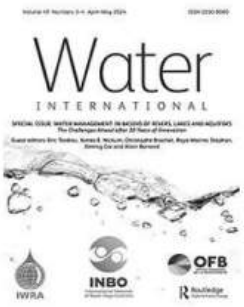

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VIEWPOINT

Reflections on transboundary water conflict and cooperation trends

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ABSTRACT

This article explores major findings and evolutions in understandings of transboundary water conflict and cooperation over the last three decades, focusing on the trends emerging from the Transboundary Freshwater Diplomacy Database. It is found that since the 1940s, countries tend to cooperate over shared water resources, in contrast to media portrayals of 'water wars'. Water conflicts, which have increased slightly since 2000, are mostly fuelled by water quantity disputes or unilateral infrastructure developments. Institutions play a role in facilitating cooperation and reducing conflict over shared waters, but their growth and adoption have slowed over the last few decades.

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Transboundary water conflict and cooperation; river basin organizations; freshwater agreements; transboundary freshwater diplomacy database; transboundary aquifers; shared waters

Introduction

Many of the world's water resources are transboundary in nature, with 313 river and lake basins (McCracken & Wolf, 2019; TFDD, 2023), more than 300 wetlands (Rosenblum & Schmeier, 2022), and almost 600 aquifers stretching across international political borders (IGRAC & UNESCO-IHP, 2021). Surface water basins cover 47% of the Earth's land surface and account for around 60% of freshwater flow (De Stefano et al., 2012; McCracken & Wolf, 2019). These waters are also home to 52% of the world's population (McCracken & Wolf, 2019). Climate change, population growth, and uneven patterns of economic development are contributing to the depletion and contamination of transboundary freshwater resources in many parts of the world. Given these challenges and water's status as a vital resource, it would seem that water scarcity or infrastructure development could act as a powerful impetus for violent conflict and war between states. Indeed, the water wars discourse has historically been, and continues to be, prevalent in media, policymaking, and academic circles for decades (see Gleick, 1993; Homer-Dixon, 1994; Ki-Moon, 2007 in UN News, 2008; Harris 2021 in Borda, 2021 for examples). However pervasive this discourse has been, quantitative analyses of water scarcity, other water-related challenges, and conflict have demonstrated that there are no modern instances where water has acted as a *casus belli* for war between states (Wolf, 2007).

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Grim predictions that warned 'the wars of the next [21st] century will be about freshwater' (Serageldin, 1995 in Barnaby, 2009) have so far fallen short in explaining the hydropolitical dynamics of the past few decades. Indeed, approximately 67% of all country–country interactions over transboundary freshwater resources in this same time period have been cooperative (Wolf, Yoffe et al., 2003), over 650 freshwater agreements have been signed since 1948, and more than 120 basin organizations have been established (TFDD, 2023).

If wars are not fought over water, and violent interstate conflict over water is the exception rather than the rule, then to what extent do shared waters contribute to conflict and cooperation between states? A large body of literature has examined potential factors that can contribute to conflict in transboundary river basins, attempting to establish causal links between conflict and various physical, political, economic, and institutional factors such as water scarcity (Dinar, 2009; Gleditsch & Hamner, 2001; Tir & Stinnett, 2012), hydrological variability including flood risk (Arnell et al., 2013; Kundzewicz et al., 2008), the presence of non-water-related armed conflict (Gleditsch et al., 2006), upstream–downstream relationships (Bernauer, 1997; Munia et al., 2016), more general political or economic relations between states (Bernauer & Böhmelt, 2014; De Bruin et al., 2023), and the existence or the design of treaties and institutions (De Stefano et al., 2017; Mitchell & Zawahri, 2015). Other researchers have adopted a forward-looking approach that did not focus so narrowly on conflict but also attempted to assess the extent of cooperation, utilizing global data sets such as the Transboundary Freshwater Diplomacy Database[1] (TFDD) to map conflict and cooperation interactions to predict potential conflict hotspots (De Stefano et al., 2017; Wolf, Yoffe et al., 2003). From this work, a growing water cooperation discourse has evolved, which highlights how shared waters may induce cooperation, possibly even with regard to other issues due to the mutual dependencies created by transboundary water networks (Wolf, 1998). Other authors have built on this work to explore the contributions of institutional capacity to conflict prevention and cooperation (Hearns et al., 2014; Mitchell & Zawahri, 2015; Schmeier, 2013; Wolf, Stahl et al., 2003; Wolf, Yoffe et al., 2003), suggesting that the capacity of basin treaties, organizations, as well as positive relations, play a key role in preventing or mitigating water conflicts in the long run.

The reality, of course, is much more nuanced than what any of these framings of transboundary water conflict and cooperation suggest. Conflict and cooperation are not absolute states of affair, but rather represent a continuum and can even coexist (Mirumachi, 2015; Sadoff & Grey, 2005; Zeitoun & Warner, 2006). Moreover, the focus on the state as a unitary hydropolitical actor obscures the fact that there are different perspectives within a state and other governance actors at the subnational and non-governmental levels, creating intrastate dynamics that affect shared water governance and cooperation (Menga, 2016; Warner & Zawahri, 2012). Furthermore, recent research notes that much literature has insufficiently considered different actors that shape and/or are influenced by transboundary water conflict and cooperation, such as women, indigenous groups, marginalized communities, and others (De Silva et al., 2018; Gaard, 2001).

Our understanding of transboundary water conflict and cooperation has undergone significant changes in the past 30 years, but we are still missing critical pieces of the evolving puzzle. Therefore, this article overviews the evolution in our understanding of

transboundary water conflict and cooperation, particularly through the lens of the TFDD. By spotlighting major developments, trends, and gaps in transboundary water conflict and cooperation in the past 30 years, this article underscores the progress made in – and the challenges to – transboundary water governance, discussing both the reasons for these trends and implications for sustainable governance of shared water resources.

Developments and trends in transboundary water conflict and cooperation

Conflict and cooperation

Over the past three decades, our understanding of transboundary water conflict and cooperation has shifted from a focus on 'water wars' in the 1980s/1990s to a recognition that cooperation is more prevalent than conflict over international waters. Although we are unable to address all of the major trends that led to this shift within the limited scope of this article, we would like to highlight three core factors. First, there has been a move away from a narrow focus on armed, violent, or militarized conflict, such as is the focus in other fields, e.g., international security and peace and conflict research. This shift has shed clarity on the extent of conflict within basins and led to the understanding that there is a low likelihood of violent conflict at the interstate level over shared freshwater. Second, the study of transboundary water cooperation has expanded, acknowledging that conflict and cooperation can coexist rather than being mutually exclusive phenomena. Lastly, the use of events data, particularly the TFDD's Events Database, has provided a foundation for research on transboundary water conflict and cooperation.

The Events Database has enabled researchers to test various indicators or predictors that contribute to conflict and/or cooperation outcomes within a basin. Initial research aimed at identifying basins at risk of conflict suggested that conflict would be more common in high-population, low-income states with overall unfriendly relationships (Wolf, Yoffe et al., 2003; Yoffe, 2001). Specifically, places where large infrastructure projects were planned without adequate institutional arrangements to address potential conflicts were seen as vulnerable. Although the link between large infrastructure and limited institutional capacity was supported, the causal relationships of other factors were less robust (Yoffe et al., 2004, 2003). Subsequent studies delved deeper into additional indicators and found that basin size and political regime type have a more significant impact on conflict prevalence (Brochmann & Gleditsch, 2012; Mitchell & Zawahri, 2015). Contrary to common assumptions, the upstream–downstream relationship was found to have a weak association with conflict (Beck et al., 2014). Regarding potential indicators for cooperation, research has evolved to indicate that cooperation is more likely between democratic states with extensive trade relations and regional organizations (Kalbhenn, 2011). Similar legal systems, contiguous geography, and greater dependence on shared freshwater resources also contribute to cooperation. Interestingly, higher precipitation levels have been found to reduce the potential for cooperation, contrary to expectations (Zawahri & Mitchell, 2011; also see Brochmann, 2012; Dinar et al., 2019; Giordano et al., 2013; Tir & Stinnett, 2011).

It is important to note two key points. First, there is no single determining factor for conflict or cooperation. The unique context of each transboundary river basin and its riparian states leads to a multitude of factors contributing to both

conflict and cooperation. Second, although cooperation outweighs conflict in transboundary basins, the most recent (limited) data indicate an increase in low levels of conflict while cooperation may be decreasing (Kåresdotter et al., 2023). Continued research in this field is vital,[2] particularly in the face of climate change and the associated risks of increased precipitation intensity and variability, floods, and droughts. However, one general conclusion that can be drawn is the necessity of adequate institutional capacity to reduce the likelihood of potential conflicts (Wolf, Yoffe et al., 2003). The TFDD has further evolved research on institutional capacity through two focal points: freshwater agreements and river basin organizations.

Freshwater agreements

Countries have opted to institutionalize cooperation in 209 basins through freshwater agreements (TFDD, 2023). Such agreements are often assumed to become a means for preventing the (re-)emergence of conflict and for strengthening cooperation (Brochmann, 2012).

Various characteristics and trends can be observed with regard to agreements. First, while the number of agreements has grown over time, there has been variation in this growth, with the 1970s and the 1990s/2000s being particularly prolific, and the most recent two decades seeing an overall decline in the average number of agreements signed (McCracken et al., Forthcoming).[3] Second, geographic distribution of treaties is highly varied. While Europe and Africa feature a particularly high treaty density, the Middle East, South America, and parts of Asia have some basins with no agreement at all (TFDD, 2023). Third, the scope, focus, and content of basin agreements have changed over time. Earlier agreements were often regulatory and focused on one specific issue – usually water allocation (as reflected in, e.g., the 1906 Convention between Mexico and the United States for the distribution of waters of Rio Grande). Regulatory agreements in later decades began to focus more on environmental and water quality issues (as reflected, e.g., in the 1960 Agreement on the Protection of Lake Constance against Pollution), or expressed interest in joint water resources exploitation for the sake of economic development (as reflected, e.g., in the 1972 Convention Concerning the Status of the Senegal River; Giordano et al., 2013; Hamner & Wolf, 1997; TFDD, 2023). Significantly influenced by the emergence of the Integrated Water Resources Management (IWRM) paradigm, agreements since the 1990s have become more holistic and often focus on the integrated management of the basin with its various hydrological, environmental, and socioeconomic dimensions (as seen, e.g., in the 2004 Agreement on the Establishment of the Zambezi Watercourse Commission; Schmeier & Cuadrado Quesada, 2023). Finally, agreements have become more comprehensive over time in their water law principles and their governance mechanisms, reflecting key water law principles as codified in the 1997 UN Convention on the Non-Navigational Uses of International Watercourses (1997 UN Watercourses Convention) and the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992 UN Water Convention) and including increasingly often more sophisticated mechanisms for cooperation, e.g., for preventing and mitigating disputes (Schmeier & Cuadrado Quesada, 2023).

The formation of agreements over transboundary aquifers is not as advanced, with about 120 agreements mentioning groundwater and only 15 agreements (or treaty-like arrangements) existing solely over transboundary aquifers.[4] Governance arrangements over transboundary aquifers remain quite weak (Albrecht et al., 2017), reflecting how much international law on shared groundwater resources is lagging behind. This is also reflected at the global level, where the 2008 Draft Articles on the Law of Transboundary Aquifers, developed by the International Law Commission, have still not been adopted by the international community and remain highly contested among states and scholars (McCaffrey, 2011).

River basin organizations

In more than 100 basins around the world, countries have opted to institutionalize cooperation beyond the mere adoption of treaties through the establishment of basin organizations (TFDD, 2023). Although several basin organizations had already been established in the early years of transboundary water cooperation (especially in the 1960s and 1970s), slightly more than half of all basin organizations existing today have been established since 1990. Like treaties, basin organizations are also distributed unequally across the world, again with Europe and Africa featuring the highest coverage.

These basin organizations fulfil a variety of functions and govern issues such as water allocation, water quality, navigation, hydropower development and operation, environmental management, and many more (Schmeier, 2017). They also provide a variety of governance mechanisms, such as platforms for joint decision-making, processes for basin planning and management, procedures for notification of or consultation on planned measures, and instruments for stakeholder engagement (Schmeier, 2013).

While some scholars and, in particular, the general media have criticized basin agreements and organizations for their lack of effectiveness in addressing conflict dynamics or their inability to bring about change in basins, research shows that basin organizations have actually played a considerable role in preventing and mitigating conflicts over shared water resources and in strengthening cooperation (Earle & Wouters, 2015; Schmeier, 2013). Basin organizations have been crucial in moving cooperation beyond the mere absence of conflict and in generating and distributing the benefits that can be obtained from cooperative water governance in comparison to unilateral strategies (Berardo & Gerlak, 2012; Schmeier, 2013; Wingqvist & Nilsson, 2015) The ability to successfully do so, however, depends on the institutional capacity (Saruchera & Lautze, 2016; Schmeier, 2017), including specific mechanisms in treaties and basin organizations (i.e., conflict resolution mechanisms; De Bruyne & Fischhendler, 2013; Mitchell & Hensel, 2007).

Acknowledging emerging challenges as well as shortcomings in basin governance and in related institutional capacities, basins in various parts of the world have recently experienced change or reform processes through which riparian states aim to improve the resilience or the effectiveness of basin governance. Often these reforms aim to address lessons learned relating to more adaptive management approaches or the inclusion of a wider variety of actors. Research on institutionalized cooperation over shared water resources is also increasingly exploring these changes, reflecting a growing understanding of the role of non-state actors in transboundary water interactions and

acknowledging the nuanced nature of these interactions (De Bruyne et al., 2020; Schmeier, 2013). The next section turns towards an examination of evolving framings of transboundary water dynamics, with an emphasis on the role of power (Zeitoun & Warner, 2006) in determining transboundary water outcomes, the need for a multiscalar understanding of hydropolitics, and what is missing from the data.

Evolving framings of transboundary water conflict–cooperation dynamics

As illustrated, there have been significant changes within the field of transboundary water conflict and cooperation over the last 30 years. Upon reflection, certain aspects can be identified that indicate further evolution and highlight areas in need of continued research and evolving thinking. Among the evolving frames of transboundary water conflict and cooperation dynamics, which encompass the interactions between states and non-state actors, two frames are of particular interest: multiscalar hydropolitics and what is missing from empirical research on transboundary conflict and cooperation.

Multiscalar hydropolitics

As discussed above, we have seen that a large body of literature has argued that the presence of a treaty or a River Basin Organization (RBO) may reduce the likelihood of hydropolitical conflict, as treaties and RBOs can contain mechanisms for joint decision-making among riparian states, data sharing, and flow variability that reduce uncertainties and increase a basin's adaptive capacity or processes for preventing, mitigating, or resolving disputes (Gerlak et al., 2011; Milman et al., 2013; Schmeier, 2013). However, the establishment of cooperative institutions is not an end-all answer to water conflict. Treaties and RBOs do not always lead to the absence of conflict, cooperation, or increased hydropolitical resilience due to many potential factors, including the design of the legal or institutional arrangement, the degree and extent of implementation) or contextual and external elements that inhibit the effectiveness of agreements and RBOs. This last category of factors can be unique to a particular basin, but generally includes challenges relating to the nature of the conflict itself, the extent of technical capacity in the basin, and the prevalence of regional cooperation in non-water sectors between the riparians.

One factor we would like to focus on, however, when considering the evolving framings of transboundary conflict–cooperation dynamics is when agreements are negotiated in contexts of power asymmetries. Scholars from the London Water Research Group have been quick to point out the simultaneity of conflict and cooperation, observing that not all cooperation leads to desirable outcomes, especially in situations where a hydro-hegemonic state wields a disproportionate amount of power relative to other basin riparians (e.g., Mirumachi, 2015; Zeitoun & Mirumachi, 2008; Zeitoun et al., 2011). Indeed, hydro-hegemonic theory, originally conceptualized by Zeitoun and Warner (2006) and later refined by Cascão and Zeitoun (2010), Menga (2016), and Warner et al. (2017), has been used to advance hydropolitical analysis that emphasizes the role of power in determining the nature of transboundary water arrangements. By teasing out the nuances embedded within hydropolitical interactions, it is possible to see how the exercise of 'soft' power by hegemonic states, such as Israel in the Jordan Basin and India on the Ganges Basin, perpetuates the existence of arrangements that may look

cooperative on paper but, in reality, are highly inequitable and skewed in favour of the basin hegemon (Zeitoun et al., 2011).

A common element in hydro-hegemonic analysis, transboundary water conflict and cooperation in general, and of broader international relations literature that focuses on Waltz's (1959) second image, is a state-centric perspective that precludes understanding how interactions over transboundary waters occur within states, as well as between them. This neorealist perspective that defines a state as a fixed unit of sovereign space, often treating it as a black box and disregarding inherent variability within and between states, precludes the inclusion of non-state actors into analysis on international conflict and cooperation. This, along with the sharp polarity between the domestic and foreign spheres and the conception of the state as 'prior to and as a container of society', form the territorial trap hydropolitical analysis often falls into (Agnew, 1994, p. 59). In light of this, a growing body of work addresses the politics of scale in transboundary water governance, demonstrating how states are often engaged in multi-chessboard games in which they navigate around the pressures exerted by actors at the domestic, interstate, and transnational levels (see Harris & Alatout, 2010; Norman & Bakker, 2009; Norman et al., 2012; Warner & Zawahri, 2012 for examples). Non-governmental organizations, for example, can pressure hegemons into altering their behaviour through lobbying and alliance formation, as seen when an alliance of local and international non-governmental organizations and other activists temporarily halted the construction of Turkey's Ilisu Dam (Warner, 2012). Expanding hydropolitical analysis beyond the realm of the state will result in a better understanding of how non-state actors, Indigenous and subnational groups, transnational institutions, and domestic constituencies can influence states' conflict and cooperation over transboundary water resources, unpacking the black box and countering the long-standing idea of a state as a hydropolitical unity.

What is missing from empirical research?

Thus far we have kept our focus on empirical findings and the different approaches to the study of transboundary water conflict and cooperation. However, it is equally important to pay attention to what is lacking in the extant literature and related data sets. Missing from many data sets on transboundary water conflict and cooperation, such as those within the TFDD, is what is missing in society – equal representation for Nature, for Indigenous and marginalized communities, and for women (Gaard, 2001). For example, there is a gap in the literature concerning women's role as decision makers at the higher levels of water governance (De Silva et al., 2018). This lack of information means that current data used for the management of transboundary waters may not be fully representative, leading to decisions that put at risk the physical, emotional, mental, and spiritual well-being of communities – contributing to resource-based disputes and inequities.

Nature is rarely given a seat at the table when transboundary water agreements are written (Porta & Wolf, 2021; Turgul et al., Forthcoming). The focus of international freshwater agreements, as discussed above, has shifted, from regulating and developing water resources to managing and allocating shared waters, to considering water quality and the environment (Giordano et al., 2014). The environment has gained increasing mentions since the 1960s, although generally in a rather vague and general manner

(Giordano et al., 2014). Mere consideration of the environment does not equate to equitable representation of Nature in a water negotiation setting if Nature is only considered in regard to how humans benefit from it.

In addition to increased attention to the environment, attention to the marginalization of women has increased in recent years. Despite this, a data gap remains, augmenting disconnected socioeconomic, ecosystem, and governance structures. Insufficient data about gendered water governance at regional to international scales contributes to a limited comprehension regarding women's contribution to water governance and security (De Silva et al., 2018; Ray, 2007) – and an underrecognition of how women can contribute to greater freshwater access and freshwater infrastructure to benefit community needs, social mobility, market gains, and social–environmental sustainability (De Silva et al., 2018). Recent research has demonstrated the extent to which transboundary water governance has been masculinized (Sehring et al., 2022) by revealing, for instance, the underrepresentation of women in leadership positions in river basin organizations (Best, 2019).

Part of the solution is filling the data-deficiency within transboundary water conflict and cooperation research with more nuanced information, such as intersectionality – gender, race, and class distinctions – to recognize that women's experiences are pluralistic, not uniform (Fletcher, 2018). Relationships to water and Nature are also pluralistic (Evers et al., 2017). Momentum around the concept of granting legal rights of nature (Epstein et al., 2023) may help generate more specific ways to manage shared waters equitably with Nature as well.

Future directions

Research on transboundary conflict and cooperation dynamics has revealed more and more complexities over the years. While most of the earlier findings persist – such as the prevalence of cooperation over conflict and the conflict-mitigating role of institutions – numerous additional aspects to consider when studying conflict and cooperation dynamics have become visible. Some of these aspects, such as the need to take a multiscalar approach to the study of transboundary water dynamics, have already been discussed above. In the present section, we briefly highlight future directions for research on transboundary water conflict and cooperation.

New technologies are presenting both new opportunities and new challenges. Monitoring from both satellites and citizen scientists, for example, is circumventing much of the secrecy and securitization that states have sometimes held historically (Donchyts et al., 2022). On the other hand, real-time decision-making on issues such as dam operation still require communication and trust-building between riparians. Other technologies, such as desalination (Aviram et al., 2014; Walschot & Katz, 2022), may shift the hydropolitics of shared rivers if the price comes down sufficiently, to where low-lying coastal areas could achieve some of the inherent advantages that upstream riparians currently hold.

In light of the persistent lack of attention to the issues of groundwater sharing (Stephan et al., 2022; UN Water, 2022) – both from law, governance, and policy making and, although increasingly less, from research – more efforts are needed to ensure that the world's many transboundary aquifers receive adequate attention

to mitigate their continuous deterioration. This includes developing not only a better understanding of the nature of transboundary aquifers – including their linkages to surface waters, which determine the applicability of the legal regime (see examples of treaties in Lautze et al., 2018) – but also a better understanding of the reasons behind the persistent lack of institutionalized cooperative arrangements over shared groundwater resources (such as started by Albrecht et al., 2017).

Climate change and its potential implications for conflict and cooperation dynamics represent another dimension increasingly receiving attention. Some authors argue that the impacts of climate change are likely to lead to more conflict or even the earlier forecasted water wars (Link et al., 2016), especially in the context of the broader climate security debate (Boas & Rothe, 2016; Busby, 2021). Others, however, continue to emphasize the cooperation potential of shared water resources and the conflict-mitigating role of institutions (Schulze & Schmeier, 2012; Tilleard & Ford, 2016; Tir & Stinnett, 2012), although their ability to deal with upcoming climate challenges varies across basins and depends on numerous factors (Cooley & Gleick, 2011; De Bruyne et al., 2020; Dinar et al., 2019).

One additional aspect of transboundary water governance that merits more attention relates to intersectoral linkages between transboundary water resources, food, and energy, and thus nexus approaches to transboundary waters (De Strasser et al., 2016). Commitments under the Sustainable Development Goals relating to food and energy security, for instance, have considerable implications for water resources and have so far been driving their overexploitation. This is problematic because decisions over the use of water resources are often taken at the national level in line with national food and energy security priorities, thereby compromising the sustainability of transboundary water resources.

Conclusion

From water wars discourse to institutionalized cooperation to recognizing that transboundary water interactions are nuanced and complex, our understanding of conflict and cooperation over shared freshwater resources has undergone significant transformations in the past 30 years. Data emerging from the TFDD on water-related events, treaties, and institutions have underpinned much of this evolution, which has shed light on how conflict may be mitigated and cooperation promoted in international basins. However, our understanding of transboundary water dynamics is still incomplete. There is a need for a more nuanced understanding of how these dynamics are affected by power and play out at multiple spatial scales. Similarly, more attention needs to be paid to what is missing from most empirical research on water conflict and cooperation, namely representations of Nature, Indigenous and marginalized communities, and women. With climate change on the horizon and new technologies presenting new opportunities and challenges to transboundary water governance, it is clear that much more work remains on the research agenda. We are confident, however, that the next 30 years of research will yield even more innovative solutions to the governance of our most precious resource.

Notes

1. The TFDD, housed at Oregon State University, is a collection of data sets, including the register of international river basins, international freshwater treaties, international freshwater events, and international river basin organizations. Established by Aaron T. Wolf and contributed to in partnership with IHE Delft, The Fletcher School at Tufts University, and other partners, the database monitors, analyses, and makes publicly available the most comprehensive data sets on transboundary freshwater river basins and their institutions.
2. The authors and broader research team associated with TFDD are currently, as of the time of writing, updating all three major data sets: the International Freshwater Events Database, the International Freshwater Agreements Database, and the International River Basin Organizations Database.
3. Average of less than 20 agreements signed per decade between 1860 and 1940, whereas between 1950 and 1980, between 60 and 80 were signed per decade. This peaked in the 1990s, with over 120 signed, then decreased with slightly over 80 signed in the 2000s, and only slightly above 40 agreements signed in the 2010s (McCracken et al., Forthcoming).
4. Aquifers with specific groundwater arrangements include: Nubian Sandstone, Genevese, Guarani, Al-Sag/Al-Disi, Illuemeden, Taoudeni/Tanezrouft, Northwestern Sahara, Senegalo-Mauritanian, and Stampriet.

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