Transboundary Water Resources Management Practices: Comparative Analysis of Nile and Senegal River Basins

Kiram Tadesse[1]* and Yeshtila Wondemeneh Bekele[2]

Abstract

This study discusses the existing transboundary water resource management practices in Nile and Senegal River basins. By identifying key drivers of change that contribute to successful management of shared water resources, this study draws lessons in building effective institutional frameworks towards a common call for cooperative utilization of Nile waters. It adopted a Qualitative Comparative Analysis (QCA) design, with in-depth qualitative analysis of selected cases and Key Informant Interviews (KII) to analyze the drivers of change and evolution of the institutional frameworks that have been governing the Nile and Senegal River Basins and how they are affecting the cooperation process. The study argues that the compound effects of hydro-ecological phenomenon, legal regimes, historical beliefs and unilateral actions of the riparian's have been among the major factors that have influenced the cooperation process and determined their outcomes. The study has put forward some recommendations aimed at striking win-win solutions that could pave the way for Nile riparians come to a cooperative framework. These include, among others, focusing on benefits sharing than water allocations, focusing on scientific or technical issues than political, understand the views of local actors, contest the legitimacy of the old-regimes through re-negotiation of Cooperative Framework Agreement (CFA) with Egypt and Sudan, and change power relations in the basin.

Keywords: Nile River Basin: Senegal River Basin: Transboundary Waters Management: Water Cooperation: Hydropolitics

[1] Center for Regional and Local Development Studies, Addis Ababa University, Addis Ababa, Ethiopia; *kiram2212@gmail.com

[2] Center for Regional and Local Development Studies, Addis Ababa University, Addis Ababa, Ethiopia: Email: yeshtila@yahoo.com

1. Introduction

Water is referred to as the life blood of Earth's ecosystems because of its important significance in the natural world. Ayaa (2012) argues the delineation of water as an essential resource is interwoven in the various functions of the nature and the human society in countless ways making it one of the most complicated sources of challenges of the mankind (Varis et al., 2008). Water is also associated to the creation of many dramatic conflicts among different competing demands and users throughout human history (Abukhater, 2013). Amid this demand leading to conflicts and the increasing significance of water resources shared across national borders and the underlying resources management practices have attracted considerable research interest in many scientific fields. Pressed by a mix of demographic, political, social, environmental, technological and economic drivers the underlying challenges thus call for seeing water in a broad development framework (Varis et al., 2008). Because water knows no political boundaries (GIZ, 2011), nations vie for their fair share of water for different uses. The situation gets more complex as transboundary water resource, which can describe as water shared across political, economic, or social boundaries (Beach et al., 2000). Hence, the intricacy of man-made boundaries and the natural delineation of the concerned parties as upstream or downstream riparians make the issue of international water disputes a formidable and volatile one (Mirumachi et al., 2016).

This situation is further complicated by the fact that a large portion of major freshwater basins in the world fall within the jurisdiction of more than one nation (Uitto and Duda, 2002). UN states that approximately 40% of the world's population lives in river and lake basins that comprise two or more countries, and perhaps even more significantly, over 90% lives in countries that share basins (UN-Water, 2008). As to Varis et al. (2008) nearly 47% of the area of the world (excluding Antarctica) falls within transboundary basins, while nearly 60% of the area i.e. 20 countries in Africa; at least 80% of their total areas are within transboundary basins. As a result, water related conflicts are expected to escalate due to exponential population growth, industrial development, and increasing urbanization, as well as the negative consequences of climate change.

Therefore, according to Varis et al., (2008), the way forward for these competing interests is whether to cooperate in order to sustainably manage and reap maximum benefits from the shared water resource or languish continuously. However, the management of transboundary water resources remains a complicated process which presents policy-makers with complex geopolitical, economic, and environmental as well as supranational challenges that are being amplified by exponential population growth, uneven economic development, and environmental degradation. Abukhater (2013) argues that the persistence of water conflicts in many arid regions is not simply a matter of water shortages, but rather the lack of equitable agreements that govern the allocation of disputed water resources to mitigate the adverse impacts of hostility and resentment. Thus, managing these resources efficiently, pragmatically, and equitably is increasingly becoming a priority for policy decision processes (Iyob, 2011).

In order to confront such complex conflicts over shared water resources, many riparians chose to address the issue through Integrated Water Resource Management (Merrill, 2008). This approach has a mixed success in different parts of the world, such as among the Senegal River Basin (SRB) countries that show regional cooperation for equitable utilization rather than conflicting over the shared resource. However, historically, the Nile River Basin (NRB) has exemplified many of the transboundary water resources management problems as witnessed by inter-basin conflict, devastating floods, crippling drought, and unstable political and economic development as well as diplomatic spat (ibid). Driven by a number of factors the NRB countries – Burundi, Egypt, Ethiopia, Eritrea, Kenya, Sudan, South Sudan, Republic of Congo, Rwanda, Tanzania and Uganda – have been engaged in long tumultuous teamed up as ‘upstream’ and ‘downstream’. Interactions between the Nile riparian countries are characterized by mutual distrust, intimidation, and competition. Although Ethiopia and other upstream riparians have been demanding for “reasonable and equitable utilization” through a negotiated cooperative institutional framework, however downstream countries of Egypt and Sudan advocating for the doctrine of “limited territorial integrity” and insist their right to have the water resource preserved by citing the principle of “do no harm” (Brady, 2015).

Egypt, in particular maintains its hypersensitivity to any reduction or diversion of Nile's flow calling the river as a life-sustaining umbilical cord (Hefny and Amer, 2005). Decades old efforts bore no fruit to engender trust and cooperation among the NRB riparians with an ultimate aim of concluding a just and comprehensive basin-wide organization, eventually leading the basin to remain elusive (Azarva, 2010). This left the NRB with neither commonly agreed views on how the Nile waters should be equitably and reasonably used nor common views with collaborative solutions on sharing the resource (Tafesse, 2017). Because of the interest and obligation among every riparians to utilize its water resources to maximum level there is possibility of conflict in the NRB (Arsano, 2007). The conflicting interests of upstream and downstream countries have generated inter-regional tension that inhibited cooperative efforts in order to realize basin-wide win-win mechanism.

Contrastingly, the SRB has a long history of water cooperation. It encompasses Guinea, Mali, Mauritania and Senegal. The SRB countries signed 13 international treaties and established Organisation pour la Mise en Valeur du Fleuve Sénégal (OMVS) in 1972. When the Senegal River Basin (SRB) transboundary water resource management experience is not only a political success in conflict resolution to augment cooperative approach in water negotiation in general, but according to (Alam and Dione, 2004), it is also a success in improving access to basic services by contributing in reducing poverty. While the basin also sets good example in crafting and developing institutional framework for cooperation, the countries further move towards a closer regional integration. Eventually, to address the potential for conflict the SRB riparian countries employed several methods towards practical cooperation concepts in water negotiation in general.

This study draws lessons in building effective institutional frameworks for cooperation on transboundary waters, and the methods used in conflict resolution with reference to the NRB and the SRB. Although the two river basins differ in complexity ways of size, hydrology and socio-political factors, however they also share colonial heritage, mutual trust and pan-African solidarity. The objective of this study, therefore, is to investigate key drivers of changes in both the NRB and the SRB, and analyzes methods used in conflict

resolution lessons and parallels that can be extrapolated to benefit the theory and practice of cooperation concepts in water negotiation in general, as well as examine the experience of crafting and developing institutional framework of cooperation on both basins.

By drawing lessons in building effective cooperation and examine the experience of crafting and developing institutional framework of cooperation, this study intends to contribute on ways to make positive progress towards ending the impasse among the NRB riparians through successful practical lessons driven from the SRB.

2. Theoretical Framework

This section synthesizes relevant theories which are pertinent to the subject of investigation. By focusing on major theories that has been written on transboundary waters in relation to cooperation, conflict, power and perception, and equitable utilization, it offers a summary and analysis of relevant theories.

Collective action theories

Researchers discussing “collective action” tend to emphasize more proximate, historically contingent causes, rather than cost-benefit matrices; think in terms of large human groups with marked differences in power, wealth, and hierarchy; and favor the compilation of case based surveys as an analytical method (Carballo, 2012). Terje Tvedt sees limitations of the theory and tried to incorporate the idea which holds that when rational individual behavior and companies’ profit-seeking fail to provide public goods, the common or shared interest of a group might enable collective action (Tvedt, 2010). "The tragedy of the commons," written by Garrett Hardin in 1968, centers scholarly and policy discussions on the management of resources from common pools on institutions – or rather, on their seeming absence (Hardin, 1968).

Power asymmetry and water hegemony theory

Politics, power structure, and relationships have been identified as important factors by water governance scholars in shaping common pool resources, primarily in the context of irrigation system management and hydropower development (Suhardiman et al., 2018). Scholars like Zeitoun and Warner

(2006), in particular, posit that relative power differences can cause various forms of hydro-hegemony. According to their "Framework of Hydro-Hegemony," if a basin state with superior power acts for the collective good of the basin, there is leadership in this form of hydro-hegemony (Mirumachi et al., 2016).

Hydropolitics theory

The term "hydropolitics" is believed to have first coined by John Waterbury in his book "Hydropolitics of the Nile Valley" (Waterbury, 1979). He implicitly defines hydropolitics as the study of inter-state politics regarding the management of shared water resources, in order to respond to a question "how can sovereign states, pursuing national self-interest cope with the challenge of bi- or multinational coordination in the use of a common resource?" In a broader and more comprehensive interpretation Meissner (1998) portrays hydropolitics as the "systematic investigation with respect to the interaction between states, non-state actors and a host of other participants, like individuals within and outside the state, regarding the authoritative allocation and/or use of international and national water resources".

Water stress theory

Water stress occurs when water demand exceeds the available amount during a certain period (Roy, 2022), and areas with low rainfall, high population density or intense agricultural or industrial activities exhibit high frequency to water stress. Wiebe (2001) states that as water stress becomes water scarcity, more water projects will be planned and constructed, increasing discord between riparians. Moreover, many scholars theorize that increasing water scarcity creates conflict in transboundary basins (Bernauer and Böhmelt, 2014).

Equitable and reasonable utilization theory

Zeitoun and Jägerskog (2011) see equitability in transboundary water management as a key to effective cooperation. However, operationalization of the concept of cooperation for equitable utilization, which is seemingly context specific, presents a definitional challenge. To that end, it is necessary to formulate concrete yet flexible and adaptable parameters of cooperation process in terms of parameters of treaty formation, which are a moving target

themselves, to be able to evaluate the impact of a cooperation policy-development approach, or lack thereof. However, UN Convention (2008) mandates river basin states to establish joint mechanisms of cooperation with a number of factors such as, the population, the social, economic and other needs, present and future, the natural characteristics, the contribution to the formation and recharge, the existing and potential utilization, and its effects of the water system among others.

In this research, we draw upon a combination of three key theoretical frameworks: water stress, power asymmetry (water hegemony), and the principle of equitable and reasonable utilization of water resources. Water stress, which refers to the strain on available water resources due to factors like population growth, climate change, and inefficient management, serves as a central theme in understanding the challenges faced by regions with limited water availability. The concept of water hegemony highlights how power imbalances shape the distribution and control of water, often resulting in inequitable access and use. By integrating these theories, we are able to critically examine how power dynamics and water scarcity intersect to impact water governance in the Nile and Sengal basins.

In the results and discussion section, our analysis aligns with the core tenets of these theories to explore the implications of water stress and hegemony on the fair and reasonable allocation of water resources. We examine how power disparities influence decision-making processes, particularly in both Nile and Sengale river basins where water resources are scarce or contested. Additionally, we assess how the principle of equitable water utilization, which emphasizes fairness and sustainability, can either be upheld or undermined by prevailing power structures based on the experience of two basins. Our findings reveal the complex interplay between these theories, providing insights into more just and sustainable approaches to water management.

3. Methods of the Research

3.1 Physical and Political Context of NRB and SRB

The Nile River is the longest river in the world (6,825 km), its basin connecting 11 riparian countries: Egypt, Ethiopia, Sudan, South Sudan, Burundi, Eritrea, Kenya, Republic of Congo, Rwanda, Tanzania and Uganda. It is very large both in terms of drainage area as well as in terms of the quantity of water it carries in its watercourse, making up a relatively modest portion of the area of the majority of other nations (Tadesse, 2008). Being the most important reliable sources of renewable water supplies in the Nile basin countries, and a source of food and water security has historically led to tensions around management of the scarce water resources (ECDPM, 2017). The Nile Basin's extraordinary variety of geographical and ecological systems makes it challenging to categorize or separate. Geographically, a state that water flows into (Egypt and Sudan) is known as a downstream state and a state that water flows out of (Burundi, the Democratic Republic of the Congo (DRC), Ethiopia, Eritrea, Kenya, Rwanda, South Sudan, Tanzania, and Uganda) is known as an upstream state. The separation between the two primary sources of the Nile River, the Blue and White Nile states, adds a crucial geographical component to the interaction between the nations that make up the Nile River Basin.

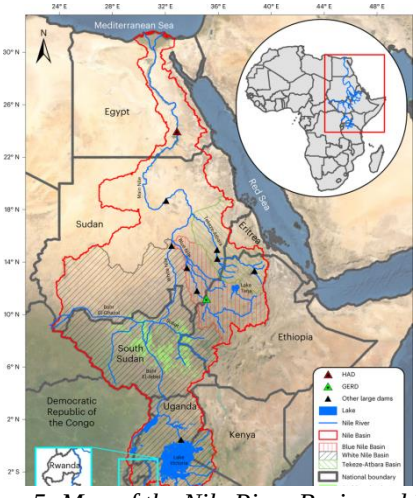

Figure 5: Map of the Nile River Basin and its tributaries (Nature Climate Change, 2023)

The three main tributaries of the Senegal River, located in Guinea's Fouta Djallon Mountains, are the Bafing, Bakoye, and Faleme. Together, they flow, making it the second largest in West Africa. The Senegal River rises in Guinea and flows 1,800km to reach the Atlantic Ocean, passing through Senegal, Mauritania, and Mali (Newton, 2008). The basin is divided into three separate areas: the valley, home to wetlands and ecological richness, the upper basin with its mountains, and the delta. These three locations have radically varied topographical, hydrographic, and climatic circumstances, as well as wide seasonal temperature changes (Adams, 2000). Landlocked Mali sought to have the Senegal River's international status recognized after independence in order to ensure navigation rights. Freedom of navigation on the Senegal River derives from the principle of reciprocity, not universal access (Alam and Dione, 2004).

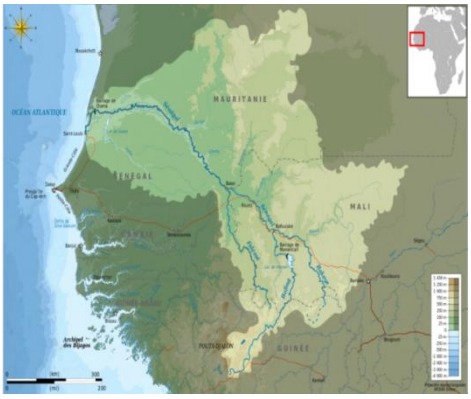

Figure 2: Map of the Senegal River Basin ©OMVS

3.2 Methods of Data Collection and Analysis

The research methodology is designed in a way that seeks to construe a better understanding of the issue of cooperation process in the contexts of the two river basins, on the one hand, and to clarify the significance of equitable utilization in influencing perception and boosting future cooperation for regional development among the NRB countries on the other. Having established this need for a new understanding and expansion of research, and to address the profound research problem and examine the perplexing questions, this study explores using the convergent design within Qualitative Comparative Analysis (QCA).

To meet its methodological approach the study employed Key Informant Interviews (KIIs) as primary and document review as secondary sources of data. Interviews were conducted with two (2) professional transboundary water negotiators, two (2) officials from basin organizations, two (2) scholars and/or

scientific experts knowledgeable about the intricacies of the NRB and the SRB water management. Thus, the study analyzed three major cases that are systematically selected based on contextual characteristics of the two river basins. These cases were carefully identified based on existing literatures, which reflect a variety of categories and geopolitical contexts, to be able to examine, test, and validate casual associations. Using multiple literatures, the development and effectiveness of cooperative framework relating to the NRB and the SRB have been analyzed.

Interviewees were selected deliberately to ensure that quality data is obtained, as well as to select participants that illustrate the full range of viewpoints about basin cooperation. Snowballing technique was also utilized in order to encounter and discuss the central questions with knowledgeable and helpful subjects, identified based on their reputation.

In order to ensure representation interviewees were from Ethiopia, Uganda, Senegal and USA in person, via video call applications, and on phone call. The purpose of these interviews was to develop a contextual understanding of implementation, as well as perceived cooperation, and of the level of satisfaction between the river basins. This follows the technique of semi-structured interviews using both grand tour questions and floating prompts to allow respondents to share freely while maintaining enough consistency across interviews to aid hypothesis testing. However, other backup questions were also asked when needed, to clarify certain issues or to obtain more relevant information. The responses were transcribed and analyzed to extract significant lessons and relevant content fitting to the case under discussion. However, given the significant number of riparian states involved among the two river basins, selection and identification of KIIs limits to investigate every potential objective and subjective arguments offered for each phenomenon, and its players in the analysis.

The research adheres to ethical code of conduct when obtaining data or information from either KIIs or institutions. Accordingly, KIIs were invited based on voluntary participation, and they were also given informed consent and time to review the information they provided, maintaining anonymity with a promise to communicate findings.

4. Results and Discussions

This section presents the results of the study and provides a comparative analysis on two basins based on identified theme of the discussion. Therefore, the results and discussions cover findings based on the cases collected from the NRB and the SRB and interviews conducted to substantiate the analysis.

4.1 Key drivers of change in NRB and SRB

4.1.1 Water stress in the basins

The "Falkenmark Water Stress Index" leveled the NRB as a water-scarce region lived with turbulence and riparian disputes (Falkenmark, 1989). The decline of the annual discharge of the Nile during the 1899–1945 sub-period was the most significant aspect of the physical environment of the NRB that have induced Egypt to concentrate its efforts to guarantee and to try to increase its annual supply of water (Tayia et al., 2021). In this regard, the NRB displays an inherent water stress problem mainly because the current amount of waters in the basin is not sufficient for its hundreds of millions of people.

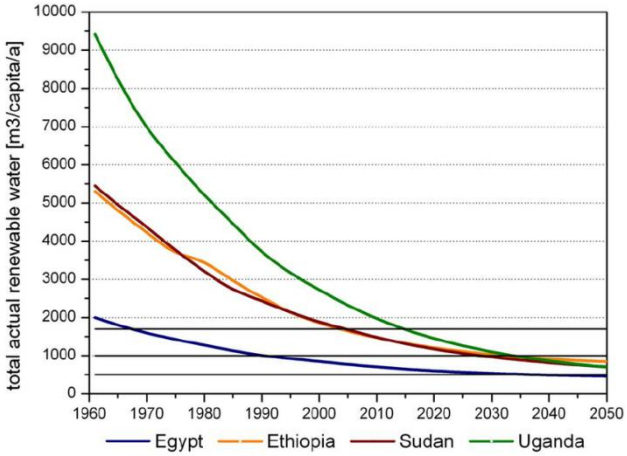

Figure 3: Increasing water stress projection in all Nile countries under the assumption of constant water availability (Link et al., 2013)

Figure 3 shows that since 1960 the NRB exhibits an increasing water stress, and the same threshold projection in all Nile countries under the assumption of constant water availability shows since 1990s Egypt surpassed water stress and falls under water shortage at below 1000 m^3 per inhabitant per year. Similarly, the basin becomes more likely contentious, particularly between Ethiopia,

Egypt, Sudan and Uganda falling under water shortage at below 1000 m^3 per inhabitant per year starting from early 2030s (Link et al., 2013). A UN report (2021) states that Egypt could run out of water by 2025 as the country is facing an annual water deficit of around 7 BCM. Hydrology of NRB is "very much skewed," and yet the population growth of the basin pause another challenge. In 1950s the total population of the Nile Basin countries was around 100 million and in 2010 it grew to more than 400 million and now it is well over 500 million people. Even if not all the population in most of the basin countries is dependent on the Nile; but "the water volume does not grow that much, while the per capita of the water availability is going down" (KII 1, 2023).

Similarly, the NRB becomes more likely contentious, particularly between Ethiopia, Egypt, Sudan and Uganda falling under water shortage at below 1000m^3 per inhabitant per year starting from early 2030s (Link et al., 2013). In this regard, the NRB displays an inherent water stress problem mainly because the current amount of waters in the basin is not sufficient for its hundreds of millions of people. Out of the total estimated net evaporation on loss from the dams has been estimated as 18 billion cubic meter (BCM) per year the High Aswan Dam in Egypt is the biggest loss due to the size of the reservoir surface area and the climate (NBI, 2015). Prior to evaporation at Aswan Dam the Nile used to be calculated 84 billion m^3 of water (Zeidan, 2015). However, "that is clearly not enough to supply the needs of all people in the NRB" (KII 2, 2023). AQUASTAT database results show a trend of water stress or scarcity for the SRB at below 1700 m^3 per inhabitant per year, and then of water shortage at below 1000 m^3 per inhabitant per year (Zisopoulou et. al., 2022). At below 2500 m^3 per inhabitant per year, Senegal and Mauritania are in a situation of water vulnerability (Faye, 2022).

Table 1: Declining renewable freshwater resources per capita (m^3) in SRB

Country	Period		Characteristics of renewable freshwater per capita (m^3)
	1958 – 1962	2017 – 2022	
Mali	22,301 m^3	6290 m^3	Renewable freshwater resources per capita (in m^3) continued to decrease between 1958 and 1962 and 2018–2022 at the level of the three countries.
Mauritania	12,538 m^3	2589 m^3	
Senegal	11,612 m^3	2458 m^3	

However, the water stress in the SRB was "shared due to the 1960s and 1970s severe draught that led the basin countries to look at ways to work together to mitigate the disaster" (KII 3, 2023).

4.1.2 Power asymmetry and hydro-hegemony in the basins

The different trajectories of relations among the NRB and the SRB countries show how power manifests in water allocation, management and development. The role of asymmetric power and hydro-hegemony or a state with more relative power in the basin can determine the status-quo of "water allocation".

> *"The NRB has unnatural water right politics because, it is a basin where the sources of the water did not benefit, but those non-contributors or downstream countries, namely; Egypt and Sudan are politically powerful" (KII 4, 2023).*

This expert argument is supported by Cascão (2008), who states Egypt's overwhelming asymmetry in power sustained its Nile hegemony. This gains an absolute hydro-hegemonic view in the NRB because; the 1959 bilateral agreement between Egypt and Sudan which allocates 100% of the Nile waters to themselves is "the major challenge to strike cooperation in the river basin" (KII 5, 2023). The old agreements lay the foundation for downstream countries of "Egypt and Sudan insist on their historical right and have agreed to stand against any demand arising from upstream countries, and they cannot change their thoughts" (KII 4, 2023). The regular views expressed by these downstream countries of the NRB are often "threat rather than good faith and cooperation" (KII 6, 2023).

However, Ethiopia's role through its effort for the NBI demonstrated a relatively weak upstream country can influence the institutional structure of basin-wide water management via reconfiguration of domestic water policy (Brady, 2015). In the SRB, France's absolute control over the river during its colonial rule brought each riparian country to rally together in a spirit of Pan-Aficanism. Although Senegal is a dominant power in the region, "there is no absolute hegemonic practice, except for Senegal has been considered as a benevolent hegemony" (KII 4, 2023). Two of the river's three headstreams rise in Guinea, however it joined OMVS lately in 2005, it expressed dissatisfaction and left the organization in 2023 (Africanews, 2023).

Table 2: Key differences in power asymmetry and hydro-hegemony in NRB and SRB

Aspect	NRB	SRB
Power Dynamics	Characterized by asymmetric power, with Egypt as a hydro-hegemon due to its military, economic, and international support.	No absolute hydro-hegemony, with Senegal being seen as a benevolent hegemon.
Geopolitics	Geopolitical influence is significant, with Egypt's control over the Nile affecting regional politics.	Guinea's strategic interests were less considered within OMVS, leading to its departure in 2023.
Water Allocation Approach	Water allocation is heavily influenced by historical agreements and hydro-hegemony, often seen as a zero-sum game.	More equitable approach with less dominance from any one country, despite colonial history and sporadic tensions.
Upstream Countries	Upstream countries like Ethiopia are politically weak but have attempted to influence basin-wide management (e.g., NBI).	Guinea, Mali, Mauritania, and Senegal share a more cooperative relationship with less

		dominance from any single country.
Downstream Countries	Egypt and Sudan dominate water allocation, with a historical agreement (1959) allocating 100% of Nile waters to them.	No historical agreement with absolute water rights, but collaboration within the Senegal River Riparian States Organization (OMVS).

4.1.3 Unilateral actions enforcing equitable utilization in the NRB

The pursuit of unilateral actions and resisting any political pressure in order to push for governance architecture that promotes equitable utilization from Nile waters. Upstream countries can employ the tactics of leverage mechanisms, which include water diplomacy, unilateral construction of development infrastructures and coalition with other upstream countries (Endaylalu, 2019). The benefit coming out of the "unilateral development projects should target other basin member states" (KII 2, 2023). Although Egypt, Ethiopia, and Sudan recognize Nile River's international character, however there is no agreed regime governing the actions of the three countries (Kendie, 1999a). This situation creates unilateral development projects. Such unilateral action will eventually influence Egypt and Sudan positively to come to smooth governance architecture that brings everybody to the negotiating table with equal power (KII 5, 2023).

4.1.4 The role of GERD in creating upstream counter hydro-hegemony in NRB

When Ethiopia announced the GERD project, which provides an alternative countering discourse, Egypt responded negatively and decided to use all means to subvert the project (Endaylalu, 2019). One of the senior expert whom I interviewed noted that

> *GERD has broken the myth that downstream countries have veto power over the use of the Nile. The project demonstrates that countries can build and operate huge hydraulic infrastructure without external*

> *aid or loan countering the negative campaign of Egypt to block external financing of projects on Nile" (KII 5, 2023).*

As noted by a senior expert above, GERD brought a paradigm shift on hydro hegemony of the NBR. The GERD also initiated a lot of "discussions, negotiations, and diplomatic activities including the 2015 Declaration of Principles (DOP) between upstream Ethiopia, and downstream Egypt and Sudan" (KII 4, 2023). After the GERD the upstream non-hegemonic riparian country began challenging the age-old Egypt's hydro-hegemony. Other upstream countries have also supported Ethiopia as they argue that Egypt should not undermine Ethiopia's right to the Nile (Chen and Swain, 2014).

4.2 Conflict and cooperation in the basins

Like many other international river basins Nile and Senegal River basins take into consideration a number of "historical contexts," that give them exceptional characteristics that go beyond water management but tackle conflict" (KII 4, 2023). There is a consensus that there is some degree of cooperation in the NRB. But in many cases Nile didn't come with an actual cooperation that brings basin-wide benefits associated with not negotiating when there are strong power asymmetries between the basin countries. Brady (2015) argues that the NRB sees an emergence of cooperation of both institutional and legal cooperation during which time water scarcity was continuously increasing because of population growth, economic development, and climate change. Yet, bilateral cooperation agreements remain "the preferred courses of action by few countries, as the cooperating riparians expect the benefits to eventually outweigh the risks" (KII 6, 2023).

> *"Even though cooperation has been promoted in the NRB, still some of the approaches followed by downstream countries are not conducive for cooperation" (KII 1, 2023).*

Despite this senior expert's argument, eventually, there has been a move from tension to cooperation as part a universal aspiration of riparians, and yet several cooperation projects have been listed under the NBI. However, Link et al. (2013) say, the Nile basin countries are still far from implementing an efficient basin-wide water resources management system.

In contrast, the SRB countries, from the start, were attempting to find a mutual interest in the light of ever-changing context (Mbengue, 2014). The river basin states sought to artificially control the availability of water in the basin amid the emerging tremendous social, economic and ecological problems due to unsustainable water management (Vick, 2006). The vulnerability of the populations of the Senegal basin states serve as a catalyst for cooperation, because in order to improve "the countries believed that collaboration on the development of the water resource would improve the standard of living of the population in the region" (KII 3, 2023). Hence, the SRB countries did not wait for a conflict to happen to adhere to a cooperative approach over the use of the water resources.

> *"The Senegal River Basin is a successful international cooperation model" (KII 1, 2023).*

These expert hails the SRB's track in accordance with the ultimate reason why the SRB has overcome all possible differences between the four riparians unlike the NRB is that "the SRB is not politically contested river basin" (KII 4, 2023). Similarly, the cooperation between the SRB countries is implied through a joint planning, non-visa requirement for citizens to move from one basin to the other basin country.

Table 3: Key differences in conflict and cooperation in NRB and SRB

Aspect	NRB	SRB
Cooperation & Conflicts	Cooperation is hindered by Egypt and Sudan's stance on 'historical rights' and their resistance to upstream countries' demands.	Despite past conflicts such as 1991 Mauritania-Senegal conflict, there has been successful restoration of diplomatic relations and joint work.
Institutional Arrangements	Egypt and Sudan's opposition limits effectiveness of Nile Basin Initiative (NBI)	OMVS serves as the main basin-wide management organization, though

		Guinea's exit in 2023 reflects tensions.
Historical Context	The 1959 bilateral agreement between Egypt and Sudan is a key challenge to cooperation, based on 'historical right' to Nile waters.	France historically controlled the river during colonial times, but post-independence cooperation has been key.

4.3 Vision sharing Vs benefit sharing

The cultural orientation governing the NRB and the SRB diverges between "vision sharing" and "benefit sharing," respectively, as means to equitable utilization of the water resources. This defines 'what is desirable' and 'what was possible' in either river basins. The NRB countries initiated a program called "shared vision" as of 1999, with about eight projects, which were designed to build confidence between the riparians and to put in place enabling environment for cooperation (NBI Act, 2002).

> *"Desire of the NRB 11 riparians differs from one another, and the situations for many of the upstream countries, necessitates the agenda of development, but for downstream countries like Egypt it means an issue that affect its water security" (KII 1, 2023).*

As to this authority there is divergence of interests between riparians mainly on development among upstream countries and water security issue for downstream country of Egypt. In contrary, in the SRB the sharing of benefits between the SRB countries is governed by the principle of "common and indivisible property" which is designed to manage the common facilities in the basin (Bolognesi et al., 2015). The benefit sharing identifies mutually beneficial and sustainable arrangements to ensure "the direct benefits generated by the facilities and distributed benefits derived from the multiple uses of water rather than physical water allocation" (KII 3, 2023).

4.3.1 Legal and institutional frameworks for cooperation: *Nile Basin Initiative (NBI) and Cooperative Framework Agreement (CFA)*

The birth of NBI in 1999 emerges instrumental for the first time, among the NRB

riparians, to agree on a "shared vision objective" which aims to achieve sustainable socio-economic development through "equitable utilization" of the Nile waters (NBI, 2020). The NBI is much comprehensive in the sense that the riparians establish cooperation in order for all countries in the basin can have the chance to develop without interring to unnecessary conflict. The Nile riparians still continue to collaborate on things they think they can collaborate under the NBI; "however sustaining the NBI has its own ups and downs" (KII 4, 2023). Initiated in 1997 and concluded in 2007, the Cooperative Framework Agreement (CFA) is also an approach that seeks multilateral negotiations for a comprehensive legal framework among NRB countries (NBI, 2007).

> *"CFA is a good basis to implement the principle of equitable and reasonable utilization in the NRB" (KII 6, 2023).*

Even though the NBI envisions for the creation of a basin-wide cooperation and the CFA is taken as a good basis for cooperation over Nile waters as indicated by an expert above, however another mode of cooperation between "Egypt and Sudan solely protects their interest by avoiding a further basin-wide cooperation like through CFA" (KII 5, 2023).

4.3.2 Organization for the Development of the Senegal River (OMVS)

The legal and institutional framework for the SRB is comprehensively defined through OMVS. The OMVS has implemented a special legal regime since 1978's Bamako Convention with the adoption of specific instruments for the management and operation of joint works (Bolognesi et al., 2015). Not only was the Bamako Convention the first post colonial West African treaty concluded in relation to water resources management, but also the institutional machinery upon which it rested was progressive and the powers entrusted to the Inter-State Committee departed from general international law as well as international practice. Mbengue (2014) says the Convention has left almost no room for unilateral action by the riparians in the exploitation of the river. The Convention provides that "the SRB countries share the investment costs and operational fees on the basis of the benefits that each co-owner country will have from the operation of common works" (KII 3, 2023). Thus, OMVS is depicted as a demonstration of "a pioneering approach to transboundary water cooperation in Africa" (KII 2, 2023).

In the light of the findings of this exploratory research, it would be important to improve further the understanding of the local, national, regional, geopolitical and economic or developmental dynamics that keep NRB and its riparians in a full-fledged non-cooperative state. At the same time, it would be important to better understand the dynamics that could not bring the riparian countries closer in good-faith, trust and genuine and sustained dialogue. It would also be particularly important to further investigate how the national political dynamics within Ethiopia, Egypt and Sudan affect the nature of the transboundary water interactions and future development of the Nile waters.

5. Conclusion and Recommendations

5.1. Conclusion

Context Matters

The SRB countries shared a common colonial heritage, such as the French language and institutions. The leaders also built mutual trust and confidence imbued with the spirit of Pan-Africanism borne out of anti-colonial struggle. This laid the foundation for the emergence of a strong sense of solidarity. The OMVS includes only four members whose economic interests are close and very interdependent.

The NRB echoes the realities in the SRB, where the challenges are similar and the aspirations and opportunities parallel each other. The situation of the NRB is notably characterized by policies that are primarily dependent on the national scale and on the implementation of exclusive bilateral agreements, recalling the strong heterogeneity of preferences from within the basin countries. The SRB countries never had long, adversarial not to say hegemonic interstate histories. Compared to the NRB countries their size, both in terms of population and land area, is considerably smaller.

A perspective on coordination

In the SRB, Senegal initiated fostering asymmetries for the emergence of a hegemon directing negotiated actions and eventually avoiding a political-economy of the status-quo. Yet, the NBI is dealing with a number of actors and with asymmetries which complicate the identification of win-win situations and the accounting of preferences. Therefore, the risk of inaction in

the NRB is greater. The history of the NBI highlights this difficulty to go beyond the status-quo, particularly through the ongoing CFA ratification process that aims to institutionalize basin-wide organization. The OMVS parties come together around a "shared vision" of the river. The stability of the governance framework seems to have favored the inflow of financial resources at an early stage of cooperation. In parallel, riparians benefit from highly interconnected economic dynamics, in addition to being relatively good and predictable. This economic environment is particularly favorable to cooperation. Nevertheless, the definition of a "shared vision" for the action of the NBI and the matching of costs and benefits into coordination efforts clearly illustrate the progress made towards revitalization in collaborative action.

Unlike the case for the SRB, there is to date no international instrument that is specifically dedicated to bring the NRB countries together for equitable utilization of the Nile waters. But arrangements for observing the contours of the plan are contained in the NBI instruments adopted in the "shared vision" program that was launched in 1999. The past interactions between the NRB riparians over Nile waters development could be summarized as an opposition between exclusive unilateral resource capture and containment strategies. The NBI comes as a transitional project for Nile riparians to augment discussions, while OMVS emerges a strong, stable regional organization, proving its critical importance for regional integration in West Africa.

Change in hydro-political structure

There is a consensus that the NRB shows some degree of cooperation but often lacks basin-wide benefits due to power asymmetries between countries. Bilateral agreements remain favored by some countries, expecting long-term benefits. Cooperation in the NRB has grown, despite increasing water scarcity from population growth, economic development, and climate change. However, some approaches from downstream countries hinder full cooperation. While cooperation has moved forward, the basin is still far from an efficient water management system. In contrast, the SRB countries have sought mutual interests from the start, facing pressures from demographic and urban growth. Water consumption has led to competition, but Senegal, as the

region's economic engine, plays a "benevolent hegemon" role. SRB countries pursued cooperation early on, aiming to improve living standards through joint water resource management. The SRB's success in overcoming differences lies in its lack of political contestation, with joint planning and free movement across basin countries.

Vision sharing Vs benefit sharing

The cultural orientation governing the NRB and the SRB diverges between "vision sharing" and "benefit sharing," respectively, as means to equitable utilization of the water resources. This defines 'what is desirable' and 'what is possible' in either river basins. The NRB countries initiated a program called "shared vision" as of 1999, with about eight projects, which were designed to build confidence between the riparians and to put in place enabling environment for cooperation. Desire of the NRB 11 riparians differs from one another, and the situations for many of the upstream countries, necessitates the agenda of development, but for downstream countries like Egypt it means an issue that affect its water security. In the SRB the sharing of benefits between the SRB countries is governed by the principle of "common and indivisible property" which is designed to manage the common facilities in the basin. The benefit sharing identifies mutually beneficial and sustainable arrangements to ensure the direct benefits generated by the facilities and distributed benefits derived from the multiple uses of water rather than physical water allocation. The OMVS parties come together around a "shared vision" of the river. The stability of the governance framework seems to have favored the inflow of financial resources at an early stage of cooperation.

In parallel, riparians benefit from highly interconnected economic dynamics, in addition to being relatively good and predictable. This economic environment is particularly favorable to cooperation. Conditions that are particularly conducive to cooperation surround the OMVS, which has demonstrated its ability to adequately address challenges. Moreover, the SRB riparians took advantage of their shared commonalities, such as the French language and education systems and other institutions. The countries Pan-

African drive for anti-colonialism serves as a historical basis for the emergence of a strong sense of solidarity among each other.

5.2. Recommendations

Based on the findings of the study that draw lessons from the SRB, we recommend riparian countries to take the following policy measures in order to overcome the challenges that observed in NRB.

1. ***Develop a mechanism to share benefit***

The concept of benefit sharing is recognized to play an important role in the management of hydroelectric facilities that eventually resolved conflict and reduce tensions among the countries in the region. Nile riparians may require allocating the investment costs and operational fees on the basis of the benefits that each co-owner country will have from the operation of common works.

2. ***Riparian countries should focus on scientific issues, not only on political matters***

Trust, good faith, awareness, technical research and capacity development are necessary but not sufficient conditions for the NRB countries to create. Continuing to develop awareness among the NRB riparians on the CFA is necessary if dialogue is considered as the best way forward. Awareness raising could also go beyond the legal aspects of transboundary water resources development. A technical understanding of the possible impacts and issues at stake may also be important to ensure that decisions are taken on the basis of information that encompasses all aspects of the challenges.

3. ***Riparian countries should be open to understand the views of local actors***

Independent research would be needed to understand the views of local actors. No agreement on basin-wide development architecture is likely to be viable if local water users are not convinced that it is in their best interests.

4. ***Develop and support programs that meet increasing water demand***

The foreseeable increase in irrigation water demand and storage capacity in the NRB riparians due to their growing development ambitions is at the heart of the existing and future tensions with downstream countries. Rather than focusing only on exploitation of the Nile waters, the upstream countries could try to find a balance between the exploitation and the gains that is going to happen.

5. ***All riparian countries should contest the legitimacy of the old legal regime and reposition power relations in the basin***

The upstream or non-hegemonic riparians of the NRB may further push contesting the old-age hydro-hegemony ushered by Egypt and Sudan through the use of consistent diplomacy. They may also reinforce counter-hydro hegemony mechanisms such as the NBI and its programs such as the CFA. Unilateral construction of investment infrastructures, like the GERD project, by non-hegemonic riparians is also recommended.

6. ***Egypt should accept the new reality and behave as a "benevolent hegemony"***

As a primary economic power on the NRB, which has been using different forms of power to execute its hydro-hegemony such as geography, economic or material power, and diplomacy or bargaining power, Egypt may take on the "genuine intention" so as to bring the NRB countries together by endorsing the CFA and its objectives.

Conflict of Interest

The authors declare that there are no known conflicts of interest.

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References

Abukhater, A. (2013). Water as a Catalyst for Peace: Transboundary Water Management and Conflict Resolution (1st ed.). Routledge. https://doi.org/10.4324/9780203081112

Adams, A. (2000). The Senegal River: Flood Management and the Future of the Valley. 31 p. https://www.iied.org/sites/default/files/pdfs/migrate/X170IIED.pdf?

Alam, U., & Dione, O. (2004). West Africa: A regional approach to reducing poverty in the Senegal River Basin. *World Bank Document No. 22. World Bank.*

Africanews. (2023). Guinea junta suspends membership in regional development group. *Africanews. https://www.africanews.com*

Arsano, Y. (2007). Ethiopia and the Nile: The dilemma of national and regional hydro politics. *Center for Security Studies, Swiss Federal Institute of Technology.*

Ayaa, P. (2012). Multi-national river basin cooperation and management: Case study of the Senegal River Basin. Utah State University. *All Graduate Plan B and Other Reports, 175*, 85.

Basheer, Mohammed & Nechifor, Victor & Calzadilla, Alvaro & Gebrechorkos, Solomon & Pritchard, David & Forsythe, Nathan & Gonzalez, Jose M. & Sheffield, Justin & Fowler, Hayley & Harou, Julien. (2023). Cooperative adaptive management of the Nile River with climate and socio-economic uncertainties. Nature Climate Change. 13. 1-10. 10.1038/s41558-022-01556-6.

Beach, H. L., Hamner, J., Hewitt, J. J., Kaufman, E., Kurki, A., Oppenheimer, J. A., & Wolf, A. T. (2000). Transboundary freshwater dispute resolution: Theory, practice, and annotated references. *United Nations University Press.*

Bernauer, T., & Böhmelt, T. (2014). Basins at risk: Predicting international river basin conflict and cooperation. *Global Environmental Politics, 13*(3), 46–64.

Bolognesi, T., Bréthaut, C., Sangbana, K., & Tignino, M. (2015). Transboundary governance in the Senegal and Niger River Basins: Historical analysis and overview of the status of common facilities and benefit arrangements. *Geneva Water Hub, University of Geneva.*

Brady, C. A. (2015). Freshwater negotiation in the Nile River Basin: What explains the patterns of conflict and cooperation?

Carballo, D. M. (2012). Cooperation and collective action: Archaeological perspectives. *University Press of Colorado*.

Cascão, A. E. (2008). Ethiopia – Challenges to Egyptian hegemony in the Nile Basin. *Water Policy, 10*(2), 15–28.

CFA. (2007). *Agreement on the Nile River Basin Cooperative Framework*. Entebbe.

Chen, H., & Swain, A. (2014). The Grand Ethiopian Renaissance Dam: Evaluating its sustainability standard and geopolitical significance. *Energy Development Frontier, 3*(1), 11–19.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). (2011). Transboundary water resources management. https://doi.org/10.1002/9783527636655

Endaylalu, G. A. (2019). Counter hydro-hegemony mechanisms and their roles in the Eastern Nile Basin. *International Affairs and Global Strategy, 76*, 35–39.

European Centre for Development Policy Management (ECDPM). (2017). The Nile Basin Initiative: Balancing historical rights, national needs and regional interests. Political Economy Dynamics of Regional Organizations in Africa. *https://ecdpm.org/application/files/4216/5546/8782/NBI-Policy-Brief-PEDRO-Political-Economy-Dynamics-Regional-Organisations-Africa-ECDPM-2017.pdf*

Falkenmark, M. (1989). The massive water scarcity now threatening Africa – Why isn't it being addressed? *Ambio, 18*(2), 112–118.

Faye, C. (2022). Water resources management and hydraulic infrastructures in the Senegal River Basin: The case study of Senegal, Mali, and Mauritania. *River Basin Management: Under a Changing Climate*, 1–22.

Food and Agriculture Organization (FAO). (1997). Irrigation potential in Africa: A basin approach. *http://www.fao.org*

Hefny, M., & El-Din Amer, S. (2005). Egypt and the Nile Basin. *Aquatic Sciences, 67*(1), 42–50.

Iyob, B. (2011). Resilience and adaptability of transboundary rivers: The principle of equitable distribution of benefits and the institutional capacity of the Nile Basin Initiative. *Angewandte Chemie International Edition, 6*(11), 951–952.

Lautze, J., Giordano, M., & Borghese, M. (2005). Driving forces behind African transboundarywater law: Internal, external, and implications. *African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa – An International Workshop,* 26-1–26-13.

Link, P. M., Piontek, F., Scheffran, J., & Schilling, J. (2013). On foes and flows: Water conflict and cooperation in the Nile River Basin in times of climate change. *ResearchGate, 1–50.*

Mbengue, M. M. (2014). A model for African shared water resources: The Senegal River legal system. *Review of European, Comparative & International Environmental Law, 23*(1), 59–66.

Meissner, R. (1998). Water as a source of political conflict and cooperation: A comparative study of the Middle East and Southern Africa. *Rand Afrikaans University*, *168*(4), 293–312.

Merrill, J. C. (2008). Water management and decision-making in the Nile Basin: A case study of the Nile Basin Initiative. *University of South Florida*.

Mirumachi, N., Anthony, J., & King, A. (2016). Revisiting transboundary water governance: Power, conflict, cooperation, and the political economy. *School of Oriental and African Studies & King's College London*.

Newton, J. T. (2008). Case study of transboundary dispute resolution: Organization for the Development of the Senegal River (OMVS). *Tufts University. http://www.transboundarywaters.orst.edu/research/case_studies/OMVS_New.htm*

Nile Basin Initiative (NBI). (2002). *Nile Basin Initiative Act*. Entebbe.

Nile Basin Initiative (NBI). (2020). Our Nile – Our benefits. Entebbe. *http://www.nilebasin.org*

Paisley, R. K., & Henshaw, T. W. (2013). Transboundary governance of the Nile River Basin:Past, present, and future. *Environmental Development, 7*(1), 59–71.

Roy, T. (2022). Water stress. *Monsoon economies*, 113–136.

Zeidan, B. (2015). Water Conflicts in the Nile River Basin: Impacts on Egypt Water Resources Management and Road Map. https://www.researchgate.net/publication/327228212_NILE_WATER_CONFLICT_MANAGEMENT

Appendix A-1

Interview Protocol for NRB

The following questions are aimed at soliciting the best refection of experts/officials on the practices transboundary water resource management in the Nile River Basin (NRB).

1. Why does river basin management matters in NRB?
2. Is there cooperation in NRB?
3. What is desirable and what is possible to cooperative over Nile River?
4. What is the hydro-political traction of the NBI around different policy areas?
5. In terms of preconditions what kind of governance architecture are needed for equitable utilization?
6. What was the most challenging scenario in striking cooperation among the NRB states?
7. How does the Nile hydro-politics changed with the GERD?
8. Does Cooperative Framework Agreement (CFA) failed and why?
9. How should riparian countries avoid zero-sum game?
10. If upstream countries in other river basins can build development projects, what is preventing Ethiopia, and other upstream states from doing the same on the Nile?
11. What are the foreseeable practical limitations for cooperation with the existing agreements in Nile River?

Appendix A-2

Interview Protocol for SRB

Questions générales sur le bassin du fleuve Sénégal pour les experts de l'OMVS

1. Quels sont les principaux moteurs de changement dans le bassin du fleuve Sénégal qui expliquent les résultats de la coopération dans les négociations, les traités et d'autres domaines du droit international et quelles sont leurs implications politiques ?
2. Quel a été le scénario le plus difficile pour établir une coopération entre les États du bassin du fleuve Sénégal ?
3. Le plus souhaitable devient-il le résultat possible dans la gestion du fleuve Sénégal ?
4. Quelle a été la traction hydropolitique de l'OMVS autour de différents domaines politiques ?
5. Quels sont les principaux intérêts des États membres dans l'OMVS face à l'hégémonie hydroélectrique ?
6. Quels sont les domaines dans lesquels l'OMVS s'attachera le plus à promouvoir la coopération et l'intégration autour de domaines spécifiques ?
7. Quelle est la contribution des partenaires au développement pour que l'OMVS atteigne ses objectifs ?
8. Comment évaluez-vous la participation du public au développement de l'OMVS ?
9. Quels sont les enseignements et les parallèles qui peuvent être extrapolés pour bénéficier à la théorie et à la pratique des concepts d'utilisation équitable dans la négociation de l'eau dans le bassin du fleuve Sénégal ?