International Water Cooperation and Conflict: A New Event Dataset

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Abstract

Many qualitative case studies provide valuable insights into the determinants of international water cooperation and conflict. In recent years, several researchers have moved on to large-N research in order to find out to what extent some of the case-specific results are empirically relevant across larger sets of international river basins. One major challenge in this large-N work concerns data. This paper describes a new event dataset on international river basin cooperation and conflict worldwide for the time-period 1997-2007. Water-related events between riparian countries are characterized on a scale ranging from -6 (most conflictive) to +6 (most cooperative). We provide descriptive statistics for the new data and compare them to the only other publicly available dataset on international river basin events, the Transboundary Freshwater Disputes Dataset (TFDD). Our data confirm that cooperation outweighs conflict; there are no reported offical interactions in many of the world's river basins; most documented interactions concern issues of water quantity and infrastructure; and cooperation and conflict are not mutually exclusive, but often occur in conjunction. However, the comparison also indicates substantial differences that stem from different sources for newsmedia information, different search strings for selecting news-media items, differences in substantive definitions, and differences in coding rules and procedures. Future research on the causes of international water cooperation and conflict is likely to produce more robust results now being equipped with two independently generated complementary datasets.

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1. Introduction

Many scientists and policy-makers focusing on natural resources and the environment have voiced concern that water is one of the most contested and therefore conflict-prone renewable natural resources. Freshwater systems thus offer important opportunities for studying key questions of international conflict and cooperation.

While the total amount of global freshwater is constant, the geographic distribution and quality of water resources exhibit great variation, partly for natural reasons, but partly also because of human activity. Increasing population density, economic activity, and unsustainable water management practices have led to over-appropriation and degradation of many of the more easily accessible freshwater resources at local and regional levels.[1] Many of these water systems extend across international boundaries. Around 260 freshwater systems are in fact shared by two or more countries, covering around 45% of the Earth's continental landmasses.[2] Some areas of the world suffer primarily from acute water scarcity, others from pollution. All of these problems have direct implications for human health, ecosystems, and socioeconomic development more broadly.[3]

Are we facing a Malthusian trap of constant or, due to climatic changes, even diminishing water supply on the one hand and increasing water demand on the other (see authors)? If so, will increasing over-appropriation and degradation of freshwater systems lead to conflict among countries sharing these systems, or will it motivate more cooperation? What are the conditions under which conflict or cooperation is more likely?

The existing literature has, until a few years ago, addressed these questions primarily by means of qualitative case studies of individual international freshwater systems, or comparison of a few such systems. These studies describe and analyze the processes that lead to international conflict or cooperation.[4] The obvious limitation of such studies is that their results tend to be context-specific and are thus hard to generalize.

[1] Alcamo, Flörke, and Marker 2007; and Vörösmarty et al. 2010

[2] Wolf et al. 1999

[3] Bernauer and Kalbhenn 2010

[4] Dinar and Dinar 2003

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Quantitative, large-N research has, in recent years, sought to produce more generic insights into the determinants of cooperation and conflict in international river basins.[5] One major challenge in such large-N research concerns data availability, notably with respect to the dependent variable (cooperation, conflict). These challenges have motivated us to construct a new event dataset on international river basin cooperation and conflict worldwide, which we present in this paper.

Some of the existing large-N work on the subject uses an analytical setup that defines the dependent variable in terms of militarized interstate conflict and relegates water problems to the other (independent) side of the equation. For instance, it examines whether water scarcity or sharing an international freshwater system increases the probability of militarized interstate disputes.[6] While providing valuable insight, in a large-N context, into the relationship between water and war, these studies' dependent variables capture only extreme forms of interstate conflict and do not address cooperation. Moreover, they do not offer direct information on whether a conflict was motivated, primarily or in part, by water problems. Other large-N studies explaining cooperation and conflict over water typically use three types of dependent variables: water-related international treaties; river claims; or data on cooperative and conflictive events pertaining to international rivers and lakes.

Studies focusing on treaties – usually defined as a binary variable, whether a treaty for a given international freshwater system exists – are interesting because international treaties are usually the legal backbone of international cooperative efforts.[7] However, treaties can proxy for cooperation, but not for conflict, and do not capture forms of cooperation other than those materializing in the form of a treaty. Trying to address this limitation, other studies code and use event data that identifies and characterizes cooperative and conflict events between countries in international river systems. One such effort is the Transboundary Freshwater Disputes Database[8], the other the ICOW River Claims dataset[9]. As discussed below, coding event data for international river basin cooperation and conflict is

[5] Notably, Wolf, Yoffe, and Giordano 2003; Espey and Towfique 2004; Furlong, Gleditsch, and Hegre 2006; Conca, Wu, and Mei 2006; Brochmann and Gleditsch 2006; Gleditsch et al. 2006; Gizelis, Powers, and Wooden 2007; Hensel et al. 2008; Zeitoun and Mirumachi 2008; Brochmann and Hensel 2009; Hamner 2009; Gerlak and Grant 2009; Stinnett and Tir 2009; Tir and Ackermann 2009; authors; Dinar et al. 2010; and Zeitoun, Mirumachi and Warner 2010.

[6] Gleditsch et al. 2006; and Furlong, Gleditsch, and Hegre 2006

[7] Espey and Towfique 2004; Stinnett and Tir 2009; Tir and Ackermann 2009; and Dinar et al. 2010

[8] Wolf et al. 2011; and http://www.transboundarywaters.orst.edu

[9] http://garnet.acns.fsu.edu/~phensel/icow.html; see also Rothman 2007; The ICOW River Claims dataset project is still ongoing. It has, thus far, been completed for the Americas, Northern and Western Europe, and the Middle East. It focuses on river claims defined as "...evidence of contention involving official representatives of two or more nation-states" (Hensel 2005).

very challenging. Hence we view such events data as complementary to, but not a substitute for, other approaches.

Our new dataset follows the TFDD approach to some extent. The next section describes the main differences between the two datasets. We then discuss how our dataset was constructed, provide some descriptive information, and compare the new data with the TFDD data. Additional information and the dataset itself are available at: <web address>

The comparison of our dataset with the TFDD shows that, at the aggregate level, the two datasets agree on several important points: cooperation outweighs conflict; there are no reported official interactions in many of the world's river basins; most interactions concern issues of water quantity and infrastructure; and cooperation and conflict are not mutually exclusive, but often occur in conjunction. The comparison also shows that the two datasets differ considerably in several respects that are very likely to have important implications for empirical results of studies on the determinants of cooperation and conflict in international river basins. As discussed in the concluding section of the paper, future research on these determinants is likely to produce more robust results in now being able to rely on two independently generated datasets.

2. Novel Elements of the Dataset

Event data have a long tradition in international relations scholarship. Examples include the World Event/Interaction Survey (WEIS) Project (McClelland), the Conflict and Peace Data Bank (COPDAB)[10], or 10 Million International Dyadic Events[11]. Event data are not limited to "extreme" forms of interaction, such as violent conflict or treaty formation; it is very much possible to construct event scales representing a continuum of conflict and cooperation to study interactions at a more fine-grained level.[12]

why event data

Most large-N event data research on international river cooperation and conflict has, thus far, relied on a single data source: the TFDD. Compared to other areas of event data research (e.g. the study of civil war), reliance on a single data source is untypical. The construction of large event datasets always involves important trade-offs and imperfect solu-

[10] Azar 1980

[11] King and Lowe's 2003

[12] Goldstein 1992; and Howell 1983

tions to key challenges, and some mistakes in data coding are virtually unavoidable, no matter how much time is invested and how well-trained and diligent data coders are. The obvious conclusion is that research efforts are more likely to produce robust and reliable findings if they are able to build on two or more datasets that were generated independently. In this section we highlight the most important differences between the TFDD and our new dataset. The following section demonstrates that these differences have important implications for the resulting dataset.

The TFDD approach is very useful in that it covers both cooperative and conflictive events among country pairs in international river basins. It also covers events that are less intense than militarized interstate conflict and, conversely, less intense than the conclusion of an international water treaty. For these reasons we follow the event data approach. However, our data generation process differs from the TFDD in several important ways:

First, our dataset provides more explicit information on both events and non-events. In particular, it distinguishes river basin-country-pair-years that experienced neutral (neither cooperative nor negative) events from river basin-country-pair-years where no water-related interactions of any type were observed.[13] Distinguishing more clearly between neutral events and non-events results in considerable differences between the two datasets. For instance, our dataset codes more events than the TFDD for the Nile in the time-period 2000-2005. Table A.5 in the Appendix lists the number of events per river basin in the time-period 1997-2007. Our dataset lists all river basin-country pair-years (based on a revised version of the Owen, Furlong & Gleditsch, 2004 data, see Table A.1 in the Appendix), with a dummy variable indicating whether or not an event occurred in a given river basin-country-pair-year.

Second, the search algorithm (see next section) used by the TFDD for retrieving newsmedia reports (the "raw-material" from which the event data is coded) from digital archives differs from the algorithm we used. The main empirical implication of this difference is that our dataset includes more events than the TFDD (see next section). For instance, we found Bulgaria to be involved in six events regarding water quality in the Danube in 1999, whereas the TFDD identifies three events. Regarding the Kura-Araks basin we found two

[13] While the recently revised/updated version of the TFDD (De Stefano 2009 and 2010) provides some clarity in that events coded zero refer to neutral events, it remains unclear whether the absence of events indicates that during the specified dyad-basin-year no events were identified or whether the coding had not yet been completed. The TFDD team could not provide a conclusive answer to this issue upon our request.

events in 1998, both of which are not in the TFDD. For many of the international river basins we coded for purposes of a feasibility study, using FBIS (the main source the TFDD was based on at the time of our cross-checks, other newsmedia sources were added later), at least one event per year identified through our search algorithm was missing in the TFDD. It should be noted, however, that in the course of the recent update of the TFDD the search string was revised.[14] This points to yet another difference in the information retrieval process between the two datasets: we consistently use a uniform search algorithm and one newsmedia archive (BBC Monitoring, see below) for the entire time-period covered by our dataset; the TFDD uses various newsmedia sources and has changed its search algorithm over time. The results of a more systematic comparison of the TFDD with our dataset are discussed in the next section.

Third, the TFDD's BAR (Basins at Risk) scale is based on the WEIS and COPDAP scale. Our International Rivers Cooperation and Conflict scale (IRCC scale) drops categories on the COPDAP scale that are, with regard to international rivers, empirically irrelevant (notably -7 and +7, i.e. major war, unification of two countries) and fine-tunes the remaining categories to better fit the empirical context of shared water resources.

Forth, we add several new variables. We include a saliency indicator (taking into account public concern as expressed in press articles) and additional information on events (e.g. the direction in terms of which riparian country's officials act with respect to whom, characteristics of the information source, whether an event is linked to other events).

Finally, the TFDD is conceptualized primarily for selective information retrieval from a database via a website. While the TFDD team kindly provided us with a spreadsheet version of the data, several data management steps (detailed further below) were required to render the data compatible with the requirements for systematic statistical analysis. Our dataset is available in a common large-N format that can very easily be transformed into dataset structures with different units of analysis (e.g. river basins or river basin-country-pairs per year). We use common identifiers, such as Correlates of War (COW) country codes and the PRIO shared rivers dataset basin codes, to facilitate merging with other dataset for inferential analyses.

[14] De Stefano et al. 2009, 2010

3. Dataset Construction

3.1 Unit of analysis and dataset structure

The unit of analysis in our dataset is the *river basin-country-pair-year*. That is, for each international river basin we group the riparian countries of that basin into pairs (such that each country is grouped with each remaining country once per year). We observe and code whether any water-related events took place among a given country-pair in a given year, and the intensity of cooperation or conflict of these interactions. Each event enters as a separate row in the datamatrix allowing for event-level analyses. At the same time, users may collapse the data by basin, country-pair, or year and only consider aggregate cooperation and conflict intensities. This dataset structure is standard in the international cooperation and conflict literature, with the exception that our structure has one additional level of complexity, in that we pair countries only when they share an international river basin.

The dataset is based on undirected dyads. This means that for instance, an event in which Hungary and Romania accuse each other of polluting the Danube is coded once, rather than twice in directional form. Directional would mean that one observation records behavior of Hungary towards Romania and another observation records the behavior of Romania towards Hungary. Nonetheless, directional analysis of our data is still possible because the variable *direction* indicates which country (if any) was the initiator of the event. The data is arranged so that the first country code in any given country-pair is always the smaller of the two. This setup facilitates merging the data with other dyadic datasets.

This dataset structure has the advantage that events can be traced back very easily to both the river basin and the country (or country-pair), making it easy to change the unit of analysis. Several large-N studies on international river basins suggest that results can differ depending on whether the river basin-country-pair-year or the river basin-year is the unit of analysis.[15] Our structure also allows for easy merging with many other datasets that offer information at the country, country-pair, river basin (or any combination thereof) - we use Correlates of War country codes to identify countries and the international river basin IDs of the PRIO shared rivers dataset[16] to that end.

[15] E.g. Hoffman 2003; Espey and Towfique 2004; Gerlak and Grant 2009; Hamner 2009; and Tir and Ackerman 2009

[16] Owen, Furlong, and Gleditsch 2004

3.2 Coverage

Our dataset covers all international river basins from 1997 to 2007. In identifying international river basins we follow the standard approach in hydrology defining a river basin "...as the area which contributes hydrologically (including both surface- and groundwater) to a first order stream, which, in turn, is defined by its outlet to the ocean or to a terminal (closed) lake or inland sea. Thus, river basin is synonymous with what is referred to in the U.S. as a watershed and in the UK as a catchment."[17] Whenever a perennial tributary in a given basin extends across the political borders of two or more countries, the respective river basin is international. This definition subsumes rivers that form part of a larger international river basin. For instance, the Yarmuk is part of the Jordan basin, the Amu Darya is part of the Aral sea basin. We exclude river basins where only an extremely small part is located in another country - this makes them, for all practical purposes, domestic rather than international river basins. Several such cases exist along the border of Norway and Sweden, for instance. As noted above, we rely on a revised version of the Owen, Furlong & Gleditsch (2004) list of international river basins and country pairs, which conforms to these characteristics (see Table A.1 in the Appendix).[18] Our choice of time-period was motivated by considerations of data quality regarding newsmedia items: we checked several newsmedia archives and found BBC monitoring to best fit our needs. This archive dates back to 1997

If more than one event is recorded for a given basin-country-pair-year, each such event is recorded as a separate observation in the dataset. If there is only one event or no event for a given basin-country-pair-year, the dataset contains one observation for this unit.

[17] http://www.transboundarywaters.orst.edu/publications/atlas/atlas_html/thematicMaps.html

[18] The revisions were mostly carried out in collaboration with Marit Brochmann and Nils Petter Gleditsch from PRIO. Owen, Furlong & Gleditsch (2004) list all river-sharing dyads from 1816 to 2002, including both contiguous and non-contiguous countries. This data can easily be extended to 2007 because, according to the Correlates of War (2008) System Membership Data, no significant changes in riparian countries sharing an international river have taken place, with the exception of Montenegro's independence in 2006. Rather than including all dyads in the international system, the dataset only includes those that actually share a river. However, certain instances in which a former riparian (i.e. Russia with former Soviet countries) interacts with current riparians are maintained in the dataset. In these cases, the variable *ev* assumes the value 1; hence such events can be removed if needed.

3.3 Information retrieval

Information on water related events was retrieved from newsmedia reporting made accessible through BBC Monitoring (http://www.monitor.bbc.co.uk/).[19] The latter provides texts, translated into English, from local newsmedia, international newswire services, and other sources. We used these text documents for content analysis to create an event-dataset that relies on local, national, and international news rather than on large western press agencies such as Reuters alone. Including local sources is important in our context, where events that are of local (or regional) importance may not feature high on the international agenda and may thus be ignored or underreported by globally active news agencies.[20] As noted above, we thus use a single newsmedia archive (BBC Monitoring) and a uniform search string for retrieving information from this archive, whereas the TFDD uses varying sources over time and has modified its search string over time as well. The recording-units[21] are individual newsmedia items that were extracted from the BBC Monitoring Database using the search strings described in the Appendix.

Content Analysis: Choose Media Sources: BBC Monitoring
Choose Searching Method: Search Strings

With this approach we obviously face the same challenges as virtually all other event dataset projects, namely selectivity of the newsmedia in their reporting. As noted by Franzosi: "...perhaps all data are biased in some ways. What is important is to know the type and form of bias in order to be able to gage its effect on evidence and conclusions."[22] For this reason, we include a variable that indicates the impartiality of the newsmedia source, based on whether or not reporting is independent of the government. Data for this variable is coded based on information by FBIS (http://wnc.dialog.com/).

3.4 Coding

Using various types of newsmedia reports (including newspaper articles), rather than newswire reports from one global news agency (e.g. Reuters), has important implications for coding. The heterogeneity of news sources comes with strong heterogeneity in how events are described and commented on. Even though automated coding is becoming

[19] We tested FBIS and BBC Monitoring for a randomly chosen set of international rivers and years and found BBC monitoring to have the most extensive and efficient coverage, where efficiency refers to how much relevant information a given search string generates.

[20] Our dataset makes it easy to move from information on a given river basin-country-pair-year to the raw data on individual events to cross-check and if necessary revise/correct data based on BBC Monitoring or other sources. Specific newsmedia texts used for the coding are available from the authors on request.

[21] E.g. Krippendorff 2004, 99-100

[22] Franzosi 2004, 172

automatic coding; human coding;

more popular in the social sciences[23] we concluded that potential efficiency gains would be overshadowed by too many coding errors. We thus relied on human coding. Automated analysis of newsmedia texts in ways that capture the semantic context imposes very high requirements on coding software because such items vary strongly in length, style of writing, and vocabulary.[24] Commonly used software, such as KEDS and the VRA-Reader are optimized for Reuters' lead paragraphs. These parsers are not capable of deciphering the semantic context of complex texts found in a more heterogeneous set of newsmedia reporting.[25] Other routines, such as Relation Mining, manage different types of text-input, but are constrained in the topics they are capable of coding correctly.

the problems with human coding

Besides the problem of labor-intensity, the main challenge with human coding is of course subjectivity. Coding water cooperation and conflict requires an assessment by the coder of whether a cooperative or conflictive event is in fact water related, and how intensive the respective event is. To minimize subjectivity in coding we established standardized coding rules and rigorously trained all coding assistants to make sure these rules were well understood and complied with. In addition, we regularly checked whether data collection and processing were consistent with the coding rules. Moreover, we included several variables that permit tracing of potential coding errors. For instance, we used both a string code and a numeric code for international river basins, countries, and types of events. The data generation and data management process was documented in a consistent manner. Any problems concerning how to code certain events were documented in a traceable way to permit replication.

To allow for maximum transparency, the variables *date* and *source* can be used to identify each newsmedia item we coded. Consequently, in case of doubt concerning the accuracy of a specific coding, these can easily be cross-checked. Finally, each coding assistant recoded a sub-sample of river basin-years previously coded by a different assistant.[26] We found that different coders in most cases agreed on codings for cooperation or conflict levels (our most important variable), the direction of action, the issue dealt with, and whether or not an event constitutes a new event or is connected to a prior event. There was more disagreement with respect to codings of salience.[27]

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[23] E.g. Schrodt 2000 — automatic coding method

[24] Wüst 2006, 9

[25] Wüst 2006, 15

[26] E.g. Hodson 1999, 29

[27] Please refer to the appendix for more details on intercoder reliability

The coding process focuses on more than 20 variables (Table 1). *Country, ccode,* and *acr* are coded for each of the countries involved in a given event. They provide the name of the respective country (string), its cowcode, and its cowacronym.[28] We use cowcodes and cowacronyms as unique identifiers because many country- or dyad-level datasets in research on international cooperation and conflict rely on these codes. *basinname* is the name of the international river basin, *basinno,* and *basinacr* are a unique number and acronym assigned to each river basin. We use the numbers and acronyms of PRIO's shared rivers dataset.[29] The river *basin* names (basin) were revised in collaboration with PRIO (see Table A.1 in the Appendix). Basinnameuni is a unique basin name for each basin number (see Appendix A.1). Again, this approach facilitates the merging of our data with data from other sources.

Table 1 about here

The variable *year* records the year in which an event occurred. In combination with basin and country codes it allows for the analysis of our data at different levels of analysis (country-year, country-pair-year, basin-year). Disaggregating the data to monthly, weekly, or even daily events makes little sense in our context because most covariates commonly used in this area of research (e.g. economic indicators, political system data) are only available on a yearly basis. However, we also code the specific date (*date*), that is, the day an event reportedly occurred.

Issue and *issueno* identify events as concerning "water quality", "water quantity", or "joint management". These three categories are identical to those used in the TFDD. Water quality refers to events concerning pollution. Water quantity refers to events concerning water scarcity and allocation. Joint management concerns events that alter the flow of a river, for instance the construction of a dam (for coding examples refer to Table A.7 in the Appendix). Distinguishing issue areas facilitates analysis of whether the extent of cooperation or conflict differs across issue areas, and/or whether determinants of cooperation or conflict do so. The issue codes allow researchers to split the dataset along issue lines. *Issueno* assigns a number to each of these three categories, whereas *issue* is a string variable. This redundancy also facilitates checks for coding mistakes. For instance, in a pilot

[28] See http://www.correlatesofwar.org/.

[29] http://new.prio.no/CSCW-Datasets/Geographical-and-Resource-Datasets-/Shared-rivers/

project we found that one coder consistently coded *issueno* 3 instead of 1 and vice versa; this error was easily detected and removed by cross-checking with the string variable *issue*.

Event is a short description of the event, for example "Turkish prime minister visits Bulgaria, proposal on dam in Arda river", or "letter of Bulgarian environment minister to Serbian counterpart proposing joint expert group on waste water discharge". This description is included for reasons of traceability.[30]

level of cooperation or conflict associated with each event

Tightly linked to the event description is the variable "ircc", the key variable in our dataset. It codes the level of cooperation or conflict associated with each event. It is coded in integers ranging from -6 to +6. Table A.2 in the Appendix describes the thirteen categories. Like the TFDD bar-scale[31], our ircc scale builds on the WEIS and COPDAB scales, but differs from those scales in substance. The TFDD scale ranges from -7 (formal declaration of war) to 7 (voluntary unification into one nation). Because both -7 and 7 are never observed empirically with respect to water events, we dropped these two categories. Moreover, we revised the remaining 13 categories in ways that are more specific to the context of international water issues. For example, a bar scale value of +5 in the TFDD refers to military, economic or strategic support, such as "selling nuclear power plants or materials".[32] On our scale, category +5 refers to official support for signing of an international freshwater treaty.

Descr is a variable that can help in avoiding coding mistakes. Whereas *event* is a short description of the specific event, descr is a verbal statement concerning the type of event, such as "signing of freshwater treaty" (ircc=+5) or "meeting of high officials discussing joint water issues" (ircc=+1). These descriptions coincide with those used for describing the ircc categories.

The variable *direction* indicates whether cooperation is mutual or unidirectional. If country 1 initiates the event, *direction* takes the value 1, if country 2 does so, *direction* takes the value 2, and if the event is mutual, *direction* is coded 3. This variable can, for instance, be used in studies that seek to explain which country (within a given country pair) is likely to behave more cooperatively).

[30] Note that the statistical software package we used (STATA) limits string variables to 80 characters so that longer variable names might end abruptly. However, 80 characters should be sufficient to trace the respective text element if necessary.

[31] Yoffe and Larson 2002

[32] http://www.transboundarywaters.orst.edu/database/event_bar_scale.html

We add a variable that captures the public saliency of problems concerning international rivers. This variable may be useful in research on international water cooperation and conflict, for salient issues are more likely to lead to (positive or negative) government action than less salient ones. The variable *salience* uses three[33] qualitative categories to code the saliency of water issues as expressed in newsmedia reporting. In particular, an event is coded as highly salient if many citizens are (potentially) affected; low salience refers to events that hardly affect anybody; and any events inbetween these two extremes are coded to be of medium salience. One potential problem with this saliency measure is that newsmedia reporting in autocratic countries is likely to be biased, depending on the interests of the ruling elite. The fact that we take into account newsmedia reports on the same event from several sources, including international newsmedia, the two riparian countries concerned, and other countries should mitigate this problem to some extent. However, we add a dummy variable *neusour*, which indicates the independence of the newsmedia source from the government. Users of our data can thus control for the independence of newsmedia sources and examine, for instance, whether autocracies and/or dependent newsmedia tend to overreport cooperative (or conflictive) events. *Source* and *sourceloc* refer to the name and the location of the newsmedia sources used to code events.

Finally, the variable *case* assigns a unique number to each case. That is, the first observation is coded 1; for each subsequent observation this number increases by one if this observation is a different event and stays the same if it concerns the same event (irrespective of the dyad or year the event occurs in). This variable helps in identifying whether governments really cooperate (or experience conflict) on many different issues, or merely interact on the same issue repeatedly. For instance, when India and Pakistan discuss the same hydro-power project on the Indus several or many times, the variable *case* has the same integer value for all related events (coding examples can be found in Table A.7 in the appendix). Depending on the purpose of their studies, users can decide whether to weigh repeated events differently in constructing cooperation-conflict scales or simply aggregate ircc scores for related events rather than treating them as if they were independent.

[33] In a pilot test we found that using more categories makes coding less reliable.

5. Descriptives

Most international river basins in our dataset are shared by two countries, some by 3 or 4, and only very few by 5 or more countries. The basin with the largest number of riparians is the Danube (18). It is hardly surprising, therefore, that a disproportionally large number of events (26% of all events recorded in our dataset) take place in the Danube basin (Table 2). The large number of riparian countries implicates that, for instance, a meeting of the International Commission for the Protection of the Danube attended by all riparian countries generates 153 dyadic events. Table 2 therefore also displays the number of cases per event, that is, the number of unrelated events. Even in terms of unrelated events, the Danube ranks highest. Other basins, such as the Amur show a relatively high number of related events and only a moderately high number of unrelated events.

Table 2 about here

The distribution of events across country pairs is uneven as well. The most extreme case concerns Hungary and Slovakia, which are associated with more than 5.2% of all events, all of them dealing with the river Danube (table 3). Most of these events relate to a lengthy dispute between the two countries over the Gabčíkovo – Nagymaros Dams project. However, once the data is aggregated to the case level, Sudan and Egypt are the countries featuring highest on the list with 62 distinct events (table 3). Hungary and Romania are associated with many Danube related events as well (around 2% of all events). Many of these events concern an important (accidental) water pollution event in Romania that had massive downstream effects in Hungary and other Danube countries. Romania and Ukraine experienced a lengthy dispute (accounting for about 2.5% of all events) because of Ukrainian plans to construct a canal in the Danube Delta area; this plan is opposed by Romania. Besides these events involving riparians of the Danube, Russia and China are also responsible for more events than other dyads (about 2% of all events). Those events concern the Amur and Tumen river basins.

Table 3 about here

Figure 1 about here

In presenting distributions of cooperative and conflictive events, we distinguish between events and non-events, that is, river basin–country dyad–years in which no event occurs and those where events occurred. In more than one third of all basin-dyad-years covered by our dataset, some event occurred. Slightly more than half of these events concern joint management, whereas 19% and 26% of the events pertain to water quantity and water quality respectively.

A large share of events concerns joint management. This is why the distributions of total and joint management events over the categories of the ircc-scale are somewhat similar (Figure 1, upper left and right panels). Very few extreme events occurred in the time-period covered by our dataset: 2 events of a highly cooperative nature took place (+6 on the ircc-scale); 8 events of a highly conflictive nature occurred (-5 on the ircc-scale). Whereas events concerning joint management span almost the entire range of possible intensity scores, events concerning water quality only range from -4 to +4.[34] The median of all 5881 events on the cooperation-conflict spectrum is 2. The distributions of total events as well as joint management and water quality events are visibly skewed towards the cooperative side of the spectrum. There is no obvious time-trend in the frequency of conflictive, cooperative and neutral events (figure 2).

Figure 2 about here

While 5881 observations in our dataset record events (36.84%; nev=0), 10084 observations (63.16%, nev=1) are basin-country-pair-years with no reported events. In 74 of our 262 basins, we observe at least one event in the time-period 1997-2007. By implication, no event was reported in the remaining 188 basins (Table A.9 in the Appendix lists all basin-country pairs with no recorded events). While this phenomenon is less acute than the rare-

[34] For example: one of the most conflictive events (-5; no events with a conflict intensity of -6 were reported in our period of analysis) is "A Romanian border guard boat forces a Ukrainian cruise ship off course, aiming Romanian guns at the passengers". This event took place between Romania and the Ukraine in October 2004. Interestingly, one of the most cooperative events happened earlier that year between the same two countries: "Romania approves draft law on ratification of Romanian-Ukrainian treaty on state borders and mutual assistance" (providing for a joint border commission to establish the river border line). The other highly cooperative event (+6) concerns Kyrgyzstan and Kazakhstan ratifying an agreement regulating the joint use of the water facilities on the Chu and Talas rivers (May 2001).

events phenomenon encountered in research on armed conflict, in our case it raises the issue of how to deal with non-events, particularly in comparison with reported events where the ircc-scale value is zero. Examples of neutral events are “Iran's Director of Ports and Shipping Organization states deepening and widening the Volga Canal by Russia will make the waterway suitable for international traffic”, “both parties (Germany and Poland) said that the regulation of the Oder must be tackled in a trilateral effort, together with the Czech Republic”, or “Bulgarian president Purvanov expresses sympathy with flood victims in Austria, Germany, Czech Republic”. It is obvious that recoding non-events from missing values on the ircc-scale to zero on that scale has massive implications for the overall distribution (figure 2). Based on the *nev* (no event=1) variable users of the dataset can explicitly decide on which approach makes more sense for their research.

Users may also be interested in using the median values of related events – to that end they can use the variable *case* to collapse the dataset to the median value of the respective set of related events.

The data we coded also shows that conflict and cooperation may well go hand in hand. In 15% of the river basins in the IRCC dataset, both cooperative and conflictive events took place at some point in time (Table A.8 in the Appendix). The riparians of the Danube basin, for instance, have experienced a high number of conflictive events, but also a high number of cooperative events (table 4). Depending on the research question in mind, various ways of identifying how conflictive a river basin might be appropriate. Table 4 lists river basins with more than 10 events (of any conflict or cooperation intensity) in total that also have a ratio of conflict events (ircc≤-1) of 10% or higher. Apart from the issue of related events discussed above, newspapers might report more frequently on larger and hence arguably more important basins. Table A.5 in the Appendix weights the number of conflictive events (ircc≤-2 and ircc≤-1) by the number of total events per river basin.

Table 4 about here

Finally, the saliency of around three quarters of all events is low, whereas only three percent of all events are coded as very salient. The large share of low-salience events is partly due to the fact that joint management events are dominant, and around 80% of those events are of low salience. Around 70% of the water quality and quantity events have a low

salience character, and more than 20% a medium level of salience. The distribution is similar when aggregating events.

6. Comparison With the TFDD

To compare the TFDD data with our own data, we went through several data management steps, starting with the raw data of the TFDD.[35]

- We checked the countries listed as being involved in an event against the description of the event and added missing countries whenever necessary and possible.
- We tried to manually identify the countries involved whenever country names were unclear.
- We excluded external actors, e.g. third parties such as international organizations or NGOs.
- We added country codes according to the Correlates of War system.
- We excluded non-international and non-identifiable river basins.
- We added river basin codes (PRIO shared rivers database codes).
- We excluded all events that were of exclusively domestic character (without any potential effects on other countries).
- We added dates whenever these were missing but obvious from the event description.
- We adjusted the dataset structure, so that for each event, each basin-country-pair involved enters as a separate observation. This is the data structure the original TFDD data has in many cases; however, in some cases events involving more than two countries are not properly divided up into all possible country-pairs.

[35] We completed these data management steps in May 2010. Since the TFDD appears to undergo continuous revision and updating it is possible that the TFDD data we are using for comparison is not identical anymore to the TFDD data found in that database at present. Since recent efforts of the TFDD team have focused more on updating to the most recent years, rather than on revisions of data for 2007 and prior, this "moving goal-posts" issue should be minor.

For reasons of commensurability, the following comparison drops events coded zero on the BAR and IRCC scale. The reason is that we were not able to clearly and consistently distinguish non-events from neutral (coded as zero) in the TFDD.

In very general terms, the two datasets agree on several important points: cooperation outweighs conflict; there are no reported interactions in many of the world's river basins; most interactions concern issues of water quantity and infrastructure; and cooperation and conflict are not mutually exclusive, but often occur in conjunction. As to the latter, 18.4% of all river basins in the TFDD dataset experience both cooperative and conflictive events at some point in time. The corresponding number in the IRCC dataset is 15%.

There are, however, substantial differences between the IRCC and TFDD with respect to some basic characteristics. For example, the total number of events differs quite strongly (table 5 and figure 3). The IRCC dataset contains more than twice as many events for the time-period 1997-2007 as the TFDD dataset (4797 vs. 1985) (figure 3). Since the TFDD does not provide information on whether and how individual events are related we are unable to explain this strong difference. The IRCC includes 5881 events, and 4797 events if we exclude events with ircc=0. When we collapse related events into cases (a set of related events), there are 1505 such cases.

Table 5 about here

Figure 3 about here

Because the number of events in the two datasets as well as the range of the cooperation conflict scales differ, any comparison of how observed events are distributed on these scales is challenging. Comparing the median bar- and ircc-score per basin-country-pair-year (figure 4, right panel), which is the most appropriate approach for our purposes, we observe similar yet not identical distributions.

Figure 4 about here

Finally, we compare the shares of cooperative (ircc>0, bar>0) and conflictive (ircc<0, bar<0) events in total cooperative and conflictive events per year (again, the zero category

is excluded). While noticeable differences exist for some years, the overall share, the share of cooperative and conflictive events is very similar (figure 5).

Figure 5 about here

7. Discussion

Many qualitative case studies on international river basins offer important insights into the factors that influence water-related cooperation and conflict between the riparian countries in those basins. In recent years, this large body of literature is being complemented by large-N quantitative studies. Those studies build heavily on the theoretical and empirical findings of prior case study research, but strive for more generalizable inferences than is possible on the basis of case-specific research.

Much of this large-N research on international river basin cooperation and conflict relies on data for the dependent variable (cooperation, conflict) from one single data source, the TFDD. Very much like in other fields of research (e.g. the study of civil wars), the construction of large event datasets on international water issues involves challenges and trade-offs with respect to concept definitions, information sources, coding procedures, and other points. “Objectively correct” solutions to the many challenges arising in event data generation are usually not available. Robust answers to the main research questions of concern can, therefore, only be arrived at through empirical testing of hypotheses on more than one dataset, and ideally several datasets that are generated independently.

This paper does *not* try to show that the new dataset presented here is better than the TFDD. It shows, however, that different choices with respect to concepts, measurement scale, information source, search algorithm, coding procedure, and so on, have important implications for the resulting data. These choices result in important differences between the TFDD data and our dataset for the same phenomenon, the same countries, and the same time-period.

It would be surprising indeed if these differences between the two datasets did not result in significantly different findings in empirical testing of theoretical arguments about interna-

tional river basin cooperation and conflict. A fruitful next step will be to replicate the most important studies that rely on the TFDD data with the data introduced in this paper, such as Yoffe et al (2003, 2004), Wolf, Stahl & Macomber (2003), Wolf, Yoffe & Giordano (2003), or Brochmann & Gleditsch (2006). The former group of papers conclude that conflict is more likely and also more intense when institutional capacity is insufficient to deal with (potential) changes in a basin, i.e. when population density is high, income is low, overall relations between countries are unfriendly, there is a lack of freshwater treaties and large dams or other water development projects are planned. Brochmann & Gleditsch (2006) find a positive relationship between the number of water related events and the signing of freshwater treaties.

If results differ significantly across the two datasets, it will be important to find out which observations are driving differences in results and how discrepancies between the two datasets could be handled or resolved.

non-events

Another important issue that concerns both datasets and should be addressed in further research is how to deal with units of analysis (in our case river basin-country pair-years) for which no events are observed. Should those observations be treated like observations with neutral events? Are those "non-events" due to media-reporting bias or some specific country or environmental problem characteristics? As revealed through the more explicit coding of non-events in our dataset, observations with no reported events account for a large share of total observations. It remains to be examined how sensitive the results of existing studies are to different ways of handling non-events.

Yet another issue that deserves closer attention is the relationship between cooperative and conflictive events. As noted by Zeitoun, Mirumachi and Warner (2010), Wolf et al. (2003), Yoffe et al. (2004), and Zawahri and Gerlak (2009, 218) cooperative and conflictive interactions are not mutually exclusive, but often occur in conjunction. The existing large-N literature offers virtually no systematic insights into how events within any given river basin-country pair affect each other. The explicit coding of related events in our dataset will facilitate such research.

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Tables and Figures in Main Paper

Table 1: Variables

Name	Description
country	Country names (country1, country2), string variable
Ccode	Correlates of War country codes (cow codes)
Acr	Correlates of War country acronyms (acr1, acr2)
Basinname	Unique basinname for each basin number (basinno)
Basinnameold	Basinname according to PRIO or as used in BBC monitoring
Basinno	Basin number, according to PRIO shared rivers dataset
Basinacr	Basin acronym, according to PRIO shared rivers dataset
Year	Year in which an event occurred (1997-2007)
Date	Date on which an event has reportedly taken place (day, month, year)
Issue	"water quality", "water quantity", "joint management", according to the definitions of the TFDD
Issueno	Joint management=1, water quality=2, water quantity=3
Event	Short description of the event
Ircc	level of cooperation or conflict associated with each event, -6 (most conflictive) to +6 (most cooperative)
Descr	Verbal statement concerning the type of event
Direction	Indicates whether event/action is mutual or unidirectional. If country 1 initiates the event, direction takes value 1, if country 2 does so, direction takes the value 2, if the event is mutual, direction is coded 3
Salience	Three qualitative categories for saliency of water issues, as expressed in newsmedia reporting, 1=low saliency, 2 medium, 3=high saliency
Source	Newsmedia source
Sourceloc	Location of newsmedia source
Neusour	Indicates whether newsmedia source is independent from the government
case	Unique number, allows for identification of related events
nev	Dummy variables for identifying basin-country-pair-years with no event

Table 2: International river basins with more than 10 cases and/or more than 100 events

Basinnumber	Basinname	# Cases	# Events
59	Danube/Donau Basin	144	2181
130	Nile Basin	106	1529
231	Zambezi	26	183
122	Mekong	23	313
104	Euphrates Tigris Basin	18	273
131	Ganges Brahmaputra Meghna Basin	13	49
64	Aral Sea Basin	13	25
50	Elbe/Labe	12	29
114	Indus	10	49
35	Amur	7	169

Note: cases refers to unrelated events, whereas events simply counts interactions irrespective of whether or not they are related.

Table 3: Country-pairs whose share in total cases and/or events is greater than 5%

country1	country2	# cases	# events
Sudan	Egypt	62	100
Ethiopia	Egypt	57	87
Ethiopia	Sudan	46	63
Bulgaria	Romania	43	98
Romania	Ukraine	41	291
Hungary	Slovakia	37	306
Uganda	Egypt	37	52
Kenya	Egypt	35	58
Hungary	Ukraine	31	118
Yugoslavia (Serbia)	Bulgaria	31	51
Hungary	Romania	31	235
Russia	China	15	182
Turkey	Iraq	10	133

Table 4: International river basins with a large share of conflictive cases and/or events

basinname	basinno	# cases	# conflict cases	ratio	# events	# conflict events	ratio
Ganges Brahmaputra Meghna Basin	131	13	6	46.15	49	20	40.82
Niger	139	6	2	33.33	57	4	7.02
Tumen/Rumen	80	6	2	33.33	30	7	23.33
Indus	114	10	3	30	49	14	28.57
Amur	35	7	2	28.57	169	40	23.67
Aral Sea Basin	64	13	3	23.08	25	9	36
Danube/Donau Basin	59	144	32	22.22	2181	422	19.35
Elbe/Labe	50	12	2	16.67	29	3	10.34
Zambezi	231	27	4	14.81	183	35	19.13
Nile Basin	130	106	12	11.32	1529	162	10.6

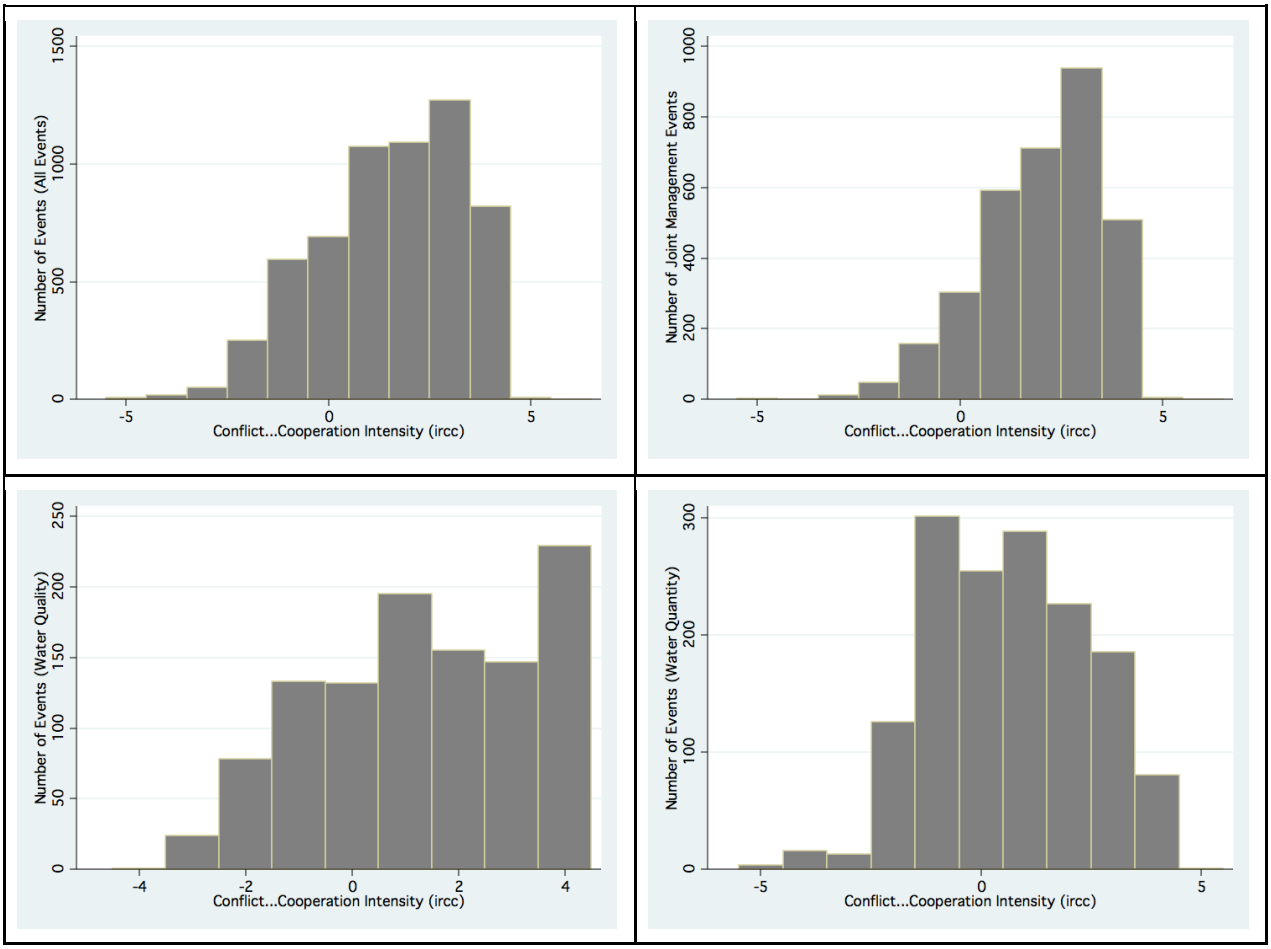
Table 5: Basic characteristics IRCC and TFDD

	IRCC	TFDD
No of basins	262	261[36]
no of dyads	760	725
No of basin dyads	1279	1243
Total no of events	4797	1985
Year with most events	2000	2004
Year with least events	1997	2006
No of basins with at least one event	70	96

Note: Events where ircc=0 and bar=0 are excluded.

[36] This number refers to the number of basins in the TFDD as provided by its authors. A paper describing the recent update of the dataset, states 265 basins for the period until 1999 and 276 thereafter. The Oyupock/Oiapoque basin is included in our data but missing in the TFDD data.

Figure 1: Distribution of events on the cooperation–conflict spectrum



Notes: the unit of analysis for figure 1 is the basin-country-pair-year-event. This means that basin-country-pair-year observations with no recorded events (nev=1) are not considered.

Figure 2: Conflictive, cooperative, and neutral events, per year

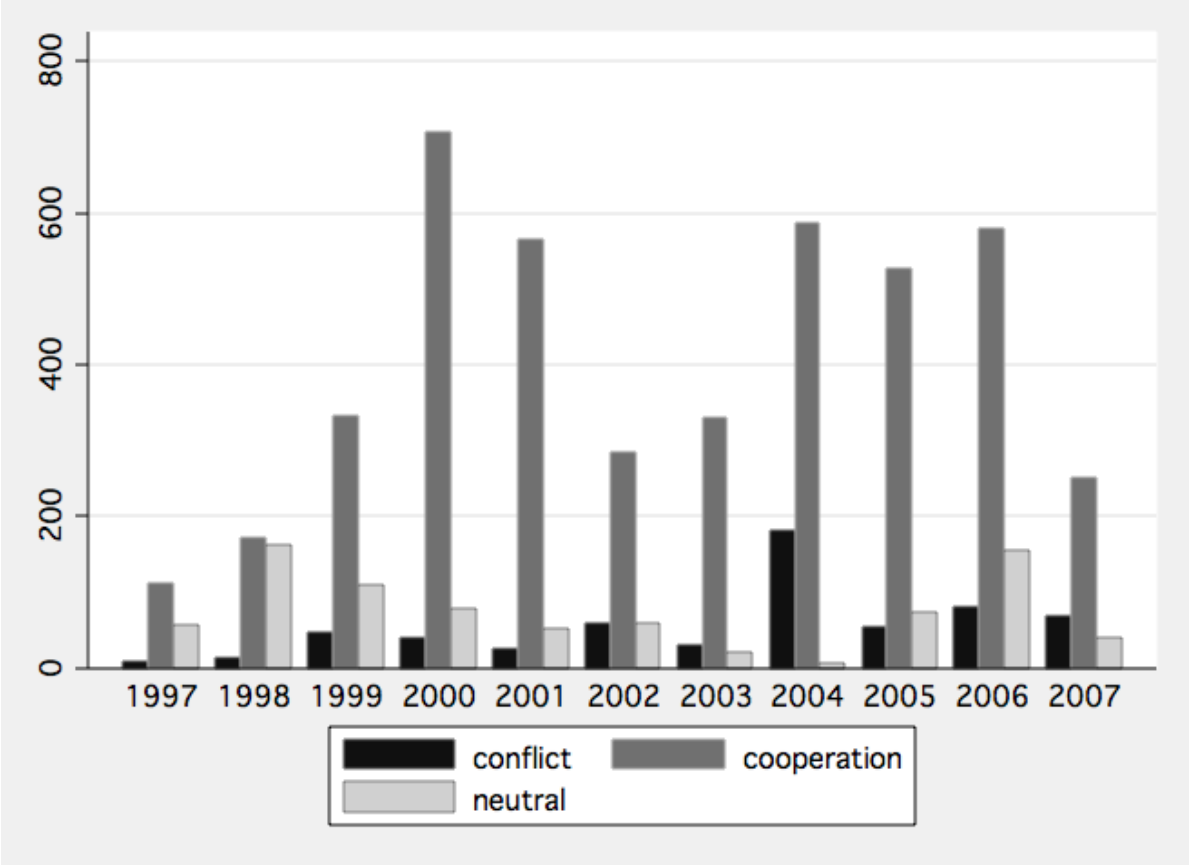
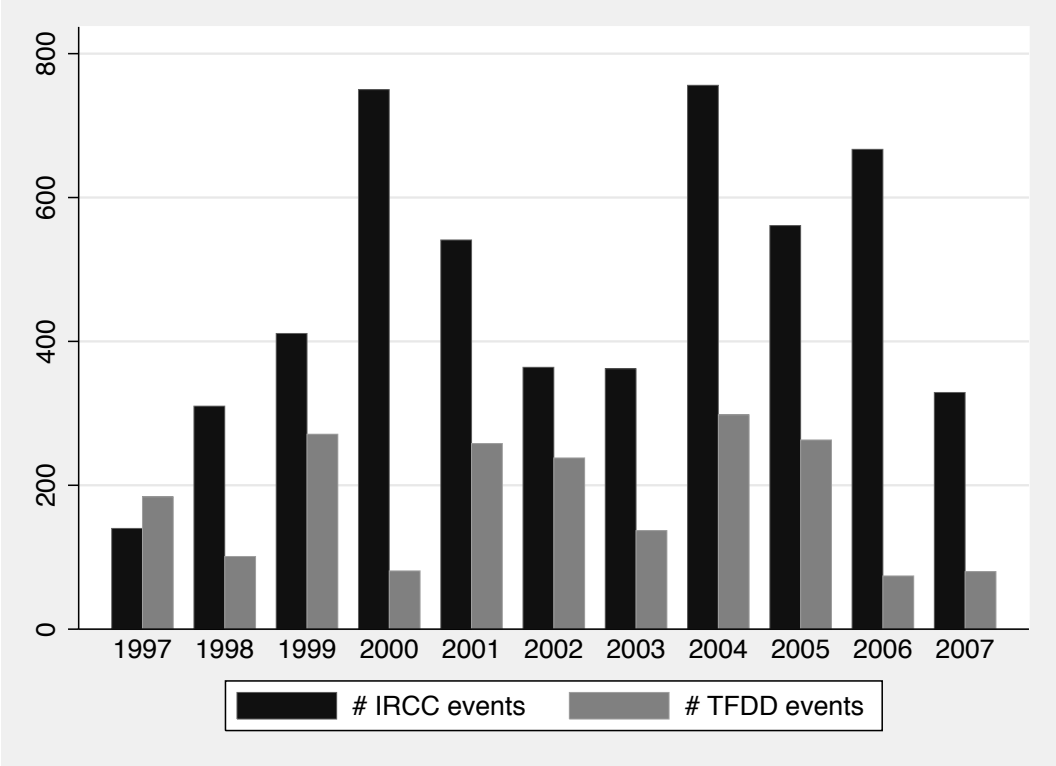
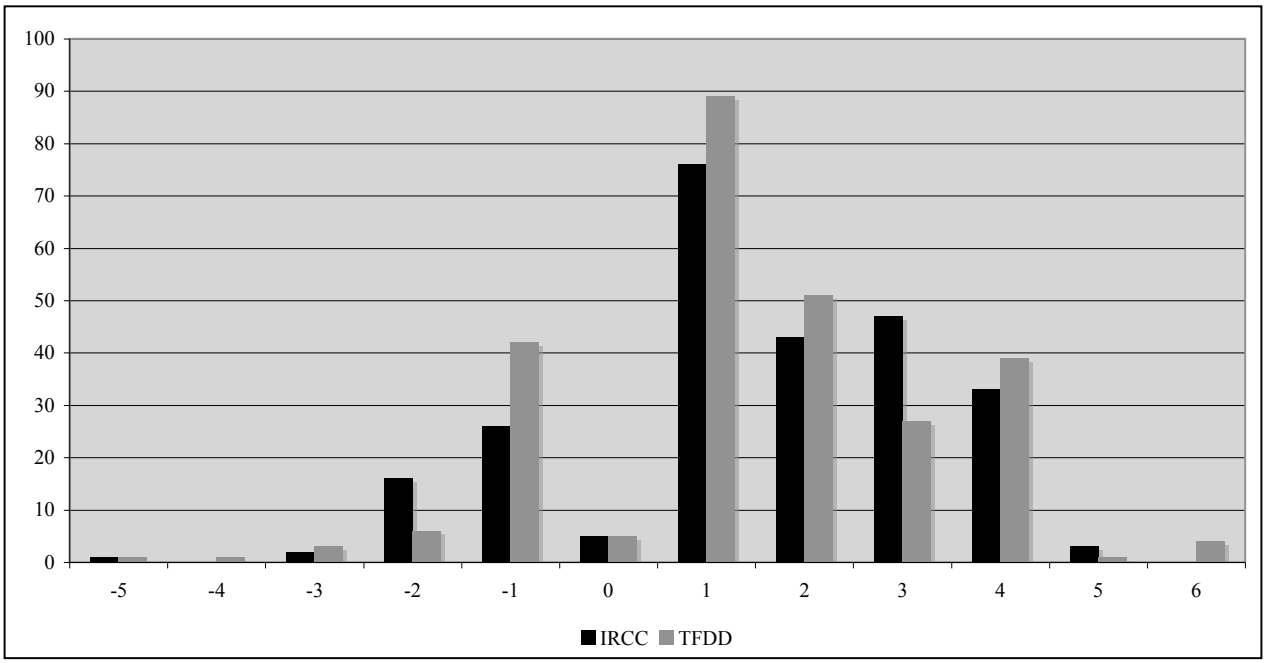


Figure 3: Number of events, IRCC and TFDD



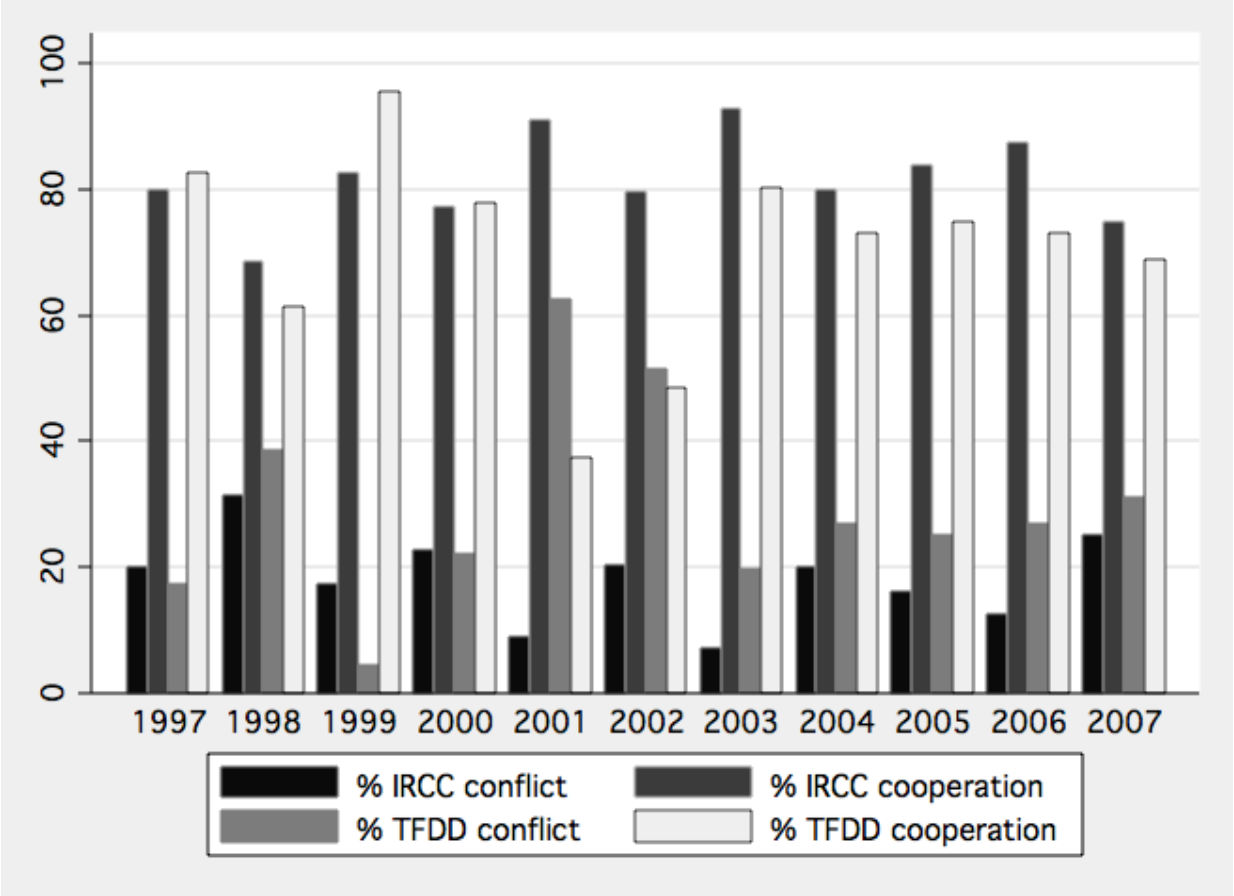
Note: events with ircc=0 and bar=0 are excluded.

Figure 4: Median (basin-country-pair-year) IRCC and TFDD scores



Note: Events where ircc=0 and bar=0 are excluded. The few cases in the zero-category in the right panel are an artifact of using the basin-country-pair-year median.

Figure 5: Shares of Conflictive and Cooperative Events



Note: neutral and missing events ignored

Online APPENDIX

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A.1: International River Basins

A first round of revisions to the Owen et al. list of shared rivers was carried out in collaboration with Marit Brochmann and Nils Peter Gleditsch in May 2010. In a second round (March and April 2011), the authors of this paper again revised the spellings of river basin names and created unique basin name strings (the Owen dataset included more than 300 distinct names and the TFDD around 380 for 261 basins). Furthermore, we corrected the basin dyad year structure of the following basins: Nahr Al Kabir Al Shamali (115), Nahr Al Kabir Al Janoubi (119), and Oyupock/Oiapoque (211). The final list of river basin names and basin numbers is listed below.

Basin number	Basin name
2	Jenisej/Yenisey
3	Tana
4	Grense Jacobselv
5	Naatamo
6	Pasvik
7	Firth
8	Tuloma
9	Torne/Tornealven
10	Yukon
11	Kemi
12	Ob/Irtysh
13	Olanga
14	Oulu
15	Vuoksa
16	Glomma
17	Klaralven
18	Alsek
19	Volga/Idel/Sari-Su
20	Chilkat
21	Taku
22	Narva
23	Stikine

24	Parnu
25	Whiting
26	Salaca
27	Gauja
28	Venta
29	Daugava
30	Nelson-Saskatchewan
31	Lielupe
32	Barta
33	Fraser
34	Neman
35	Amur
36	Dnieper
37	Bann
38	Wiedau
39	Foyle
40	Lava/Pregel
41	Ural
42	Erne
43	Prohladnaja
44	Vistula/Wista/Weichsel
45	Castletown
46	Fane
47	Flurry
48	Oder/Odra
49	Don
50	Elbe/Labe
51	Columbia
52	Rhine
53	Schelde
54	Yser
55	Ubsu-Nur
56	Har Us Nor
57	Mississippi
58	St. Lawrence
59	Danube/Donau Basin
60	Seine
61	Dniester
62	Skagit
63	Pu Lun T'o
64	Aral Sea Basin
65	Rhone
66	Mius
67	St. John (North America)
68	Elancik

69	Po
70	Kogilnik
71	Sarata
72	Isonzo
73	Ili/Kunes He
74	St. Croix
75	Garonne
76	Sujfun
77	Krka/Gurk/Drava
78	Roia
79	Terek/Tergi
80	Tumen/Rumen
81	Neretva
82	Colorado
83	Mino
84	Tarim
85	Bidasoa
86	Sulak
87	Douro/Duero
88	Vardar
89	Ebro
90	Struma
91	Drin
92	Maritsa
93	Kura-Araks
94	Velaka
95	Yalu
96	Lima
97	Nestos/Mesta
98	Rezvaya
99	Samur
100	Coruh
101	Lake Prespa
102	Tagus/Tejo
103	VijosÎ
104	Euphrates Tigris Basin
105	Guadiana/Odiana
106	Han River
107	Atrak
108	Asi/Orontes
109	Astara Chay
110	Hari/Rud
111	Rio Grande (North America)
112	Murgab
113	Medjerda

114	Indus
115	NahrAlKabirAlShamali
116	Kowl-E-Namaksar
117	Tafna
118	Oued Bon Naima
119	Nahr Al Kabir Al Janoubi
120	Helmand/Hirmand
121	Jordan
122	Mekong
123	Wadi Al Izziyah
124	Tijuana
125	Salween
126	Guir
127	Daoura
128	Dra
129	Yaqui
130	Nile Basin
131	Ganges Brahmaputra Meghna
132	Irrawaddy
133	BahuKalat/Rudkhanehye
134	Dasht
135	Bei Jiang/Hsi
136	Red/Song Hong
137	Lake Chad
138	Kaladan
139	Niger
140	Karnaphuli
141	Fenney
143	Beilun
144	Ma
145	Ca/Song Koi
146	Massacre
147	Artibonite
148	Senegal
149	Hondo
150	Candelaria
151	Grijalva
152	Baraka
153	Pedernales
154	Belize
155	Gash
156	Sarst˘n
157	Motaqua
158	Coatan Achute
159	Suchiate

160	Coco/Segovia
161	Volta
162	Lempa
163	Gambia
164	Paz
165	Choluteca
166	Goascoran
167	Rio Negro
168	San Juan
169	Geba
170	Corubal
171	Awash
172	Saigon
173	Song Vam (Co Dong)
174	Komoe
175	Pakchan
176	Little Scarcies
177	Great Scarcies
178	Orinoco
179	OuËmË
180	Sassandra
181	Sixaola
182	Juba-Shibeli
183	Changuinola
184	Catatumbo
185	Lake Turkana
186	Mono
187	Moa
188	Congo
189	Chiriqui
190	St. Paul
191	Loffa
192	Barima
193	Amacuro
194	Essequibo
195	Mano-Morro
196	Cavally
197	St.Johns/St.John (Africa)
198	Cestos
199	Tano
200	Jurado
201	Cross
202	Bia
203	Golok
204	Lotagipi Swamp

205	Maroni
206	Amazon
207	Akpa
208	Sembakung
209	Bangau
210	Pandaruan
211	Oyupock/Oiapoque
212	Corantijn/Courantyne/Corentyne
213	Benito/Ntem
214	OgoouË
215	Patia
216	Mira
217	Mataje
218	Utamboni
219	Mbe
220	Lake Natron
221	Tami
222	Nyanga
223	Sepik
224	Zarumilla
225	Tumbes/Puyango/Poyango
226	Umba
227	Chira
228	Chiloango
229	Fly
230	Tjeroaka-Wanggoe
231	Zambezi
232	Ruvuma
233	Okavango
234	Kunene
235	La Plata/Plate/Parana
236	Lake Titicaca-Poopo System
237	Cuvelai/Etosha
238	Cancoso/Lauca
239	Sabi
240	Buzi
241	Limpopo
242	Orange River
243	Zapaleri
244	Incomati/Komati
245	Umbeluzi
246	Maputo
247	Lagoon Mirim
248	Chuy
249	Valdivia

250	Puelo
251	Comau
252	Yelcho
253	Palena
254	Aysen
255	Baker
256	Pascua
257	Seno Union/Serrano
258	Gallegos-Chico
259	Cullen
260	San Martin
261	Aviles
262	Carmen Silva/Chico
263	Rio Grande (South America)
264	Lake Fagnano

A.2: Information Retrieval From BBC Monitoring

The recording-units[1] are individual newsmedia items that were extracted with the following string of keywords[2]:

<river basin name> AND (pollut OR contamin* OR toxic waste OR purification OR sewage OR effluence OR scarc* OR shortage OR lack OR insufficiency OR stream OR waterway OR tributary OR canal OR watercourse OR dike OR dyke OR irrigation OR dam* OR diversion OR flood OR drought)*

where <river basin name> is a placeholder for a specific international river basin name, e.g. Danube, and *s are wildcards, i.e. "pollut*" will find "pollution", "pollutant", "pollute", "polluting", and "polluted".

Our choice of these keywords is a modification of the list of keywords used for the TFDD.[3] The reason for choosing these water-related terms, rather than keywords more directly associated with cooperation and conflict (e.g. water AND conflict), is that our approach yields more efficient search results. In particular, when we included Yoffe and Larson's cooperation and conflict terms this generated many irrelevant hits.[4] Once these irrelevant hits are eliminated, the resulting search results are equal to those obtained without the inclusion of the cooperation and conflict terms. Also different from Yoffe and Larson, we explicitly search for events in certain international river basins by including the river basin's name (if a given river basin has differing names or spellings we used all of those).[5] We do so for two reasons. First, searching separately for each river basin allows for more efficient handling of search results for subsequent coding. Second, BBC Monitoring (and also other databases, such as FBIS) limit the number of items that can be identified and downloaded;

[1] E.g. Krippendorff 2004, 99-100
[2] As noted by Rothman (2007) automatic search, based on pre-defined keywords, enhances the data reliability in terms of case selection.
[3] http://www.transboundarywaters.orst.edu/projects/bar/BAR_chapter2.htm
[4] Yoffe and Larson 2002
[5] The recent update of the TFDD modified the search string, now also including river basin names (De Stefano et al. 2009, 3)

hence it is not possible to carry out a global search and retrieval of newsmedia items per year for all river basins. Yet another problem is that the nomenclature for international river basins is quite inconsistent, existing datasets and also newsmedia reports frequently use somewhat different names for the same river or misspell river names; and there are cases where different rivers have the same or very similar names. We double-checked the inclusion of all international river basins by constraining the search to individual countries and used the term "river" in our search while excluding the river name and hence all results retrieved by using the first string. Newsmedia texts frequently use the term "river" alongside the specific name of the river. This strategy results in the following keywords:

(water OR stream OR river OR waterway OR tributary OR canal OR watercourse OR watershed OR lake OR channel OR reservoir) AND (pollut OR contamin* OR toxic waste OR purification OR sewage OR effluence OR scarc* OR shortage OR lack OR insufficiency OR dike OR dyke OR irrigation OR dam* OR diversion OR flood OR drought) NOT (<river basin names>)*

where *<river basin names>* includes the list of all international river basins that we searched for initially. The second set of keywords also ascertains that we capture any international freshwater related events that are not linked to a specific international river basin. The disaggregation of such events to the river basin level usually follows directly from the type of event: e.g. if two countries sign an agreement on maximum permissible pollution levels, the scope of this agreement can easily be identified based on the newsmedia text (in fact, many agreements apply to all river basins the respective countries share).

We used full text searches because searching only titles could overlook relevant events. For example, an article by the MTI news agency in Budapest on a conflict over the construction of a dam in the Danube basin has the title "New Slovak envoy to Hungary wants to strengthen friendship".[6]

Table A.2: Retrieved newsmedia items per river basin

Basin	Items
Akpa	1
Amazon	332
Amazonas	90
Amur	644
Araks	17
Aral Sea	369
Artibonite	153
Asi	131
Astara	8
Atrak	2
Atrek	5
Aviles	9
Awash	78

[6] MTI news agency Budapest, June 14th 1999

Ayeyarwady	2
Aysen	15
Baker	1059
Baraka	34
Beilun	6
Belize	446
Benito	111
Bia	8
Bidasoa	4
Black River	2
Brahmaputra	65
Buzi	28
Ca	51
Candelaria	25
Catatumba	2
Catatumbo	18
Cavally	3
Cestos	1
Changuinola	1
Chico	31
Chiloango	2
Chira	6
Choluteca	1
Chu	381
Chui	11
Chuy	305
Coco	64
Colorado	277
Columbia	312
Congo	3314
Corentyne	6
Coruh	5
Cross	80
Cullen	10
Cuvelai	5
Danube	2355
Dara	480
Dasht	274
Daugava	32
Dayan	84
Dnepr	208
Dnieper	83
Dniester	856
Dnipro	32
Don	817

Douro	34
Dra	2
Draa	8
Drava	52
Drim	2
Drin	12
Duero	1
Dvina	19
Ebro	4
Elbe	123
Ertis	1
Essequibo	36
Etosha	2
Euphrates	2055
Evros	1
Fane	4
Flurry	9
Fly	123
Foyle	6
Gambia	540
Ganges	86
Garona	1
Garonne	12
Garun	5
Gash	88
Golok	10
Grijalva	1
Guadiana	5
Han	1437
Har Nuur	1
Hari	149
Harirud	20
Helmand	985
Hirmand	69
Hondo	11
Hsi	58
Ili	95
Incomati	5
Indus	323
Irrawaddy	638
Irtysh	145
Ishim	16
Jacobs	6
Jordan	11024
Juba	712

Jubba	129
Jurado	13
Kabir	9
Kaladan	8
Karisu	27
Karnaphuli	7
Kebir	10
Komati	8
Kra	18
Krka	22
Kunene	25
Kura	80
La Plata	57
Labe	95
Lake Chad	60
Lake Natron	4
Lake Rudolf	1
Lake Turkana	1
Lauca	1
Lempa	3
Liba	6
Lielupe	4
Lima	744
Limpopo	106
Ma	1563
Mana	16
Maputo	1158
Maracaibo	96
Mareb	1
Maritsa	78
Maroni	38
Marowijne	5
Massacre	431
Mataje	2
Mbe	1
Mbini	9
Meghna	12
Mekong	524
Mesta	11
Minho	8
Mino	4
Mira	237
Mississippi	2
Moa	38
Mono	33

Morghab	13
Morro	17
Murgab	11
Murghab	9
Murghob	9
Narva	88
Natron	9
Negro	21
Nelson	1276
Neman	4
Nemunas	9
Neretva	361
Niemen	1
Niger	388
Nile	2438
Ntem	10
Nyanga	37
Ob	52
Oder	82
Odra	63
Ogooue	2
Oiapoque	1
Okavango	31
Oksu	1
Oral	148
Orange	150
Orontes	9
Oud Bon Naima	2
Oued Bon Naima	1
Oyapock	1
Paita	4
Palena	1
Parnu	7
Pascua	8
Pasvik	1
Patia	5
Paz	1
Pedernales	6
Plate	34
Po	7
Poopo	7
Pregel	3
Pregola	1
Pregolya	4

Red	47
Rhine	197
Rhone	56
Rio Grande	134
Rovuma	13
Roya	22
Ruvuma	18
Sabi	90
Saigon	3
Salween	63
Samur	47
San Juan	15
San Martin	58
Saskatchewan	1
Save	53
Schelde	2
Scheldt	2
Segovia	18
Seine	86
Senegal	1704
Sepik	78
Serrano	51
Sirdaryo	57
Soca	29
St. Croix	1
St. John	147
St. Paul	43
Struma	8
Suchiate	1
Sulak	6
Syr Darya	159
Syrdarya	176
Tabasco	14
Tagus	11
Tajo	1
Taku	108
Tami	9
Tana	163
Tano	8
Tarim	121
Tarnak	17
Tejo	1
Terek	151
Tergi	1
Theiss	1

Tigris	1807
Tijuana	29
Tisa	152
Tisza	1634
Titicaca	12
Tobol	20
Topol	124
Tuloma	1
Tumbes	7
Tumen	40
Tysa	81
Ubsu-Nuur	1
Umba	1
Umbeluzi	5
Ural	282
Uvs Nuur	1
Valdivia	82
Vardar	27
Vida	34
Vistula	49
Volga	736
Volta	75
Wadi Al Izziyah	5
Xi	235
Xijiang	28
Yafi	7
Yalu	45
Yenisey	74
Zambezi	227
Zarumilla	3

Note: this table uses the original list of river basin names from Owen et al. because we retrieved the newsmedia items based on late list and only later on created unique river basin names for each basin number.

A.3: International River Cooperation and Conflict (IRCC) Scale

6	**alliance** ratification of freshwater treaty
5	**official support** signing of freshwater treaty
4	**agreement/commitment** closing plant in own country that possibly leads to pollution in other country offering voluntary commitment, such as water supply financial support for water projects in other country, such as creation of sewage treatment facility

	any legally binding, cooperative actions that are not treaties cooperative/joint water management (irrigation, water supply, etc.) projects
3	**agreement of low scale** visit by head of state with discussion joint water issues meeting of environmental ministers/heads of states for talks on joint water issues drafting cooperation agreement/joint policy agreement to set up cooperative working groups setting up expert group/commission (on joint water issues)

2	**verbal support** official support of policy meeting of river commission with expression of policy goals minor reaction to environmental accidents, such as establishment of an information hotline invite inspectors from other country in order to dispel doubts on possible pollution, etc. proposing compromise/solution to a dispute expressing willingness to come to an agreement
1	**minor official exchanges, talks or policy expressions** meeting of high officials discussing joint water issues visit by lower officials for talks on joint water issues proposing talks on joint water issues submitting position on joint water problem demanding action from other country(code -1 if with negative connotation); calling for international assistance after a flood, etc. is to be coded positively, i.e. ircc=1 informing other country about environmental accidents
0	**neutral acts** rethorical statements interaction by private actors (no involvement of government, officials, etc.)
-1	**mild verbal expressions displaying discord in interaction:** proposing unwanted dam or other flow regulation demanding action from other country (code +1 if with positive connotation; calling for international assistance after a flood, etc. is to be coded positively, i.e. ircc=1) delaying talks/refuse to take part in talks refusing to accept compromise/ solution to dispute proposed by other country failure to come to reach agreement in dispute settlement attempt
-2	**strong verbal expressions displaying hostility in interaction:** failure to report environmental accidents harmful to other country (e.g. oil leaking off sunken ship) turning to court making threatening demands and accusations (only if by officials) postponing heads of state visits refusing participation in meetings/summits expectation that country will do any of the actions described in ircc -3 or lower (in these cases use "expectation of" and then add the expected action as described in ircc -3, etc. for descr, i.e. descr could be "expectation of closing a dam's flood gates causing harmful consequences for other country"
-3	**hostile actions:** disposal of waste in shared water contamination of shared water abrogation of a water agreement opening/closing a dam's flood gates causing harmful consequences for other country
-4	breaking diplomatic relations intentious pollution unilateral construction of water projects against another country’s protest reducing flow of water to another country
-5	any violent acts (that do not yet constitute a war)
-6	Violent conflict, formal declaration of war

A.4: Intercoder Reliability

The following table provides information on intercoder reliability, measured by Krippendorff's alpha.[7] We used the ordinal version of Krippendorff's alpha and considered missing values.[8] Ideally, the estimate should be based on a randomly selected sample of recoded cases. Unfortunately, this is not feasible for several reasons. Part of the coding routine is the selection of those articles that need to be coded. The recording-units are thus not defined a priori. Alternatively, we thus randomly selected basin-years to be recoded. However, the random selection resulted in many basins with only very few events so that a systematic assessment of intercoder reliability was not possible. It did, nevertheless, serve to gain a more qualitative impression of intercoder reliability and those variables that appear to be more difficult to code than others. To estimate a reliability measure we chose the Nile basin to be recoded, since this is one of the basins for which most events are reported. As shown in Table A.3 there is more congruence when considering only two rather than three different coders. Whereas different coders mostly agree on cooperation levels, the direction of action, the issue dealt with and whether or not an interaction constitutes a new event or is tied to former interactions, there are often diverging codings for salience. This variable should therefore be used with caution.

Nile 1997 - 2002, two coders

Variable	alpha	95% confidence interval	
confl/coop	.731	.684	.777
salience	.000		.224
direction	.637	.543	.724
issue	.799	.717	.882
case	.810	.773	.845

Nile 2003 - 2007, three coders

Variable	alpha	95% confidence interval	
confl/coop	.531	.503	.557
salience	.000		.055
direction	.950	.936	.963
issue	.410	.339	.479
case	.935	.927	.942

A.5: Conflictive Events Per River Basin

basinname	basinno	total events	conflict	Conflict ratio
Cancoso/Lauca	238	1	1	100.00%
Colorado	82	2	2	100.00%
Corantijn/Courantyne/Corentyne	212	1	1	100.00%
Samur	99	2	2	100.00%
Terek/Tergi	79	2	2	100.00%

[7] Krippendorff 2004
[8] Hayes and Krippendorff 2007

Vistula/Wista/Weichsel	44	4	4	100.00%
Rio Negro	167	5	3	60.00%
Atrak	107	2	1	50.00%
Krka/Gurk/Drava	77	26	11	42.31%
Ganges Brahmaputra Meghna Basin	131	51	21	41.18%
Aral Sea Basin	64	28	11	39.29%
Kura-Araks	93	3	1	33.33%
Volta	161	6	2	33.33%
Dniester	61	22	7	31.82%
Euphrates Tigris Basin	104	295	93	31.53%
Indus	114	49	14	28.57%
Daugava	29	4	1	25.00%
Han River	106	4	1	25.00%
La Plata/Plate/Parana	235	4	1	25.00%
Nestos/Mesta	97	4	1	25.00%
Amur	35	173	40	23.12%
Asi/Orontes	108	9	2	22.22%
Helmand/Hirmand	120	61	13	21.31%
Volga/Idel/Sari-Su	19	101	21	20.79%
Rio Grande (North America)	111	5	1	20.00%
Danube/Donau Basin	59	2182	422	19.34%
Orange River	242	16	3	18.75%
Zambezi	231	195	36	18.46%
Tumen/Rumen	80	72	13	18.06%
Ob/Irtysh	12	77	13	16.88%
Senegal	148	41	5	12.20%
Nile Basin	130	1531	162	10.58%
Elbe/Labe	50	29	3	10.34%
Lake Chad	137	26	2	7.69%
Kunene	234	14	1	7.14%
Niger	139	57	4	7.02%
Amazon	206	31	1	3.23%
Oder/Odra	48	56	1	1.79%
Mekong	122	406	1	0.25%
Buzi	240	7		0.00%
Congo	188	131		0.00%
Cross	201	2		0.00%
Dasht	134	13		0.00%
Dnieper	36	6		0.00%
Douro/Duero	87	2		0.00%
Essequibo	194	3		0.00%
Gambia	163	3		0.00%
Guadiana/Odiana	105	1		0.00%
Hari/Rud	110	29		0.00%
Incomati/Komati	244	11		0.00%

Jordan	121	1		0.00%
Lake Natron	220	3		0.00%
Limpopo	241	4		0.00%
Maputo	246	8		0.00%
Maritsa	92	3		0.00%
Mataje	217	1		0.00%
Mono	186	2		0.00%
Murgab	112	1		0.00%
NahrAlKabirAlJanoubi	119	1		0.00%
Neretva	81	7		0.00%
Okavango	233	11		0.00%
Oyupock/Oiapoque	211	1		0.00%
Pascua	256	5		0.00%
Po	69	1		0.00%
Red/Song Hong	136	1		0.00%
Rhine	52	2		0.00%
Salween	125	1		0.00%
San Martin	260	11		0.00%
St.Johns/St.John (Africa)	197	1		0.00%
Struma	90	1		0.00%
Tumbes/Puyango/Poyango	225	5		0.00%
Ubsu-Nur	55	1		0.00%
Ural	41	1		0.00%
Yalu	95	3		0.00%
Total or Average		330	924	18.25%

A.6: Number of Events Per River Basin in IRCC and TFDD

BASIN NO	IRCC Events	TFDD Events
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12	65	16
13		
14		
15		
16		
17		

18		
19	93	5
20		
21		3
22		3
23		
24		1
25		
26		1
27		1
28		1
29	1	6
30		26
31		1
32		1
33		
34		9
35	139	17
36	5	10
37		1
38		
39		
40		
41	1	2
42		
43		
44	4	10
45		
46		
47		
48	46	8
49		3
50	21	4
51		5
52	1	61
53		4
54		
55		
56		1
57		
58		20
59	1998	246
60		
61	15	4
62		
63		3
64	23	115

65		1
66		1
67		
68		1
69	1	
70		2
71		2
72		
73		6
74		1
75		
76		1
77	21	
78		
79	2	1
80	63	7
81	5	3
82	2	8
83		1
84		5
85		
86		3
87	2	2
88		1
89		
90	1	
91		2
92	3	7
93	3	10
94		2
95	3	1
96		1
97	4	2
98		2
99	2	1
100		
101		
102		2
103		1
104	251	46
105	1	2
106	4	4
107	1	1
108	9	4
109		
110	20	
111	4	24

112	1	
113		
114	35	198
115		2
116		
117		
118		
119	1	
120	40	18
121		96
122	365	386
123		
124		
125	1	7
126		
127		
128		
129		
130	1339	228
131	49	134
132		2
133		
134	5	
135		
136	1	3
137	13	1
138		
139	56	9
140		
141		2
142		
143		
144		
145		
146		
147		
148	37	19
149		
150		
151		
152		
153		
154		
155		
156		
157		
158		

159		
160		
161	6	23
162		
163	2	11
164		
165		
166		
167	5	
168		
169		
170		
171		1
172		
173		
174		
175		
176		
177		
178		
179		
180		
181		
182		
183		
184		
185		
186	1	
187		
188	130	14
189		
190		
191		
192		
193		
194	2	
195		
196		
197		
198		
199		
200		
201	1	
202		
203		1
204		
205		

206	31	9
207		
208		
209		6
210		
211	1	
212	1	
213		
214		
215		
216		
217	1	
218		
219		
220		
221		
222		
223		
224		2
225	5	2
226		
227		1
228		5
229		
230		
231	172	37
232		
233	11	4
234	11	1
235	4	5
236		
237		
238	1	
239		
240	3	1
241	4	4
242	16	7
243		
244	11	
245		
246	8	
247		
248		
249		
250		
251		
252		

253		
254		
255		
256	2	
257		
258		
259		
260	5	
261		
262		
263		
264		

A.7: Coding example (selected events and variables)

country1	country2	basinname	issue	event	ircc	descr	case
Russia	Kazakhstan	Ob/Irtysh	water quantity	Kazakh government spokesman said that countries with an interest in the river - Kazakhstan, China and Russia - had undertaken not to inflict losses on each other.	1	minor official exchanges, talks or policy expressions	1148
Russia	Kazakhstan	Ob/Irtysh	water quantity	Deputy Prime Minister and Foreign Minister of Kazakhstan told journalists about talks China and Kazakstan held on the problems of cross-border rivers where China announced plans to use about 10 per cent of the flow of the Cherny Irtysh River. H	1	Proposing talks on joint water issues	1148
Russia	Kazakhstan	Ob/Irtysh	water quality	Intergovernment Russian-Kazakh commission on the Irtysh water basin to prevent mercury contamination of the river.	2	meeting of river commission with expression of policy goals	1149
Russia	Kazakhstan	Ob/Irtysh	water quantity	Kazakhstan, China and Russia set up a special council that will handle problems of the River Irtysh passing through their territories.	3	setting up expert group/commission (on joint water issues)	1148
Russia	China	Ob/Irtysh	water quantity	Because China has been planning to get up to 50 per cent of the flow of the Kara Irtysh river, Russia is very much concerned and fears that this will lead to very serious economic and ecological consequences.	-1	mild verbal expressions displaying discord in interaction	1148

Russia	Belarus	Daugava	water quality	Belarus to demand compensation from Russian company for fuel spill in Daugava on 23 March.	-1	demanding action from other country	1068
Russia	China	Amur	water quality	Russians blame China for polluting border river Amur.	-1	mild verbal expressions displaying discord in interaction	1
China	North Korea	Tumen/ Rumen	joint management	Chinese minister gives support to Tumen Jiang development, stating that the Chinese government will, as always, support the international cooperative development undertaking in the Tumen Jiang area, together with other countries and international	2	official support of policy	1412

A.8: River basins with both cooperative and conflictive events

In 15% of all river basins in the IRCC dataset (18.4% in the TFDD dataset) we observe both cooperation and conflict at some point in time. The names of these basins are listed below. The basins in which both cooperation and conflict events are recorded are mostly the largest basins in terms of the number of riparians. This makes sense intuitively, for a given country might behave more cooperatively towards one of its co-riparians and less so towards others.

Amazon
Amur
Aral Sea Basin
Asi/Orontes
Atrak
Cancoso/Lauca
Colorado
Corantijn/Courantyne/Corentyne
Danube/Donau Basin
Daugava
Dniester
Elbe/Labe
Euphrates Tigris Basin
Ganges Brahmaputra Meghna Basin
Han River
Helmand/Hirmand
Indus

Krka/Gurk/Drava
Kunene
Kura-Araks
La Plata/Plate/Parana
Lake Chad
Mekong
Nestos/Mesta
Niger
Nile Basin
Ob/Irtysh
Oder/Odra
Orange River
Rio Grande (North America)
Rio Negro
Samur
Senegal
Terek/Tergi
Tumen/Rumen
Vistula/Wista/Weichsel
Volga/Idel/Sari-Su
Volta
Zambezi

A.9: IRCC basin dyads without any reported events

country1	country2	basinname
Russia (USSR)	Mongolia	Jenisej/Yenisey
Finland	Norway	Tana
Russia (USSR)	Norway	Grense Jacobselv
Finland	Norway	Naatamo
Russia (USSR)	Finland	Pasvik
Russia (USSR)	Norway	Pasvik
Finland	Norway	Pasvik
USA	Canada	Firth
Russia (USSR)	Finland	Tuloma
Finland	Sweden	Torne/Tornealven
Finland	Norway	Torne/Tornealven
Sweden	Norway	Torne/Tornealven
USA	Canada	Yukon
Russia (USSR)	Finland	Kemi
Russia (USSR)	Norway	Kemi
Finland	Norway	Kemi
Russia (USSR)	Mongolia	Ob/Irtysh
Kazakhstan	Mongolia	Ob/Irtysh
China	Mongolia	Ob/Irtysh
Russia (USSR)	Finland	Olanga
Russia (USSR)	Finland	Oulu

Russia (USSR)	Finland	Vuoksa
Sweden	Norway	Glomma
Sweden	Norway	Klaralven
USA	Canada	Alsek
Russia (USSR)	Belarus	Volga/Idel/Sari-Su
Belarus	Kazakhstan	Volga/Idel/Sari-Su
USA	Canada	Chilkat
USA	Canada	Taku
Russia (USSR)	Estonia	Narva
Russia (USSR)	Latvia	Narva
Russia (USSR)	Belarus	Narva
Estonia	Latvia	Narva
Estonia	Belarus	Narva
Latvia	Belarus	Narva
USA	Canada	Stikine
Estonia	Latvia	Parnu
USA	Canada	Whiting
Estonia	Latvia	Salaca
Estonia	Latvia	Gauja
Latvia	Lithuania	Venta
Russia (USSR)	Lithuania	Daugava
Latvia	Lithuania	Daugava
Latvia	Belarus	Daugava
Lithuania	Belarus	Daugava
USA	Canada	Nelson-Saskatchewan
Latvia	Lithuania	Lielupe
Latvia	Lithuania	Barta
USA	Canada	Fraser
Poland	Russia (USSR)	Neman
Poland	Latvia	Neman
Poland	Lithuania	Neman
Poland	Belarus	Neman
Russia (USSR)	Latvia	Neman
Russia (USSR)	Lithuania	Neman
Russia (USSR)	Belarus	Neman
Latvia	Lithuania	Neman
Latvia	Belarus	Neman
Lithuania	Belarus	Neman
Russia (USSR)	North Korea	Amur
China	North Korea	Amur
Mongolia	North Korea	Amur
Russia (USSR)	Belarus	Dnieper
United Kingdom	Ireland	Bann
Germany	Denmark	Wiedau
United Kingdom	Ireland	Foyle
Poland	Russia (USSR)	Lava/Pregel

United Kingdom	Ireland	Erne
Poland	Russia (USSR)	Prohladnaja
Poland	The Czech Republic	Vistula/Wista/Weichsel
Poland	Slovakia	Vistula/Wista/Weichsel
Poland	Ukraine	Vistula/Wista/Weichsel
Poland	Belarus	Vistula/Wista/Weichsel
The Czech republic	Slovakia	Vistula/Wista/Weichsel
The Czech republic	Ukraine	Vistula/Wista/Weichsel
The Czech republic	Belarus	Vistula/Wista/Weichsel
Slovakia	Ukraine	Vistula/Wista/Weichsel
Slovakia	Belarus	Vistula/Wista/Weichsel
Ukraine	Belarus	Vistula/Wista/Weichsel
United Kingdom	Ireland	Castletown
United Kingdom	Ireland	Fane
United Kingdom	Ireland	Flurry
Russia (USSR)	Ukraine	Don
USA	Canada	Columbia
Netherlands	Belgium	Rhine
Netherlands	Luxembourg	Rhine
Netherlands	France	Rhine
Netherlands	Liechtenstein	Rhine
Netherlands	Switzerland	Rhine
Netherlands	Austria	Rhine
Netherlands	Italy	Rhine
Belgium	Luxembourg	Rhine
Belgium	France	Rhine
Belgium	Liechtenstein	Rhine
Belgium	Switzerland	Rhine
Belgium	Germany	Rhine
Belgium	Austria	Rhine
Belgium	Italy	Rhine
Luxembourg	France	Rhine
Luxembourg	Liechtenstein	Rhine
Luxembourg	Switzerland	Rhine
Luxembourg	Germany	Rhine
Luxembourg	Austria	Rhine
Luxembourg	Italy	Rhine
France	Liechtenstein	Rhine
France	Switzerland	Rhine
France	Austria	Rhine
France	Italy	Rhine
Liechtenstein	Switzerland	Rhine
Liechtenstein	Germany	Rhine
Liechtenstein	Austria	Rhine
Liechtenstein	Italy	Rhine
Switzerland	Germany	Rhine

Switzerland	Austria	Rhine
Switzerland	Italy	Rhine
Germany	Austria	Rhine
Germany	Italy	Rhine
Austria	Italy	Rhine
Netherlands	Belgium	Schelde
Netherlands	France	Schelde
Belgium	France	Schelde
Belgium	France	Yser
Russia (USSR)	China	Har Us Nor
Russia (USSR)	Mongolia	Har Us Nor
China	Mongolia	Har Us Nor
USA	Canada	Mississippi
USA	Canada	St. Lawrence
Switzerland	Poland	Danube/Donau Basin
Switzerland	Austria	Danube/Donau Basin
Switzerland	Hungary	Danube/Donau Basin
Switzerland	The Czech Republic	Danube/Donau Basin
Switzerland	Slovakia	Danube/Donau Basin
Switzerland	Italy	Danube/Donau Basin
Switzerland	Albania	Danube/Donau Basin
Switzerland	Montenegro	Danube/Donau Basin
Switzerland	Croatia	Danube/Donau Basin
Switzerland	Yugoslavia (Serbia)	Danube/Donau Basin
Switzerland	Bosnia-Hercegovina	Danube/Donau Basin
Switzerland	Slovenia	Danube/Donau Basin
Switzerland	Bulgaria	Danube/Donau Basin
Switzerland	Moldova	Danube/Donau Basin
Switzerland	Romania	Danube/Donau Basin
Switzerland	Ukraine	Danube/Donau Basin
Germany	Montenegro	Danube/Donau Basin
Poland	Austria	Danube/Donau Basin
Poland	Italy	Danube/Donau Basin
Poland	Albania	Danube/Donau Basin
Poland	Montenegro	Danube/Donau Basin
Poland	Croatia	Danube/Donau Basin
Poland	Yugoslavia (Serbia)	Danube/Donau Basin
Poland	Bosnia-Hercegovina	Danube/Donau Basin
Poland	Slovenia	Danube/Donau Basin
Poland	Bulgaria	Danube/Donau Basin
Poland	Moldova	Danube/Donau Basin
Poland	Ukraine	Danube/Donau Basin
Austria	Italy	Danube/Donau Basin
Austria	Albania	Danube/Donau Basin
Austria	Montenegro	Danube/Donau Basin
Hungary	Italy	Danube/Donau Basin

Hungary	Albania	Danube/Donau Basin
Hungary	Montenegro	Danube/Donau Basin
The Czech republic	Italy	Danube/Donau Basin
The Czech republic	Albania	Danube/Donau Basin
The Czech republic	Montenegro	Danube/Donau Basin
Slovakia	Italy	Danube/Donau Basin
Slovakia	Albania	Danube/Donau Basin
Slovakia	Montenegro	Danube/Donau Basin
Italy	Albania	Danube/Donau Basin
Italy	Montenegro	Danube/Donau Basin
Italy	Croatia	Danube/Donau Basin
Italy	Yugoslavia (Serbia)	Danube/Donau Basin
Italy	Bosnia-Hercegovina	Danube/Donau Basin
Italy	Slovenia	Danube/Donau Basin
Italy	Bulgaria	Danube/Donau Basin
Italy	Moldova	Danube/Donau Basin
Italy	Ukraine	Danube/Donau Basin
Albania	Montenegro	Danube/Donau Basin
Albania	Croatia	Danube/Donau Basin
Albania	Yugoslavia (Serbia)	Danube/Donau Basin
Albania	Bosnia-Hercegovina	Danube/Donau Basin
Albania	Slovenia	Danube/Donau Basin
Albania	Bulgaria	Danube/Donau Basin
Albania	Moldova	Danube/Donau Basin
Albania	Romania	Danube/Donau Basin
Albania	Ukraine	Danube/Donau Basin
Montenegro	Croatia	Danube/Donau Basin
Montenegro	Yugoslavia (Serbia)	Danube/Donau Basin
Montenegro	Bosnia-Hercegovina	Danube/Donau Basin
Montenegro	Slovenia	Danube/Donau Basin
Montenegro	Bulgaria	Danube/Donau Basin
Montenegro	Moldova	Danube/Donau Basin
Montenegro	Romania	Danube/Donau Basin
Montenegro	Ukraine	Danube/Donau Basin
Belgium	Luxembourg	Seine
Belgium	France	Seine
Luxembourg	France	Seine
Poland	Ukraine	Dniester
USA	Canada	Skagit
Russia (USSR)	Kazakhstan	Pu Lun T'o
Russia (USSR)	China	Pu Lun T'o
Russia (USSR)	Mongolia	Pu Lun T'o
Kazakhstan	China	Pu Lun T'o
Kazakhstan	Mongolia	Pu Lun T'o
China	Mongolia	Pu Lun T'o
Afghanistan	Turkmenistan	Aral Sea Basin

Afghanistan	Kyrgyzstan	Aral Sea Basin
Afghanistan	Uzbekistan	Aral Sea Basin
Afghanistan	Kazakhstan	Aral Sea Basin
Afghanistan	China	Aral Sea Basin
Afghanistan	Pakistan	Aral Sea Basin
Turkmenistan	Kyrgyzstan	Aral Sea Basin
Turkmenistan	Kazakhstan	Aral Sea Basin
Turkmenistan	China	Aral Sea Basin
Turkmenistan	Pakistan	Aral Sea Basin
Tajikistan	Kyrgyzstan	Aral Sea Basin
Tajikistan	Kazakhstan	Aral Sea Basin
Tajikistan	China	Aral Sea Basin
Kyrgyzstan	China	Aral Sea Basin
Kyrgyzstan	Pakistan	Aral Sea Basin
Uzbekistan	China	Aral Sea Basin
Uzbekistan	Pakistan	Aral Sea Basin
Kazakhstan	China	Aral Sea Basin
Kazakhstan	Pakistan	Aral Sea Basin
China	Pakistan	Aral Sea Basin
France	Switzerland	Rhone
France	Italy	Rhone
Switzerland	Italy	Rhone
Russia (USSR)	Ukraine	Mius
USA	Canada	St. John (North America)
Russia (USSR)	Ukraine	Elancik
France	Switzerland	Po
France	Austria	Po
Switzerland	Austria	Po
Switzerland	Italy	Po
Austria	Italy	Po
Moldova	Ukraine	Kogilnik
Moldova	Ukraine	Sarata
Italy	Slovenia	Isonzo
Kyrgyzstan	Kazakhstan	Ili/Kunes He
Kyrgyzstan	China	Ili/Kunes He
Kazakhstan	China	Ili/Kunes He
USA	Canada	St. Croix
France	Spain	Garonne
France	Andorra	Garonne
Spain	Andorra	Garonne
Russia (USSR)	China	Sujfun
Montenegro	Croatia	Krka/Gurk/Drava
Montenegro	Bosnia-Hercegovina	Krka/Gurk/Drava
Yugoslavia (Serbia)	Bosnia-Hercegovina	Krka/Gurk/Drava
France	Italy	Roia
Russia (USSR)	Georgia	Terek/Tergi

Spain	Portugal	Mino
Afghanistan	Tajikistan	Tarim
Afghanistan	Kyrgyzstan	Tarim
Afghanistan	China	Tarim
Afghanistan	Pakistan	Tarim
Tajikistan	Kyrgyzstan	Tarim
Tajikistan	China	Tarim
Tajikistan	Pakistan	Tarim
Kyrgyzstan	China	Tarim
Kyrgyzstan	Pakistan	Tarim
China	Pakistan	Tarim
France	Spain	Bidasoa
Russia (USSR)	Georgia	Sulak
Russia (USSR)	Azerbaijan	Sulak
Georgia	Azerbaijan	Sulak
Montenegro	Macedonia	Vardar
Montenegro	Greece	Vardar
Macedonia	Yugoslavia (Serbia)	Vardar
Macedonia	Greece	Vardar
Yugoslavia (Serbia)	Greece	Vardar
France	Spain	Ebro
France	Andorra	Ebro
Spain	Andorra	Ebro
Montenegro	Macedonia	Struma
Montenegro	Greece	Struma
Montenegro	Bulgaria	Struma
Macedonia	Yugoslavia (Serbia)	Struma
Macedonia	Greece	Struma
Macedonia	Bulgaria	Struma
Yugoslavia (Serbia)	Greece	Struma
Yugoslavia (Serbia)	Bulgaria	Struma
Albania	Montenegro	Drin
Albania	Macedonia	Drin
Albania	Yugoslavia (Serbia)	Drin
Montenegro	Macedonia	Drin
Macedonia	Yugoslavia (Serbia)	Drin
Russia (USSR)	Armenia	Kura-Araks
Russia (USSR)	Georgia	Kura-Araks
Russia (USSR)	Azerbaijan	Kura-Araks
Russia (USSR)	Iran (Persia)	Kura-Araks
Russia (USSR)	Turkey/Ottoman Empire	Kura-Araks
Armenia	Georgia	Kura-Araks
Armenia	Azerbaijan	Kura-Araks
Armenia	Iran (Persia)	Kura-Araks
Armenia	Turkey/Ottoman Empire	Kura-Araks
Georgia	Azerbaijan	Kura-Araks

Georgia	Iran (Persia)	Kura-Araks
Georgia	Turkey/Ottoman Empire	Kura-Araks
Azerbaijan	Turkey/Ottoman Empire	Kura-Araks
Bulgaria	Turkey/Ottoman Empire	Velaka
Spain	Portugal	Lima
Bulgaria	Turkey/Ottoman Empire	Rezvaya
Georgia	Turkey/Ottoman Empire	Coruh
Albania	Macedonia	Lake Prespa
Albania	Greece	Lake Prespa
Macedonia	Greece	Lake Prespa
Spain	Portugal	Tagus/Tejo
Albania	Greece	Vijosë
Iran (Persia)	Syria	Euphrates Tigris Basin
Iran (Persia)	Jordan	Euphrates Tigris Basin
Iran (Persia)	Saudi Arabia	Euphrates Tigris Basin
Turkey/Ottoman Empire	Jordan	Euphrates Tigris Basin
Turkey/Ottoman Empire	Saudi Arabia	Euphrates Tigris Basin
Iraq	Saudi Arabia	Euphrates Tigris Basin
Syria	Saudi Arabia	Euphrates Tigris Basin
Jordan	Saudi Arabia	Euphrates Tigris Basin
Turkey/Ottoman Empire	Lebanon	Asi/Orontes
Azerbaijan	Iran (Persia)	Astara Chay
Afghanistan	Turkmenistan	Hari/Rud
Afghanistan	Turkmenistan	Murgab
Algeria	Tunisia	Medjerda
Afghanistan	China	Indus
Afghanistan	India	Indus
Afghanistan	Pakistan	Indus
Afghanistan	Nepal	Indus
China	Pakistan	Indus
China	Nepal	Indus
India	Nepal	Indus
Pakistan	Nepal	Indus
Turkey/Ottoman Empire	Syria	NahrAlKabirAlShamali
Iran (Persia)	Afghanistan	Kowl-E-Namaksar
Morocco	Algeria	Tafna
Morocco	Algeria	Oued Bon Naima
Iran (Persia)	Pakistan	Helmand/Hirmand
Egypt/UAR	Syria	Jordan
Egypt/UAR	Lebanon	Jordan
Egypt/UAR	Jordan	Jordan
Egypt/UAR	Israel	Jordan
Syria	Lebanon	Jordan
Syria	Jordan	Jordan
Syria	Israel	Jordan
Lebanon	Jordan	Jordan

Lebanon	Israel	Jordan
Lebanon	Israel	Wadi Al Izziyah
USA	Mexico	Tijuana
China	Myanmar (Burma)	Salween
China	Thailand	Salween
Morocco	Algeria	Guir
Morocco	Algeria	Daoura
Morocco	Algeria	Dra
USA	Mexico	Yaqui
Central African Republic	Eritrea	Nile Basin
China	Bhutan	Ganges Brahmaputra Meghna Basin
China	Myanmar (Burma)	Ganges Brahmaputra Meghna Basin
China	Nepal	Ganges Brahmaputra Meghna Basin
India	Bhutan	Ganges Brahmaputra Meghna Basin
India	Myanmar (Burma)	Ganges Brahmaputra Meghna Basin
Bhutan	Bangladesh	Ganges Brahmaputra Meghna Basin
Bhutan	Myanmar (Burma)	Ganges Brahmaputra Meghna Basin
Bhutan	Nepal	Ganges Brahmaputra Meghna Basin
Bangladesh	Myanmar (Burma)	Ganges Brahmaputra Meghna Basin
Myanmar (Burma)	Nepal	Ganges Brahmaputra Meghna Basin
China	India	Irrawaddy
China	Myanmar (Burma)	Irrawaddy
India	Myanmar (Burma)	Irrawaddy
Iran (Persia)	Pakistan	BahuKalat/Rudkhanehye
Iran (Persia)	Pakistan	Dasht
China	Vietnam, Dem. Rep.	Bei Jiang/Hsi
China	Laos	Red/Song Hong
China	Vietnam, Dem. Rep.	Red/Song Hong
Laos	Vietnam, Dem. Rep.	Red/Song Hong
Niger	Cameroon	Lake Chad
Niger	Central African Republic	Lake Chad
Niger	Chad	Lake Chad
Niger	Algeria	Lake Chad
Niger	Libya	Lake Chad
Cameroon	Central African Republic	Lake Chad
Cameroon	Chad	Lake Chad
Cameroon	Sudan	Lake Chad
Central African Republic	Chad	Lake Chad

Central African Republic	Algeria	Lake Chad
Central African Republic	Libya	Lake Chad
Chad	Algeria	Lake Chad
Chad	Libya	Lake Chad
Algeria	Sudan	Lake Chad
Libya	Sudan	Lake Chad
India	Myanmar (Burma)	Kaladan
Mali	Sierra Leone	Niger
Benin/Dahomey	Sierra Leone	Niger
Benin/Dahomey	Algeria	Niger
Niger	Sierra Leone	Niger
Niger	Algeria	Niger
Ivory Coast	Sierra Leone	Niger
Ivory Coast	Algeria	Niger
Guinea	Sierra Leone	Niger
Guinea	Algeria	Niger
Burkina Faso (Upper Volta)	Sierra Leone	Niger
Burkina Faso (Upper Volta)	Algeria	Niger
Sierra Leone	Cameroon	Niger
Sierra Leone	Nigeria	Niger
Sierra Leone	Chad	Niger
Sierra Leone	Algeria	Niger
Chad	Algeria	Niger
India	Bangladesh	Karnaphuli
India	Myanmar (Burma)	Karnaphuli
Pakistan	Myanmar (Burma)	Karnaphuli
Bangladesh	Myanmar (Burma)	Karnaphuli
India	Bangladesh	Fenney
China	Vietnam, Dem. Rep.	Beilun
Laos	Vietnam, Dem. Rep.	Ma
Laos	Vietnam, Dem. Rep.	Ca/Song Koi
Haiti	Dominican Republic	Massacre
Haiti	Dominican Republic	Artibonite
Mexico	Belize	Hondo
Mexico	Guatemala	Hondo
Belize	Guatemala	Hondo
Mexico	Guatemala	Candelaria
Mexico	Belize	Grijalva
Mexico	Guatemala	Grijalva
Belize	Guatemala	Grijalva
Eritrea	Sudan	Baraka
Haiti	Dominican Republic	Pedernales
Belize	Guatemala	Belize
Ethiopia	Eritrea	Gash

Ethiopia	Sudan	Gash
Eritrea	Sudan	Gash
Belize	Guatemala	Sarstùn
Guatemala	Honduras	Motaqua
Mexico	Guatemala	Coatan Achute
Mexico	Guatemala	Suchiate
Honduras	Nicaragua	Coco/Segovia
Mali	Benin	Volta
Mali	Ivory Coast	Volta
Mali	Burkina Faso (Upper Volta)	Volta
Mali	Ghana	Volta
Mali	Togo	Volta
Benin/Dahomey	Ivory Coast	Volta
Benin/Dahomey	Burkina Faso (Upper Volta)	Volta
Benin/Dahomey	Ghana	Volta
Benin/Dahomey	Togo	Volta
Ivory Coast	Burkina Faso (Upper Volta)	Volta
Ivory Coast	Ghana	Volta
Ivory Coast	Togo	Volta
Guatemala	Honduras	Lempa
Guatemala	El Salvador	Lempa
Honduras	El Salvador	Lempa
Gambia	Guinea	Gambia
Senegal	Guinea	Gambia
Guatemala	El Salvador	Paz
Honduras	Nicaragua	Choluteca
Honduras	El Salvador	Goascoran
Nicaragua	Costa Rica	San Juan
Guinea-Bissau	Senegal	Geba
Guinea-Bissau	Guinea	Geba
Senegal	Guinea	Geba
Guinea-Bissau	Guinea	Corubal
Somalia	Djibouti	Awash
Somalia	Ethiopia	Awash
Djibouti	Ethiopia	Awash
Cambodia (Kampuchea)	Vietnam	Saigon
Cambodia (Kampuchea)	Vietnam, Dem. Rep.	Song Vam (Co Dong)
Mali	Ivory Coast	Komoe
Mali	Burkina Faso (Upper Volta)	Komoe
Mali	Ghana	Komoe
Ivory Coast	Burkina Faso (Upper Volta)	Komoe
Ivory Coast	Ghana	Komoe

Burkina Faso (Upper Volta)	Ghana	Komoe
Myanmar (Burma)	Thailand	Pakchan
Guinea	Sierra Leone	Little Scarcies
Guinea	Sierra Leone	Great Scarcies
Colombia	Venezuela	Orinoco
Colombia	Brazil	Orinoco
Venezuela	Brazil	Orinoco
Benin/Dahomey	Togo	Ouèmè
Benin/Dahomey	Nigeria	Ouèmè
Togo	Nigeria	Ouèmè
Ivory Coast	Guinea	Sassandra
Costa Rica	Panama	Sixaola
Kenya	Somalia	Juba-Shibeli
Kenya	Ethiopia	Juba-Shibeli
Somalia	Ethiopia	Juba-Shibeli
Costa Rica	Panama	Changuinola
Colombia	Venezuela	Catatumbo
Uganda	Kenya	Lake Turkana
Uganda	Ethiopia	Lake Turkana
Uganda	Sudan	Lake Turkana
Kenya	Ethiopia	Lake Turkana
Kenya	Sudan	Lake Turkana
Ethiopia	Sudan	Lake Turkana
Guinea	Liberia	Moa
Guinea	Sierra Leone	Moa
Liberia	Sierra Leone	Moa
Cameroon	Uganda	Congo
Cameroon	Tanzania	Congo
Cameroon	Burundi	Congo
Cameroon	Zambia	Congo
Cameroon	Malawi	Congo
Cameroon	Sudan	Congo
Gabon	Uganda	Congo
Gabon	Tanzania	Congo
Gabon	Burundi	Congo
Gabon	Zambia	Congo
Gabon	Malawi	Congo
Gabon	Sudan	Congo
Central African Republic	Uganda	Congo
Central African Republic	Tanzania	Congo
Central African Republic	Burundi	Congo
Central African Republic	Rwanda	Congo
Central African Republic	Angola	Congo
Central African Republic	Zambia	Congo
Central African Republic	Malawi	Congo

Central African Republic	Sudan	Congo
Congo	Uganda	Congo
Congo	Tanzania	Congo
Congo	Burundi	Congo
Congo	Zambia	Congo
Congo	Malawi	Congo
Congo	Sudan	Congo
Congo, Dem. Rep. of the	Uganda	Congo
Congo, Dem. Rep. of the	Burundi	Congo
Congo, Dem. Rep. of the	Rwanda	Congo
Congo, Dem. Rep. of the	Sudan	Congo
Uganda	Tanzania	Congo
Uganda	Burundi	Congo
Uganda	Rwanda	Congo
Uganda	Angola	Congo
Uganda	Zambia	Congo
Uganda	Malawi	Congo
Uganda	Sudan	Congo
Tanzania	Burundi	Congo
Tanzania	Rwanda	Congo
Tanzania	Sudan	Congo
Burundi	Rwanda	Congo
Burundi	Angola	Congo
Burundi	Zambia	Congo
Burundi	Malawi	Congo
Burundi	Sudan	Congo
Rwanda	Zambia	Congo
Rwanda	Malawi	Congo
Rwanda	Sudan	Congo
Angola	Sudan	Congo
Zambia	Sudan	Congo
Malawi	Sudan	Congo
Costa Rica	Panama	Chiriqui
Guinea	Liberia	St. Paul
Guinea	Liberia	Loffa
Venezuela	Guyana	Barima
Venezuela	Guyana	Amacuro
Venezuela	Suriname	Essequibo
Venezuela	Brazil	Essequibo
Guyana	Brazil	Essequibo
Suriname	Brazil	Essequibo
Liberia	Sierra Leone	Mano-Morro
Ivory Coast	Guinea	Cavally
Ivory Coast	Liberia	Cavally
Guinea	Liberia	Cavally
Ivory Coast	Guinea	Cestos

Ivory Coast	Liberia	Cestos
Guinea	Liberia	Cestos
Ivory Coast	Ghana	Tano
Panama	Colombia	Jurado
Ivory Coast	Ghana	Bia
Thailand	Malaysia	Golok
Uganda	Kenya	Lotagipi Swamp
Uganda	Ethiopia	Lotagipi Swamp
Uganda	Sudan	Lotagipi Swamp
Kenya	Ethiopia	Lotagipi Swamp
Kenya	Sudan	Lotagipi Swamp
Ethiopia	Sudan	Lotagipi Swamp
Suriname	Brazil	Maroni
Cameroon	Nigeria	Akpa
Malaysia	Indonesia	Sembakung
Malaysia	Brunei	Bangau
Malaysia	Brunei	Pandaruan
Guyana	Brazil	Corantijn/Courantyne/Corentyne
Suriname	Brazil	Corantijn/Courantyne/Corentyne
Equatorial Guinea	Cameroon	Benito/Ntem
Equatorial Guinea	Gabon	Benito/Ntem
Cameroon	Gabon	Benito/Ntem
Equatorial Guinea	Cameroon	Ogooué
Equatorial Guinea	Gabon	Ogooué
Equatorial Guinea	Congo	Ogooué
Cameroon	Gabon	Ogooué
Cameroon	Congo	Ogooué
Gabon	Congo	Ogooué
Colombia	Ecuador	Patia
Colombia	Ecuador	Mira
Equatorial Guinea	Gabon	Utamboni
Equatorial Guinea	Gabon	Mbe
Indonesia	Papua New Guniea	Tami
Gabon	Congo	Nyanga
Indonesia	Papua New Guniea	Sepik
Ecuador	Peru	Zarumilla
Kenya	Tanzania	Umba
Ecuador	Peru	Chira
Congo	Congo, Dem. Rep. of the	Chiloango
Congo	Angola	Chiloango
Congo, Dem. Rep. of the	Angola	Chiloango
Indonesia	Papua New Guniea	Fly
Indonesia	Papua New Guniea	Tjeroaka-Wanggoe
Tanzania	Botswana	Zambezi
Tanzania	Mozambique	Ruvuma
Tanzania	Malawi	Ruvuma

Mozambique	Malawi	Ruvuma
Angola	Zimbabwe	Okavango
Zimbabwe	Namibia	Okavango
Zimbabwe	Botswana	Okavango
Brazil	Bolivia	La Plata/Plate/Parana
Brazil	Argentina	La Plata/Plate/Parana
Brazil	Uruguay	La Plata/Plate/Parana
Bolivia	Paraguay	La Plata/Plate/Parana
Bolivia	Argentina	La Plata/Plate/Parana
Bolivia	Uruguay	La Plata/Plate/Parana
Paraguay	Uruguay	La Plata/Plate/Parana
Peru	Bolivia	Lake Titicaca-Poopo System
Peru	Chile	Lake Titicaca-Poopo System
Bolivia	Chile	Lake Titicaca-Poopo System
Angola	Namibia	Cuvelai/Etosha
Mozambique	Zimbabwe	Sabi
Mozambique	Zimbabwe	Limpopo
Zimbabwe	South Africa	Limpopo
Zimbabwe	Botswana	Limpopo
Bolivia	Chile	Zapaleri
Bolivia	Argentina	Zapaleri
Chile	Argentina	Zapaleri
Mozambique	South Africa	Umbeluzi
Mozambique	Swaziland	Umbeluzi
South Africa	Swaziland	Umbeluzi
Brazil	Uruguay	Lagoon Mirim
Brazil	Uruguay	Chuy
Chile	Argentina	Valdivia
Chile	Argentina	Puelo
Chile	Argentina	Comau
Chile	Argentina	Yelcho
Chile	Argentina	Palena
Chile	Argentina	Aysen
Chile	Argentina	Baker
Chile	Argentina	Seno Union/Serrano
Chile	Argentina	Gallegos-Chico
Chile	Argentina	Cullen
Chile	Argentina	Aviles
Chile	Argentina	Carmen Silva/Chico
Chile	Argentina	Rio Grande (South America)
Chile	Argentina	Lake Fagnano