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Editorial

Damming Disputes: Conflict Prevention in Water Management

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1. Introduction

Water—A Resource Ripe for Conflict

Water has a unique combination of qualities that contributes to the many conflicts with respect to its control and use. Water is necessary for the basic survival of all life forms. It is also utilized on a large scale across a wide range of economic sectors, and its use has to be coordinated with the provision of many other basic services, such as energy and food. Unlike many other natural resources, water also has economic and ecological value when left in situ, i.e., when it is not extracted for human use, as it sustains ecosystems and provides humanity with ecosystem services. In addition, its supply is stochastic, meaning that users have to deal with significant uncertainty regarding not only the quantity of the resource but also its quality and the location and timing of its supply.

Water security is a critical aspect of climate change, human security, and sustainable development, particularly in regions and communities where competing water usage, climate change impacts, and cross-border water agreements contribute to conflicts. Geopolitical factors, segregation, water availability, and access rights affect shared water agreements. Climate change further exacerbates water issues by altering precipitation patterns and triggering droughts, floods, and other scenarios that impact water availability and provisioning capacity for states and communities.

Moreover, water moves, often crossing jurisdictional boundaries. Recent tallies have identified 310 river basins that cross international boundaries in which over half of the world's population lives [1] and nearly 470 transboundary groundwater basins ([2]). These international transboundary sources supply over 80% of the world's freshwater. Additionally, the study by [3] included in this Special Issue identified 300 transboundary wetlands. The number of basins, aquifers, and wetlands that cross subnational jurisdictions is exponentially higher still, and with each jurisdiction, the number of relevant stakeholder groups multiplies.

In many cases, water is the boundary itself. According to the Global Subnational River-Borders (GSRB) database, at least 23% of the world's non-coastal national borders, 17% of interior state and province borders, and 12% of the world's interior local-level political borders are determined by large rivers [4]. Given the many and varied actors, interests, institutions, and stakeholders involved in managing water resources, disputes and conflicts over water management are commonplace. As such, many observers, including policymakers, water managers, and academics, cite concerns over "water wars", and the quote often misattributed to Mark Twain "Whiskey is for drinking. Water is for fighting over". While water may be prone to creating conflict, such an outcome is not inevitable.

Extensive literature exists, investigating the extent, intensity, and drivers of conflict over water. This includes theoretical and empirical studies, the latter of which rely on a variety of both case studies and statistical analyses. Perhaps the most prominent among this literature is the focus on conflict and cooperation over transboundary waters (for reviews see [5,6]). A seminal and much-cited study by Yoffe et al. [7] found that incidents of violent

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conflict between countries were relatively rare and that incidents of cooperation were more common than those of conflict. These findings were in stark contrast to many warnings regarding the risk of "water wars" ([8–10]).

Other researchers stressed, however, that a lack of instances of high-intensity violence over water did not imply a lack of conflict. Lower-intensity conflict is still relatively commonplace. Moreover, an analysis of past events is not necessarily indicative of future trends, especially given growing populations and demands and climatic change. In addition, some observers pointed out that cooperation and conflict should not be viewed as opposite ends of a spectrum but rather as phenomena that could coexist in relationships between parties (e.g., [11,12]). Moreover, a lack of violence and even instances of cooperation may belie deeper underlying conflicts if they occur because one party imposes its will on another weaker party—a phenomenon that has come to be called "hydro-hegemony" ([13]).

Domestic water conflict is arguably more common than international conflict ([14,15]). Moreover, domestic factors can contribute to international water conflict and vice versa ([14,16]). Research on domestic disputes has found that while both demand-side and supply-side factors can serve as drivers of conflict, the former tend to be significantly more important than the latter ([17]). The identification of drivers is, of course, especially important in attempts to minimize and mitigate such water-based conflicts.

Water stress and climate crises pose significant challenges exacerbated by social, political, and governance issues. Nagabhatla et al. [18] reflect on how these challenges result in diverse impacts on communities, particularly vulnerable populations, also leading to conflict, forced displacement, and migration. Water conflicts can cascade into multifaceted crises such as violent conflicts and political and civil instability.

2. Water and Conflict Prevention

Within the vast literature on the conflict over water, the lion's share of studies looks at empirical evidence with respect to the extent and causes of conflict. A smaller share of the literature focuses on conflict resolution, and relatively few studies look at conflict prevention ([19]). The work that does can be divided into the literature on (a) diplomacy and diplomatic efforts, (b) institutional arrangements, (c) policy instruments, and (d) technological developments.

A burgeoning literature on what is called water diplomacy or hydro-diplomacy looks at methods that promote cooperation and agreements between parties, especially at the international level. Much of these draw on principles drawn from general diplomacy, but some are based on more general rules for conflict management (e.g., [20–23]) or even on spiritual and religious foundations (e.g., [24,25]). Nagabhatla et al. [10] argue that hydro-diplomacy provides a framework to balance traditional water-sharing practices of local communities with the demands of large-scale commerce and economic-oriented water management approaches. Therefore, it is crucial to understand the interconnected dynamics of water, migration, conflicts, and climate change impacts. In this respect, consensus building can play a vital role in supporting long-term regional water governance plans and policies, particularly in conflict settings.

The work focusing on institutions places focus on organizations and governance rather than interpersonal relations and procedures that tend to be the focus of the hydrodiplomacy literature (e.g., [26]). Of particular interest, especially in more recent years, has been the focus on the inclusion of different stakeholders, including third-party and civil society actors (e.g., [27,28]), a particularly challenging task given the wide range of interests that can be involved.

Given the large number of stakeholders interested in many disputed water issues, a fair amount of work has gone into investigating stakeholder engagement and processes for enabling dialogue. Intuitively, one might surmise that more actors will lead to more conflict and/or that more diverse actors may lead to more conflict. In studies on large collaborative water management in sites in the U.S. and Argentina, Lubell et al. [29] seem to confirm such hypotheses; however, they found that the number of issues was not correlated

with more conflict. Such findings indicate that more inclusive institutional arrangements that attempt to bring in collaborative input from diverse stakeholders are more likely to encounter conflict. Thus, policymakers may be inclined to limit the number of stakeholders in order to avoid such outcomes.

A few factors, however, detract from such an interpretation of the findings. Firstly, more actors and more issues are likely to be highly correlated, so distinguishing between the two can be difficult. Secondly, there may be issues of endogeneity, by which it may be that more contentious issues draw in more actors rather than more actors resulting in more conflict. Thirdly, achieving consensus or avoiding conflict in one forum may simply be deferring it to other arenas down the road. Still, even with these caveats, the work on institutional design and networks and stakeholder engagement is a burgeoning field in terms of conflict prevention and shows much promise.

The work on policy instruments looks at the role of measures such as information exchange, rules on prior informed consent, the establishment of dispute resolution mechanisms, and other such options that can build trust and reduce some of the underlying causes of conflict and/or facilitate cooperation between parties. Other works within this sub-literature have focused on the potential for benefit sharing, cost sharing, and side payments to promote cooperation and reduce the potential for conflict (e.g., [30–32]). While the bulk of the literature has found that such arrangements can promote cooperation by expanding the set of potentially mutually beneficial outcomes, some observers have noted that these approaches can come at a cost of complicating negotiations or management by increasing the number of actors and/or increasing the transaction costs of negotiations (e.g., [33]).

Of course, the literature on policy instruments tends to overlap somewhat with the literature on the role of institutions given that both fall under the broader framework of governance regimes. As such some work focuses on the role of policy instruments within treaties (e.g., [34,35]) while others look at the role of different levels of government involvement in implementing instruments (e.g., [36]).

Finally, some of the literature focuses on the role that technological developments can play in reducing drivers of conflict, including scarcity, variability, uncertainty, and lack of transparency ([37]). Technologies such as remote sensing are often utilized to facilitate data diffusion and increase transparency, as well as monitor compliance (e.g., [38–41]). This can be especially useful in areas with limited historical data ([42]). Machine learning and other types of artificial intelligence have also been applied to supply data, aid in predictions of flooding and drought, and even forecast future conflict hotspots ([43–45]).

Water-specific technologies such as desalination and wastewater reuse have been highlighted by some observers as being potential "game-changers" in terms of their potential to obviate conflict by reducing scarcity and uncertainty (e.g., [46–48]). While such technological innovations have no doubt changed some of the basic assumptions about interstate and multistakeholder interactions, several have noted their limitations and cautioned against viewing them as a technological fix or some type of silver bullet (e.g., [49–51]).

3. New Insights into Water and Conflict Prevention

This Special Issue is dedicated to the continuation of this somewhat underdeveloped aspect of water conflict management: conflict prevention. It contains a range of theoretical and empirical studies, with examples from cases from around the world. The studies span several of the themes mentioned above, with several addressing more than one.

Smith and Winterman [52] compare three different institutional approaches to facilitating hydro-diplomacy at an international level, with a comparative assessment of three case studies. They find that there is a need for institutional mechanisms that govern transboundary water cooperation to promote political resilience and that efforts to "depoliticize" such processes by limiting work to technical aspects risk making the efforts and the institutions ineffective.

Medrano-Pérez et al. [53] also focus on the institutional aspects of conflict prevention but not in a transboundary context and rather in the context of domestic groundwater management in Mexico. Looking at two different aquifer systems that face multiple pressures and high demand, they highlight the importance of stakeholder empowerment in mitigating conflicts over the asymmetry of power among stakeholders. Identifying what they refer to as the construction of hydrosocial territory, they demonstrate how citizen participation has raised awareness among stakeholders of their rights and helped enable them to influence public decision making.

Lee et al. [54] and Robertson [55] focus on two different policy analysis tools that have the potential to reduce conflict over water management. Lee et al. [54] examine the increasingly popular policy instrument of social impact assessments (SIAs). They give an overview of SIAs' relevance to integrated water resource management (IWRM) and then provide evidence of their usefulness from surveys conducted in Taiwan. They find that despite the potential for SIAs to assist in reducing social disputes over water, water professionals still suffer from a lack of understanding about both the usefulness and limitations of the policy tool.

Robertson [55] looks at a different type of analytical tool. Building both on the body of work of Nobel Prize winner Elinor Ostrom, which addresses the sustainable management of common pool resources (CPR), and the substantial literature on adaptive management, Robertson presents a diagnostic assessment tool dubbed a "CPR heatmap" based on Ostrom's key design principles for CPRs ([56]). Taking a case study of groundwater management in Queensland, Australia, Roberston demonstrates how the tool can be used to relatively quickly identify areas of potential conflict.

Noting that the provision of reliable information about shared waters is a necessary first step in preventing conflict among parties, Hoffman Rosenblum and Schmeier [3] present a new database of transboundary wetlands. They add to previous databases, such as that established by the secretariat of the Ramsar Convention, which is limited to those wetlands deemed "of international significance" by their host countries. Noting that not all countries are signatories to the Convention, they utilize geographical information systems (GIS) to combine existing databases in order to identify wetlands that were previously not recognized as crossing international boundaries. The authors express hope that this first step in the identification of shared aquatic ecosystems will lead to the development of joint management regimes that will both protect the resources as well as reduce the potential for conflict over them.

The use of GIS as a management tool is just a small example of the potential for technologies to assist in conflict prevention. The articles by Hernández-Gutiérrez et al. [57] and Walschot and Katz [58] focus more directly on the impact that technology and infrastructure development can have on conflict over water. Hernández-Gutiérrez et al. [57] examine conflicts that stemmed from the construction of hydroelectric dams, focusing on four case studies from three countries within Latin America: Guatemala, Ecuador, and Peru. While hydroelectric dams are ostensibly a source of renewable clean energy and can provide many additional benefits, such as flood protection, they often lead to conflicts due to issues such as the displacement of populations, disputes over benefit sharing or cost sharing, or environmental damage. In evaluating the three case studies, Hernández-Gutiérrez et al. [57] found that dams tended to disproportionately impact indigenous populations and further aggravated economic and social marginalization. Governments and business interests, however, tended to view local opposition to dam construction as a rejection of progress. These differing viewpoints led to sometimes violent conflict between stakeholders. The authors offer some preliminary recommendations for how to avoid such conflicts in the future, including ensuring that governments abide by their own laws and regulations regarding public participation and the freedom of speech and assembly. In the years following the periods covered in the case studies, the Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean was adopted at Escazú, Costa Rica. If implemented by

ratifying parties, the Escazú Agreement could be one such instrument that ensures that such recommendations are fulfilled.

Walschot and Katz look at the impact that desalination has had on international conflict and cooperation. Aviram et al. [48] posited that by reducing scarcity and variability, two important drivers of disputes, desalination should be expected to reduce conflict; however, they claimed that the impact on cooperation could not be assumed a priori given that it may incentivize parties to work together, but it could also allow them to pursue unilateral policies rather than collective ones. Later work by Katz [51], however, demonstrated that desalination could actually be a source of new conflicts: For instance, parties may now dispute waters of marginal quality that, prior to desalination, were of little interest. Both previous studies were based largely on anecdotal information from case studies. In their study, Walschot and Katz attempt to evaluate actual impacts empirically using both quantitative and qualitative methods, using an extension of the Basins at Risk database ([59]) and applications of the Transboundary Waters Interaction Nexus (TWINS) model ([11]). They did not find any consistent trends in terms of either international conflict or cooperation and concluded that the impacts of desalination on conflict and cooperation cannot be assumed and are likely to be determined by the larger geopolitical context of any given case.

Sarsour and Nagabhatla [60] employed document and content analyses, along with primary and secondary data assessment, to analyze spatial and temporal patterns in order to evaluate how the mandate of Sustainable Development Goals (SDGs)—mainly SDG 6 (water for all) and SDG 13 (climate action)—targets and indicators could help boost water security for regions, nations, and communities in the Middle East and Northern Africa (MENA Region). UN-Water's 2013 water security conceptual framework guided the examination of water and climate security concerns, enabling the identification of gaps and needs toward planning the agenda for the "water security future". The in-depth assessment focus on the occupied Palestine territories also benefitted from discourse analysis and from emerging scholarship on the role of hydro-political perspectives in steering water security planning by offering potential solutions to mitigate water insecurity, climate change risks, and conflicts related to water resources.

The key points from this paper reflect how hydro-hegemony places significant stress on the water sector within the state and in settings where effective cross-border water governance is a key challenge. Additionally, the absence of consensus building for regional water agendas often perpetuates conflicts between communities and states. The authors emphasized that in such cases, the escalating water and climate crises will likely continue to deepen. For vulnerable regions such as the occupied Palestinian territories (OPT) wherein restrictions and geopolitical tensions surround shared waters and pose significant challenges to coping and adapting for both people and stakeholders, it is imperative to develop strategic policies and measures to address these issues effectively and ensure sustainable water management, climate resilience, and peaceful cooperation in the region.

4. Concluding Notes

Water disputes are a frequent occurrence, involving multiple stakeholders and sectors at various levels, from local to global levels. A lack of clarity and disagreements over rights, allocations, and resource distribution often serve as catalysts for potential conflicts. It is crucial to address these challenges by implementing a diverse range of strategies, including legal, institutional, technological, and diplomatic measures, to prevent, mitigate, or resolve water-related conflicts.

This Special Issue focuses on presenting frameworks, approaches, and innovative instruments in water policy that contribute to the prevention of conflict over water resources. While much of the discourse in academia and the media tends to emphasize the potential for acute or violent conflicts, particularly between nations, this issue takes a broader perspective. It explores water conflicts across different levels and settings, from sub-national to regional and supranational, and emphasizes proactive and forward-looking

approaches to prevent conflicts rather than merely reacting to crises. The contributions to this issue include a mix of theoretical analyses and empirical studies. The common theme is to identify the drivers of conflict in order to be better able to address them proactively.

The contributions in this Special Issue shed light on the importance of international relations and regional cooperation in water management, particularly in cross-border contexts. By examining the dynamics of water conflicts and exploring preventive measures, the aim is to foster the development of cooperative frameworks and anticipatory strategies. The knowledge accumulated in this Special Issue will contribute to promoting sustainable water governance, enhancing shared understanding, and facilitating peaceful cooperation among diverse actors. Ultimately, our collective efforts in analyzing best practices and effective insights will shape future water policies and actions to prevent conflicts in the field of water resource management and regional cooperation. In conclusion, by prioritizing conflict prevention and considering the complexities of water disputes, we can pave the way for effective water policies and actions that foster cooperation and sustainable resource stewardship.

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