Beyond Borders - The Challenges of Hydropower Use in Transboundary River Basins

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ABSTRACT

The utilisation of hydropower has diverse environmental, political, and legal implications for countries located along shared river basins. This study examines two cases to illustrate the complex issues that arise from the allocation of transboundary rivers: the Southeastern Anatolia Project (GAP) initiated by Turkey in 1977 (Akanda et al., 2007, p.2) and the construction of the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile River, which began in 2011 (Verhoeven, 2021, p.159). Both examples highlight significant international conflicts among neighbouring countries originating from large-scale hydropower initiatives on shared rivers. These conflicts are further polarised by the disproportional power dynamics between countries located upstream along the shared river and their downstream counterparts. By analysing these case studies, this thesis will discuss the environmental impacts of hydropower and the accountability nations have over their use of shared freshwater resources in case it negatively impacts the river in adjacent countries. The research aims to provide insights into the challenges and possibilities of creating equitable and sustainable transboundary water management policies.

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INTRODUCTION

The increasing awareness around the topic of climate change, has prompted the re-evaluation of the use of non-renewable energy sources. As a result, several governments have taken initiatives to reduce their reliance on fossil fuels and lower carbon emissions by switching to more sustainable energy sources. Hydropower is widely regarded as one of the most reliable renewable energy technologies available today. For this reason, in recent decades there has been a sharp increase in the installation of hydropower plants worldwide, making it the most significant contributor to renewable energy generation. Hydropower contributes around 17% to the annual global electricity production (Iho et al., 2023, p.191) and it constitutes 71% of the total renewable energy generation worldwide (Moran et al., 2018, p.11892)

Although hydroelectric dams appear to be a more sustainable option than fossil fuels, their implementation is controversial from an environmental perspective, as they can lead to deterioration in water quality and the flow of rivers and damage ecosystems. (Chen et al., p.79) Not only do hydropower plants threaten wildlife within rivers, but they can also cause severe political issues due to conflicting interests in water allocation between neighbouring countries along transboundary river basins. The regulation of rivers that are shared among nations is a sensitive subject, that is further amplified by the asymmetrical power dynamics between nations along the river basin. (Lee et al., 2023, p.103) Due to their geographical location, those countries where transboundary rivers have their rise, typically hold power over their downstream counterparts that rely on the waterflow coming from their upstream neighbours.

This thesis aims to explore the complex topic of a country's entitlement to natural resources within its borders and point out the necessity of international cooperation in these matters.

This paper discusses two main questions. Firstly, *what are the environmental impacts of hydroelectricity generation on rivers, and can it be conducted sustainably without irreversible harm to the river ecosystems?* Secondly, *how can countries be held accountable for taking ownership and causing irreversible harm to the shared natural resources within their borders, especially regarding river regulations and freshwater supplies?* To address these questions, this thesis presents two case studies: the Southeastern Anatolia Project (GAP) in the Tigris-Euphrates Basin and the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile River. These cases both showcase political conflicts that originate from the use of hydropower and observe the environmental, political, and legal aspects of transboundary river management.

The central hypothesis suggests that while hydropower projects bring significant socioeconomic benefits for the countries that implement them, their environmental costs create increased tensions in transboundary river basins; therefore, certain policies that protect downstream countries from potential environmental degradation and loss of access to water resources are necessary. Despite extensive literature evaluating the use of hydropower as a renewable energy source or focusing on the political and legal aspects of freshwater allocation, fewer studies have reflected on how these large-scale electricity projects shape individual domestic endeavours to provide sustainable water security in transboundary river countries through the lens of national sovereignty.

Therefore, his research seeks to fill the gap by analysing the legal implications of dam constructions through the case studies and assessing the possibility of cooperation in these shared river basins. The topic of territorial sovereignty versus integrity in the allocation of shared resources will be employed as a framework throughout this analysis, guiding the investigation on achieving regional stability and international cooperation.

The limitations of the study primarily lie within the fact that imposing external regulations onto a country's own resource management is quite difficult through international

treaties. Furthermore, despite all the negative aspects listed, as of today, hydropower is the most productive form of renewable energy generation, and it provides, in many senses, a more sustainable alternative to fossil fuels. (Kishore et al., 2021, p.1) Therefore, despite pointing out all the issues around the utilisation of dams, this research acknowledges that hydropower is important in global efforts to lower carbon emissions. For all these reasons, the primary goal of this thesis is to raise awareness to the cross-country conflicts caused by the lack of international cooperation in environmental protection and contribute to the mutual understanding that avoiding the exploitation of rivers is essentially a joint interest for all parties.

CHAPTER 1

The Environmental Impact of Hydropower & Transboundary River Conflicts

This chapter focuses on hydropower from the dual perspectives of renewable energy generation and transboundary water resource management. Part I provides a detailed overview of hydropower, covering its operational principles and the possible environmental implications of damming rivers. It contrasts the positive aspects of hydropower as a potential sustainable energy source with the disadvantages these technologies have on river ecosystems. Additionally, this section distinguishes between the environmental impacts of the mega-dam projects that are in the focus of this thesis and small-scale hydropower projects that are potentially feasible and less harmful. After explaining the core mechanisms of hydropower plants, Part II introduces a theoretical and conceptual framework that will be applied to analyse the case studies specified in Chapter 2. It defines the key terminologies, such as absolute and limited territorial sovereignty and territorial integrity, in the context of transboundary river regulations. Furthermore, this section introduces the superior-subordinate power dynamics that typically appear between upstream and downstream riparian countries.

1.1 The Feasibility of Hydropower as an Alternative to Fossil Fuels

Rivers have long served as lifelines for human civilisations because they provide essential resources for agriculture, transportation, and energy generation. Over centuries, societies have regulated river flows for various purposes, including flood control, irrigation,

navigation, and, more recently, electricity production. (Chen et al., 2015, p.79) The latter happens through hydropower plants, which often include dams. While "hydropower plants" specifically denote facilities designed to generate electricity using water flow, the term "dam" refers to the structures used to impound water, which can serve various functions beyond electricity generation. (Tefera & Kasiviswanathan, 2022, p.2) For the purpose of this thesis, the terms "hydropower plant" and "dam" will be used interchangeably to indicate facilities involved in hydroelectricity generation. The storage based establishments, that are in the focus of this paper, generate power by filling up reservoirs at higher altitudes with water and opening the gates once the filling is done. As the water falls down, the stored energy of the still water in the reservoir turns to kinetic energy (energy that a body possesses by being in motion), which is captured by turbines attached to generators, which convert this power into electricity. (Bonsor, 2001)

In recent decades, there has been a sharp increase in the use of hydropower, especially in developing nations, and it has become a vital source of electricity in many countries. (Moran et al., 2018, p.11891) It is considered a renewable energy source because it relies on the power of gravity and the continuous water cycle; therefore, it is constantly available, which makes it a feasible long-term investment. As increasing awareness around climate change has prompted decision-makers to reconsider the energy sources used, several governments have launched campaigns to reduce the reliance on oil and gas. (Kishore et al., 2021, p.2) Because it appears to be a potential alternative to fossil fuels, there have been numerous initiatives to promote and expand hydropower capacity globally. Furthermore, dams also contribute to flood prevention and control, which protects local communities from extreme weather events and ensures the stable management of water. (Zarfl et al., 2015, p.162)

As a result, by 2010, hydropower amounted to approximately 16% of global electricity generation (Chen et al., 2015, p.79). It remained a significant contributor within the next decade,

with a slight increase to 17% of the global share by 2019 (Iho et al., 2023, p.191). Additionally, as the demand for electricity has been increasing notably due to the constant population growth and a pressing need to reduce greenhouse gas emissions, hydropower is increasingly recognised as a possible, more sustainable option for providing adequate power supplies. (Tefera & Kasiviswanathan, 2022, p.16), Hydropower is generally viewed as quite reliable, and there are still plenty of feasible locations alongside rivers where high-capacity hydropower plants could be established in the future (Tefera & Kasiviswanathan, 2022, pp. 9-12)

Despite its relative eco-friendly image compared to fossil fuels, hydroelectric dams cause a significant decrease in the quality and quantity of the water flow in rivers, harm the natural ecosystems, and, if installed carelessly, pose a threat to the irrigation and drinking water supply of countries located along the river. (Zarfl et al., 2015, p.167) This research focuses on large-scale hydropower generation facilities, such as mega dams, that adversely affect river ecosystems. Therefore, the upcoming section will list the most notable environmental factors of such initiatives. However, it is important to note that small-scale run-of-river hydropower plants offer a more sustainable and environmentally friendly form of renewable energy generation than storage-based dams. (Uhunmwangho & Okedu, 2009, p.535)

The operation principles of large-scale hydropower plants include converting flowing rivers into segmented pools, which disrupts natural flow patterns. Withholding water at higher altitude areas has several negative consequences for downstream ecosystems, such as altered sedimentation patterns and reduced water flow, leading to disrupted water habitats. (Chen et al., 2015, pp.85-86). They can also threaten the reproduction and survival of certain species, such as salmon, that migrate through different sections of the rivers throughout their lifetime. Although there are certain features that can mitigate these adverse effects, such as fish ladders designed to enable fish migration past dams, the risk of ecological disruption remains

significant. (Iho et al., 2023, p.193) Along with these detrimental effects on the environment, large-scale hydropower projects also negatively impact the communities living by the river. These projects can decrease the surrounding properties' economic and recreational value, as free-flowing rivers typically offer higher benefits than those used for electricity generation. (Iho et al., 2023, p.194) Considering all the above-listed aspects of hydropower, the feasibility of implementing such projects is highly dependent on various environmental, geographic, economic, and social factors.

However, these are not the only issues that emerge from damming rivers. The use of hydropower can be grounds for severe political conflicts among adjacent countries that share rivers and rely on the same freshwater supplies. The upcoming section of this chapter will outline the international political aspects of regulating transboundary rivers and define the fundamental terminology at the heart of these issues, with a special emphasis on conflicting incentives between upstream and downstream countries. This section will also serve as a framework for the analysis of the case studies presented in Chapter 2.

1.2 Transboundary Water Issues & National Sovereignty

Regulating and managing shared natural resources beyond borders is highly debated among neighbouring countries. As there are 263 rivers worldwide that cross two or more countries (Lee et al., 2023, p.12), the regulation of shared freshwater resources is a sensitive issue in many regions that can lead to severe conflicts between adjacent states. The allocation of transboundary rivers raises critical questions about whether countries are entitled to claim ownership of natural resources located within their borders. If so, to what extent can other nations that share the same assets influence the decisions that are made about an over-arching project such as establishing a new hydropower plant?

The opinions about these questions vary tremendously based on the individual standpoint of stakeholders. The regulation of rivers and the establishment of hydroelectric dams is an international matter as it affects the vital water supplies of all countries located along a certain river. However, in numerous cases countries prioritise their own interests and decide to invest in hydropower plans without considering its possible negative implications on the adjacent countries. These decisions often lead to political conflicts and an if unresolved, these conflicts can easily turn into armed struggles. (Dinar, 2012, pp.116-117) Furthermore, the regulation of rivers can also be used as a political tool to threaten neighbouring countries by depriving them of their vital water sources. The geographic placement of countries along a river creates power asymmetries between upstream and downstream nations because of the unequal distribution of benefits and risks associated with water usage and management. To evaluate these uneven power dynamics, this paper uses the theoretical framework of national sovereignty versus territorial integrity over the allocation of transboundary natural resources.

When discussing the issue of river regulations, upstream countries typically support the idea of **absolute territorial sovereignty** over the watercourse, which means that "A state may freely utilize waters flowing over its territory, regardless of the adverse effects on other states" (El-Fadel et al., 2002, p.105). Downstream countries tend to oppose this concept because it grants their upstream counterparts unlimited access to the shared water supply. Instead, they often advocate for other principles, such as **absolute territorial integrity**, according to which countries along the river are prohibited from altering the course, the rate, and the quality of water that flows down to neighbour states. (El-Fadel et al., 2002, p.105) Compared to the first concept, this proposition is highly disadvantageous for upstream countries because it not only safeguards the watercourse from being exploited but also prohibits the equitable use of the waterpower within protective restraints. Alternatively, **limited territorial sovereignty** offers a middle ground between the two extremes. It suggests that states along the course of the river

can utilise it as long as they do it within reasonable limits and ensure that there will be no harm done to the watercourse of other states. (El-Fadel et al., 2002, p.105) Finding the best solution to conflicts over the use of hydropower and water allocation is very dependent on the individual characteristics of the disputed region as well as the historical background of the relationship between the affected nations. It is also important to note that in the case of rivers that pass through multiple countries, the states that are not at either endpoint of the watercourse can be considered as both upstream and downstream countries, depending on the direction from which they are viewed.

Diplomatic processes play a significant role in precluding potential water allocation disputes. Collaborative governance offers a joint approach that brings together opposing perspectives (Ulibarri, 2024, p.316) to propose a solution that facilitates the interest of all parties. However, negotiations in this field require much compromise on the behalf of all involved parties and these decisions might cause immense discomfort for some of the decisionmakers. For this reason, transboundary water interaction does not always result in clear decisions or actions that are either positive or negative; at times, it stays in a prolonged status quo that requires less effort to maintain instead of negotiating for better deals and addressing specific issues. (Vij et al., 2024, p.1) This state of non-decision making can create an extended stalemate between nations, providing a low risk and low reward outcome for the stakeholders involved. However, once negotiations about shared river basins start, the neutral environment shifts to either a co-operative alliance or a battle between conflicting goals. (Vij et al., 2024, pp.1-4)

The conceptual framework builds upon the above-mentioned principles and illustrates them by applying these theories to two distinct case studies of hydropower use in the Tigris-Euphrates Basin and in the Blue Nile River, representing asymmetrical power dynamics between riparian countries in Chapter 2. The upcoming sections will draw parallels between the

environmental, political, and legal implications of damming rivers and provides a comprehensive analysis of the feasibility of hydropower.

CHAPTER 2

Two Case Studies: Power Dynamics between Upstream and Downstream Countries

This chapter will examine the political connotations and the possible conflicts that emerge from the use of hydropower through the comparative analysis of two case studies that exemplify disproportional power dynamics between upstream and downstream countries along international rivers. The first case we will analyse is the Tigris-Euphrates Basin, where Turkey initiated the largest regional water development project in 1977 (Akanda et al., 2007, p.2), which is still ongoing. In this example, Turkey's geographic advantage of being an upstream country grants it hegemony to intervene with the allocation of rivers in the region, which has vastly detrimental effects on Syria and Iraq. Due to the regulation of these rivers, downstream nations experience a severe water shortage, which has led to political, social, economic, and environmental issues. (Al-Ansari et al., 2023, p.471)

The second case under observation will be the recent establishment of the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile River. This development has significantly disrupted the status quo and sparked dissatisfaction and conflict in the downstream countries, Sudan and Egypt. Since the initial filling process started in 2020 (Ahmed et al., 2024, p.3), this large-scale hydroelectric investment caused a significant decrease in the flow and quality of the water in the Nile, which sparked political conflicts between the neighbouring states.

Even though the essence of these two cases might appear similar from a political perspective regarding the upstream-downstream power dynamics, there is an important

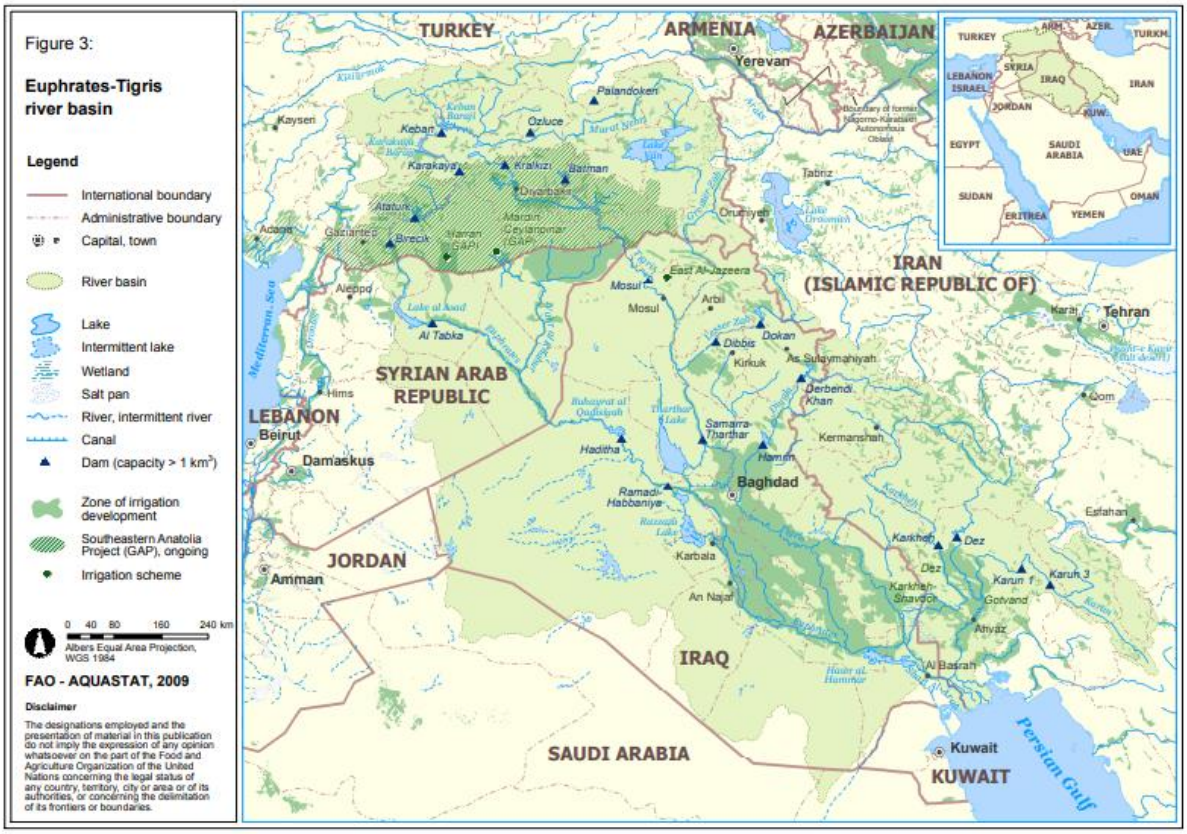
distinction between them. Historically, despite being a downstream country, Egypt has been in a position of hegemony over the Nile River due to its colonial status and relative economic prosperity compared to the other riparian countries. (Yimer, 2022, p.80) However, this advantage seems to have diminished by now as Egypt had to negotiate about the allocation of the Nile after the GERD was ready to start operating.

This chapter seeks to provide a comparative analysis of the political aspects of hydropower in these two regions and clarify its implications for upstream and downstream countries. By examining these case studies, this paper aims to provide a comprehensive understanding of the complexities between water resource management, national interests, and regional geopolitics while addressing the challenges and opportunities countries along transboundary river basins face. The discussion on the power dynamics in the two cases will explore how hydropower influences political alliances and economic dependencies and how it affects the shared environment. Furthermore, the cases aim to reflect on the focal question of this thesis about whether countries are entitled to claim ownership of the rivers that flow through them.

2.2 First Case Study-Turkey's South-Eastern Anatolia Project (GAP) and the Tigris-Euphrates River Basin

1.Figure: Euphrates-Tigris River Basin Map

Source: Food and Agriculture Organization of the United Nations (FAO). (2009).



Located within the historical region of Mesopotamia, the Tigris and the Euphrates rivers both spring from Southeastern Anatolia. They follow separate courses until they meet in the Al-Qurnah region of Iraq to form the final section of the river, the Shatt al-Arab, which then flows into the Persian Gulf, creating a delta. The Euphrates, with a length of approximately 2700 kilometres, is the largest river in Western Asia and has supported various civilisations throughout history (El-Fadel et al., 2002, p.100). The Tigris-Euphrates river system, along with

its smaller tributaries, descends from the eastern Turkish mountains through valleys into the uplands of Syria and northern Iraq.

The Euphrates is divided among these three nations: Turkey, with approximately 40% of the total length of the river, while the rest is distributed between Syria and Iraq, with about 25% and 35%, respectively (Akanda et al., 2007, p.1). In terms of catchment areas, Iraq has the largest portion of the Euphrates River basin, amounting to nearly 40%, compared to 28% in Turkey and 17% in Syria. The rest of the Euphrates' catchment area is located in Saudi Arabia, but due to the extreme aridity, the river's flow is minimal there and does not significantly impact the river's hydrology. (Al-Ansari et al., 2023, p.471) The Euphrates is not only one of the most historically significant rivers in the world but also an essential freshwater resource for all three countries.

As the climate in Mesopotamia is quite dry, the significance of local rivers is especially prominent. The irregularity and uneven precipitation throughout the year create a seasonal water flow on the Tigris and the Euphrates (UN, 2009, p.1), which has made it necessary for locals to regulate them for flood control and irrigation. These practices have long-rooted foundations originating from ancient societies (Engel & Brückner, 2018). However, the technological advancements of the 20th century made the scale of these regulations grow out of proportion. These recent changes have sparked political tensions between countries in the region and emphasised the superior-subordinate nature of power dynamics between the riparian countries.

In the late 1970s, the government of Turkey initiated an overarching regional development project aiming to generate hydroelectricity, called the Southeastern Anatolia Project, or Güneydogu Anadolu Projesi, from now on, mentioned as GAP. This project is the most extensive multisectoral local development aspiration that involved the construction of 22 dams and 19 hydropower plants on the Tigris and the Euphrates rivers, along with an

irrigation network of nearly 1.7 million hectares of land. (Akanda et al., 2007, p.2) Although it started nearly five decades ago, GAP is still an ongoing initiative, and some establishments are still under construction or planned for the future. This project contributes to approximately 25% of the total hydroelectricity generation in the country. (Yilmaz et al., 2019, p.599) The most productive hydropower plant in the GAP is the Atatürk Dam, which has been operating since 1993. (Kankal et al., 2016, p.127)

Despite its tremendous economic benefits for Turkey, GAP has faced significant opposition from adjoining countries, particularly Syria and Iraq, because of its adverse effects on their national fresh water supplies. Despite a protocol that was signed in 1987 between Turkey and Syria to ensure fair access to the water, at its total capacity, the GAP project would reduce the water flow of the Euphrates to Syria by 40% and to Iraq by 80% (El-Fadel et al., 2002, p.103) This is a detrimental cut to the essential freshwater supplies of the downstream countries that threaten sufficient irrigation and diminishes the capacity of local agriculture. As a result, the downstream countries have faced severe water shortages, leading to reduced crop harvests and increased desertification.

With the rising local population and the pressing issues of climate change, the desire to create long-term water and food security in the region is more urgent than ever. Based on these factors and the region's steadily increasing standard of living, the three countries combined would require 149% of the total available water in the Tigris-Euphrates basin to cater for all water requirements. (Al-Ansari et al., 2023, p.475) Since it is impossible to fulfil such needs, the allocation of water causes competition and friction among upstream and downstream countries.

Furthermore, the reservoirs in hydropower plants disrupt the natural water flow, so the areas where the water is accumulated experience increased sedimentation, loss of vegetation,

and changes in the local ecosystem. In contrast, downstream areas suffer from reduced sediment and nutrient flow, leading to ecological degradation and habitat loss. (Adamo et al., 2020, p.57)

Because of the conflicting interest in water allocation, the discourse around river management issues is quite heated among upstream and downstream governments. Turkey justifies the project, claiming that the Tigris and the Euphrates are 'transboundary' rivers that give Turkey absolute sovereignty over the allocation of their water as opposed to viewing them as 'international' rivers, which would mean that the water in the region needs to be distributed proportionally. Additionally, the economic benefits of generating electricity locally within the country would save up to 28 million tons of oil for Turkey annually, making the government even more firm in their standpoint on territorial sovereignty. (Akanda et al., 2007).

However, for Syria and Iraq, the potential reduction in water flow poses a significant threat to the livelihoods of citizens. For this reason, the downstream countries initiated a financial campaign against the projects involved in the GAP, which convinced the World Bank not to provide financial aid for the execution of these hydropower facilities without Turkey's agreement to sign a river treaty. Because the government opposed the treaty, Turkey had to bear the cost of the project without external funding, which delayed the competition of the project. (El-Fadel et al., 2002, pp.102-103)

It is important to note that wars and severe armed struggles have also played a massive role in destroying the water system of downstream nations, further complicating efforts to manage and rehabilitate water infrastructure in the region. (Al-Ansari et al., 2023, p.476) The political turmoil in the region following the Arab Spring in 2011 further amplified the water shortages both in Iraq and Syria, and it has led to a significant destruction of the infrastructure.

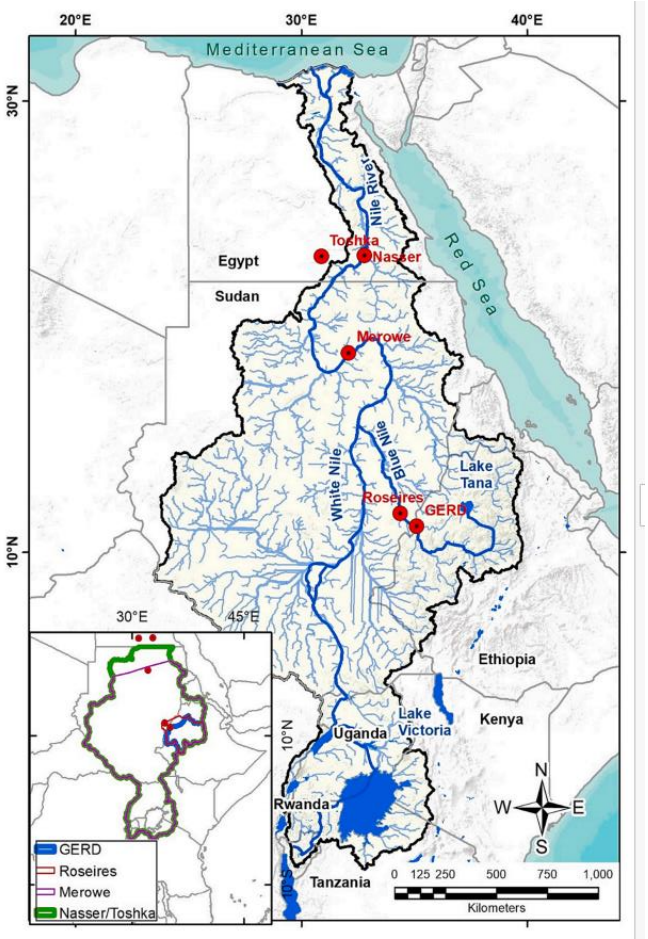
Therefore, the water management challenges in the Tigris-Euphrates basin need considerate attention to rebuild and stabilise the region's water systems. Moving forward,

addressing the unrelated political tension between all parties could help create a cooperative regional river management system and ensure equitable use of the hydro resources of the rivers.

2.3 Second Case Study -The Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile River

2 Figure: The Nile River and five main reservoirs (GERD, Roseires, Merowe, Nasser, and Toshka)

Source: Ahmed, M., Abdelrehim, R., Elshalkany, M., & Abdrabou, M. (2024). Impacts of the Grand Ethiopian Renaissance Dam on the Nile River's Downstream Reservoirs. Journal of Hydrology, 130952.



Much like the Tigris-Euphrates Basin, the Nile also played an essential role in the formation of ancient civilisations. According to archaeologists, the oldest irrigated agriculture

in the area started around 5000 BC in Egypt. (Angelakıs et al., 2020, p.2). Since then, the Nile has remained an integral part of the survival and prosperity of the communities in the 11 countries that share the Nile Basin (Diriba et al., 2008, p.297). With a length of 6695 kilometres, the Nile is not only the longest river in Africa but also on the entire planet. The river comprises two main tributaries: the White Nile, which originates from Lake Victoria, and the Blue Nile, which springs from Lake Tana in Ethiopia. Among the tributaries, the Blue Nile contributes most significantly to the water that flows to downstream countries, with around 85% originating from Ethiopia (Hailemariam, 2021, p.1), while the White Nile provides the remaining 15% of the water flow. The Nile is the primary source of fresh water in the region, contributing more than 90% to the national water supply in Egypt and 77% to Sudan (Diriba et al., 2008, p.298), which plays a crucial role in supporting agriculture, industry, and daily life throughout the countries. This paper focuses on the Blue Nile to observe the superior-subordinate power dynamics along the river because there have been recent changes in the use of hydropower along that section of the river, which provides the majority of the water supply in the Nile.

Historically, despite being a downstream country, Egypt has been in a superior position in the Nile basin due to its geographical location, relative economic prosperity, strategic alliances during the colonial era, and diplomatic efforts that secured significant control over the river's water resources. (Tekuya, 2020, p.10) Egypt maintained influence and dominance over the Nile region because several upstream countries suffered structural weaknesses from proxy wars and unstable governments while facing economic backlash and a lack of international support. (Ranjan, 2024, p.21) However, there has been an immense shift in power dynamics between countries along the Blue Nile since 2011, when Ethiopia announced the construction of the Grand Ethiopian Renaissance Dam (GERD), the largest mega-dam project in Africa. (Yimer, 2022, p.84) It is argued that Ethiopia took advantage of Egypt's momentary political instability during the Arab Spring in 2011 when it announced the establishment of the GERD

to prevent resistance. (Yimer, 2022, p.79) However, the reasoning behind the construction of the dam is more complex, involving Ethiopia's desire for economic development, energy security, and water resource management.

Once finished, the power plant will have a capacity of 6450 megawatts, providing food and energy security for nearly 56% of the local population (Hailemariam, 2021, p.1). The operation of this dam will bring about a significant economic improvement for the entire nation and symbolise Ethiopia's aspirations towards energy independence and providing better living conditions for its citizens. Moreover, Ethiopia not only plans to meet its national electricity needs with the GERD but also intends to export the generated energy to neighbouring countries, thus creating additional economic benefits. (Verhoeven, 2021, p.166)

Despite its immense economic benefits for Ethiopia, the governments of Sudan and Egypt voiced strong concerns about the project. Their primary issues revolve around water security, especially during the initial phase of the GERD's operation, because depending on the pace of the filling period, the natural flow of the river is altered tremendously. The initial filling phase of the new dams typically involves a more significant reduction in water flow while the required amount of water is accumulated in the reservoir. Once the dam begins regular operations, the water flow in the surrounding area increases; however, it still potentially affects water availability for downstream users and has a detrimental impact on the natural ecosystems. The operation of the GERD began with three filling phases, the first of which started in July 2020. The last phase of the filling took place in August 2022; since then, GERD has been operating at nearly total capacity. (Ahmed et al., 2024, p.3)

Both Egypt and Sudan depend heavily on the Nile for their agricultural activities, which are critical for their food security and economic stability. Therefore, the filling of the GERD caused severe tensions between Ethiopia and the downstream riparian countries. Estimates suggest that food production from irrigated agriculture in Egypt could be reduced by up to 19%

during the filling of the reservoir, and it would cause a 4% decline during the operation of the dam. (Elsayed et al., 2020, pp. 1-16) Whereas in Sudan, the filling of the dam has a negative impact on the irrigation supply in the short- to medium-term, but afterwards, the water flow will improve during the operation of the GERD.

While both Sudan and Egypt had previously used the Nile for hydropower generation (Ranjan, 2024, pp.21-22), none of the previous dams have matched the scale and potential impact of the GERD. This mega-dam not only exceeds previous projects in terms of energy production capacity but also impacts the surrounding countries more significantly than any former establishments.

From an ecological perspective, the dam's construction poses significant threats to downstream agriculture. The reservoir or the GERD traps sediment that would normally flow down and nourish farmland. This loss of sedimentation leads to the erosion of nutrient-rich topsoil, particularly in the Nile Delta region, which reduces soil fertility and crop yields, leading to a higher need for imports and food insecurity in the region. Furthermore, erosion reduces the soil's water retention capacity, leading to increased drought stress on crops. (Luna et al., 2024, pp.1-3) The issue of water shortage in Egypt has been further heightened by the sharp increase in inflation rates since the outbreak of the 2020 pandemic. As the world's largest wheat importer, Egypt sources 80% of its wheat from the Black Sea region, which has faced severe disruptions since the Russian invasion of Ukraine in 2022. Consequently, Egypt's reliance on the Nile for agriculture increased significantly during these critical times, coinciding with the initial filling phases of the GERD (Prantner & Al-Naggar, 2023, p.274).

The question of national dominance over the river flow and equitable water distribution caused serious disputes between the riparian states. Ethiopia holds great interest in claiming absolute territorial sovereignty over the section of the Blue Nile located within its borders. (Ranjan, 2024, p.19) Because of the conflicting incentives around hydropower utilisation and

Ethiopia's unilateral decision to construct and fill the GERD within a short time frame, the political tensions in the region became high, with the possibility of this conflict escalating to an armed struggle. As an initial response to the mega-dam construction, Egypt and Sudan tried to deter Ethiopia from the project; however, once they realised it was impossible, the downstream countries threatened to launch a targeted military attack against the GERD. Although Egypt and Sudan have taken similar standpoints on the issue previously, in recent years, Sudan has taken a stance against causing structural damage to the hydropower plant, as it would cause serious floods in the country due to the dam's proximity to the border. (Goldberg, 2023, p.13) Therefore, for Sudan, the best solution would be the implementation of binding legal treaties that regulate the GERD without the possibility of escalating the conflict. In conclusion, seeking legal guidance to resolve the issue would be the most feasible solution to ensure cooperation along the Blue Nile, as it is possible to reach a mutually beneficial agreement with positive outcomes on water management. (Goldberg, 2023, p.5)

CHAPTER 3

International River Treaties & Discussion

Having examined the environmental and political aspects of hydropower in the two case studies, this chapter will now focus on the legal dimensions of implementing transboundary river treaties. By observing international policies, this section will address the management of conflicts that stem from the superior-subordinate power dynamics along transboundary rivers between upstream and downstream countries or related to historical hierarchies. Part I of this chapter will evaluate previous efforts to legally regulate river management in the Tigris-Euphrates Basin and along the Blue Nile River. This section will outline why previous attempts failed to reach a verdict agreeable to all stakeholders. Building on these arguments, Part II will discuss the international endeavours to regulate these conflicts and assess the possibilities and challenges of creating mutually beneficial, cooperative agreements on transboundary river courses that consider the incentives of all affected communities. Eventually, Part III will return to the initial question whether the use hydropower can be employed in an environmentally sustainable way. This section aims to reflect on the hypothesis that hydropower entails asymmetrical power dynamics in transboundary river basins and considers whether outside authorities could or should infringe on national sovereignty over rivers by discussing these questions.

3.1 The Legal Implications of Hydropower Conflicts in the Tigris-Euphrates Basin and along the Blue Nile River

The regulation of the Tigris and the Euphrates in Mesopotamia has led to longstanding disputes among the countries involved. Despite various treaties and agreements attempting to address water-sharing conflicts between Turkey, Syria, and Iraq, finding a middle ground has been unsuccessful thus far. These difficulties are compounded by the region's broader political instability and unrelated geopolitical hostilities, complicating efforts to find a cooperative solution. (Aydin & Aras, 2005, p.25) Tensions among the riparian states escalated after Turkey initiated the GAP project in 1977, leading to severe negative consequences for Syria and Iraq regarding the quantity and quality of water in the shared rivers. (El-Fadel et al., 2002, pp.100-104) To address these issues, in 1987, Syria and Turkey signed a bilateral agreement in which Turkey promised to ensure a minimum of 500 m3/s of water flow per year (Akanda et al., 2007, p.3) to Syria in exchange for cooperation in regards to not supporting the PKK, the Kurdish Workers Party (Kibaroğlu, 2016, p.110), that has been an underlying conflict between the nations. (El-Fadel et al., 2002, p.103) However, this agreement was short-lived; disputes and mutual suspicions soon resurfaced, leading to further conflicts over water allocation. Despite the protocol, the completion of the GAP project at its total operation capacity threatens to diminish and potentially eliminate water access to downstream countries. (El-Fadel et al., 2002, p.101)

In 2001, after decades of hostility, negotiations started again about allocating transboundary rivers in the region, and eventually, Turkey, Syria, and Iraq signed an Agreement on a Joint Technical Committee.(Kibaroğlu, 2008, p.188) The objective of this contract was to provide sustainable utilisation of water resources in the region by initiating joint projects on rural development and environmental protection. Several different framework agreements have been introduced after this one. However, the political destabilisation in the region and the

American invasion of Iraq had repercussions on transboundary water politics, and negotiations about river allocation were not the top priority during those times. (Kibaroğlu, 2008, p.188) These agreements were later revisited in 2009 with a similar objective through a treaty signed between Turkey and Iraq about developing a functional approach towards water allocation. (Kibaroğlu & Scheumann, 2013, p.291) Despite these collaborative efforts, the issues surrounding the allocation of the water of the Euphrates and Tigris have not been resolved due to conflicting interests and the lack of willingness to compromise on individual national incentives.

Similarly, the regulation of the Nile River also faced complex challenges throughout history and treaties have struggled to equitably manage the shared fresh water supplies. In the case of the Nile Basin, up until the mid-20th century, the United Kingdom played a significant role in shaping the river treaties as an external stakeholder due to its colonial powers. In 1902, Ethiopia signed the Anglo-Ethiopian Treaty under the influence of the British Empire. (Woldetsadik, 2014, p.171) This treaty sought to secure control for the United Kingdom over the Nile's water flow to benefit its colonial territories, particularly Egypt and Sudan, which were under the Anglo-Egyptian Condominium at the time. The agreement also included a critical provision where the Ethiopian Emperor pledged not to construct any works on the Blue Nile, Lake Tana, or the Sobat River that would arrest their flow into the Nile without British consent (Woldetsadik, 2014, pp. 274-275). By this treaty the British empire aimed to protect its hydraulic interest in downstream countries and ensure a stable water supply for agriculture and economic activities in Egypt and Sudan. Despite its long-term restrictions on Ethiopia's sovereignty over its water resources, the treaty provided immediate benefits by securing Ethiopia's borders and gaining international recognition. (Woldetsadik, 2014, pp. 273-275) As Ethiopia was the only country in the region that was not colonised, this was a strategic success to ensure its recognition as an independent state. Later, this treaty was followed by the Nile

Waters Agreement in 1929, this time between Egypt and the United Kingdom, which aimed to prevent any upstream projects on the river without Egypt's consent (Dinar, 2012, p.125).

After the Nile region gained independence form colonial powers Egypt and Sudan signed a bilateral agreement in 1959 that distributed the entirety of the river amongst themselves. (Salman, 2013, p.19) Despite being the upstream country, in geographically the most powerful position, Ethiopia was excluded from both treaties. Egypt's and Sudan's unilateral decisions to control the river's resources without including Ethiopia have sparked regional tensions and disputes around the Nile. Upon recognising the need for more inclusive management of the Nile, in 1999, the countries along the river basin established the Nile Basin Initiative (NBI) supported by the World Bank (Metawie, 2004, p. 52). The NBI was a great success because, for the first time in history, all countries along the Nile River were included. It gave all parties a channel to communicate while enabling them to work on their own regional development projects. (Jungudo, 2021, p.208)

However, despite its achievements, the NBI has not created a comprehensive regional legal framework to tackle issues around the allocation of the Nile. One significant issue is the lack of binding legal status, which means that agreements made under the NBI cannot be enforced under international law, thus any state can object to following the principles at any time. Additionally, ensuring equitable water use is challenging because there are persistent power asymmetries among the stakeholders. Another challenge is the varying economic and political stability levels among the member countries, which can hinder collaborative efforts.

One of the main goals of the NBI was to achieve a cooperative framework agreement that would create inclusive principles for all riparian countries along the Nile. However, due to conflicting claims over the river flow, the agreement faced significant backlash by historically more powerful nations. Therefore, it was only signed by six countries in 2010, without the participation of downstream countries Egypt and Sudan (Salman, 2013, p.20). Since then, no

new international treaties regarding the Nile have been established. As a result, when the government of Ethiopia announced the construction of the GERD in 2011, it was met with serious objections on behalf of the leaders of Egypt and Sudan. (Turhan, 2020, p.72) Since there is a lack of binding agreement to regulate the allocation of the river flow, the mega-dam project further strained relations between the upstream and downstream countries.

3.2 The Possibilities and Challenges of Creating Mutually Beneficial Transboundary River Agreements

Along with the above mentioned regional initiatives to tackle transboundary river conflicts, there have been other principles proposed by international governmental organisations to regulate the use and management of shared water resources more effectively. In 1966, the International Law Association introduced a set of guidelines known as *The Helsinki Rules on the Uses of the Waters of International Rivers* to provide a framework for the management of transboundary water resources. These guidelines included sections about international drainage basins, transboundary groundwater resources and created a set of principles for their equitable and reasonable utilisation. (International Law Association, 1966) While the *Helsinki Rules* provide a comprehensive framework for the management of transboundary water resources, its impact is not as transformative because it is a soft law, meaning that it only serves as non-binding guidelines that carry persuasive arguments to influence the events of international water allocation.

Later, in 1997, after more than twenty years of negotiations the UN issued the *Convention on the Law of the Non-navigational Uses of International Watercourses*, which was adopted by the International Law Commission. (McCaffrey, 1998, p.17) The *UN Watercourses Convention* builds upon the principles outlined in the Helsinki Rules. This framework covers

various sections, including Article 5, which states that transboundary rivers should be used equitably; Article 6, which defines equity as depending on a range of factors and does not mean equal distribution; and Article 8, which emphasises the importance of international cooperation along transboundary rivers. (United Nations, 1997)

This *UN Convention* holds stronger power than the *Helsinki Rules* as it establishes legally binding obligations for the member states that ratify it. However, despite the positive votes from the majority of the UN member states, the *Watercourses Convention* has not been ratified by three voters including Turkey (Rieu-Clarke & Loures, 2009, p.190) While the convention offered advantageous aspects to downstream countries, the government of Turkey reasoned its objection by stating that it creates inequality between states and that prioritising the prevention of environmental harm fails to establish the equitable use of river flows. (El-Fadel et al., 2002, p.105)

Consequently, this example shows that even legally binding international agreements have little success in limiting national sovereignty and regulating what happens within the borders of an independent nation. For this reason, nurturing a neutral or positive relationship among adjoining countries is essential for reaching the mutually desired outcome in managing shared resources. (Vij et al., 2024, p.1) In the theory of international relations, cooperation among nations occurs when they 'adjust their behaviour to the actual or anticipated preferences of others'. (Keohane, 2005, p.51) Meanwhile, hostilities erupt along transboundary river basins when countries refuse to modify their behaviour to accommodate the concerns of their neighbours. (Zawahri, 2006, p.1044) Despite conflicting interests over the allocation of transboundary rivers, the benefits of cooperation among neighbouring countries outweigh the potential drawbacks of unilateral action. Collaboration and mutual understanding can lead to more effective and sustainable management of shared resources, benefiting all parties involved. (Grey et al., 2009, p.15) Cooperation along transboundary river basins is possible even despite

prior disputes over the regulation of the water. To achieve collaboration, all parties must have an interest in it; once it exists, a neutral mediator is needed to coordinate the negotiations and support reaching an agreement. Political stability among stakeholders is essential for creating river treaties that are successful in the long run. (Zawahri, 2006, p.1051)

3.3 The Future of Hydropower and its Potential Feasibility from a Political and Ecological Perspective

This final section returns to the question: Under what circumstances would hydropower be both politically and ecologically sustainable? The notion that large dams provide a way out of poverty for developing nations has led to major investments in dam construction with the hopes of reaching economic stability. (De Faria et al., 2017, p.533) These hydropower plants paved the way for economic prosperity in developing countries in the early 20th century; however, by now, most of the mega dams used in those regions have been shut down due to their adverse effects on the environment. (Moran et al., 2018, p.11891) On the other hand, in countries like Ethiopia, large-scale hydropower investments seem a plausible pathway towards improving the standard of living. Projects such as the GERD hold the potential to generate significant electricity, boost local economies, and provide a sustainable energy source despite ongoing concerns regarding their environmental and geopolitical impacts. (Ahmed et al., 2024, p.1) For this reason, downstream countries in such regions are highly susceptible to environmental harm caused by their neighbouring states; therefore, providing a protective legal framework is essential to maintain fair access to shared freshwater resources. Hydropower is not inherently bad; when managed properly, it can be a viable and sustainable energy source. However, it is important to distinguish between large mega-dam projects, such as the examples in the case studies, and small-scale environmentally considerate investments that do not disrupt

the river ecosystems to such extremes. While large dams and reservoirs have significant adverse hydrological effects, micro-hydropower typically brings net benefits to communities and has a minor environmental footprint. (Moran et al., 2018, p.11892) The future of hydropower lies within the development of such small-scale, low-impact projects that balance energy production with ecological preservation and equitable resource distribution.

CONCLUSION

The use of hydropower in transboundary river basins creates power asymmetries among neighbouring countries along shared river basins. Territorial sovereignty grants upstream countries an immense advantage over executing projects that only benefit their national incentives. Compromise is a key term in dealing with conflicting interests. Minimising collateral damage on the shared river course should be a top priority in forming international water treaties, rather than striving for the best possible outcome from one party's point of view. Understanding the dynamics of transboundary river governance is essential for establishing collaborative and effective management strategies. This knowledge helps successfully address the challenges of clashing interests and prevents the use of river regulations as a political tool to exercise power over adjacent countries. Moreover, effective management and cooperation among nations can mitigate the potential negative impacts of hydropower on inter-state relations between the stakeholders. Shared decisions over cross-countries rivers can also lead to positive and mutually favourable relations between states that bring prosperous technological, economic, and social benefits.

REFERENCES

Journal Articles

Adamo, N., Al-Ansari, N., & Sissakian, V. (2020). How dams can affect freshwater issues in the Euphrates-Tigris basins. Journal of Earth Sciences and Geotechnical Engineering, 10(1), 43-76.

Ahmed, M., Abdelrehim, R., Elshalkany, M., & Abdrabou, M. (2024). Impacts of the Grand Ethiopian Renaissance Dam on the Nile River's Downstream Reservoirs. Journal of Hydrology, 130952.

Al-Ansari, N., Adamo, N., Hachem, A. H., Sissakian, V., Laue, J., & Abed, S. A. (2023). Causes of Water Resources Scarcity in Iraq and Possible Solutions. Engineering, 15(9), 467-496.

Al-Muqdadi, S. W. (2019). Developing strategy for water conflict management and transformation at Euphrates–Tigris basin. Water, 11(10), 2037.

Angelakıs, A. N., Zaccaria, D., Krasilnikoff, J., Salgot, M., Bazza, M., Roccaro, P., ... & Fereres, E. (2020). Irrigation of world agricultural lands: Evolution through the millennia. Water, 12(5), 1285.

Chen, S., Chen, B., & Fath, B. D. (2015). Assessing the cumulative environmental impact of hydropower construction on river systems based on energy network model. Renewable and Sustainable Energy Reviews, 42, 78-92.

De Faria, F. A., Davis, A., Severnini, E., & Jaramillo, P. (2017). The local socio-economic impacts of large hydropower plant development in a developing country. Energy Economics, 67, 533-544.

Dinar, S. (2012). The geographical dimensions of hydro-politics: International freshwater in the Middle East, North Africa, and Central Asia. Eurasian Geography and Economics, 53(1), 115-142.

Elsayed, H., Djordjević, S., Savić, D. A., Tsoukalas, I., & Makropoulos, C. (2020). The Nile water-food-energy nexus under uncertainty: Impacts of the Grand Ethiopian Renaissance Dam. Journal of Water Resources Planning and Management, 146(11), 04020085.

El-Fadel, M., Sayegh, Y. E., Ibrahim, A. A., Jamali, D., & El-Fadl, K. (2002). The Euphrates–Tigris Basin: A case study in surface water conflict resolution. Journal of Natural Resources and Life Sciences Education, 31(1), 99-110.

Goldberg, M. (2023). The Grand Ethiopian Renaissance Dam: Prospects for Cooperation amid Threats of Conflict. SAIS Review of International Affairs, 43(2), 5-19.

Grey, D., Sadoff, C., & Connors, G. (2009). Effective cooperation on transboundary waters: A practical perspective. Getting transboundary water right: Theory and practice for effective cooperation.

Hailemariam, G. (2021). Nile as a Transboundary River and The Ethiopian Grand Renaissance Dam (GERD): The Issue of Sovereignty-Cooperation Dilemma. Journal of Political Sciences & Public Affairs, 9(6).

Iho, A., Soininen, N., Vehviläinen, I., Koljonen, S., Artell, J., & Belinskij, A. (2023). Rivers under pressure: Interdisciplinary feasibility analysis of sustainable hydropower. Environmental Policy and Governance, 33(2), 191-205.

Kankal, M., Nacar, S., & Uzlu, E. (2016). Status of hydropower and water resources in the Southeastern Anatolia Project (GAP) of Turkey. Energy Reports, 2, 123-128.

Kibaroğlu, A., & Scheumann, W. (2013). Evolution of transboundary politics in the Euphrates-Tigris river system: new perspectives and political challenges. Global Governance: A Review of Multilateralism and International Organizations, 19(2), 279-305.

Kishore, T. S., Patro, E. R., Harish, V. S. K. V., & Haghighi, A. T. (2021). A comprehensive study on the recent progress and trends in development of small hydropower projects. Energies, 14(10), 2882.

Lee, H., Son, J., Min, S., Lee, H., & Park, M. S. (2023). Natural Resources Conflicts on Borderlands by the Five Spheres of Earth System. Land, 12(2), 389.

Moran, E. F., Lopez, M. C., Moore, N., Müller, N., & Hyndman, D. W. (2018). Sustainable hydropower in the 21st century. Proceedings of the National Academy of Sciences, 115(47), 11891-11898.

Prantner, Z., & Al-Naggar, A. A. A. (2023). Economic and Political Impact of the Russia-Ukraine War on Egypt. Historical Kan Periodical, 16(59).

Ranjan, A. (2024). Grand Ethiopian Renaissance Dam dispute: implications, negotiations, and mediations. Journal of Contemporary African Studies, 1-19.

Rieu-Clarke, A., & Loures, F. R. (2009). Still not in force: should states support the 1997 UN Watercourses Convention?. Review of European Community & International Environmental Law, 18(2), 185-197.

Salman, S. M. (2013). The Nile basin cooperative framework agreement: A peacefully unfolding African spring?. Water International, 38(1), 17-29.

Tefera, W. M., & Kasiviswanathan, K. S. (2022). A global-scale hydropower potential assessment and feasibility evaluations. Water Resources and Economics, 38, 100198.

Turhan, Y. (2021). The hydro-political dilemma in Africa water geopolitics: The case of the Nile river basin. African Security Review, 30(1), 66-85.

Ulibarri, N. (2024). An analysis of micro-scale conflict in collaborative governance. Journal of Public Administration Research and Theory, 34(2), 316-330.

Verhoeven, H. (2021). The Grand Ethiopian Renaissance Dam: Africa's Water Tower, Environmental Justice & Infrastructural Power. Daedalus, 150(4), 159-180.

Vij, S., Warner, J. F., Mehta, A. S., & Barua, A. (2024). Status quo in transboundary waters: Unpacking non-decision making and non-action. Global Environmental Change, 85, 102821.

Yilmaz, Y. A., Sen, O. L., & Turuncoglu, U. U. (2019). Modeling the hydroclimatic effects of local land use and land cover changes on the water budget in the upper Euphrates–Tigris basin. Journal of Hydrology, 576, 596-609.

Zarfl, C., Lumsdon, A. E., Berlekamp, J., Tydecks, L., & Tockner, K. (2015). A global boom in hydropower dam construction. Aquatic Sciences, 77, 161-170.

Zawahri, N. A. (2006). Stabilising Iraq's water supply: what the Euphrates and Tigris rivers can learn from the Indus. Third World Quarterly, 27(6), 1041-1058.

Books

Keohane, R. O. (2005). After hegemony: Cooperation and discord in the world political economy. Princeton University Press.

Webpages

Bonsor, K. (2001). How hydropower plants work. Retrieved from http://science.howstuffworks.com/environmental/energy/hydropower-plant1.htm

Reports and Legal Documents

Food and Agriculture Organization of the United Nations (FAO). (2009). AQUASTAT Transboundary River Basins – Euphrates-Tigris River Basin. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

International Law Association. Committee on the Uses of the Waters of International Rivers. (1966). Helsinki Rules on the Uses of the Waters of International Rivers. International Law Association.

United Nations. (1997). Convention on the Law of the Non-navigational Uses of International Watercourses. Retrieved from https://legal.un.org/ilc/texts/instruments/english/conventions/8_3_1997.pdf