International Water Disputes: Winners and Losers

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Abstract

The consumption of shared water resources has been a source of both cooperation and conflict among nations across the globe. The sharing of surface and/or ground water resources has been a major international issue for centuries, leading to water disputes that have become increasingly contentious and volatile in recent years, particularly in regions with high demand for water resources. These conflicts are often attributed to factors such as rapid population growth, limited access to alternative water resources, and the political and economic influence of more powerful nations. This article explores various cases of shared water resources in the Americas, Middle East, Africa, and South and Southeast Asia, highlighting instances where some countries have benefited disproportionately while others have been excluded from negotiations, leading to conflicts. To resolve such conflicts, the involvement of local and national authorities, experts, and international organizations becomes crucial.

Keywords: water treaties, transboundary, shared resources, water conflict, groundwater, river basins

1. Introduction

Although the amount of freshwater available on Earth has remained fairly stable throughout human and geological history, the rising global population is projected to be 9.6 billion leading to an increase in water demand by as much as 56% by 2025 (IRIN 2020). However, most of the Earth's water is either saltwater (97.5%) or locked away in ice caps and valley glaciers (1.75%). Climate change is exacerbating the problem of water scarcity, particularly in areas where seasonal freshwater availability is threatened by the disappearance of mountain glaciers in places like the Himalayas and Andes. The United Nations reported in 2010 that only 0.007% of the world's water is economically available for human use, or about 13,500 km^3, which equates to roughly 2300 m^3 per person. This represents a 37% drop in availability since 1970. Compounding the issue further, water scarcity is a complex problem that transcends political and geographic boundaries, as nearly half of the world's land surface falls within international watersheds (Wolf 2007).

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Water is an invaluable resource that is essential for domestic, agricultural, industrial, and environmental purposes. Throughout history, countries have utilized water resources to manage their economies and populations, with upstream nations enjoying a strategic advantage. The expansion of agriculture and industrial development has resulted in both conflict and collaboration among riparian states. In certain developing countries like India, Pakistan, and China, excessive use of private water pumps is causing underground water resources to deplete at unsustainable and alarming rates. On a global scale, disparities in the distribution of water quality and quantity are exacerbating the increase in inter-state and intra-state conflicts. (IRIN, 2020), most noticeably in the Middle East (Jordan, Tigris, and Euphrates Rivers), Southeast Asia (Indus, Ganges-Brahmaputra and Mekong Rivers), Africa (Nile River, Niger River), North America (Colorado River and Rio Grande) and La Plata River in South America. A similar narrative is evident in the case of many other rivers such as the Nile, Colorado, and Indus.

The pressure on water resources in various transboundary river basins, such as the Nile, Colorado, and Indus, has increased due to population growth and the subsequent demand for water. However, the gender dynamics of water conflict and cooperation at the transboundary level are often concealed, and research and policies are guided by implicit assumptions (Sehring et al. 2022). Climate change exacerbates environmental degradation and erratic weather patterns, potentially amplifying variability and unpredictability in water supply. As a result, competition among water users escalates in crucial areas, heightening the likelihood of significant conflicts, especially between early and late developers of transboundary water resources (Zhao et al. 2022). In this paper, an attempt is made to identify regions where such conflicts have caused regional instability and inequitable distribution of water resource benefits among one or more countries.

2. Transboundary Issues

International transboundary water conflicts arise when two or more countries share ground or surface water resources (Kliot et al. 2001, Zeitoun and Warner 2003, Seligman and Peterson 2008). Currently, there are 280 transboundary river basins covering about 45.3% of the earth's land surface and populated by about 40% of the world's population (Wolf 1998, Wolf 2000, Kliot et al. 2001, Wolf 2007, Swain 2008)). These water basins are essential sources of water supply for a significant percentage of people worldwide and are managed by multiple jurisdictions. Since the 1950s, more than 200 international treaties and agreements have been signed to resolve issues associated with water management (ITD 2010).

Despite the existence of over 200 international treaties and agreements, population growth has led to increased demand for water, resulting in renewed conflicts between nations (e.g., between Egypt-Sudan, U.S.-Mexico, Israel-Palestine), but has also led to difficulty in managing water resources in these basins. Effective management of basins can be challenging due to various factors such as (1) the vast scale of the basins and multiple countries involved in the management process, (2) absence of endorsed strategies and policies delineating the sanctioned utilization of these river basins, (3) growing scarcity of water caused by population growth and high demand, (4) uneven distribution of water due to climate and hydrologic conditions, (5) misuse of water due to competing national interests, and (6) the relative power and histories of the countries involved. Additionally, lack of approved plans and policies and limited access to alternative freshwater sources can also hinder effective basin management (Peter 1993, Kliot et al. 2001, Uitto and Duda 2002). Apart from the issues mentioned above, more powerful nations usually acquire water resources through various means, such as taking over land or constructing extensive hydraulic projects like dams and hydro-power stations on rivers. They may also use containment tactics by issuing economic sanctions or political isolation, creating vague treaties, or encouraging shared control of these resources. Military and economic means are also employed by stronger countries, either by providing financial aid or threatening weaker nations to gain control of water resources (Zeitoun and Warner 2006). The governance of transboundary waters is a highly intricate process, often complicated by tense relations and technocratic water management. Consequently, managing Transboundary Rivers in South and Southeast Asia is anticipated to grow increasingly intricate owing to shifts in the geopolitical landscape (Williams 2022).

While water distribution has not been a significant cause of conflicts in recent times, disputes over water resources and the inadequacy of treaties to efficiently manage and distribute these resources can lead to regional instability. The subsequent sections offer an overview of water disputes in both the eastern and western hemispheres that have garnered attention in recent years, as the demand for water resources has risen. The labels of "winners" and "losers" are assigned based on the participants' historical use of shared water resources, as well as how much they have benefited disproportionately.

2.1. Losers/winners in the eastern hemisphere

The Indus River System (Fig. 1) the Ganges-Brahmaputra-Meghna (GBM) River System (Fig. 2), and the Mekong River System (Fig. 3) are the three main international water basins related to long-term water conflicts in the south and

southeast Asia. These basins are located in dry (Indus River) and temperate (GBM) climate and their annual runoff is dependent upon glacial melt from the Himalayas/Karakorum and annual rainfall during the monsoon season (June-October) in India, Pakistan, Bangladesh and the lower Mekong basin. The presence of some of the world's most heavily populated countries (e.g., India and China) in the basin, the creation of two new countries (Pakistan and Bangladesh; formerly East Pakistan), climate change, and reliance of all countries on the river basins for their fresh water supply and economic development, are some of the major factors responsible for long term conflicts and water disputes in the basins.

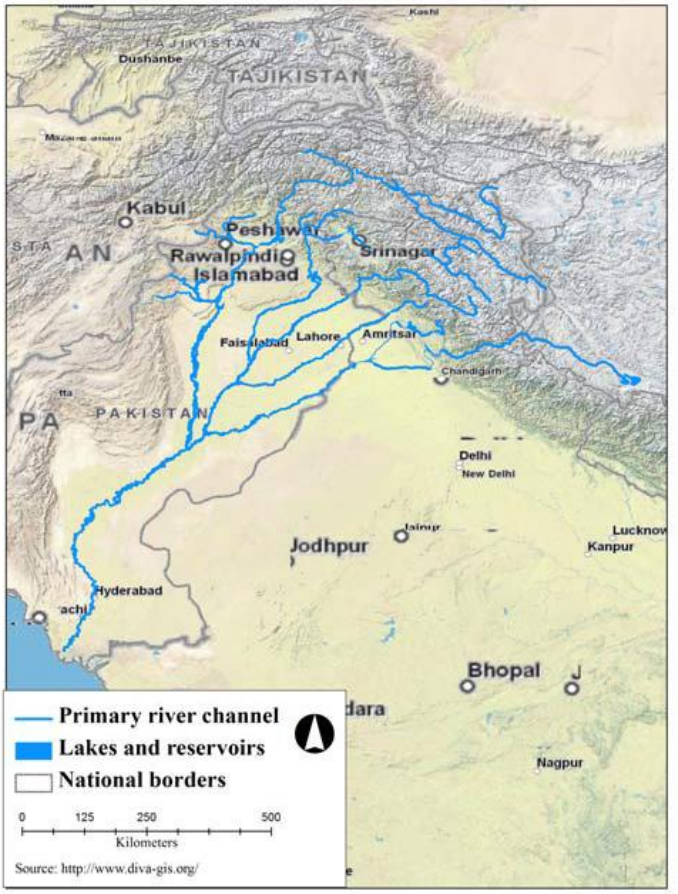

Figure 1. Indus River System.

Indus River System: Historically, the Indus basin (Fig. 1) was once an arid pastoral watershed, but in the 20th century, it was transformed into one of the world's most heavily irrigated and populated river basins. Drastic changes have occurred in the basin because of the implementation of the world's largest modern

integrated irrigation system. The irrigation project was launched by British colonial rule in the 19th century, which spurred political, social, and environmental transformations that continued after India and Pakistan were created in 1947 (Gilmartin 2020).

The Indus River System comprises the Indus River (2800 km long) and its five east-flowing tributaries, the Kabul River, and the Swat River (Seligman and Peterson 2008, Wolf 2009). The Indus River originates in the Tibetan Himalayas and flows through India and Pakistan before emptying into the Arabian Sea. The Kabul River begins in Afghanistan and flows through Kabul before joining the Indus River in Pakistan. Afghanistan and Pakistan are two nations that share the waters of seven rivers, of which the most significant is the Kabul River, stretching over 700 km. The river originates in the Hindu Kush Mountains of Afghanistan and receives substantial flows from the Kunar/Chitral River in Pakistan. This river is of significant importance to both countries due to its immense contribution to their economy and livelihoods. The Kunar River starts as the Mastuj River in Chitral in Pakistan and contributes about 75% of the flow in the Kabul River. Kunar River joins the Kabul River near Jalalabad, Afghanistan and continues to flow as the Kabul River. The Kabul River, originating in Afghanistan, traverses Pakistan's Khyber Pakhtunkhwa province for 140 kilometers before ultimately joining the Indus at Attock near the Punjab border. The river significantly contributes over 16 million acre-feet of water to the Indus River, with Pakistan serving as both the upper and lower riparian of the Kabul River. Other shared rivers, including the Kurram, Gomal, and Shamil/Kaitu, flow into Parachinar and the South and North Waziristan districts of Khyber Pakhtunkhwa from the Afghan provinces of Paktia, Ghazni, and Khost. The Chitral/Kunar River is a major contributor to the Indus River's water flow, further emphasizing Pakistan's importance as a riparian state (Kakakhel 2018).

The Indus River basin is about 1.1 million km^2 in size, with a water discharge rate of 15 million km^3/year, and is occupied by Afghanistan, Pakistan, India, Tibet, China, and Nepal (Seligman and Peterson 2008, Wolf 2009). The basin has been a source of disputes between India and Pakistan since the independence of India and the creation of Pakistan in 1947, because (1) Pakistan and India occupy 86% of the basin, (2) The river system plays a crucial role as a principal source of irrigation water and generator of hydro-electric power in both countries, and (3) India is the upper riparian nation with more control on water management and usage. The regulation of the Indus and Kabul Rivers is inadequate, as evidenced by the catastrophic floods that have occurred in Pakistan in recent years. The floods of 2010 and 2022 caused significant devastation, resulting in the loss of nearly 4,500

lives, the displacement of 21 million people, and total damages estimated at 43 billion US dollars. The severity of these floods highlights the need for improved river management strategies and flood control measures to mitigate the risks associated with these natural disasters.

The first conflict started immediately after India's independence in 1947, when India decided to close down canals on the Ravi and Sutlej Rivers (two of the five tributaries of the Indus River) by cutting off the water supply to the arable lands in Pakistan (CCN 2008; Wolf 2009). Since then, after going through 10 years of numerous failed agreements and negotiations, both India and Pakistan signed the Indus Water Treaty in 1960, under the World Bank supervision (Wolf 1998, Haftendorn 2000, Wolf 2000, Kliot et al. 2001, Wolf 2007, Seligman and Peterson 2008, Rahaman 2009, Wolf 2009). Under the terms of the treaty, Pakistan and India were granted unimpeded access to the three Western Rivers (Indus, Jhelum, and Chenab) and three Eastern Rivers (Sutlej, Ravi, and Beas) respectively. Additionally, a two-member Permanent Indus Commission was established, with one representative from India and one from Pakistan. The commission is responsible for ensuring that neither country interferes with the other's use and management of water from the river system. A key objective of this agreement is to facilitate the sharing of tributaries within the river basin between the two nations (Wolf 1998, Kliot et al. 2001, Wolf 2007, Seligman and Peterson 2008, Wolf 2009). One significant postulation of this agreement is to facilitate the sharing of tributaries within the river basin between the two nations. The construction of the Baglihar dam on the Chenab River by India in 1999 (without input from Pakistan) led to another set of disputes. The disputes were finally resolved in 2007, again, with the intervention of the World Bank (Seligman and Peterson 2008). Groundwater studies in the Indus River basin are scanty and recent studies show a decline in groundwater levels (Mehmood et al. 2022).

Because both countries want to avoid interdependence, they have abided by the Indus Water Treaty. Nevertheless, because both countries rely on this basin for their social and economic development, with significant population growth in both countries, this river basin is still the cause of conflicts, and it is also ravaged by natural disasters. The 2010 flooding of Pakistan is an example of the problem of the construction of dams and canals by India the upstreams of the Indus River and its tributaries. Thus, it can be deduced that both India and Pakistan have emerged victorious under the aforementioned agreement. However, Pakistan, being the lower riparian nation of the basin, has considerably more at stake. The other countries, Tibet, China, Afghanistan and Nepal, never participated in any agreement/negotiations/treaties because they have largely been ignored from

negotiations as they occupy only 14% of the river basin, and they are the upstream countries for both the Indus and Kabul Rivers.

***Ganges River Basin**:* The Ganges River basin (Fig. 2) also known as the Ganges-Brahmaputra-Meghna (GBM) River System, consists of the Ganges (2525 km long), Brahmaputra (2900 km long), and Meghna Rivers (Sarkar et al. 2007, Seligman and Peterson 2008, Rahaman 2009, Wolf 2009). The longest river, the Ganges, after originating in the Higher Himalayas flows through India in the southeast into Bangladesh (CCN 2008; Wolf 2009).

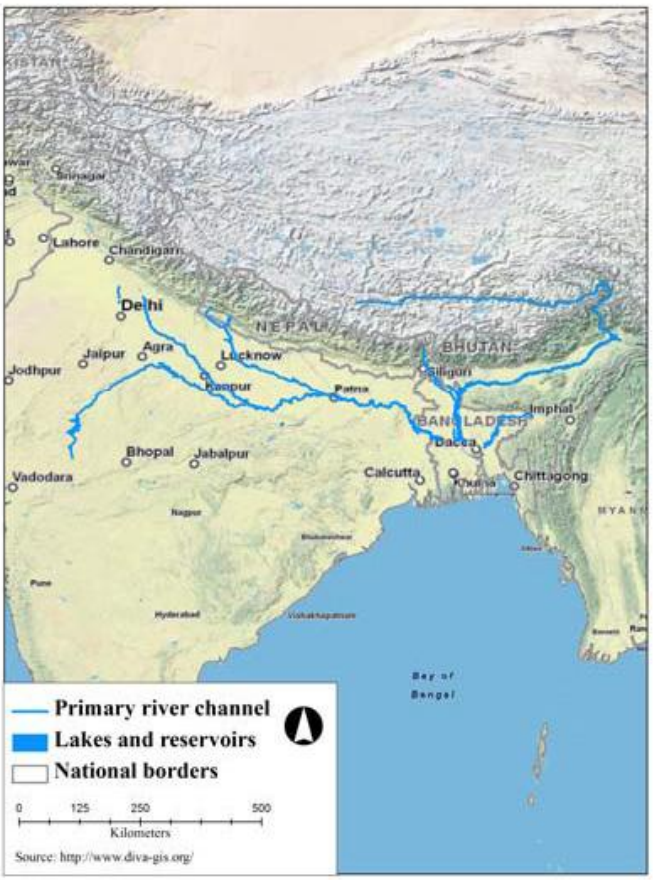

Figure 2. Ganges-Brahmaputra-Meghna (GBM) River System.

The second longest river, Brahmaputra, originates in Tibet and flows through China into India and then Bangladesh before joining the Ganges River (Seligman and Peterson 2008, Wolf 2009). The combined Ganges and Brahmaputra Rivers (known as Padma River in Bangladesh), are joined by the Meghna River, which originates in Bangladesh, and eventually, all three rivers empty into the Bay of

Bengal (Seligman and Peterson 2008, Wolf 2009). Through their entire course, the rivers flow through India, China, Nepal, Bangladesh, Bhutan and Myanmar (Seligman and Peterson 2008, Rahaman 2009, Wolf 2009). The catchment area of the river basin is about 1 million km^2 with an annual average discharge of 38,525 m^3/s (Sarkar et al. 2007, Seligman and Peterson 2008, Rahaman 2009, Wolf 2009). Though 60% of the annual discharge of the river basin is contributed by Nepal, India occupies 58% of the basin followed by China and Nepal, which occupy 20% and 9% of the basin respectively (Seligman and Peterson 2008). Since the 1950s, the basin has been the source of controversies and conflicts among all countries because of water scarcity, severe flooding, pollution and salinization of fresh water (Wolf 2009).

The first conflict started between India and Pakistan with India's unilateral decision to build the Farakka Barrage dam in upstream Ganges in West Bengal to divert water from the Ganges River to the Houghly River to maintain its navigability (Wolf 1998, Wolf 2000, Kliot et al. 2001, Sarkar et al. 2007, Wolf 2007, Seligman and Peterson 2008, Wolf 2009). The Farakka Barrage dam started its operation in 1975 by diverting large quantities of water from the Ganges river away from Bangladesh to Calcutta, thereby causing water shortages in Bangladesh during the dry season (march - June) and deluge during the rainy season (June - November) (Wolf 1998, Wolf 2000, Wolf 2007, Seligman and Peterson 2008). The diversion of water contributed to significant financial losses in Bangladesh. The lack of water supplies disrupted agriculture, fisheries, navigation and other economic and development activities (Wolf 1998).

Throughout the construction of the Farakka dam (1960 – 1970), India and Pakistan held several unsuccessful meetings to resolve water management and supply conflicts. After the creation of Bangladesh in 1971, India and Bangladesh finally decided to establish the Indo-Bangladesh Joint Rivers Commission in 1972, which failed to resolve the water allocation problem between the two countries. After almost 30 years of contention and because of Bangladesh's failure to convince India to provide more water from the upstream river, both countries signed the Ganges Water Treaty in 1996, which is effective until 2026 (Haftendorn 2000, Kliot et al. 2001, Sarkar et al. 2007, Wolf 2007, Seligman and Peterson 2008, Rahaman 2009, Wolf 2009). The treaty specifically addresses water allocation between both countries using a specific formula (Seligman and Peterson 2008); (Kliot et al. 2001).

India has also signed three treaties with Nepal. The first agreement was signed in 1954 when both India and Nepal consented to the construction of a dam on the

Kosi River, which is part of the GBM basin and originates in Tibet and flows through Nepal into India. An Indo-Nepal Kosi Project commission is responsible for renewing the treaty and resolving conflicts between India and Nepal (Seligman and Peterson 2008). The second treaty was signed in 1959 to build a dam on the Gandaki River, which also originates in Tibet and flows through Nepal into India. The third treaty is the Makhali Treaty which was signed in 1996 and requires both countries to consult each other before implementing any construction projects on the Makhali River, which borders Nepal and India (Seligman and Peterson 2008, Rahaman 2009, Wolf 2009). The goals of these treaties are to control flooding, ensure adequate irrigation, and share hydroelectricity generated by either country.

It is relevant to mention that (1) no treaty was signed with China and Tibet due to their presence in upstream of the GBM basin; (2) being present in downstream of the Ganges, Makhali, Kosi and Gandaki Rivers, India signed three treaties with Nepal to share water available in the basin; (3) because of its upstream existence, India exploits water available in the Brahmaputra River to a greater extent; and (4) Bangladesh suffers a lot both socially and economically due to its reliance on Brahmaputra River and its downstream presence in the river basin. Bangladesh is on the losing side in South Asia.

The Sino-Indian water disputes within the Ganges-Brahmaputra-Meghna (GBM) basin have become increasingly complex due to the erosion of trust caused by China's apparent vested interests in water diplomacy. In addition to pursuing economic gains, such as the generation of hydropower, the Chinese government aims to safeguard its strategic interests by dominating hydrological data and water policy information. Such interests could potentially impede foreign relations unless extensive collaborative efforts to share water resources are undertaken (Xie et al. 2018).

Mekong River System: The Mekong River basin is a geographical area formed by the Mekong River, which originates from the Tibetan Himalayas. This river spans a distance of approximately 4,350 kilometers and traverses through China before reaching its lower basin in Vietnam (Fig. 3). The Mekong River basin is a significant region that is vital to the economies and livelihoods of millions of people in the surrounding areas. It is characterized by diverse topography, drainage patterns and geomorphology. The drainage area of the basin is about 806,000 km^2 with an annual average discharge of 11,030 m^3/s. The basin is occupied by China, Myanmar, Thailand, Laos, Cambodia, and Vietnam (Van Zalinge et al. 2004, Lu and Siew 2006, Kummu and Varis 2007, Le et al. 2007, Seligman and Peterson 2008, Wolf 2009).

The Mekong River basin, situated across several countries, has not been a source of severe discord among them. However, the treaties signed in relation to the river basin have created issues in recent decades. China, being one of the upper basin countries, has been constructing dams for several years to increase its hydroelectric capability, and has refrained from participating in the 1957 Mekong Agreement, the 1975 Joint Declaration, or the 1995 Mekong River Agreement (Kliot et al. 2001, Van Zalinge et al. 2004, Lebel et al. 2005, Lu and Siew 2006, Sneddon and Fox 2006, Kummu and Varis 2007, Le et al. 2007, Wolf 2007, Seligman and Peterson 2008, Rahaman 2009, Wolf 2009). In 1995, a multilateral agreement was signed by the four lower basin countries, namely Thailand, Laos, Cambodia, and Vietnam, to establish the Mekong River Commission (MRC). The commission consists of members from each of the aforementioned countries, while China and Myanmar agreed to consult with the committee. The main objective of the committee is to decide on water usage for various purposes such as irrigation, hydropower, navigation, flood control, fisheries, tourism, and water management, among others. This is due to the fact that the member countries have different water usage requirements in the river basin. In addition, the committee ensures that the involved countries consult with each other regarding the use of water and sign agreements (Van Zalinge et al. 2004, Lebel et al. 2005, Lu and Siew 2006, Sneddon and Fox 2006, Kummu and Varis 2007, Seligman and Peterson 2008, Wolf 2009). As per the 1957 agreement, Thailand funded Laos to build a hydroelectric project in exchange for a portion of the generated power (Wolf 1998). The MRC agreement also has a clause that allows countries to build dams for power generation but does not provide any guidelines about water usage during drought conditions and prolonged dry seasons (Kliot et al. 2001, Van Zalinge et al. 2004, Sneddon and Fox 2006).

Other agreements include the Greater Mekong Sub-region Cooperation (GMS) established in 1992 with the help of the World Bank; the Association of South East Asian Nations (ASEAN) of 1967 that now comprises Indonesia, Malaysia, the Philippines, Singapore and Thailand (five original members) along with Japan, China and Korea; the China-ASEAN Free Trade Area (CAFTA) of 2002 between China and ASEAN countries. The major focus of all these agreements is to encourage cooperation among all nations so that water usage, and development projects, such as hydroelectricity generation, and tourism, can be coordinated (Wolf 2009).

Evidently, China and Myanmar neither signed the 1957 Mekong Agreement nor the 1995 Mekong River Agreement. The creation of the MRC definitely helped lower river basin countries to manage water usage for their own developmental

projects. The creation of CAFTA has aided in the inclusion of all participants present in the basin except Myanmar, thereby enabling the implementation of a holistic approach to the transboundary problem, especially in the context of using water for the economic development of each country.

Figure 3. Mekong River System.

In recent times, the construction of hydroelectric facilities and dams in the upper Mekong basin has led to disputes between states in the upper and lower basin. Consequently, it appears that China has gained the upper hand in this conflict. The surge in the construction of such facilities has generated a significant impact on the region's hydrology, environment, and water resources. As a result, the dispute

has become a matter of concern and has garnered the attention of various stakeholders, including policymakers, academics, and industry experts. The conflict has highlighted the need for better management and coordination among the states involved in the upper and lower Mekong basin. Implementing effective policies and strategies that promote sustainable development and cooperation could help mitigate the negative impact of such construction activities and resolve ongoing disputes.

2.1.1. Middle East

Fresh water availability has been the cause of discord in the Middle East for centuries. The main factors contributing to this discord are (1) the presence of this region in arid and semi-arid climate; (2) lack of access to alternative water sources other than existing river basins, and aquifers and (3) sharing of existing water sources among multiple countries with varying degrees of need due to geo-political and socio-economic conditions. The two major river basins that have drawn international attention due to transboundary conflicts, the Jordan-Yarmouk River basin and the Tigris-Euphrates River basin, are discussed in this section.

Tigris-Euphrates Rivers*:* The Tigris-Euphrates River basin comprises the Tigris (1,900 km long) and Euphrates (2,800 km long) Rivers (Fig. 4). The river basin has a drainage area of approximately 789,000 km^2, and an annual average discharge is 1,441 mcm (Seligman and Peterson 2008); (Wolf 2009). The river basin is occupied by Iraq, Turkey, Iran, Syria, Jordan and Saudi Arabia of which 60% is occupied by Iraq and Iran. After originating in Turkey, the Euphrates River flows into Syria and then enters Iraq. The Tigris River takes a different path by forming the border with Syria and then flows into Iraq where it meets the Euphrates. The combined Tigris-Euphrates River (200 km long) forms the border between Iraq and Iran.

Turkey is the main contributor of water in both the Tigris and Euphrates Rivers, which also occupy the upper portion of the basin. These rivers are the main source of irrigation water for Iraq and they also provide Iraq its access through the Persian Gulf to the Arabian Sea for oil shipment (Seligman and Peterson 2008). Turkey, Iraq and Syria rely on these rivers for their hydroelectricity generation as well. As each of these three countries relies heavily on the rivers for their socio-economic development, this basin has been the cause of disputes among these three countries for decades. During the 1960s, the three countries negotiated water allocation from these rivers with the help of the then-Soviet Union. With significant population growth and climate change, unilateral decisions taken by each country to build dams, such as, Keban Dam by Turkey (1965 – 73) and Al-Tabka Dam by Syria

(1968 – 73) on the Euphrates River has reduced the downstream flow of the water into Iraq, thereby leading to intense hydro-political tension among these three countries. The first conflict started in 1975 after the completion of the Tabqa Dam, when Iraq and Syria were on the verge of war. The conflict was deflated by Saudi Arabia's intervention, and both countries agreed to an interim allocation of water (Peter 1993, Seligman and Peterson 2008, Wolf 2009). The water allocation formula of 1975 was finalized in 1989. In this bilateral agreement, it was decided that 42% of the water from the Euphrates River would be allocated to Syria, while Iraq would receive the remaining 58% (Seligman and Peterson 2008, Wolf 2009).

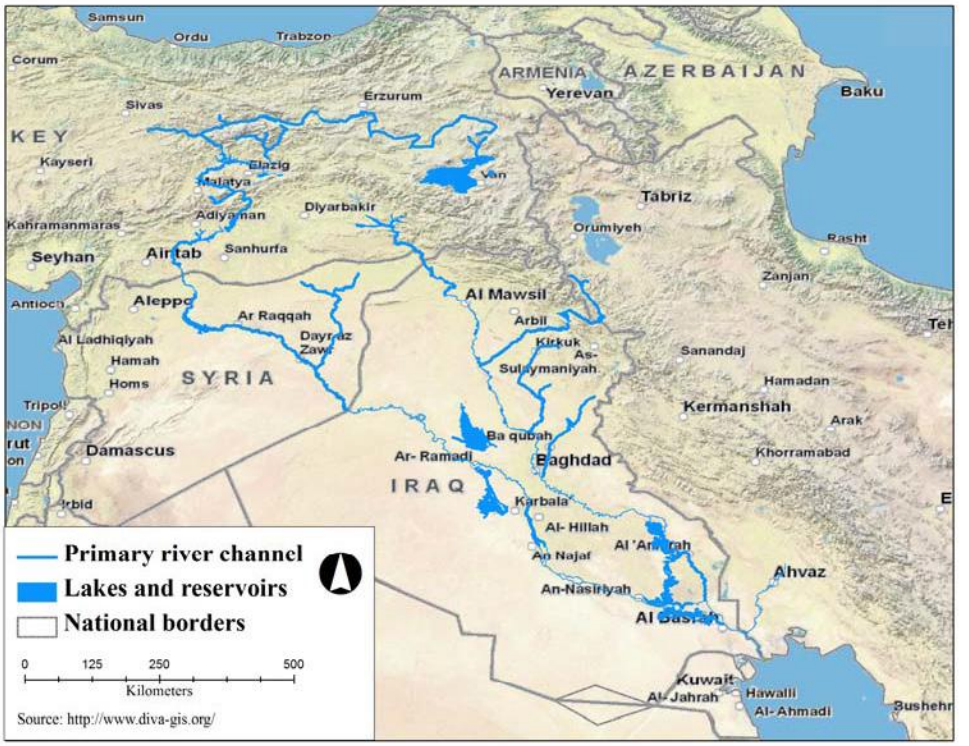

Figure 4. Tigris-Euphrates River basin.

In 1946, Iraq and Turkey entered into a formal agreement that focused on the technical aspects of dam construction rather than the apportionment of water. The agreement was aimed at developing a sustainable framework for the construction of dams in the region. The focus of the agreement was on ensuring that the technical aspects of dam construction were carried out in a manner that would ensure their effectiveness and longevity. The agreement was signed to promote

regional stability and cooperation. In 1980, Turkey and Iraq launched the Joint Technical Committee on Regional Waters, which was joined by Syria in 1983. The committee is responsible for resolving transboundary water issues. The committee's existence appears to have more of an official than practical role in addressing water disputes. Participation in the committee is voluntary, and the last effort to convene a multilateral meeting was undertaken in 1992 (Seligman and Peterson 2008); (Wolf 2009). In 1987, the Syrian and Turkish governments entered into an agreement that stipulated Turkey to provide 50% of the annual flow of the Euphrates River to Syria. This agreement, commonly known as the "Euphrates-Tigris Agreement," was an attempt to address the water resource challenges faced by both countries. The agreement was aimed at ensuring equitable and reasonable use of the Euphrates waters by both nations. The treaty has since been a crucial element in the bilateral relations between the two countries (Wolf 2009). Other treaties and agreements that have been signed by the basin nations include the 1937 treaty and 1975 agreement (i.e. the Algiers Accord) between Iraq and Iran to resolve border disputes as well as navigation rights. The failure of these agreements to resolve conflicts led to an eight-year war between Iran and Iraq in 1980, which came to an end in 1988 with Iraq accepting the border established by the 1975 agreement (Seligman and Peterson 2008).

Among the three countries (Iraq, Turkey and Syria), Turkey outshines by receiving more precipitation and internal water sources. Additionally, Turkey controls the upstream portion of the river basin, while Syria struggles to meet its basic water needs due to a lack of resources. Turkey's GAP (Southeastern Grand Anatolia Project), which involves the construction of 22 dams for irrigation and hydroelectricity generation, has created ongoing conflicts between the three countries since 1996 (Wolf 2009). Despite these tensions, Turkey seems to be the winner of this conflict. However, as Turkey's population grows and its Grand Anatolia Project on the Euphrates River gains steam, all three nations must reach a transboundary agreement to prevent future tensions.

Jordan-Yarmouk River Basin: The Jordan River basin is comprised of the Jordan and Yarmouk Rivers, as illustrated in Fig. 5. This basin is situated in the modern-day territories of Israel, the Kingdom of Jordan, Lebanon, Syria, Palestine (West Bank and Gaza), Egypt, and Golan Heights (Libiszewski 1995, Dolatyar and Gray 2000, Mimi and Sawalhi 2003, Seligman and Peterson 2008, Wolf 2009). The drainage area of the basin including all its tributaries is about 18,300 km^2, of which 80% is occupied by Israel, Jordan and Palestine (Libiszewski 1995, Seligman and Peterson 2008, Wolf 2009). The natural discharge of the basin is about 1,500 mcm, which varies according to the prevailing climatic conditions (Mimi and Sawalhi

2003). For instance, the river basin's annual flow reduces to 40% of its actual capacity during February, which then reduces to 3- 4% during the summer months thereby leading to more strenuous situations among countries relying on this basin for their water supply (Libiszewski 1995). The Upper Jordan basin comprises the Jordan River and its tributaries (Dan, Hasbani, and Banias) and flows through Southern Lebanon and most of northern Israel before emptying into Lake Tiberias (Libiszewski 1995). The lower Jordan is formed by the Yarmouk River and its main tributary Zarqa River among others, and flows through the Syria-Jordan border, Golan Heights, Israel and West Bank before converging in the Dead Sea ((Libiszewski 1995); Fig. 5).

Major water disputes in this region started after the UN's forces withdrew in 1948. After World War II, every country decided to implement its unilateral plan to draw and use water from the Jordan-Yarmouk Rivers and Mountain Aquifer (Mukhar 2006). Since then, the river basin has been the cause of numerous wars and treaties among the three riparian countries (Israel, Jordan and Palestine).

In 1953, Israel made public its National Water Career Plan to integrate water from various sources and divert them to needed areas (Libiszewski 1995, Mukhar 2006). The first part of the project required diverting water from the Jordan River to Israel's coastal plains and Negev desert (Libiszewski 1995, Mukhar 2006); (Seligman and Peterson 2008). Since its implementation in 1964, the National Water Career has been diverting annually about 420-450 mcm of water from the Upper Jordan basin to Israel (Mekorot 2011). In 1953, Jordan and the U.N. Relief and Works Agency for Palestine Refugees (UNRWA) signed an agreement to build two dams on the Yarmouk River for irrigation in Syria and Jordan (Libiszewski 1995, Mukhar 2006). As a result of border skirmishes between Israel and Syria, Johnston Unified Plan was formulated in 1955 with the help of the US (Wolf 1993, Libiszewski 1995, Mukhar 2006, Wolf 2007, Seligman and Peterson 2008, Wolf 2009). The Johnston plan proposed a formula to distribute the Jordan River's water among Israel, Jordan, Palestine and Syria. The plan was rejected by the Arab League (Jordan, Lebanon, Syria, and Egypt). Israel and Jordan, however, followed the plan to draw water from the Jordan River until 1967 (Seligman and Peterson 2008, Wolf 2009).

In the 1960s, Syria's attempt to divert Jordan River water and the Arab League's decision to build dams on the Yarmouk River without Israel's consent, gave rise to the Six-Day War of 1967 (Wolf 2009); (Wolf 1993); (Haftendorn 2000); (Dolatyar and Gray 2000); (Mukhar 2006); (Libiszewski 1995); (Seligman and Peterson 2008). By the end of the war with the UN's intervention, Israel had

occupied the headwaters of the Jordan River, the West Bank, Golan Heights and the Gaza Strip, which currently supply one-third of Israel's fresh water supply (Wolf 1993, Libiszewski 1995, Seligman and Peterson 2008, Wolf 2009). Israel's concern regarding the availability of water resources played a role in its military intervention in southern Lebanon twice, first in 1978 and again in 1982. During the latter intervention, Israel aimed to establish control over the region and maintain it until 2000. This strategic move was motivated by Israel's desire to secure its access to water resources, which it perceived as being under threat (Wolf 2009). In 2002, Lebanon embarked on an irrigation project, which was met with strong disapproval from the Israeli government. The Israeli government alleged that the project was a "pretext of war" and this assertion had far-reaching implications. Under pressure from the United Nations and the United States, Lebanon was compelled to abandon its efforts. The Israeli government's objections were significant in that they undermined the legitimacy of Lebanon's initiative and had a chilling effect on the country's efforts to develop its agricultural sector (Wolf 2009). Despite a history of ongoing conflicts, no formal agreement or treaty has been established between Israel and Lebanon regarding access, usage, and management of the Jordan River's water resources.

The 1953's decision of Jordan and Syria to build two dams to draw water from the Yarmouk River was also never accomplished due to a lack of funding and Israel's political opposition (Seligman and Peterson 2008). However, Israel and Syria were drawing water from the river since 1950s. After occupying the Golan Heights in 1970s, Israel started extracting about 100 mcm of water annually from the Yarmouk River. This move led to more disputes between Israel and Jordan (Libiszewski 1995). To avoid this contentious situation, Israel and Jordan signed the Treaty of Peace in 1994, in which a Joint Water Committee was established to resolve the water disputes between the two countries. The treaty (1) allows Israel to withdraw 12 mcm and 13mcm from the Yarmouk in summer and winter respectively, and an extra 20mcm in winter from the Yarmouk; (2) requires Israel to provide 20mcm in summer from Lake Kinneret (the Sea of Galilee) and 10 mcm in winter to Jordan; and (3) guarantees Jordan about 215 mcm annually (Libiszewski 1995, Haftendorn 2000, Kliot et al. 2001, Mimi and Sawalhi 2003, Fischhendler 2004, Mukhar 2006, Zeitoun and Warner 2006, Seligman and Peterson 2008).

Figure 5. Jordan River basin.

Both Israel and Jordan reached another agreement in 1997 that required Israel to deliver an additional 25 – 30 mcm from Lake Kinneret to Jordan (Fischhendler 2004). So far, Israel has been following this agreement to avoid any disputes. In 1987, Jordan and Syria signed another treaty to build the al-Wahada dam on the Yarmouk River, which finally led to the signing of the 1997 bilateral Wahidya Dam agreement whose construction was completed in 2005. The treaty allows

Syria to build small dams upstream for its own benefit and provides 80 mcm more water to Jordan (Libiszewski 1995, Seligman and Peterson 2008, Wolf 2009).

The most notable conflict in the Jordan River basin exists between Israel and Palestine. The area under conflict includes Israel, the West Bank and the Gaza Strip, and involves drawing water other than the Jordan River from the Mountain aquifer. This aquifer originates in the West Bank and covers the Palestinian Territory and part of Israeli territory. In contrast to Israel, which employs a range of water sources to fulfill its requirements, Palestinian municipalities situated in the West Bank rely overwhelmingly on groundwater to satisfy 90% of their needs (Seligman and Peterson 2008); (Libiszewski 1995). Increasing salinity of the Jordan River water in its lower portion also forces both Israeli and Palestinian settlers in this region to rely on underground water from the aquifers. Due to the deterioration of the coastal aquifers of Israel, and water from the mountain aquifer being of good quality, Israel has increased its tapping of this aquifer. Israel has also constructed a wall that prevents Palestinian access to groundwater, and started construction of the Kedumim quarry landfill that can pollute groundwater sources for the West Bank inhabitants (Wolf 2009); (Dolatyar and Gray 2000). The end result is a volatile situation between the two states, which is fueled by the ongoing geopolitical situation. In 1993, both nations expressed mutual agreement in the form of the Declaration of Principles. Two years later, the Oslo II agreement was signed as an interim measure. (Libiszewski 1995, Haftendorn 2000, Mukhar 2006, Zeitoun and Warner 2006, Wolf 2007, Seligman and Peterson 2008, Wolf 2009). According to Annex III of the Oslo II agreement, a Joint Waters Committee was established with the purpose of managing water resources and devising policies to safeguard them against pollution. The Committee is vested with the authority to oversee the implementation of measures aimed at regulating water usage and promoting sustainable water management practices. By virtue of its mandate, the Committee plays a pivotal role in ensuring the effective management and protection of water resources within the scope of the Oslo II agreement. Despite these agreements, both countries remain at odds about water rights.

Several treaties have been signed between Israel and Jordan, Israel and the Palestinian Authority, and Jordan and Syria. Israel and Syria, and Israel and Lebanon never signed any formal treaty or agreement to deal with the problem of drawing water from the Jordan-Yarmouk River (Seligman and Peterson 2008, Wolf 2009). It appears that Israel is the only country in this region that benefits the most from its encroachment of the Golan Heights, the West Bank and the Gaza Strip, and controls 90% of water resources through its access to both the Jordan and Yarmouk Rivers and underground aquifers (Zeitoun and Warner 2006). As

Jordan is the poorest country in water resources, Jordan appears to be the loser in its conflict with Syria. With access to only underground waters and transboundary issues, Palestine appears to be the country with a lot at stake. Rapid population growth due to immigration and refugee movement in the entire basin will result in a projected population is 46.3 million for 2015, about 31% growth from the 1998 population (Mimi and Sawalhi 2003). The geopolitical situation and climate change in this region are contributing to the reduction in river flows, declining water tables, an increase in polluted water in the lower portion of the river basin, and in general an increase in water stress thereby leading to volatile relationships among countries.

2.1.2. Africa

Tropical monsoons have been the major source of water in Africa. However, in recent years, like the Middle East, Africa is suffering from a lack of freshwater supply due to long-term droughts in Ethiopia and Sudan, and severe climate changes. This water scarcity combined with (1) lack of alternative source of water supply; (2) rapid population growth in all countries and a concomitant increase in overall poverty (e.g. Ethiopia, Sudan); (3) reliance of arid downstream nations like Egypt on river basins; (4) construction of dams to channelize water flow; (5) intra-national geo-political problems within countries, like civil unrest in Sudan, Ethiopia, Egypt, and Eritrea; and (6) finally, long term famine in Ethiopia and Sudan, are contributing to severe trans-boundary conflicts. A discussion of the major water disputes in the Nile River basin, a major source of water for 10 countries in Africa, is presented in the following section. ***Nile River:*** The Nile River, the longest river in the world (6,650 km), comprises two main tributaries: the Blue Nile (originates in Ethiopia) and the White Nile flows from Lake Victoria (Fig. 6) (Seligman and Peterson 2008, Swain 2008, Teshome 2008, Cascão 2009, Wolf 2009). Both tributaries join in Sudan before flowing through Egypt into the Mediterranean Sea. The basin encompasses an area of about 3.3 million km^2 with an average annual discharge of 2,832 m^3/s and is home to about 160 million people. Of the 10 nations the Nile River flows through, the upstream nations (Sudan, Ethiopia, Uganda and Tanzania) occupy 88% of the river basin, and the rest of the six downstream countries (Egypt, Kenya, Congo, Rwanda, Burundi and Eritrea) occupies 12% of the basin (Seligman and Peterson 2008). Lake Victoria is the main source of water for the river. Other than Lake Victoria, Ethiopia, which occupies 12% of the river basin, is a major contributor of water for the river. Sudan occupies 64% of the river basin, and Egypt occupies 9% of the river basin but relies on the river for its fresh water supply. The most notable tensions exist among Egypt (the

downstream nation with an arid climate), Sudan and Ethiopia (upstream nations contributing to river flow) for centuries.

During the period from 1891 to 1925, under the rule of the British Colonial administration, a series of five treaties were signed which forbade the construction of dams and canals on the Nile and its tributaries by Ethiopia, Congo, and other countries. The purpose of these treaties was to ensure that Egypt would have access to the water resources of the Nile (Seligman and Peterson 2008). Since the 1880s, Egypt has constructed several dams to preserve its water reserves. These structures serve as an essential component of the country's water management strategy, enabling it to maintain a steady supply of water for its population and agricultural sector. The construction of these dams has allowed Egypt to mitigate the impacts of water scarcity and drought, which are common challenges in the region. Overall, Egypt's investment in water infrastructure has been a critical factor in ensuring its sustainable development and prosperity. The treaties signed during British rule did not account for the allocation of water among countries. In 1929, the UK and Egypt signed a treaty assigning 48 billion cubic meters (BCM) of water per annum to Egypt and 4 BCM per annum to Sudan (Kliot et al. 2001, Seligman and Peterson 2008, Teshome 2008, Cascão 2009). Subsequently, several treaties were signed obliterating the uneven allocation of water between Egypt and the rest of the countries in the basin. Britain and Egypt signed several treaties between 1949 – 1953 allowing the construction of Owens Fall Dam in Uganda. In 1959, Sudan and Egypt signed the Nile Waters Treaty that allowed Egypt and Sudan to receive 55.5 BCM and 18.5 BCM water from the river basin, respectively (Wolf 1998, Kliot et al. 2001, Zeitoun and Warner 2006, Seligman and Peterson 2008, Teshome 2008, Cascão 2009, Wolf 2009). According to the treaty, the Permanent Joint Technical Committee was created to supervise the construction of new projects in the basin. The treaty also enabled the construction of the Aswan High Dam in Egypt and limited the water supply for upstream countries to 1-2 BCM per year. During the signing of the treaty, Ethiopia was never consulted.

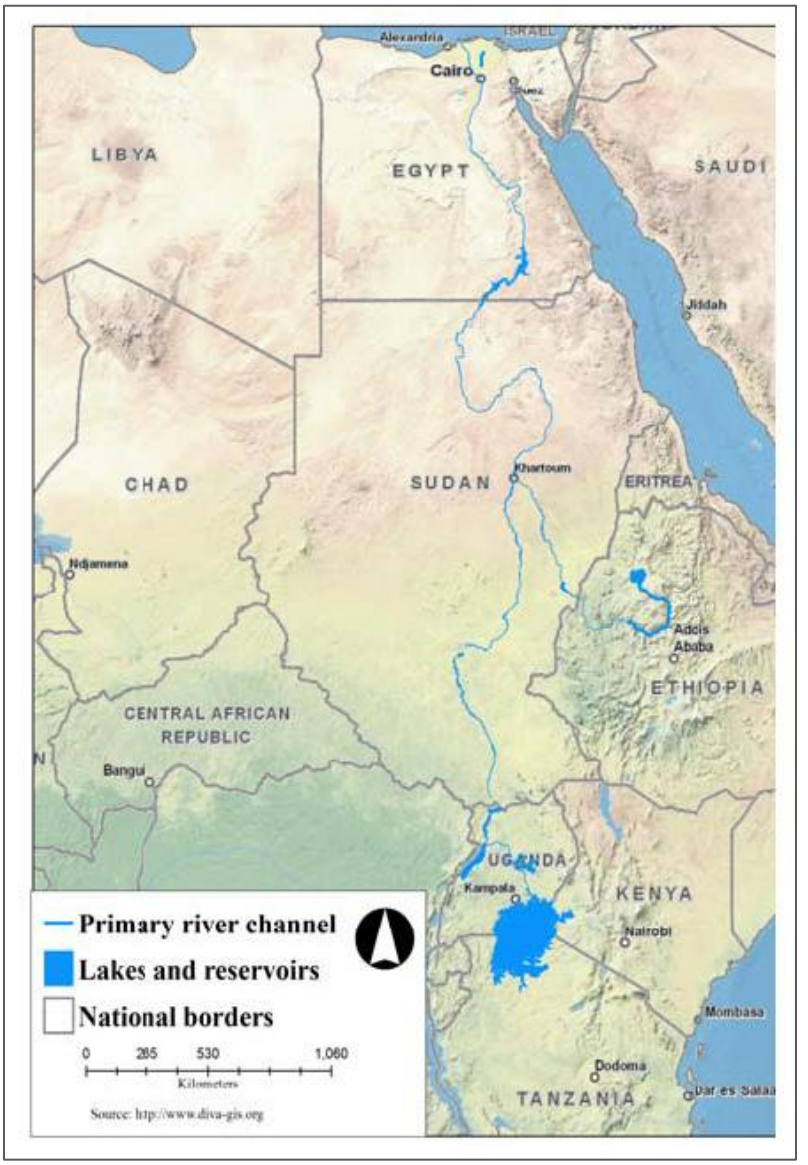

Figure 6. River Nile and its tributaries.

2.2. Losers/Winners in the Western Hemisphere

Due to a long history of famines in Ethiopia and the military government's forced relocation of citizens in 1984, Egypt and Ethiopia agreed in 1993 to collaborate with other nations regarding the use and management of Nile River waters (Seligman and Peterson 2008, Wolf 2009). Following their independence, Tanzania, Uganda, and Kenya collectively rejected the 1929 Nile Waters Agreement, which had previously granted Egypt an advantageous position in the

river basin. Eventually, in 1994, the three countries came together to sign a new agreement and establish the Lake Victoria Fisheries Organization, aimed at addressing their water issues through the utilization of Lake Victoria. All these countries except Eritrea launched the Nile Basin Initiative (NBI) in 1999 under which the Nile-COM (Nile Council of Ministers) was created to achieve sustainable socio-economic development in all countries in the basin through cooperation and effective water management (Kliot et al. 2001, Moller 2005, Swain 2008, Teshome 2008, Cascão 2009). On the one hand, the lack of implementation of the 1966 Helsinki water rule, which requires countries to cooperate for even distribution of water (Teshome 2008) in the Nile basin, has led to continuous water disputes among Egypt, Sudan and Ethiopia. The Arab Republic of Egypt, a country that relies heavily on the Nile River as its primary source of water, is frequently apprehensive about potential threats to its water supplies. The construction of dams and other projects by upper basin countries is one such threat that Egypt closely monitors. The country is concerned that such development could significantly reduce the amount of water it receives from the Nile, adversely impacting its agricultural and industrial sectors. As such, Egypt maintains a watchful eye over the situation and is actively engaged in diplomatic efforts to protect its vital water resources. (Gleick 1993). Egypt is currently positioned as the victor in the ongoing conflict, primarily due to the effectiveness of agreements and treaties signed during its time as a British colony. These agreements have served as a strategic advantage to the country, allowing it to gain leverage in the current conflict.

2.2.1. North America: Colorado River and Rio Grande/Rio Concho

This section provides a comprehensive overview of the significant river basins and aquifers in North and South America. The Rio Grande/Rio Concho region, La Plata River basin, and Lake Titicaca are among the areas where significant disputes have arisen. These water resources have been the subject of numerous international conflicts and treaties among the countries in their vicinity. The United States and Mexico share a border that extends for 3300 kilometers, which is not only a significant physical feature but also an important factor in their common water resources. This shared resource is considerable and requires a comprehensive understanding of its usage and management. (Fig. 7).

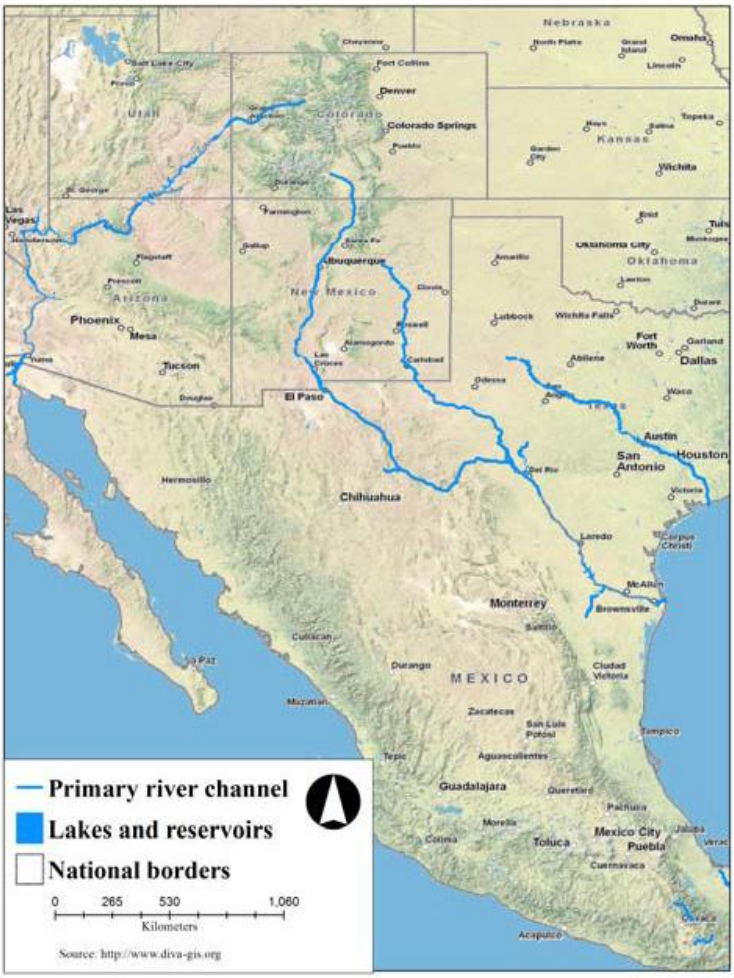

Figure 7. Shared rivers between the USA and Mexico.

Lake Mead is located on the Colorado River which provides water primarily to Las Vegas. The Colorado River enters Mexico in the State of Texas and eventually empties in the Wegner Basin in northeastern Mexico. Rio Concho and Rio Grande enter this system from northwestern Mexico (Fig. 7). Back in 2002, Mexico and the United States faced a stalemate due to Mexico's inability to meet the water supply obligations outlined in the 1944 treaty. This agreement distributes water from the Colorado River, Rio Concho, and Rio Grande between the two nations, and was created using a technique called issue-linkage. Mexico, as a downstream country, has agreed to engage in enhanced water cooperation with the United States, an upstream country. This agreement will be linking the negotiations on the Rio Grande/Rio Concho with the Colorado River. As a consequence, the

International Boundary Commission, which is responsible for governing these water resources, has recently come under scrutiny due to a range of alleged institutional shortcomings. (Mumme 2003, Mumme 2005).

2.2.2. South America: La Plata River basin

From 1994 to 2002, Mexico has not released 1.5 million acre-feet of water, resulting in reservoirs that are less than 25% full due to a prolonged drought. Some experts have alleged that a certain amount of this water has been utilized to convert the borderland into a significant producer of fresh vegetables for the American market. However, this initiative harmed Texas farmers, causing them significant harm (Vaknin 2005). Conflict has overridden cooperation for decades despite the existence of several treaties regulating the distribution of water resources, both countries have failed to adhere to the provisions laid out in these agreements. The United States has recognized the importance of cooperation and has avoided being seen as a "belligerent bully" by Mexico and the rest of Latin America. Subsequently, cooperation on water-related matters has been intertwined with garnering support and collaboration on other issues, such as drug trafficking and migration. This strategic approach has been effective as it has strengthened Mexico's negotiation power, given its control over crucial headwaters for the Lower Rio Grande, a vital irrigation source for Texas (Dinar 2007). Thus far, Mexico has been successful in securing a significant portion of the common water resources. This cooperation between the two signatories is likely due to reciprocity. Additionally, Mexico is the upstream source for other rivers shared with the United States, such as the Tijuana and New Rivers, beyond the Colorado and Rio Grande. The United States may refrain from capitalizing on its strategic location on rivers where it is upstream, in principle. Such an approach would establish a precedent for Mexico to similarly abstain from utilizing its advantageous positioning on rivers where it holds strategic importance. By adopting this approach, both nations can foster a relationship of mutual respect and cooperation, in which neither party takes undue advantage of its strategic location over the other (Dinar 2009). Overall, it seems that Mexico has emerged victorious in this longstanding dispute.

The La Plata River basin is an expansive area spanning over 3.1 million km^2, making it the fifth-largest river basin in the world. Surpassed only by the Amazon River basin in South America, La Plata basin covers a substantial portion of Paraguay, Uruguay, Argentina, Bolivia, and Brazil. With a population exceeding 100 million and boasting 75 large dams, the La Plata River basin holds enormous economic and social significance for the region. The basin comprises four primary sub-basins, including the Paraná, Paraguay, and Uruguay River Systems, as well

as the La Plata River sub-basin itself. Each sub-basin contributes to the overall ecological and hydrological balance of the area. This basin is a vital resource for the region's industries and communities, providing essential water resources for agriculture, livestock farming, hydropower generation, and urban water supply. An understanding of the complex interactions between the basin's various components is crucial for sustainable management of the area's natural resources.In terms of discharge, the Paraná River System reigns supreme, with a mean annual flow of roughly 17,100 m^3/s at Corrientes. The Uruguay River System is characterized by a mean annual flow of 4,300 m^3/s, whereas the Paraguay River System exhibits a lower mean annual flow of roughly 3,800 m^3/s at the Puerto Pilcomayo location (UNWWD 2023). These figures highlight the differences in river system capacities between the two regions, with the Uruguay River System showing a higher capacity than the Paraguay River System. These findings have significant implications for businesses and academics alike, particularly those working in the water management and environmental sectors.

Over time, the La Plata Basin has experienced changes in climate and precipitation patterns. Specifically, yearly minimum temperatures have increased by approximately 1°C per century. Furthermore, hydrological records indicate that rainfall and runoff have both increased in the basin since 1970. El Niño has also had an impact on stream flows in the area, with the four largest discharges occurring during the El Niño events of 1905, 1982 & 1983, 1992, and 1998 along the middle section of the Paraná River. The aforementioned flood occurrences have caused significant damage to both infrastructure and economic productivity, affecting a substantial number of individuals. These detrimental events have resulted in the disruption of daily routines and have harmed the livelihoods of many. The harm caused has been extensive, and the recovery process is expected to be lengthy.

Figure 8. La Plata River basin.

2.2.3. Lake Titicaca

The La Plata River basin (Fig. 8) holds vast reserves of underground water, including the Guaraní Aquifer System (GAS) - a substantial fresh groundwater reservoir, both in terms of area and volume. Covering almost 1.2 million km^2, the GAS extends across Argentina, Brazil, Paraguay, and Uruguay, with a population of nearly 15 million people. According to estimates, the GAS holds around 45,000 km^3 of water (UNWWD 2023; ITD 2010). With increasing freshwater demand, the four countries are facing tensions due to overexploitation. While the contamination and overuse of the aquifer are not presently at critical levels, there

is a potential for future conflicts (ITD 2010) given that no international legal framework for the management of its transboundary groundwater resources exists. Effective management is essential in regions where water scarcity and competition among users are common. The institutional framework for transboundary aquifers in the case of the Guarani aquifer can serve as a potential model for other international river basins around the world (UNWWD 2023).

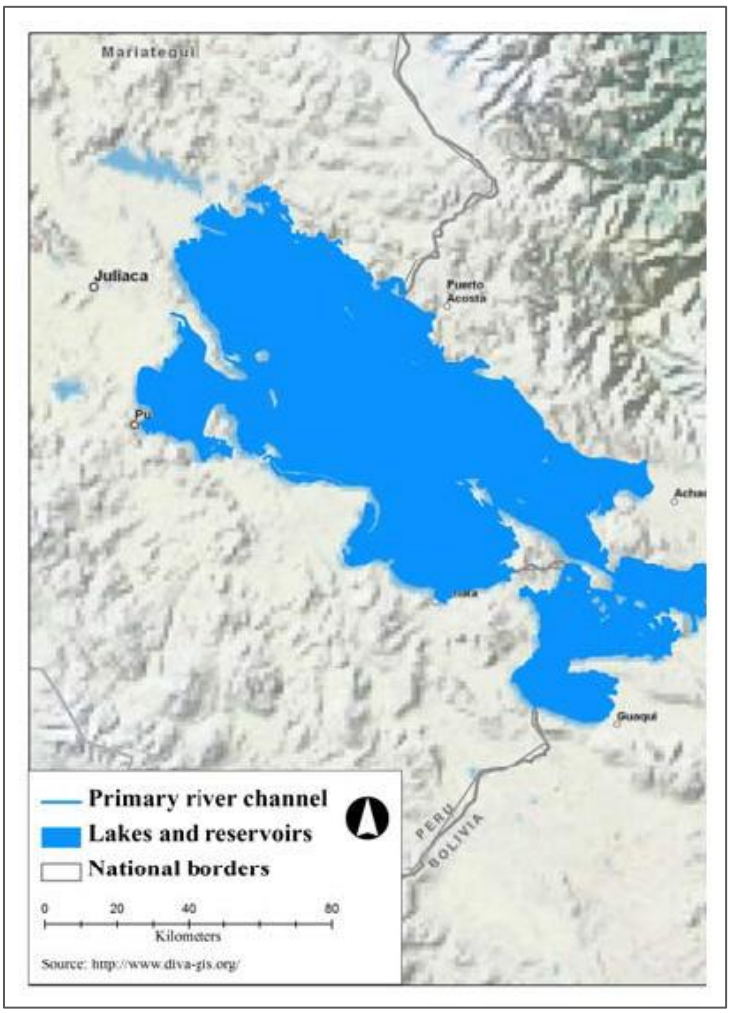

Figure 9. Location map of Lake Titicaca.

Located on the border of Peru and Bolivia (Fig. 9), Lake Titicaca served as a focal point for water-related negotiations between the two countries from 1955 to 1996. The increasing aridity of the 1980s prompted a joint effort to manage the lake's water resources more sustainably. A series of extreme droughts resulted in significant harm to subsistence and commercial agriculture, as well as livestock

production. Furthermore, severe floods in the same decade caused extensive damage to agricultural industries and infrastructure (ITD, 2010).

Peru and Bolivia have sustained a cordial relationship, with Lake Titicaca serving as a symbolic representation of their willingness to engage in mutually beneficial collaborations, “but rather a reinforcement of their willingness to cooperate when their interests are mutual” (ITD 2010). The shared resource has not been a source of contention between the two countries, but rather an opportunity to improve the living conditions of the indigent populations inhabiting the Titicaca basin. In 1955, Bolivia and Peru signed the Preliminary Convention for the Study of the Use of the Waters of Lake Titicaca, marking the first agreement between the two countries regarding the lake (ITD, 2010). While Peru ratified the convention immediately, Bolivia took 41 years to follow suit. Despite this delay, both countries have successfully managed this shared resource, with neither party embroiled in any conflict resolution.

3. Conclusions and Recommendations

In the face of growing water scarcity, the term “Water Wars” is often used to describe water management scenarios shortly. In 1947, the partition of the Indian subcontinent into India and Pakistan transformed an intra-state tension into an inter-state conflict that posed a serious threat to regional stability. The conflict between India and its weaker counterpart, Pakistan, required the intervention of a third party, given the former's greater influence. The World Bank played a crucial role in resolving the conflict by facilitating the signing of the Indus Water Treaty in 1960. This intervention was critical to achieving a fair and satisfactory outcome for both parties. This experience underscores the importance of involving all stakeholders as a prerequisite to the peaceful resolution of hydro-political disputes, especially when other avenues of conflict resolution have failed to produce any results. Anthropocene climate change in the Himalayan region makes regional cooperation on managing shared water resources all the more critical. It is paramount for India, Pakistan and Afghanistan to work closely together on sharing hydrological data and find common solutions as flooding is ravaging in all three countries.

The case of Middle-Eastern inter-state water conflict is deeply embedded in centuries of shifting political boundaries. It can be difficult to find a resolution when one riparian state, such as Turkey, holds significant geographical and political power over others like Iraq and Syria. Turkey's construction of large structures on the Euphrates River has resulted in the deprivation of water resources for other stakeholders. This unilateral action has led to increased tensions in the

region. Similarly, the equitable distribution of water resources is a significant challenge in resolving conflicts between Israel and its neighboring countries. The fact that the rivers are considered sacred by all religions adds further complexity to this hydro-political conflict.

Water conflicts are a persistent issue in both North and South America, affecting both inter- and intra-state relations. While the US-Mexico dispute was once resolved through a 1944 treaty, recent shortages of irrigation water in Texas have reignited tensions. Disagreements between the US federal government and Texas state policies have further complicated the fair distribution of water resources in the border region. In South America, conflicts in the La Plata River basin and Lake Titicaca have also arisen. Brazil currently enjoys the most benefits in the La Plata basin due to its larger stakeholder status and lack of a mutual agreement. However, the region is underlain by a vast groundwater aquifer (Guaraní Aquifer System), with Brazil having access to the majority of this freshwater resource. On a more positive note, Lake Titicaca between Peru and Bolivia is increasingly being recognized as a successful example of shared resource management.

Effective dispute resolution for shared resources requires an integrated approach to both surface and sub-surface waters as one integrated resource. Separating one from the other only creates confusion, as ground and surface waters are intimately related. It is crucial for all stakeholders, regardless of political status or gender dynamics, to come together and collaborate. Water science professionals play a vital role in technical areas such as data collection, analysis, and integrated water resource management. With natural and anthropogenic factors already depleting our water resources, time is of the essence, and mutual cooperation is necessary to ensure the effective management of these precious resources.

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