

International Water Cooperation and Environmental Peacemaking

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Abstract

Proponents of the environmental peacemaking approach argue that environmental cooperation has the potential to improve relations between states. This is because such cooperation facilitates common problem solving, cultivates interdependence, and helps to build trust and understanding. But as of now, very few cross-case studies on environmental peacemaking exist. Furthermore, much of the available literature understands peace in negative terms as the mere absence of acute conflict. This article addresses both shortcomings by studying the impact of international water cooperation on transitions toward more peaceful interstate relations. To do so, we combine information on positive water-related interactions between states with the peace scale, a recent data set measuring the degree of positive and negative peace between states. For the period 1956–2006, we find that a higher number of positive, water-related interactions in the previous ten years makes a shift toward more peaceful interstate relations more likely. This is particularly the case for state pairs that are not in acute conflict with each other.

Shortly after they gained independence in the first half of the nineteenth century, El Salvador and Honduras became involved in an intense, long-lasting conflict that involved several militarized disputes. The main reason for this conflict was disagreement about territory along their shared border and about some islands in the Gulf of Fonseca (Thompson and Dreyer 2010, 140–141). During the 1980s, both states intensified cooperation on environmental issues, among others, to preserve transboundary water resources. Notable expressions of these efforts were the Trifinio Plan (1986) and the Central American Commission for Environment and Development (1989). These cooperation efforts facilitated interactions and joint problem solving between high-ranking policy makers and citizens from both countries. During the 1990s, the conflict deescalated significantly (King et al. 2016; López 2004). Consequentially, analysts have argued that water and environmental cooperation between both states “acted as a catalyst for further cooperation” (Carius 2006, 13). Similarly, scholars have attributed a

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peacemaking effect to secret water negotiations between Israel and Jordan; to the Orange-Senqu River Commission (ORASECOM) between Botswana, Namibia, Lesotho, and South Africa; and to the water regime governing the Okavango (Abukhater 2013; Turton 2003).

Cases like these suggest that international environmental cooperation might not only tackle environmental problems and facilitate sustainable development but could also yield a peace dividend. This claim has been picked up by the literature on environmental peacemaking, which investigates whether environmental cooperation “can be an ... effective catalyst for reducing tensions, broadening cooperation, fostering demilitarization, and promoting peace” (Conca 2001, 226). In this study, “environmental peacemaking refers to all forms of cooperation on environmental issues ... which ... achieve creating less violent and more peaceful relations” between states (Ide 2018b, 3). It is part of a broader effort—usually termed environmental peacebuilding—“of governing and managing natural resources and the environment to support durable peace” (UNEP 2018).

So far, limited consensual knowledge on environmental peacemaking between states exists (Ide 2018b). Case studies from South America (Kakabadse et al. 2016), East Africa (Martin et al. 2011), the Middle East (Ide 2017), and Cyprus (Zikos et al. 2015) find that cooperation on water and biodiversity have contributed to the improvement of tense interstate relations. But other scholars, often focusing on the same cases, find little effect of environmental cooperation on wider interstate relations (Akçalı and Antonsich 2009; Barquet 2015; Colakhodži et al. 2014; Reynolds 2017). Some even argue that such cooperation depoliticizes conflicts and gives rise to new tensions (Aggestam and Sundell 2016; Büscher and Schoon 2009).

We recognize two shortcomings of this literature. First, available research on environmental peacemaking pays little attention to positive peace. In recent years, the dominant conception of peace as the absence of violence (negative peace) has been criticized in international relations (Diehl 2016), political geography (Williams and McConnell 2011), and peace and conflict studies (Gleditsch et al. 2014). Such a focus on negative peace restrains our knowledge on transitions from the mere absence of violence toward more positive forms of interaction, such as economic integration or security community (Adler 1998). In a foundational text on environmental peacemaking, Conca (2002, 9) defines peace as “a continuum ranging from the absence of violent conflict to the inconceivability of violent conflict.” However, almost all scholars doing research in this tradition either focus explicitly on the absence of violence (Barquet et al. 2014) or study cases of very tense international relations in which the avoidance of physical violence is an immediate concern, such as the Korean Peninsula (Mjelde et al. 2017), Peru–Ecuador until 1998 (Ali 2007), and Israel–Palestine (Reynolds 2017).

The second shortcoming of the current environmental peacemaking literature is that most available publications draw evidence from either one or very few cases, while there is a notable lack of cross-case investigation. We agree with

Krampe (2017, 8) that the dominant case study approach provides “a good basis, but ... constrains comparison” and generalization as it is often based on rather different definitions and operationalizations of key variables (e.g., of environmental cooperation and peace). Recently, a few large-*N* studies on the issue have been published, but these focus solely on the avoidance of violent conflict (Dinar et al. 2015; Mitchell and Zawahri 2015) or utilize data on environmental treaties (Barquet et al. 2014; Ide 2018a), which might be weak proxies for actual environmental cooperation (see the next section).

This article addresses both shortcomings—the lack of cross-case studies and the dominant focus on negative peace—in the environmental peacemaking literature. To do so, we focus on water-related cooperation in the face of environmental stress for three reasons. First, the existing literature largely agrees that water cooperation is the form of environmental cooperation most likely to yield a peace dividend, due to its cross-border nature as well as its economic and political relevance in many regions (Brochmann and Hensel 2009; Feil et al. 2009). Second, there is an extensive literature on water cooperation and conflict, which allows for a better specification of our theoretical expectations. Third, and relatedly, sufficient data on water interaction are available to test our theoretical propositions (Link et al. 2016; Petersen-Perlman et al. 2017).

More specifically, this article investigates the impact of water cooperation on transitions toward more peaceful relations between states for the period 1956–2006. To do so, data on positive, water-related interactions are combined with the peace scale recently developed by Goertz and colleagues (2016). We find that a higher number of positive, water-related interactions during the previous ten years increases the likelihood of a transition toward more peaceful relations between two states. This is especially so if these states are not in acute conflict with each other.

Theoretical Background: Water Cooperation and Peacemaking

The literature on environmental peacemaking identifies two broad mechanisms through which water cooperation can facilitate the improvement of interstate relations (Conca 2001; Ide 2018b; Lejano 2006).

The first mechanism is rooted in liberal and functionalist theories of international politics. Liberal approaches have long claimed that highly interdependent states face little incentive to fight each other (Oneal and Russett 1999) but tend to cooperate in order to address shared problems and realize common gains (Keohane and Nye 2001). This should apply to environmental interdependence as well, for instance, when rivers are shared or water pollution crosses political boundaries (Dinar 2009). In a functionalist logic, such cooperation is likely to spill over; that is, it “will set in motion economic, social and political progresses which generate pressures towards further integration” (Tranholm-Mikkelsen 1991, 4), hence creating a virtuous cycle. As the case of the Syrian–Turkish dam on the Orontes River shows, cooperation on flood

management is well able to catalyze further joint action on hydroenergy and the management of other watersheds (Scheumann and Shamaly 2016). Increased interdependence and cooperation, in turn, discourage the use of violence and facilitate the creation of a transnational community.

The second mechanism draws from constructivist theory and sociological institutionalism. According to Adler (1997, 254), citizens and policy makers tend to “institutionalize commonalities running through the whole region, including shared perceptions of external threats.” Water-related problems are often perceived as severe, shared, and external threats (Conca 2002). Statements by key decision makers announcing the need or actual plans for water cooperation send signals to broader publics that better relations between the respective states are desired and possible (Sadoff and Grey 2002). Furthermore, once water cooperation is established, it increases interactions between decision makers and civil society actors (Ovodenko 2014). Such interactions can, in turn, stimulate the building of trust and understanding. This is based on the assumption that people “develop perceptions of interest and understandings of desirable behavior from social interactions with others” (Finnemore 1996, 128). Water-related cooperation between Israeli and Palestinian communities, for instance, has been argued to give rise to more peace-prone discourses in the participating groups (Ide 2017).

In practice, these two mechanisms are usually deeply entangled and even reinforcing. The trust and understanding built during initial cooperation in the context of the Central American Commission for Environment and Development, for instance, laid the basis for further water cooperation between El Salvador and Honduras in the late 1980s, which in turn facilitated the peace process (King et al. 2016). Similarly, a spillover of water cooperation under ORASECOM increased the number of interactions and institutions through which trust building in southern Africa could take place (Turton 2003).

One can hence hypothesize that water cooperation facilitates more peaceful relations between states through the building of trust and understanding and by increasing interdependence. However, this begs the question of how to define and identify water cooperation, especially across a larger number of cases. Many existing studies on environmental peacemaking (Barquet et al. 2014; Ide 2018a) and international water interactions (Bernauer and Siegfried 2008; Ovodenko 2014) use formal treaties as indicators of cooperation.

But international water treaties might be very shallow, and even if they are well designed, follow-up interactions facilitating trust building and a spillover of cooperation are not guaranteed. In the worst case, environmental agreements even mask and reify severe conflicts (Zeitoun and Mirumachi 2008). The water accords concluded between Israel and Palestine in 1995 as articles of the Oslo II agreement, for instance, established a joint water committee (JWC). But the accords can hardly be termed cooperative given the continued strong tensions and grievances (especially on the Palestinian side), while no JWC meetings were held between 2010 and 2016, and few, if any, spillover effects occurred (Selby 2013).

Hence the kind of water cooperation that can stimulate environmental peacemaking processes is unlikely to be indicated by treaties alone. Neither are formal agreements necessary for environmental peacemaking. Rather, we propose that continuous and positive (i.e., nonhostile) water-related interactions between two or more states indicate the kind of water cooperation relevant for environmental peacebuilding. Such interactions include the formation of water treaties but also meetings of policy makers or ministerial staff; various forms of cultural, scientific, and economic cooperation; and public statements by state officials (Wolf et al. 2003). These interactions indicate the spillover (or at least continuation) of existing cooperation as well as the existence of forums and meetings where (and public statements through which) trust and understanding can be built (Ho 2017; Petersen-Perlman et al. 2017).

However, such interactions should be rather recent. Positive interactions that took place a long time ago are likely to be no longer part of the institutional memory of the state; also, the involved technical experts may have retired, and the broader public is concerned about more recent developments. Given that processes of spillover and trust building still take some time (López 2004; Martin et al. 2011), we categorize all interactions that took place during the last ten years as recent. We acknowledge that this decision is somewhat arbitrary and that time lags of one, two, and five years are more common in peace and conflict studies. But using longer time periods reduces endogeneity concerns (water cooperation could be driven by informal improvements of mutual relations one or two years before such shifts are made official), while existing case studies on environmental peacemaking show that including only time periods of two or five years might be too short (e.g., Abukhater 2013; Martin et al. 2011). Similarly, Barquet et al. (2014) find that conservation cooperation only has an effect on interstate violence prevention with a time lag of ten years.

Consequently, our first hypothesis is as follows:

H₁: A higher number of recent and positive water-related interactions make a shift toward more peaceful relations between two states more likely.

Furthermore, environmental peacemaking might not work if interstate relations are quite tense. In such a situation, positive water-related interactions are less likely to create deeper or wider interdependencies because cooperation remains securitized and receives little political support (Zikos et al. 2015). Similarly, an atmosphere of mistrust and limited interactions between decision makers and civil society actors restrains possibilities for building trust and understanding through water cooperation (Ide 2018a). We hence propose the following hypothesis:

H₂: Recent and positive water-related interactions are more likely to facilitate a shift toward more peaceful relations between two states if no acute conflict is going on between these states.

Data and Methods

Dependent Variable

The transition toward more peaceful relationships between two states provides the basis for the dependent variable of this study. Conceiving such shifts on a continuum that includes negative as well as positive forms of peace is no easy task for cross-case research. Most existing data sets only include data on the absence of acute or militarized conflicts or on transitions toward such a state (Palmer et al. 2015; Thompson and Dreyer 2010).

In this study, we draw on more recent efforts by Goertz et al. (2016) to construct a peace scale that measures the peacefulness of interstate relations. The number and severity of “disagreements and how they are dealt with by the participants are the key elements” (Goertz et al. 2016, 28) used to position a state pair (dyad) along the peace scale in a given year. Specifically, Goertz and colleagues distinguish five levels of the peace scale: severe rivalry (0), lesser rivalry (0.25), negative peace (0.5), warm peace (0.75), and security community (1). In a severe rivalry, states disagree about several key issues and resort to intense diplomatic pressure and frequently also to military violence to enforce their claims. Security communities, by contrast, are characterized by few disagreements as well as strong transnational ties and intergovernmental organizations, while violent encounters are unthinkable.

For each of the five stages of the peace scale, Goertz et al. (2016, 50–54) specify a set of indicators and several anchor cases (see Table 1 for an overview). They then use qualitative knowledge of the respective dyads, complemented by quantitative information, to classify the relationship between two states in a given year. Currently peace scale data are available for all state pairs with significant interactions for the period 1815–2006.

Because our hypotheses concern the improvement (rather than the absolute quality) of interstate relations, a shift of dyadic relations toward the positive end of the peace scale is the main dependent variable of this study. To operationalize this dependent variable for the time period under study (1956–2006), we use a binary dependent variable taking the value 1 for years in which the peace value for a given dyad increased by 0.25 points or more relative to the previous year (e.g., from “negative peace” to “warm peace” or even “security community”), and 0 otherwise.¹

Using the peace scale has three particular advantages in the context of this study. First, it allows us to consider transitions from more (values of 0 and 0.25) toward less negative forms of peace (values of 0.25 and 0.5) as well as transitions toward positive forms of peace (values of 0.75 and 1) between states. Second, comparable data are available for a large number of cases.

1. Readers interested in the distribution of positive vs. negative changes in the peace scale data for dyads in transboundary basins from 1956 to 2006 are referred to Table 6 (https://www.mitpressjournals.org/doi/suppl/10.1162/glep_a_00478/suppl_file/glep_a_00478-Table6.pdf) in the online appendix.

Table 1

Summary of the Peace Scale

<i>Value</i>	<i>Term</i>	<i>Indicators</i>	<i>Example</i>
0	severe rivalry	<ul style="list-style-type: none"> • many disagreements • key issues unresolved • frequent military encounters • preparation for future wars • diplomatic hostility 	India–Pakistan (1947–2006)
0.25	lesser rivalry	<ul style="list-style-type: none"> • several disagreements • key issues unresolved • isolated military encounters • preparation for future wars • diplomatic hostility 	Colombia–Venezuela (1841–1982)
0.5	negative peace	<ul style="list-style-type: none"> • some disagreements • key issues are mitigated or resolved • no military encounters • preparation for future conflicts • diplomatic recognition and intergovernmental cooperation 	Egypt–Israel (1989–2006)
0.75	warm peace	<ul style="list-style-type: none"> • few disagreements • key issues resolved • no military encounters • transnational ties • diplomatic relations and intergovernmental cooperation 	Argentina–Brazil (1986–2006)
1	security community	<ul style="list-style-type: none"> • few disagreements • key issues resolved • joint military planning • transnational ties • functional integration and institutionalized cooperation 	France–Germany (1992–2006)

Adapted from Goertz et al. (2016, 25–46).

Third, the peace scale identifies clearly discernible, short-term shifts (rather than long-term, gradual changes) toward more peaceful relations. This reduces potential endogeneity concerns because we can discern whether intense positive water interaction precedes such a rapid shift.

This is not to say, however, that the peace scale data are free of weaknesses. One should keep in mind that this data set is very recent, resulting in a higher risk of coding errors undetected so far. This is particularly important, as the peace scale categorization relies heavily (though not solely) on the qualitative assessments of the researchers involved. Furthermore, Kasten (2017) argues that the peace scale suffers from an ontological overload, as it includes assumptions about the causal determinants of peace into its coding decisions (although these assumptions are less relevant for our study design). Still, in light of the advantages described, we consider the peace scale the best data source currently available to operationalize the dependent variable of this analysis. Summary statistics for our dependent variable and all other variables used in our analysis can be found in the online appendix (Table 4, https://www.mitpressjournals.org/doi/suppl/10.1162/glep_a_00478/suppl_file/glep_a_00478-Table4.pdf), along with a correlation table (Table 5, https://www.mitpressjournals.org/doi/suppl/10.1162/glep_a_00478/suppl_file/glep_a_00478-Table5.pdf).

Independent Variable

To determine the number of positive water-related interactions (WaRI) (which are used as indicators for water cooperation), this study draws on the International Water Events Database (IWED). This data set records freshwater-related interactions that took place between 1946 and 2008 and orders them according to the Basins at Risk Water Event Intensity Scale (BAR scale) (Wolf et al. 2003). To construct IWED, researchers of the Oregon State University collected information on freshwater-related international interactions from electronic news data sets and used the qualitative information provided to classify them along the BAR scale. This scale differentiates fifteen categories of conflict and cooperation, ranging from -7 (formal declaration of war) to +7 (voluntary unification into one nation), with 0 referring to neutral or nonsignificant events (Yoffe and Larson 2001).

IWED and the BAR scale are considered reliable and widely used in the literature on water conflict and cooperation (Link et al. 2016). As we hypothesize that positive water-related interactions have a peacemaking effect, we utilize the cooperative side of the BAR scale to operationalize the independent variable. The following water-related events are hence considered to be positive interactions: minor exchanges and talks (+1), official verbal support (+2), cultural and scientific agreements or support (+3), economic and technological support (+4), military and strategic support (+5), conclusion of a major treaty (+6), and voluntary unification into one nation (+7; did not occur in the sample) (Wolf et al. 2003).

More specifically, we calculated the total number of positive water-related events between two states in the ten years preceding every dyad-year in our

sample (by focusing on past events, we further reduce potential endogeneity). Our independent variable accounts for the fact that even less-cooperative events according to the BAR scale, such as cultural and economic exchanges and support, can serve to build understanding and might indicate relevant spillover processes (Ide 2017; Sadoff and Grey 2002). However, we use alternative specifications of the independent variable as a robustness test (see below).

Control Variables

We include several control variables in the analysis to account for possible confounding effects. First, we utilize a binary variable to control for historical shifts, or *shocks*, in the international system (i.e., decolonization, end of the Cold War). Second, we count the *consecutive years a dyad has experienced negative peace* (negative peace or higher) and also include a quadratic term in the regression equation to account for a curvilinear relationship between peace years and shifts in interstate relations; that is, we assume that both very recent enemies and long-term friends are more likely to see their relations improve as compared to other pairs of states. Third, we control for participation in *interstate armed conflicts* outside of the dyad that could provide incentives for rapprochement between states within the dyad.

Fourth, following liberal theorists, we count the number of *international governmental organizations* (IGOs) both states of the dyad are common members of and include *logged trade data for the last ten years* between pairs of states (see Oneal and Russett 1999). Fifth, also following a liberal argumentation, we measure whether both states in a dyad are *democracies*, based on the polity IV data (Marshall et al. 2016). Finally, we account for relative military capacity, as suggested by realist theory (e.g., Bennett and Stam 2004; Zeitoun and Mirumachi 2008).

The rationale for including these control variables, as well as data sources and data transformations, are discussed in greater detail in the online appendix (see: https://www.mitpressjournals.org/doi/suppl/10.1162/glep_a_00478/suppl_file/glep_a_00478-InDepthDiscussion.pdf).

Sample and Estimation Method

Our sample includes all dyads of states within international river basins covered by the peace scale data, which only consider state pairs with significant interactions during at least one point in time (Goertz et al. 2016). It covers the years 1956–2006. To estimate the effect of positive water-related interactions on the probability of an improvement of relations between states, we use logistic regression analysis. We cluster standard errors by dyad to account for within-dyad similarities between observations and include time trends to control for a possible confounding effect of time, as the number of positive water-related interactions in our sample tends to increase over time.

Moreover, we conduct additional tests to check the robustness of our findings. First, we replace our main independent variable with counts of positive

water-related events over shorter periods (two, five, and eight years), with a variable counting only highly ranked events (score of 3 or higher on the BAR scale) as well as a variable summing BAR scores over a ten-year period to give highly negative and positive events more weight in the analysis. Second, we test for a possible rare-event bias, as recommended by King and Zeng (2001), because our data set only contains a very small proportion of dyad-years with positive changes in interstate relations (1 percent of our sample). Third, we use dyad-random effects to control for unobserved time-invariant dyad-specific characteristics that might have a bearing on water cooperation and interstate relations.

Results

Table 2 shows the results of the main analysis. First we test for the effect of our control variables alone (Model 1). The model yields an area under the curve (AUC) estimate of roughly 0.74, indicating that it fits the peace scale data fairly well. Most of the coefficients are significant and have the expected sign. In particular, the likelihood of an improvement in the relations between co-riparian states seems to increase with the number of international organizations both states in the dyad are common members of, the involvement of at least one state in an interstate armed conflict, with both states in the dyad being democracies, during system-level shocks, as well as with time, although the coefficient for the latter is only significant at the 10 percent level. Consistent with our expectations, the effect of peace years follows a U-shaped pattern, as indicated by a negative coefficient for peace years and a positive coefficient for peace years squared. We also observe a negative coefficient for relative military capabilities, but it is not statistically significant.

We now turn to testing our main hypotheses in Models 2–4. In line with our first hypothesis, we see a positive effect of the number of positive water-related interactions (WaRI) in the previous ten years on the likelihood of a rapprochement between states (positive coefficient in Model 2 with a *p*-value smaller than 0.051). This effect is robust when replacing membership in international organizations with the volume of intradyad trade over the last ten years, to a rare-event correction, as well as when controlling for unobserved heterogeneity between dyads in a dyad-random-effects model. On the other hand, effects for alternative specifications of the independent variable are not significant; that is, restricting the analysis to more recent and more intensive cooperative events actually yields weaker results (see Table 3). Overall, Hypothesis 1 thus receives support when observing longer time periods and including low- as well as high-intensity cooperative events.

To test our second hypothesis, we divide our sample into dyad-years characterized by rather peaceful (Model 3, peace scale values 0.5, 0.75, and 1) or confrontative (Model 4, peace scale values 0 and 0.25) relations. In general, we observe that the average likelihood of a shift toward more peaceful relations is lower in the peaceful and higher in the confrontative sample, as indicated by the coefficient for the constant in Models 3 and 4. However, we also see that the

Table 2
Logistic Regression Analysis

<i>Variable</i>	(1)	(2)	(3)	(4)
Log. nbr. pos. WaRI (ten years)		0.0899 (0.0461)+	0.3237 (0.0723)**	-0.0763 (0.0666)
Number of IGOs $t - 1$	0.0002 (0.000)**	0.0002 (0.000)**	0.0000 (0.0001)	0.0004 (0.0002)*
Democracies	0.0153 (0.0053)**	0.0156 (0.0054)**	0.0374 (0.0052)**	-0.0237 (0.0101)*
Interstate conflict	0.6592 (0.2842)*	0.6270 (0.2916)*	-14.7225 (0.3419)**	0.3520 (0.2821)
Peace years	-0.0377 (0.0076)**	-0.0369 (0.0076)**	-0.0096 (0.0097)	-0.0371 (0.0183)*
Peace years sq.	1.072 (0.1702)**	1.0622 (0.17)**	3.0559 (0.4824)**	0.6405 (0.2771)*
Rel. military capacities	-0.0001 (0.000)	0.0000 (0.000)	0.0014 (0.0004)**	0.0001 (0.0024)
Systemic shock	1.1293 (0.1775)**	1.1634 (0.1817)**	2.3621 (0.257)**	0.4354 (0.2301)+
Time trend	0.0108 (0.0059)+	0.0090 (0.0059)	-0.0060 (0.0079)	0.0615 (0.0118)**
Constant	-5.5180 (0.2902)**	-5.3869 (0.2864)**	-8.8819 (0.5212)**	-5.0292 (0.4556)**
Number of observations	14,981	14,981	12,099	2,882
Log likelihood	-948.21	-945.97	-309.97	-468.5
AUC	0.74	0.74	0.92	0.69

Note. Clustered standard errors in parentheses. DV = probability of shift toward more peaceful interstate relations.

** $p < 0.01$, * $p < 0.05$, + $p < 0.10$

Table 3
Robustness Checks

<i>Variable</i>	(5)	(6)	(7)	(8)
Log. nbr. pos. WaRI (ten years)				
Log. nbr. pos. WaRI (two years)	0.0853 (0.061)			
Log. nbr. pos. WaRI (five years)		0.0609 (0.052)		
Log. nbr. pos. WaRI (eight years)			0.0447 (0.0495)	
Log. nbr. high. pos. WaRI (ten years)				0.0780 (0.0514)
Log. sum WaRI scores (ten years)				
Number of IGOs $t - 1$	0.0002 (0.0000)**	0.0002 (0.0000)**	0.0002 (0.0000)**	0.0002 (0.0000)**
Log. trade (ten years)				
Democracies	0.0155 (0.0053)**	0.0155 (0.0053)**	0.0155 (0.0053)**	0.0155 (0.0054)**
Interstate conflict	0.6267 (0.2921)*	0.6371 (0.2897)*	0.6446 (0.2883)*	0.6451 (0.2889)*
Peace years	-0.0371 (0.0076)**	-0.0371 (0.0076)**	-0.0373 (0.0076)**	-0.0375 (0.0076)**
Peace years sq.	1.0685 (0.1693)**	1.0699 (0.1694)**	1.0682 (0.1703)**	1.0619 (0.1708)**
Rel. military capacities	-0.0001 (0.0006)	-0.0001 (0.0006)	-0.0001 (0.0006)	0.0000 (0.0006)
Systemic shock	1.1242 (0.1781)**	1.1368 (0.1792)**	1.1417 (0.1794)**	1.1583 (0.181)**
Time trend	0.0098 (0.0059)	0.0099 (0.0059)	0.0100 (0.0059)	0.0101 (0.0058)
Constant	-5.3382 (0.2975)**	-5.4112 (0.2928)**	-5.4464 (0.2899)**	-5.3989 (0.2856)**
Number of observations	14,981	14,981	14,981	14,981
Log likelihood	-947.22	-947.42	-947.71	-947.03
AUC	0.74	0.74	0.74	0.74
Rare-event correction	-	-	-	-
Random effects	-	-	-	-

Table continues on facing page

effect of positive water-related events is much larger in the peaceful sample than in the overall sample, which is consistent with Hypothesis 2. On the other hand, we do not see a statistically significant effect of positive water-related interactions in the confrontative sample.

To describe our results in substantive terms, we estimate incremental changes in the probability of a positive shift in interstate relations as a function of the number of positive water-related events between these states in the last ten years, with all other variables held constant at their mean. We then compare

Table 3
Robustness Checks (Continued from facing page)

(9)	(10)	(11)	(12)
	0.1026 (0.0496)*	0.0910 (0.0419)*	0.0899 (0.0419)*
0.0362 (0.0235)			
0.0002 (0.0000)**	0.0002 (0.0000)**	0.0002 (0.0000)**	0.0002 (0.0000)**
	0.1128 (0.0356)**		
0.0156 (0.0054)**		0.0162 (0.0052)**	0.0156 (0.0052)**
0.6418 (0.288)*	0.1305 (0.4126)	0.6494 (0.2883)*	0.6270 (0.2883)*
-0.0373 (0.0076)**	-0.0401 (0.0081)**	-0.0375 (0.0068)**	-0.0369 (0.0069)**
1.0613 (0.1705)**	0.9826 (0.2055)**	1.0546 (0.1763)**	1.0622 (0.1763)**
0.0000 (0.0006)	-0.0010 (0.0013)	0.0008 (0.0009)	0.0000 (0.0009)
1.1598 (0.1814)**	0.9903 (0.2257)**	1.1692 (0.1781)**	1.1634 (0.1781)**
0.0097 (0.0059)	0.0131 (0.0079)	0.0086 (0.0065)	0.0090 (0.0065)
-5.4205 (0.2855)**	-5.4191 (0.4239)**	-5.3754 (0.3095)**	-5.3869 (0.3096)**
14,981	10,605	14,981	14,981
-946.93	-633.18		-945.97
0.74	0.76	0.74	0.74
-	-	yes	-
-	-	-	yes

Note. Clustered standard errors in parentheses. DV = probability of shift toward more peaceful interstate relations.

** $p < 0.01$. * $p < 0.05$. + $p < 0.10$.

the results with the estimated effect of total trade between these states over the same period. To ensure comparability, we use the coefficients from Model 10 for both estimations. The results are shown in Figure 1. We estimate for instance that, all else equal, the effect of a shift from one to four positive water-related events is roughly comparable to the effect of a change from US\$12 billion to US\$40 billion in trade volume (i.e., an increase in the probability of a positive shift in interstate relations of roughly 12.5 percent).

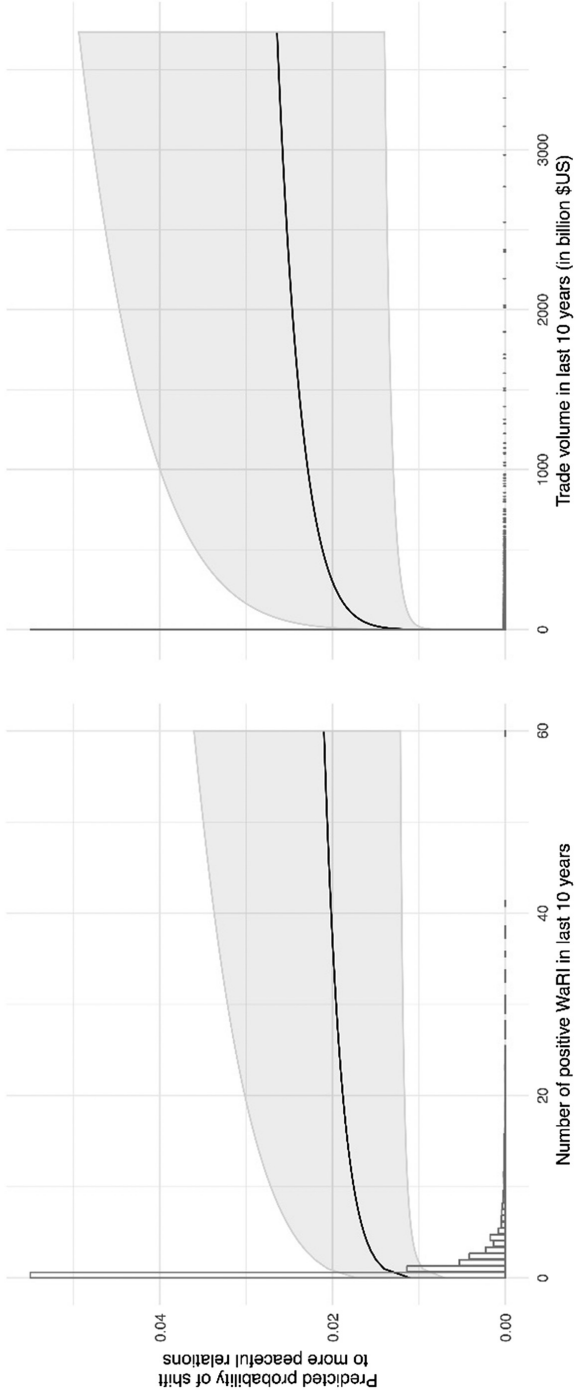


Figure 1

Estimated Changes in the Probability of a Positive Shift in Interstate Relations as a Function of Positive Water-Related Interactions (WaRI) and Overall Trade Between States, in the Last Ten Years

Shaded areas delimit 95 percent confidence bands. Superimposed bars represent the distribution of observations.

We conclude that the number of positive water-related interactions within a dyad increases the probability of this dyad moving toward the positive end of the peace scale. This effect seems to apply in particular to dyads with rather harmonious relations, thus supporting our argument that environmental peacemaking is most likely to take place in settings characterized by the absence of intense hostilities.

Discussion

The results of our study provide support for the environmental peacemaking approach: a higher number of positive, water-related interactions during the previous ten years makes a shift toward more peaceful relations between two states more likely, at least if the states are not in acute conflict with each other.

A cursory view on the qualitative literature suggests that this relationship is not a statistical artifact but rather is underpinned by observable mechanisms. The informal “picnic table talks” on water between decision makers from Israel and Jordan served as one means to build trust and working relations between both sides, which facilitated the peace talks in the 1990s. During the initial stages of these talks, diplomats also turned to positive-sum topics like water cooperation several times to move the negotiations forward when a stalemate occurred (Abukhater 2013; Haddadin 2011). Similarly, the negotiation and conclusion (in 1996) of the Mahakali Treaty paved the way for further water cooperation between India and Nepal and set a positive atmosphere for the upcoming (and eventually successful) negotiations about the renewal of the bilateral trade agreement (Swain 2002). High-level water-related interactions also served as trust-building tools during the reconciliation process between El Salvador and Honduras from 1986 to 1992 (López 2004).

Taken together, the qualitative evidence suggests that building trust and setting positive symbols (highlighted by constructivist theories) is more relevant as an environmental peacemaking mechanism than a spillover of cooperation (emphasized by liberal approaches) (see also Ide 2018b), although more research on the issue is needed. Insights from these and other case studies also strengthen the arguments that the relevant correlations are not driven by reverse causality: positive water-related interactions are not (merely) expressions of a very early stage of a peacemaking process but can actively catalyze a shift toward more peaceful international relations.

This effect is particularly pronounced in the sample of dyads that are already characterized by negative or warm peace and is absent for dyads with more tense relations. This finding is in line with a recent cross-case study claiming that already ongoing reconciliation processes are necessary for successful environmental peacemaking (Ide 2018a) but also with qualitative evidence. When analyzing cross-border water cooperation in Cyprus, Zikos et al. (2015) show that in situations of intense hostility, skepticism toward environment-related interactions prevails, frequently leading to public resistance against and state repression of cross-border

cooperation. Furthermore, even if considerable water-related cooperation takes place, for instance, between India and Pakistan on the Indus River, its effect on the overall situation is rather limited if conflict is far more prevalent than cooperation in other domains (Swain 2002).

Previous qualitative and quantitative studies also suggest that if environmental cooperation contributes to environmental peacemaking, it is usually not the most important factor but rather combines with and reinforces other processes, such as political negotiations, external mediation, and economic coordination (Ide 2018b). In line with this, the inclusion of positive water-related interactions hardly improves the model fit (Table 2), hence indicating that water-related cooperation is not the most important predictor of shifts toward more peaceful relations.

These results speak to the wider literature in at least two broad ways. First, scholars of international relations and international water politics have for a long time conceived environmental cooperation as a dependent variable whose occurrence (Giordano et al. 2014; Young 2016) and effectiveness (Garrick and De Stefano 2016; Mitchell and Zawahri 2015) have to be explained. Conversely, scholars of rivalry termination and international peacemaking have so far hardly paid attention to environmental issues in general and to water cooperation in particular as relevant explanatory factors (e.g., Goertz et al. 2016; Kupchan 2010; Rasler et al. 2013). The findings of our study highlight that environmental and especially water cooperation can also be conceived of as independent variables that potentially have a transformative effect on international politics by catalyzing shifts toward more peaceful relations.

Second, a large body of literature has discussed the question of whether renewable resource scarcity and climate change are potential causes of violent conflict, with water being a key component of these debates (Sakaguchi et al. 2017; Seter et al. 2018). However, our results indicate that environmental cooperation in the form of positive water-related interactions also offers opportunities for forging closer ties between states, hence supporting calls in the environmental security literature to focus more strongly on cases of peaceful adaptation to environmental stress (Adams et al. 2018; Barnett 2018).

This said, several uncertainties and puzzles remain. Just like Barquet et al. (2014), we find that environmental peacemaking is a long-term process that needs a decade or more to show results. In contrast to a time lag of ten years, the number of positive water-related interactions in the previous two, five, and eight years is still positively, but no longer significantly, correlated with shifts toward more peaceful relations in our analysis (Table 3). However, another cross-case study on environmental cooperation and international reconciliation yields the most significant results when using a time lag of five years (Ide 2018a). Several case studies, for example, on Israeli–Jordanian water negotiations in the 1990s (Haddadin 2011) and the Mahakali Treaty between India and Nepal (Swain 2002), also provide some support for a more short-term effect of environmental cooperation. These disparate findings reveal that the temporal dimensions of (water-related) environmental peacemaking are not yet well understood.

There are also some potential issues with the data sets we used. The peace scale data, for instance, are fairly new, and coding errors might not yet have been detected. This is especially relevant when it comes to secret or informal agreements, which already indicate an improvement of mutual relations months or years before official declarations are made. If the improvements of relations in a dyad started earlier than indicated by the peace scale data, this could raise endogeneity concerns, because some of the water-related interactions would have taken place after relations already (slightly) improved. However, we believe that using a time lag of one to ten years provides a safeguard against such problems.

Furthermore, the data on water-related interactions could be biased, as the underlying databases tend to underreport events for countries that are peripheral or where English is not an official language. This is especially the case for minor cooperative events. We cannot tell whether and how such a bias affects our results. Also, IWED does hardly contain data on secret water negotiations, but researchers have argued that such negotiations can be crucial for building trust between both sides, as exemplified by the secret “picnic table talks” between Israel and Jordan (Abukhater 2013).

Conclusions

This study provides one of the first empirical, cross-case tests of the environmental peacemaking approach. Specifically, we analyzed whether positive, water-related interactions in the previous ten years make a shift toward more peaceful relations between two states more likely. Our results suggest that such water cooperation indeed has a positive and significant effect on the improvement of interstate relations. This is particularly the case for dyads that are free of acute conflicts and at least characterized by negative peace. Sixty-two percent of the dyad-years in our sample belong to the latter category, including several cases that feature considerable tensions, such as Armenia–Turkey (1992–2006), Egypt–Israel (1990–2006), and Qatar–Saudi Arabia (1972–2006). Our findings are highly relevant, as they suggest that policy makers, donors, and civil society activists could address concerns related to environmental degradation and peace and security simultaneously by facilitating international water cooperation (Conca 2002).

Our study suggests several promising pathways for future research. To start with, it is worthwhile for environmental security scholars to focus not only on instances of conflict and violence but also on instances of cooperation and peacebuilding in the face of environmental stress. This is particularly the case at the intrastate level, which is not within the purview of this article but on which environmental and climate security scholars have built considerable expertise (Setzer et al. 2018).

Furthermore, research on international relations and environmental politics should pay more attention to environmental cooperation as an independent variable rather than as a (desired) outcome to be explained. This would allow for

fruitful cooperation between environmental politics research and peace studies to enhance knowledge on environmental peacemaking (which is a very young research field). Scholars have gone a long way, for instance, in figuring out how water cooperation might be achieved and how water conflict can be avoided (e.g., Ovodenko 2014; Petersen-Perlman et al. 2017; Zeitoun and Mirumachi 2008). As our study demonstrates, drawing on this expertise and data strongly benefits research on the impact of water cooperation on wider international relations.

When conceiving environmental cooperation as an independent variable, several options will move research on international environmental peacemaking forward. An improved peace scale with more than five categories would allow for a more nuanced analysis, but one can also draw on other indicators of more peaceful relations, such as reconciliation (Rasler et al. 2013), the absence of militarized disputes (Barquet et al. 2014), and closer economic ties (Barbieri et al. 2009).

An improvement of international relations can also be facilitated by cooperation on other environmental issues, such as conservation and renewable energy. Cooperation and peacemaking linked to these topics might follow different trajectories, for instance, because water (just like energy) issues are often more closely tied to strong political and economic interests than conservation concerns (Weinthal 2004). We hence encourage the development of environment-related interaction data sets similar to IWED, for instance, by extracting information from the Global Database on Events, Language, and Tone (GDELT 2018). Researchers could also utilize data on transboundary conservation areas (Barquet et al. 2014) and international environmental agreements (Ovodenko 2016). Coding existing agreements for institutionalized cooperation provisions (such as joint management boards) would allow more nuanced analyses of the impact of (various form of) environmental cooperation on interstate relations.

Finally, the causal mechanisms connecting environmental cooperation to peacemaking, and especially the time scales on which they operate, are not yet fully understood (see discussion section) and deserve further attention by both quantitative and qualitative studies. Conducting research along these lines would allow for fruitful interdisciplinary cooperation and further the capability of environmental peacemaking research to provide policy-relevant insights.

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