are more likely to engage in cooperative behavior.*

To be clear, H1 and H2 are not mutually exclusive. Confirming an empirical correlation between scarcity and conflict, for example, does not explicitly rule out an analogous relationship between scarcity and cooperation. Indeed, some existing studies suggest that water scarcity affects interstate relations in both positive and negative ways. For example, Wolf (2007, 260–62) notes that water can serve as either an irritant or a unifier within an international basin.[9] Likewise, Hensel et al. (2006) find that the average annual water usage as a percentage of total renewable resources increases the likelihood of both the onset of a militarized dispute and the likelihood of a peaceful settlement attempt. Following these approaches, I do not consider the two hypotheses to be in conflict with one another.

Overview of the Case

I focus on the effects of relative water scarcity in a single hydrological unit: the Aral Sea basin in Central Asia. Restricting attention to one water basin has both positive and negative features. On the positive side, I can conduct a more fine-grained analysis. By restricting attention to the Aral Sea basin, I am able to use monthly data on relative scarcity. This captures far more variation than the commonly used

[6] See Gleditsch et al. (2006) and Tir and Stinnett (2012).

[7] This argument is motivated by the reasoning outlined by Fearon (1995, 383–84).

[8] See Tir and Ackerman (2009) and Zawahri and Mitchell (2011). Dinar et al. (2011) find that cooperation is most likely at intermediate levels of water scarcity.

[9] Brochmann and Hensel (2009, 2011) argue for a more complicated relationship. They find that water scarcity increases the likelihood of laying claim to the water of a river and the onset of negotiations over existing river claims but decreases the likelihood that negotiations are successful.

Micklin P. 2007.
Annu. Rev. Earth Planet. Sci. 35:47–72

Figure 1. Map of the Aral Sea basin in Central Asia

yearly data would and allows me to examine the effects of relative water scarcity at a low level of aggregation.[10] Furthermore, as I discuss below, this level of analysis controls for a variety of factors that might also influence when, why, and how countries engage with one another. However, the single basin approach also has limitations, especially with respect to generalizability. I address this concern in greater detail in the discussion section that follows the statistical results. I acknowledge that basin-specific features may influence whether countries choose to interact cooperatively or conflictually. However, I argue that there is far less reason to suspect that country behavior in Central Asia is uniquely sensitive to short-term periods of scarcity. A finding that relative scarcity influences international relations in Central Asia therefore suggests that this will be the case elsewhere as well, even if we cannot generalize about which kind of interaction is more likely.

The Aral Sea is a landlocked body of saline water on the Uzbek-Kazakh border (see Figure 1). Substantial territory of the five post-Soviet Central Asian countries—Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan—are located within the Aral Sea's water basin. There are two major rivers: the Amu Darya and the Syr Darya. The Amu Darya originates in Tajikistan and flows through Uzbekistan and Turkmenistan, while the the Syr Darya flows through Kyrgyzstan, Tajikistan, Uzbekistan, and Kazakhstan.[11] With the exception of Kazakhstan, these rivers represent the primary source of freshwater available to the Central Asian countries.[12]

During Soviet times, the central government designed a water management system that privileged the agricultural sector.[13] The Soviets constructed large upstream reservoirs, most notably the Toktogul reservoir in the Kyrgyz SSR and the Nurek reservoir in the Tajik SSR. They used these reservoirs to store water during the winter and release it during the growing season, when it was most needed for irrigation. The release of water also generated hydroelectricity, which, due to the unified electrical grid, could be easily transported throughout the region. In winter, the downstream republics provided the Kyrgyz and Tajik republics with energy resources for heat and electricity so they could store water for the next irrigation season, rather than using it for electricity production during the winter.

After independence, the region-wide system of water and energy resource management faltered, largely because there was no longer an overarching authority to guarantee adherence to a centrally devised plan.[14] The new heads of state began discussing the problem as early as 1992. Although a variety of regional organizations related to water management formed in the immediate post-independence period, by the mid-1990s, a bilateral barter system emerged as the dominant forum for resource management.[15] As Weinthal (2001, 67–72) describes, the linkage of water, energy, and agriculture continued to shape the decision-making process. Consequently, "cooperation" in the post-Soviet period mimics Soviet-era water-for-energy exchanges.[16]

[10] Most studies do not even have yearly data, relying on the assumption that water availability remains relatively constant over time to estimate values for missing years.

[11] The Amu Darya crosses for a short while into Afghanistan and Iran, but neither of these countries has been involved in river management and their withdrawals are minimal (see McMurray and Tarlock 2005, 730).

[12] The north of Kazakhstan has alternative sources of freshwater, but the south is heavily reliant on the Syr Darya.

[13] Compliance with this system was not always voluntary; for example, McKinney discusses how, during a drought in the late 1970s, representatives of Moscow were sent to Central Asia to ensure compliance (McKinney 2003, 194–95).

[14] Without a central authority, trust (and thus cooperation) among the different actors became much more difficult to maintain (Abbink, Moller, and O'Hara 2010, 303–304).

[15] See Elhance (1997, 214–17) and Vinogradov and Langford (2001, 350–57) for a description of water management in the early post-Soviet period.

[16] Exchanges did become more complex. Energy was subsidized rather than free, and the purchase of hydroelectricity was also used as "payment" for water. However, the general scheme remained similar.

This is not to say, however, that cooperation in the region is easy. Indeed, government leaders often exhibit open hostility toward one another over this issue.[17] For example, in 2012 it was reported that the Uzbek president directly warned his Tajik and Kyrgyz counterparts that a war over water was possible (Lillis 2012, 1). I also witnessed this hostility in interviews I conducted in Kazakhstan, Kyrgyzstan, and Tajikistan during 2011–12. In these interviews, subjects from one country often blamed their counterparts in other countries for water or energy shortages. For example, one NGO representative accused another country of "sabotaging the process" of cooperation, while a government official complained that "we do not get any … positive responses to our proposal [for international] cooperation."[18] It is not immediately obvious, therefore, whether water scarcity makes cooperation harder or easier to maintain in the region.

The Central Asian case is well-suited for the study of relative water scarcity for several reasons. First, the Aral Sea basin contains two distinct cross-boundary rivers. These rivers have important similarities, allowing me to make controlled comparisons. First, they have similar flow geographies: they each cross through several countries, with a predominantly upstream-downstream configuration. Elhance (1999) highlights the role of these geographic features in his cross-basin comparative study and Stinnett and Tir (2009) find that rivers with an upstream-downstream configuration are less likely to have high institutionalization (i.e., cooperation) compared to those that feature rivers flowing along borders. Second, the Syr Darya and the Amu Darya have comparable power configurations. The rivers originate in the mountains of small, poor, and militarily weak countries (Kyrgyzstan and Tajikistan). They then flow through the same, larger, richer, and more powerful middle country (Uzbekistan) before splitting again and passing through another large and powerful country (Kazakhstan and Turkmenistan). Power configurations feature prominently in numerous studies concerning the effects of water scarcity, including those by Mandel (1992), Homer-Dixon (1994), Song and Whittington (2004), and Zawahri and Mitchell (2011).[19] Since the geographies and power configurations of the Amu Darya and Syr Darya are similar, I can set aside the impact of these attributes on interstate behavior and focus on the consequences of water scarcity.

Although there are many similarities between the two rivers, absolute scarcity is greater in the Syr Darya than the Amu Darya: the estimated annual flows are 36.57 km^3 and 78.46 km^3, respectively (Aquastat-FAO 2013, 4–6). In addition, the Syr Darya traverses the fertile Ferghana Valley, where a large part of Central Asia's agricultural production occurs. This is also a densely populated area. For example, the average population density in the three Uzbek provinces of the Ferghana Valley is 356/km^2, compared to only 61/km^2 in the rest of the country. Therefore, the estimated difference in absolute scarcity would be even larger if we used a per capita or demand-based measure. Consequently, I can use the Aral Sea case to examine the impact of relative water scarcity at different levels of absolute scarcity, while holding other important factors constant.

Second, the Central Asian case features a variety of country-level controls. The countries obtained independence from the Soviet Union relatively recently. They have followed different paths since 1991, but many similarities in their societal and governmental structures remain.[20] This helps account for the more intangible cultural and social factors that may influence propensities for conflict or cooperation. The statistical analysis includes models with dyad fixed effects to control for any remaining dyad-specific features.

Third, norms concerning the regional water management system make it easier to observe how relative scarcity affects country behavior. Countries typically codify the short-term exchanges of water for energy in written agreements or contracts and release reports to the media. Consequently, I can determine the timing of cooperative interactions with greater accuracy than would be possible if countries relied on more informal arrangements. Violations of these cooperative interactions (that is, conflictual interactions) are likewise easier to observe. Furthermore, the countries sign and break agreements regularly. This suggests that there are low transaction costs to both actions. To link a short-term decrease in water to a change in country behavior, the observed behavior must represent a response to current incentives rather than a lagged response to outdated ones. Low transaction costs and norms of formalization ensure that both of these are true.

Finally, the unilateral suspension of an existing agreement can be considered a conflictual act in Central Asia. The Soviet water-for-energy system created serious interdependencies among the countries. When initiated by a downstream country during the winter, suspensions cause severe energy deficits upstream, even when hydroelectric production increases. Residents of these countries subsequently endure electricity rationing—or total blackouts—during the coldest months of the year, threatening both their health and livelihoods. The Soviets actively promoted agriculture in the downstream regions, making them reliant on water from their upstream neighbors. Now, when water is not released in adequate quantities during the growing months, poor farmers in the downstream countries lose their crops. Water and energy suspensions are thus antagonistic acts. Consequently, I can examine both the positive and negative hypothesized effects of scarcity on country relations within a single framework.

Statistical Analysis

This section outlines the major statistical results of the article. I begin by introducing the main dependent and independent variables and the measures used for each. I then present the results of my analyses. I find that water scarcity correlates with the occurrence of both cooperative and conflictual interactions. I conclude by discussing what these results tell us about the effects of relative scarcity more broadly.

Dependent Variables

I take an event-based approach to operationalizing both conflict and cooperation. This allows me to capture how

[17] Speaking earlier in the post-independence period, Smith (1995, 351) predicted that "nowhere in the world is the potential for conflict over the resources as strong as in Central Asia."

[18] The first quote is from an interview conducted in English with representatives of an international NGO located in Kyrgyzstan on November 2, 2011, and the second is from an interview conducted in Russian with a Tajik government official on January 16, 2012.

[19] Also, see Wegerich (2008, 80–85) for a discussion of power politics in the Central Asian case.

[20] For example, Hensel et al. (2006) and Tir and Ackerman (2009) argue that joint democracy may result in higher levels of cooperation within water basins. However, none of the Central Asian dyads are jointly democratic.

countries respond to relative water scarcity in the short term. For example, signing an agreement during a period of shortage, even if not long lived, suggests that countries responded to the crisis in a cooperative manner. Events do not necessarily depend on whether countries are in a generally cooperative or generally conflictual relationship at the time. Suppose, for example, that two of the countries are cooperating over resource management when a period of relative scarcity begins. Signing a new agreement still suggests they responded cooperatively to water scarcity, perhaps by updating the division of water to account for the new conditions of shortage. Likewise, additional cuts to agreed-upon provision of resources, or a refusal to reach agreement, are conflictual events that can occur even if countries are not cooperating fully when scarcity begins.

I include events involving both water and energy management in the data. As discussed above, these two issues are inextricably linked in Central Asia. Decisions concerning energy directly affect water management as the upstream countries will only store water for use in downstream agriculture if they receive adequate supplies of fuel energy during the winter.[21] However, I exclude events concerning conflict and cooperation over other issues. By doing so, I run the risk of underestimating the effects of relative water scarcity. Linking disparate issues, in either a positive or negative way, is a time-tested tactic in international relations. However, linkages can be difficult to observe, especially if they are not made explicit. It would be difficult to systematically identify which actions in other issue areas and/or international relations more broadly are actually caused by relative water scarcity. In addition, I do not expect to exclude very many events by restricting attention to those that directly concern water and energy.[22] Since the linkage between water and energy is so tight, it is more natural for the countries to respond within these negotiating sets than to introduce additional issues (Weinthal 2001, 72–73). For this reason, I focus solely on water and energy events in the data.

The dataset includes interactions at the dyad-month level for the time period of January 2000 to December 2010. Focusing on monthly interactions allows me to identify short-term changes in behavior, which is crucial for testing the effects of short-term relative scarcity. I selected the time period for a combination of theoretical and practical reasons. The Central Asian states took time to accustom themselves to independence and to learn how to interact with one another as sovereign nations. By 2000, relations between them over water and energy management had, to some extent, normalized. While periods of transition are interesting in their own right, they are relatively rare, and the theory more directly concerns the ongoing relationships between countries. Focusing on Central Asian relations further into the independence period therefore increases the generalizability of the findings. In addition, while water data were available for the immediate post-Soviet period, the reliability of the event data was not as good. Although there was newspaper coverage of higher-level events (framework agreements, etc.), there was not consistent coverage of short-term agreements and disagreements. By 2000, the events covered by news outlets were at a similar altitude to those found in 2010.

I define a cooperative interaction as the reaching of an agreement with explicit provisions for signatory behavior concerning at least one of the following: (1) prices or terms of payment for energy, including hydroelectricity, (2) the quantity of energy produce to be delivered, (3) the price or terms of payment for water, or (4) the quantity of water to be delivered.[23] I also include situations in which lapsed agreements come back into force. Signing a new agreement or resuming an old one following a downturn in water availability both suggest that countries respond to crisis in a cooperative manner: they come together to figure out an appropriate division of water under new conditions of shortage or otherwise make cooperative overtures to their partners.

As defined above, cooperative interactions are intermediate-level events. On the one hand, I only include agreements that lay out a clear roadmap for the future. I exclude those that express more vague statements of interest in cooperation. For example, I consider an agreement that specifies the export price of hydroelectricity for a given year to be a cooperative interaction, but not a joint statement professing a commitment to "rational use of water and energy resources." I focus on agreements with concrete provisions because I am interested primarily in the actions taken in response to short-term relative scarcity. While vague agreements may lay the foundation for future cooperation, they will not impact behavior in the short term. They are also more likely to be part of broader conferences or agreements, suggesting that short-term factors like relative scarcity do not determine their timing. On the other hand, signing a concrete agreement of this kind is not a prohibitively high bar. Since the Central Asian countries sign agreements so frequently, and because they mostly have short formal (and often even shorter informal) temporal scopes, even those with concrete provisions represent relatively low levels of cooperation. They are clearly cooperative, but they do not require extensive negotiation or represent a long-term commitment to cooperative resource management.

I consider three types of events to be conflictual interactions. The most extreme kind is the occurrence of violence, which occurs only once in the dataset.[24] Following more recent trends in the literature, I do not restrict attention to the use of violence. While the original Malthusian formulation of the water wars hypothesis predicts exactly what its name implies, using this literal definition of conflict condemns the water wars hypothesis to failure; water scarcity, even if we restrict attention to very extreme levels, is undoubtedly more common than the occurrence of interstate

[21] While there are strong theoretical reasons for including both types of events, I also ran models using data that only include events explicitly related to water and hydroelectricity. The results of these models, which can be found in the Appendix, were similar to those presented below, although the effect of scarcity on conflictual interactions was somewhat stronger than its effect on cooperative ones.

[22] I was only able to locate two cases where actions in another issue were linked to water issues: in spring of 2001, Kazakhstan shut off telephone lines to Uzbekistan in response to a reduction in flows along the Syr Darya, and in 2010, Uzbekistan prevented railroad cars from crossing in to Tajikistan, apparently in protest of Tajikistan's proposed Roghun Dam. This number of events is very small relative to the number that occur within the water and/or energy spheres.

[23] To identify these, I used an extensive search of English- and Russian-language newspaper articles, supplementing with the full text of agreements where possible. The following would be adequate to code the event as a cooperative interaction (although I have more information about many events): "In 2003, Uztransgaz, an Uzbek enterprise is supposed to supply Tajikistan with about 400 million cubic meters of natural gas. The official signing of government-to-government agreements between Tajikistan and Uzbekistan "On mutual accounting for transportation of cargoes, natural gas and fuel supply in 2003" and "Tajikistan's debt to Uzbekistan" will be held in Tashkent, on February 25 (The Times of Central Asia, 2003)."

[24] In March of 2008, there was a clash between Kyrgyz and Tajik citizens over control of a dam. This is included even though it was not government-sanctioned violence. There was also one instance of threatened violence that would not be included in my dataset as I include only actions and not threats. In this interaction, Uzbekistan pointedly held exercises during the summer of 2001 to practice the takeover of a "well-defended installation" (believed to be the Toktogul reservoir).

wars over water. However, countries can take other coercive actions that unilaterally influence the distribution of available water.[25] Coercive actions of any kind have important political implications and merit study. In addition, we may experience significantly more severe scarcity in the future (Tarlock 2008, 709–10). If countries tend to respond negatively at current levels of scarcity, it is reasonable to think that their coercive reactions may escalate into violence under more severe conditions. In light of this, I consider the unilateral suspension of an existing water distribution—by stopping either water or energy flows—to be a type of conflictual interaction. As discussed previously, these are antagonistic acts and indicate a clear deterioration of relations between the Central Asian countries. In coding these suspensions, I look for substantial cuts or nondeliveries.[26] Finally, I consider failed negotiations to be conflictual acts. These are not "ongoing" negotiations, but rather situations where countries tried to reach agreement but did not succeed. While I think it is accurate to describe these failures as conflictual interactions, I present models in the Appendix that exclude them from the definition of conflictual interactions and demonstrate that the main results do not change.

The primary dependent variables take a value of one if a given interaction involving the appropriate dyad occurred in a given month. In the statistical section, I look at the occurrence of both cooperative and conflictual interactions by using the corresponding indicator variables. More information about the coding rules can be found in the Appendix.

Before proceeding, I should note three things about these data. First, the dataset includes 187 cooperative and 151 conflictual interactions.[27] This is a significantly higher number than in existing data sets. For example, the International Water Event Database lists only 16 events in the Aral Sea basin during the 2000–2008 time period.[28] There are two reasons why my data capture a greater number of interactions. First, I include energy management events as well as explicitly water-related ones for the reasons discussed above. Second, by using local as well as international news sources, I was able to gather information on less high-profile events that still represent important changes in how these countries interact.

Second, I include all dyads, even those that do not share a river, in the main analyses. The reason for this is again the interrelatedness of water and energy. Suppose, for example, Kyrgyzstan was able to obtain additional energy from Turkmenistan in a period of scarcity. This would decrease its reliance on the other Syr Darya countries for energy, raising Kyrgyzstan's bargaining power vis-a-vis these countries and, potentially, resulting in a more favorable allocation of water. However, I do restrict attention to dyads that share rivers when considering the two rivers separately and find the results are robust to this change.[29]

Finally, it is necessary to acknowledge the possibility of selection bias in the measure of cooperative interactions: what appears as cooperation may in fact be the codification of coercive relations among the states. In other words, one country may be forced to sign a cooperative agreement favorable to its partner (Zeitoun and Mirumachi 2008, 303–306). I discount the magnitude of this effect for two reasons. First, given the water-for-energy exchanges used in the region, neither the upstream nor downstream countries are in a clearly dominant bargaining position. Second, these exchanges have a seasonal dynamic. Upstream countries benefit from cooperation in winter, and downstream ones benefit in summer. If one country were dominant, we would expect cooperation to be much more likely, regardless of scarcity, during the season in which that country receives benefits. For example, if the downstream countries dominated, they would force cooperation in the growing season. I include a growing season control variable in the statistical analysis and, as will become apparent, no consistent pattern of this kind emerges. Therefore, I do not think this is a significant source of bias.

Independent Variables

The major independent variable is the level of water scarcity relative to the "normal" availability of water. To measure this, I first identify "normal" levels for the Central Asian rivers. I use data on river flow levels from a database maintained by the Scientific Information Center of the Interstate Commission for Water Coordination of Central Asia. This is the major regional organization involved in water management issues. It includes delegates from all five countries, suggesting they each had access to the same information on flow levels. Furthermore, the ICWC received support and oversight from numerous international organizations during this time period, contributing to the reliability of the data.

The top panels of Figure 2 depict the average quantity[30] of water flowing into the two major upstream reservoirs between 1992 and 2010, calculated by month.[31] The dotted lines represent one standard deviation above and below this average. Since withdrawals upstream of the reservoirs are minimal, the reservoir inflow data should accurately reflect the amount of water available on each river. Thus, I use data on the monthly inflow to the Toktogul reservoir in Kyrgyzstan for dyads along the Syr Darya and monthly inflow to the Nurek reservoir in Tajikistan to measure the relative availability of water along the Amu Darya.[32] Figure 2 demonstrates that the Amu Darya's flow is significantly larger, especially in the summer months, than the flow of the Syr

[25] Yoffe, Fiske, Giordano, Giordano, Larson, Stahl, and Wolf (2004), Hensel et al. (2006), and Hensel and Brochmann (2007) each look at the effect of scarcity on lower levels of conflict (not war).

[26] My rule of thumb was 25% reduction or three-day suspension, although I would occasionally have to take descriptions such as "substantial reduction" at face value.

[27] These are artificially inflated by the fact that energy-related interactions between Tajikistan and Uzbekistan are counted for both the Tajik-Uzbek (Syr) and Tajik-Uzbek (Amu) dyads. However, if we drop, for example, Tajik-Uzbek (Syr), the number of events becomes 139 and 108, respectively. This is still a high number for an eleven-year period.

[28] While these events are not coded as dyadic interactions, there are substantially more individual events in my data than in the IWED. This is a product of the Transboundary Freshwater Dispute Database, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University (http://www.transboundarywaters.orst.edu).

[29] There are two Uzbek-Tajik dyads in the data—one for the Syr Darya and one for the Amu Darya. Events that involve setting or breaking regulations concerning water delivery are split into their respective dyads. However, events that solely involve energy are impossible to split between the two. These events appear in both the Tajik-Uzbek (Syr) and the Tajik-Uzbek (Amu) dyads.

[30] It is possible that "normal" water availability changes over time. Studies that cover long time periods should consider using a model of the long-run trend of water availability, such as the one outlined by Dinar et al. (2011, 5), to define the baseline level of water. However, this concern can largely be ignored for shorter periods of time, such as the one under consideration here.

[31] Data come from CAWATERinfo (www.cawater-info.net, accessed June 28, 2017).

[32] The following dyads use the Syr Darya data: Kyrgyz-Uzbek, Kyrgyz-Kazakh, Kyrgyz-Tajik, Kazakh-Tajik, Kazakh-Uzbek, and Tajik-Uzbek (Syr). The following dyads use the Amu Darya data: Tajik-Uzbek (Amu), Tajik-Turkmen, and Uzbek-Turkmen. The Kazakh-Turkmen and Kyrgyz-Turkmen dyads, which do not share a river, use an average of the two.

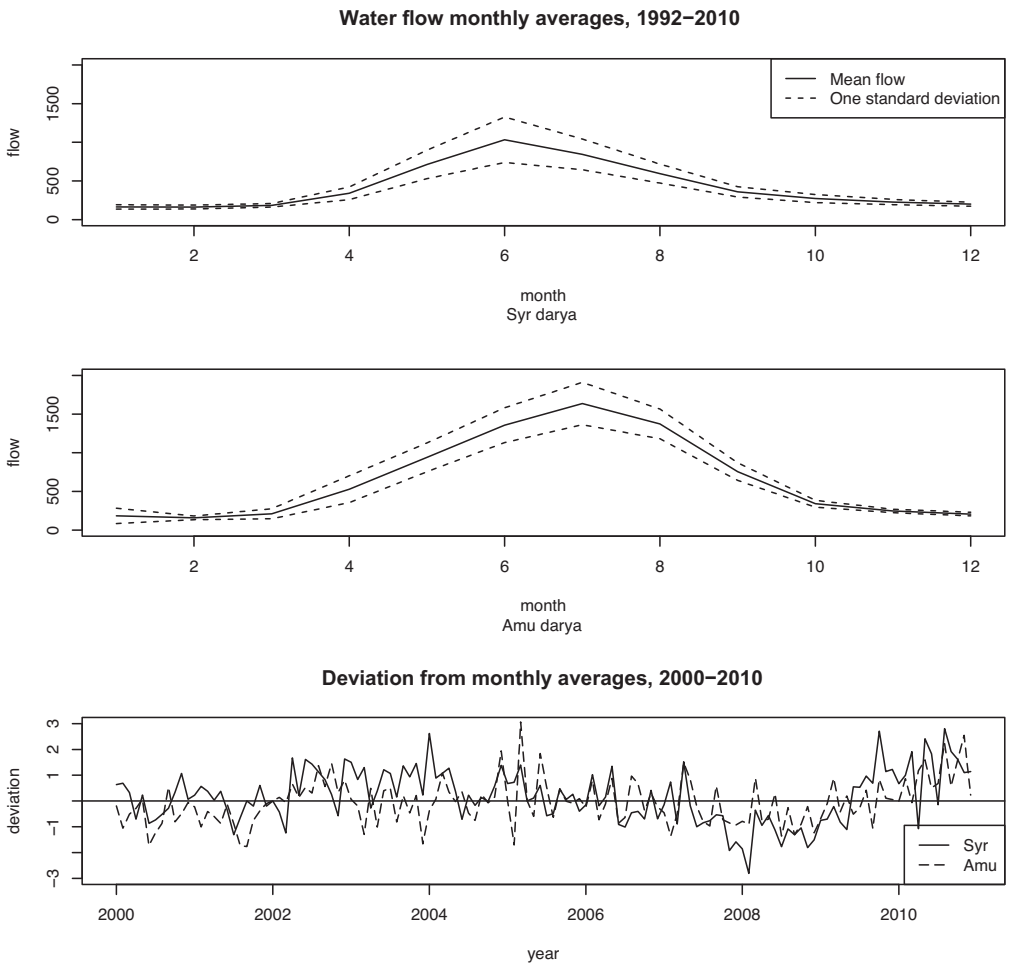

Figure 2. Measures of relative water scarcity

Darya. As discussed previously, demand along the Syr Darya is also higher. This implies that the Syr Darya has a significantly greater absolute level of water scarcity than the Amu Darya.

Having identified the baseline availability for each basin in each month, it remains to develop a measure of how scarce water is relative to this. Using the inflow data, I construct variables that measure the standardized deviation from monthly averages. For example, I subtract the average inflow to the Toktogul reservoir in January from the actual inflow in a given January. I then convert the resulting difference into standard deviations. This makes the variable comparable across both basins and months. The bottom panel of Figure 2 displays the resulting measure of relative scarcity for the 2000–10 period. Although there are some differences, the Syr and Amu Darya basins exhibit similar patterns of scarcity and abundance. For ease of interpretation, I multiply the water availability measure by –1 in the statistical analyses, so that a higher value implies greater relative water scarcity and a smaller value implies lower relative water scarcity.

My measure of relative scarcity does a good job of identifying droughts of varying lengths and levels: so long as the current month has less water than usual, it will be coded as being scarce. I can also look at the cumulative effects of longer-lasting droughts by including lagged or averaged scarcity measures. I take both of these approaches in the Appendix.

Many other variables that affect cooperation or conflict within river basins are constant over time in Central Asia. However, I do include a few control variables in some of the statistical analyses. First, I construct history variables for cooperation and conflict. The *history of cooperation* variable counts the number of cooperative interactions in the past twelve months. The *history of conflict* variable does the same for conflictual interactions. Second, I include dyad fixed effects in some analyses to control for any time-invariant factors that make interaction among certain dyads more or less likely. Third, I construct an indicator variable that takes a value of one in the growing season (June–November). In the nongrowing season, the benefits of cooperation are enjoyed by the upstream countries, and the costs are paid by the downstream countries. In the growing season, however, the reverse is true. This variable controls for any seasonal differences, including the possibility that one country's interests dominate the relationship. In some cases, I also use an indicator variable that splits the time period under analysis in half. There were some major political changes in the middle of the time period—the Tulip revolution in Kyrgyzstan, the Andijan uprising in Uzbekistan, and (a little later) the death of President Niyazov in Turkmenistan. This variable controls for any broad effects these changes might have on the relationships among countries in the region. Finally, I include a couple of time-invariant indicator variables in those models that do not include fixed effects. The first captures whether the dyad is on the Syr Darya. This controls for

Table 1. Occurrence of different types of interaction

DV: Coop. interactions	*Model 1*	*Model 2*	*Model 3*	*Model 4*
Water scarcity	0.328***	0.334***	0.354***	0.370***
	(0.112)	(0.100)	(0.091)	(0.095)
History of coop.		3.509***		0.265
		(0.619)		(0.699)
Growing season		−0.085		−0.090
		(0.187)		(0.176)
Second half		0.024		0.183
		(0.073)		(0.187)
Exchange		0.963***		
		(0.345)		
Syr Darya		0.309		
		(0.375)		
Constant	−1.920***	−3.305***		
	(0.331)	(0.327)		
Fixed effects?	N	N	Y	Y
N	1452	1320	1452	1320
DV: Confl. Interactions	*Model 1*	*Model 2*	*Model 3*	*Model 4*
Water scarcity	0.330***	0.216***	0.361***	0.240**
	(0.091)	(0.065)	(0.098)	(0.101)
History of conflict		4.163***		1.815***
		(0.680)		(0.626)
Growing season		−0.395*		−0.428**
		(0.231)		(0.205)
Second half		0.539***		0.841***
		(0.172)		(0.254)
Exchange		1.323***		
		(0.483)		
Syr Darya		0.423		
		(0.472)		
Constant	−2.164***	−4.280***		
	(0.382)	(0.478)		
Fixed effects?	N	N	Y	Y
	1452	1320	1452	1320

Notes: Models 1 and 2 are logits with dyad-clustered robust standard errors. Models 3 and 4 are conditional logits with fixed effects.
*$p < .1$; **$p < .05$; ***$p < .01$

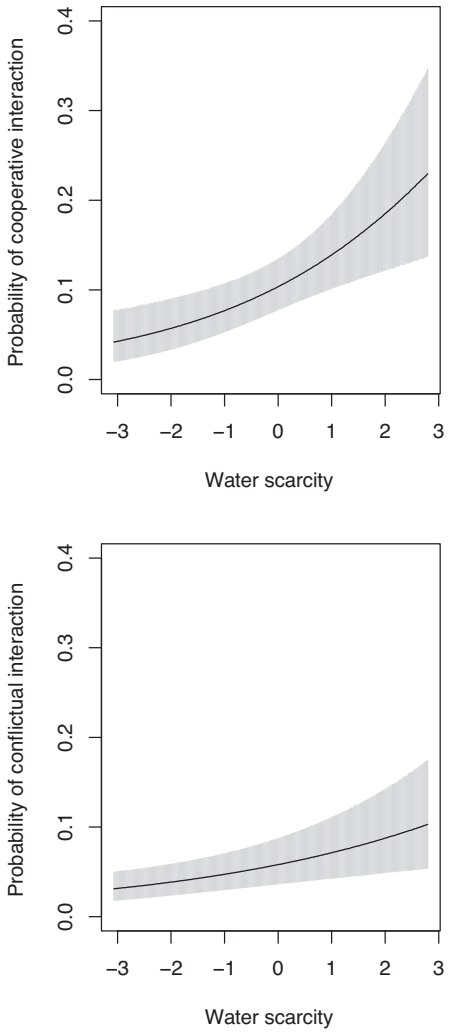

Figure 3. Predicted probabilities of interactions
Notes: These figures show the predicted probability of interactions as water scarcity moves from its minimum to its maximum level. The specifications used come from Model 2 in Table 1. All other variables are held at their means.

any river-specific differences. The second captures whether the dyads historically exchanged water for energy. Included in this are the Kyrgyz-Uzbek, Kyrgyz-Kazakh, Tajik-Uzbek (on both the Amu Darya and Syr Darya), Tajik-Kazakh, and Tajik-Turkmen dyads. I expect that dyads with these direct exchange connections interact more frequently than others.

Results

Table 1 presents the core statistical results. These models examine whether there is a relationship between relative water scarcity and the occurrence of cooperative and/or conflictual interactions. The first model only includes the relative scarcity variable, while the second adds the pertinent controls. The third and fourth models follow the same pattern, but also include dyad fixed effects to control for dyad-specific features and are estimated using a conditional logit model.[33] Water scarcity has a positive and statistically significant effect on the occurrence of both cooperative and conflictual interactions in all specifications. In other words, countries are more likely to interact with one another—in cooperative and/or conflictual manners—when water is in short supply than when it is abundant.

Figure 3 illustrates the effect of relative water scarcity on the predicted probability of interaction (from Model 2) as it increases from its minimum to its maximum. As relative scarcity grows, the predicted probability of a cooperative interaction increases from 0.039 to 0.231. On the other hand, the increase in the probability of a conflictual interaction is somewhat smaller, increasing from 0.031 to 0.104 as relative scarcity moves from its minimum to its maximum. Figure 4 illustrates this even more clearly by depicting the predicted effect of moving water scarcity from its minimum to its maximum on the likelihood of cooperative and conflictual interactions, respectively. The bars represent the 90 percent confidence intervals for this prediction. Both confidence intervals are clearly above 0, and the predicted effect on cooperative interactions is greater than the effect on conflictual ones, although the confidence intervals do overlap.

To compare the two rivers, I split the sample and performed the same analyses using each subsample. For the Amu Darya subsample, I restricted attention to the Tajik-Turkmen, Tajik-Uzbek (Amu), and Turkmen-Uzbek

[33] Throughout, these are estimated using the logit.gee model in the Zelig package (Imai, King, and Lau 2007) and the clogit model in the Survival package (Therneau and Grambsch 2014), respectively.

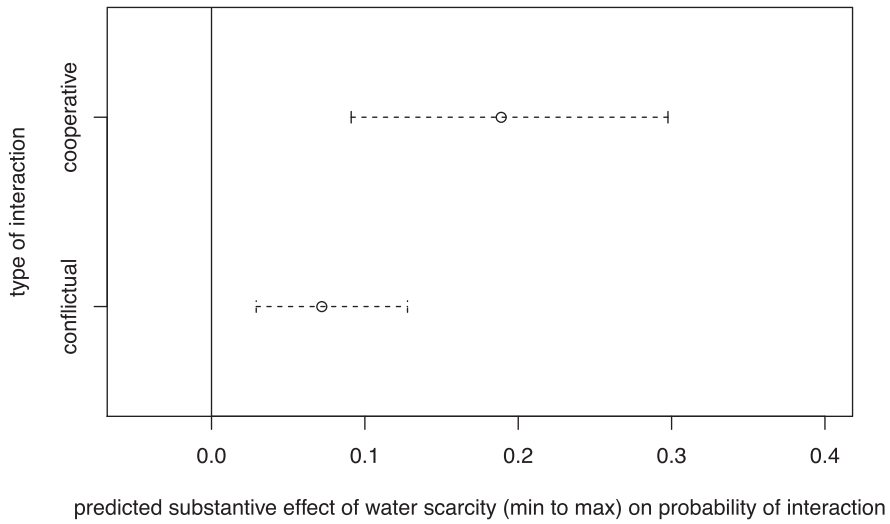

Figure 4. Predicted effect of water scarcity on the probability of interactions
Notes: This graph depicts the predicted probability of interaction when water scarcity is at its maximum minus the predicted probability of interaction when it is at its minimum. The bars represent the 90 percent confidence intervals.

Table 2. Occurrence of interactions, split-basin analyses

	Syr Darya		*Amu Darya*	
	Model 1 Coop.	*Model 2 Confl.*	*Model 3 Coop.*	*Model 4 Confl.*
Water scarcity	0.318^{***}	0.231^{**}	0.667^{***}	0.448^{*}
	(0.110)	(0.115)	(0.219)	(0.260)
History of coop.	−0.067		0.079	
	(0.866)		(1.263)	
History of conflict		2.157^{***}		−1.732
		(0.730)		(1.561)
Growing season	−0.117	−0.319	−0.254	-0.893^{**}
	(0.212)	(0.236)	(0.339)	(0.439)
Second half	−0.001	0.565^{**}	0.874^{**}	3.029^{***}
	(0.227)	(0.272)	(0.396)	(0.806)
Fixed effects?	Y	Y	Y	Y
N	720	720	360	360

Note: All models are conditional logits with fixed effects.
$^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$

dyads. The Syr Darya subsample included the Kazakh-Kyrgyz, Kazakh-Tajik, Kazakh-Uzbek, Kyrgyz-Tajik, Kyrgyz-Uzbek, and Tajik-Uzbek (Syr) dyads. The major results are presented in Table 2. These models include the control variables and the dyad fixed effects. As Table 2 demonstrates, a similar pattern emerges in each of the two basins, despite their differences in absolute levels of scarcity. For both the Syr Darya and the Amu Darya, water scarcity is positively correlated with both kinds of events. The effect is larger for cooperative ones than conflictual ones. This suggests that the effect—and certainly the importance—of relative scarcity does not depend on the level of absolute scarcity.

The control variables in both the full-sample and split-basin analyses also reveal some interesting patterns. In general, a history of interaction seems to matter. These variables are positively correlated with the occurrence of subsequent interaction of the same type (e.g., a history of cooperation is positively correlated with cooperation) in all but one of the full basin models. However, the effect of these history variables is less consistent in the split-basin analysis. Having a direct water-for-energy exchange relationship also correlates positively with both types of interaction. Conflictual interactions appear more likely in the second half of the time period and are less likely in the growing season, although this effect appears to be driven by the Amu Darya as the relationship does not hold for the Syr Darya subsample.

Robustness Checks

In addition to the main results presented, I performed a variety of robustness checks and alternative specifications, some of which are included in this section and the remainder of which can be found in the Appendix.

First, I tried several alternate specifications of the major variables. I coded three alternative specifications of the main independent variable: the first uses the 1992–99 out-of-sample mean (rather than the 1992–2010 mean) to calculate relative scarcity, the second is a three-month average of the relative scarcity variable, and the third is an "extreme scarcity" measure that takes a value of one for scarcity greater than one standard deviation from the mean and zero otherwise. The results of these analyses mirror those presented above. Another set of models, also in the Appendix, includes a lagged scarcity variable to capture any lingering effects of scarcity. The main scarcity variable (current month scarcity) follows the same pattern as above. I also tried a stricter definition of conflictual interaction that excluded failed negotiations, and the results were comparable. Finally, I controlled for the absolute difference in energy production in the dyad to test whether those with a greater differential exhibited different behavior. I did not find any effect for the energy differential variable, but the main results concerning water scarcity were unchanged.

Second, I used a multinomial logit model to examine the effect of water scarcity on cooperative and conflictual interactions simultaneously. To do so, I coded each month as either cooperative or conflictual. If only one interaction

Table 3. Occurrence of interactions, multinomial logit models

		Model 1	*Model 2*
Water scarcity	Cooperative	0.202**	0.198*
		(0.103)	(0.105)
	Conflictual	0.216*	0.158
		(0.119)	(0.122)
	Both		0.668***
			(0.159)
Constant	Cooperative	−2.205***	−2.208***
		(0.091)	(0.093)
	Conflictual	−2.519***	−2.537***
		(0.105)	(0.108)
	Both		−3.086***
			(0.146)
	N	1320	1320

*$p < .1$; **$p < .05$; ***$p < .01$

occurred, then I coded the month according to its type. If no interaction occurred, I coded the month as neutral. However, there are 59 dyad-months in which both conflictual and cooperative interactions occurred. For Model 1 of Table 3, I coded these depending on the number of different interactions. For example, if more cooperative interactions occurred than conflictual, I coded the month as cooperative. If the same number of each occurred, I coded the month as neutral. Model 1 demonstrates that water scarcity is positively associated with the likelihood of both a cooperative and conflictual month (relative to a neutral one). For Model 2, I included a fourth category for months in which both events occurred. This reveals an interesting pattern: while water scarcity increases the likelihood of cooperation or both events occurring, its effect on the likelihood of conflictual interactions on their own is not statistically significant. This suggests that when water scarcity causes conflict, cooperation tends to occur as well. For example, a conflictual act might be followed by the renegotiation of an agreement. Or, alternatively, countries might attempt cooperation before one or the other resorts to conflict.

Finally, I examined the effect of scarcity on the relationships between countries, rather than interactions among them. I coded the relationships between countries over time. In this coding, a cooperative period ends with the breaking of an agreement. A conflictual period ends with the signing of a new agreement.[34] I then used a Cox proportional hazard model to examine the probability of transitioning between periods. The numerical results are in the Appendix, but they are depicted graphically in Figure 5. The top panel of this figure illustrates the survival function for conflictual state—the probability that a cooperative interaction does not occur—when water scarcity is at its maximum and when it is at its minimum. The bottom panel depicts an analogous dynamic for the cooperative state. The takeaway point from this figure is that the survival function when water scarcity is at its maximum is below the survival function when it is at its minimum in both cases. This means that water scarcity has a substantively important impact on ending both ongoing cooperation (with a conflictual interaction) and ongoing noncooperation (with a cooperative interaction). This effect is statistically significant for both types of interaction.

[34] This coding omits any interactions that are of the same type as the current period.

These robustness checks provide support for the hypothesis that relative water scarcity affects how countries interact: in times of shortage, the Central Asian countries are likely to interact with one another in both cooperative and conflictual ways.

Discussion

The statistical evidence suggests that the Central Asian countries interact with one another during periods of relative water scarcity. Their interactions are both cooperative and conflictual. This finding contradicts the "cooperation OR conflict" paradigm we often see in the literature and supports more recent arguments that one kind of response does not necessarily preclude another from occurring. Indeed, my findings suggest that relative water scarcity not only increases the likelihood of both cooperation and conflict, but does so within the same water basin and even along the same river. A large-n, cross-basin study could not demonstrate this as convincingly: the analogous correlations might be driven by some basins responding cooperatively while others respond conflictually, rather than the same basins responding in both ways. By restricting attention to a single water basin, I disentangle these possibilities. This finding speaks to research on foreign policy substitutability (Most and Starr 1984; Clark, Nordstrom, and Reed 2008), which argues that states are not always constrained to a single policy choice when pursuing particular foreign policy goals. In line with this, the Central Asian countries sometimes used cooperation to obtain access to water and sometimes used conflict.

As with all small-n analyses, we must be careful not to overstate the generalizability of the substantive findings. Perhaps the Aral Sea countries are unique in responding to scarcity with both cooperation and conflict. Indeed, we can point to factors that might incline them to both conflict and cooperation. Their history of cooperative management under the Soviets may make cooperation more likely; after all, they not only know what cooperation looks like, but have enjoyed its tangible benefits in the past. On the other hand, the fact that the Central Asian countries are autocratic and that the downstream actors are "stronger" might incline dyads toward conflict. These competing propensities, unique to the Central Asian case, could explain the mixed response.

I argue, however, that most basins have some factors that incline them toward cooperation and some factors that incline them toward conflict. For example, India and Pakistan have a history of antagonism that makes conflict over the Indus River more likely (Mandel 1992), but they also have a framework agreement in place that might tip the scale toward cooperative responses (Hensel et al. 2006). Likewise, the countries along the Rhine are democratic, which is associated with cooperative behavior (Tir and Ackerman 2009). However, the river is considered "high salience," a factor that may make conflictual behavior more likely (Hensel and Brochmann 2007). There are countless other examples of river basins where "risk factors" for both conflict and cooperation exist. In such situations, I expect that relative water scarcity might cause both kinds of responses.

In addition, while the substantive results push us to think more deeply about whether conflictual and cooperative responses are mutually exclusive, it is not the only thing we learn from the analyses. More broadly, my findings suggest that relative water scarcity plays an import role in determining how countries interact. We cannot ignore relative scarcity if we want a complete understanding of how

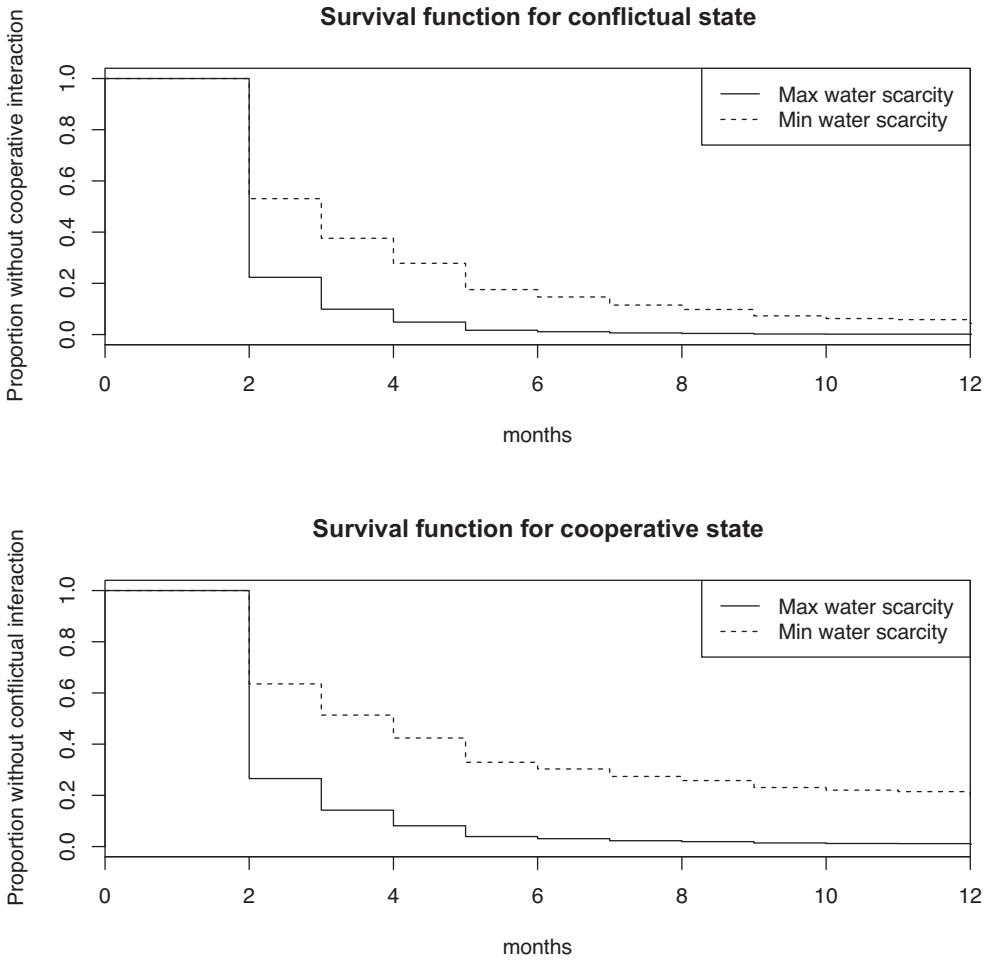

Figure 5. Survival analyses

water dynamics affect international behavior. This finding is far less likely to be case specific. Nothing about Central Asia suggests that it should be affected more by relative scarcity than other cases. For example, it is plausible that relative scarcity only matters in contexts where there is also high absolute scarcity. Yet, my findings show that relative scarcity matters for rivers with both high absolute scarcity (Syr Darya) and low absolute scarcity (Amu Darya). Countries adapt to their "normal" levels of water availability, whatever these are, and take action when they are not reached.

While this article serves as a first step toward understanding how relative scarcity affects country behavior, there remains much to be done on the topic. Future research should explore whether the findings are similar across geographic areas. It will be interesting to see whether a similar substantive result emerges in other international river basins. For example, the Mekong River is currently trying to deal with extreme weather events related to climate change and resultant river variability.[35] This might be another good case for exploring how relative scarcity affects country behavior.

Furthermore, the distinction between absolute and relative scarcity applies to resources other than water. For example, energy can be both scarce in absolute terms (how much a country produces internally or is reliably able to import) and in relative terms (a decrease in supply, generally associated with an increase in price). Distinguishing between absolute and relative scarcity in these and other issues will clarify the effects of different kinds of resource endowment shortages.

Conclusion

This note demonstrates the importance of relative water scarcity for explaining short-term changes in interstate behavior. The existing literature suggests that countries act differently when they face conditions of water scarcity. It focuses on one implication of these theories: countries in basins that typically have more water act differently than those in basins with generally less water. While we learn a great deal from such analyses, they ignore the effect of short-term changes in relative water scarcity. The evidence presented here suggests that countries do, indeed, respond to short-term periods of scarcity by engaging with their neighbors in predictable ways.

In short, we need to take water variability seriously. Countries can adapt to long-term water shortages. However, they have fewer options during periods of short-term scarcity and are therefore more likely to take international action. As climate change increases levels of water flow variability around the world, such periods will become more frequent and more severe. My findings about how this affects country relations are mixed. The Aral Sea countries reacted both cooperatively and conflictually to these events. Other countries may have similarly mixed responses. Figuring out how to tip

[35] See www.mrcmekong.org/topics/climate-change/ (accessed June 28, 2017) for more information.

the scale in favor of cooperation is an important next step in this research agenda.

With respect to Central Asia, the statistical results indicate that both cooperative and conflictual interactions between countries are more likely during periods of scarcity. However, some evidence suggests that the effect on cooperative interactions is larger and more consistent than the effect on conflictual ones. This result may be surprising to those with knowledge of the region. The Central Asian governments typically employ virulent rhetoric concerning water management, which leaves an impression of generally poor relations. Such rhetoric may play on nationalistic sentiments, but it does not reflect the reality of interstate relations. Periods of scarcity are just as likely to spur cooperation as they are to drive conflict.

We could easily use the methodology presented in this article to study other basins and their effect on interstate behavior. I agree with Wolf (2007, 260–62) that relative water scarcity may have positive effects on relations among countries under some circumstances and negative effects under others. By focusing on the availability of water relative to a basin-specific mean, the method in this note allows researchers to evaluate these effects without needing to identify or model domestic demand for water. Understanding how countries react to periods of short-term water shortage will give us a more complete picture of how water availability affects relationships at the international level.

Supplementary Information

Supplementary information is available at *the International Studies Quarterly* data archive.

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