

Environmental security in South Asia: The role of climate change in the Pakistan-India transboundary water management

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ARTICLE INFO

Vol. 3, Issue 2, 2024

Pages: 10-24

Received:

17 October, 2024

Revised:

29 October, 2024

Published:

18 November, 2024

Keywords:

Environmental

Security,

Transboundary Water

Management, Indus

Waters Treaty, Climate

Change Impact, Glacier

Retreat in Upper Indus

Basin, Water Scarcity

and Agriculture,

Pakistan-India Water

Conflicts.

ABSTRACT

This paper discusses environmental security in the context of South Asia and multidimensional analysis of changes in the watersheds of Pakistan and India due to climate change. The water resources in the Indus basin are vulnerable to the effects of global warming, climatic changes, and glacier and snowmelt. Overall, the Upper Indus Basin (UIB) has lost 23% of its glaciers since 1980 and any additional glacial shrinkage totaling 40% by 2050 could significantly jeopardize water sources necessary for agriculture, drinking, and hydroelectric developments. This is especially the case for Pakistan, with about 75 percent of the rural population involved in the agricultural sector, thereby increasing the country's exposure to water stress, poverty, and migration. To grasp these impacts, the research uses climate data reviews, countries' treaties, and statistic quantization of glaciers' melting. Built upon the Theory of Environmentalism in International Relations, the paper investigates the challenges of power, sovereignty, and economic concerns that surround the management of transboundary waters. Implications highlight the significance of adaptive capacity and resource equity for lowering water-related conflict potential. Therefore, close coordination with other countries and the establishment of sustainable water-sharing agreements are deemed to be essential for addressing future climatic changes in this volatile region.



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Introduction

Environmental security is the safeguarding of ecosystems, Natural Capital (NC) and people from environmental risks that can potentially threaten international and national stability (Vizzarri et al., 2014). As applied to international relations, it highlights how phenomena such as climate change, resource scarcity and pollution —often collectively referred to as CREs (Critical Resource Exposures) — pose threats to state security (Levy et al., 2017). The United Nations Environment Programme (UNEP) has pointed out that resource-driven conflicts accounted for 40% of all conflicts over the last 60 years, with territorial disputes and hydro-political tensions over water resources being principal causes. Hence, environmental security is very relevant in regions such as South Asia where water availability is highly unpredictable, much more so as climate change enhances the scarcity of such resources.

Water management begins as a crucial problem in South Asian region with several associated giant rivers such as Indus, Ganges and Brahmaputra which supplies water to more than 1.7 billion people in diverse countries including India, Pakistan, Bangladesh and Nepal (Mueller et al., 2012; Price & Mitra, 2017). Since agriculture uses 80% of water and engages 42% of South Asia's population in the agricultural value chain, it currently appears most sensitive to water scarcity (Atapattu & Kodituwakku, 2009; Hanjra & Qureshi, 2010). Decreased availability of freshwater is expected to be 8-10% lower by 2050 in the Indus basin and increased demand of water is likely 55% due to growth in population and urbanization (Laghari et al., 2012; Asghar et al., 2019). Management of water, therefore, is crucial for food security and economic stability of the region besides avoiding water political instabilities (Hasanain et al., 2012; Cosgrove & Loucks, 2015).

The water issue and conflict in Pakistan and India has historical jurisdiction especially around the basin of Indus water. This basin covers an area of 1,120,000 square Kilometers with 60% of its area in Pakistan and 20% in India (Hashmi et al., 2019). The 1960 Indus Waters Treaty (IWT), mediated by the World Bank, allocated the use of rivers: India was awarded eastern rivers (Ravi, Beas as well as Sutlej) while Pakistan which was recognized the western rivers (Indus, Jhelum and Chenab) (Kalair et al., 2019). It appears that over the six decades of the treaty implementation no massive conflict has emerged and yet, tensions are back due to the higher water demand, and it is estimated that the demand for water in Pakistan and India has risen up to 20-30 % over the last 30 years. Climate change exacerbates the problem, for instance through fluctuations of river flows and about 15% reduction of the glacial mass in the Himalayas which supplies water to both countries (Nie et al., 2021). All these point to the increasing importance of adopting fresh discourse and synergy in GBM in order to prevent future episodes of dispute over scarce water resources.

2. Contextual Background

The water relation between Pakistan and India has political, historical and geographical background on one side and ecological on the other side. Haines (2014) indicated that the events that shaped water relations were after the partition of 1947 and the creation of two separate dominion states of India and Pakistan out of the former British India. Peoples of both the region were dependent on the Indus basin for irrigation purpose and with the formation of Pakistan the flow of the basin was divided between the two newly founded states, this division led to immediate tensions, as India is located at the upper end of the basin controlling the head waters while downstream is Pakistan (Molle, 2009).

The Indus Waters Treaty (IWT) of 1960, widely studied by political geographers, is often seen as a cornerstone of Pakistan-India water diplomacy. Menon (2015) refers to the treaty as a rare example of successful transboundary water cooperation, facilitated by the World Bank and sustained even amid the countries' hostilities. The treaty allocated the eastern rivers (Ravi, Beas,

Sutlej) to India and the western rivers (Indus, Jhelum, Chenab) to Pakistan, with the premise of equitable utilization—a concept rooted in international water law. Desai (2021) applies the theory of "hydro-diplomacy" to the IWT, asserting that the treaty established a framework for conflict avoidance, underscoring the potential of cooperative legal agreements in managing shared resources.

The Kishanganga project also reveals with equal clarity the dynamics of power. Concerns were aroused in Pakistan due to India constructing the hydroelectric project on Jhelum River, as it would potentially divert the water away from the Neelum-Jhelum hydropower project in Pakistan. As stated by Agarwal et al. (2022), this development led to legal complexities and raised further laws about the jurisdiction and validity of the IWT amid strengthened infrastructural capacity of India.

Considering the political ecologies perspective Mehsud et al. (2021) discusses how the power structures have affected the Pakistan-India water relations. He avows that despite the legal reciprocation of obligations contained in the IWT both India and Pakistan, the inherent appreciation of geographical dynamics suggest that India exercised leverage through control of the upstream flow, which has been seen by Pakistan as a strategic threat (Gardezi et al., 2020). This concurs with Falkenmark's (1989) theory of hydropolitics, where upstream-downstream relations are thus characterized by regional distrust particularly due to water insecurity arising from such factors as climate change or population increases (Mahlakeng, 2019; Ross & Chang, 2020).

More specifically, different components of research work have examined the positive and the negative aspects of the IWT, in the recent past. According to Miner et al. (2009), on the same note the treaty is still valid however the pressure brought about by demand of water and the climate change is a major challenge to the validity of the treaty. Mukhtar (2020) in his categorization of environmental security has grouped South Asia under 'water stress', indicating that the future holds the potential for conflict, should pressure from population growth be compounded by dwindling availability of water sources as influenced by climatic change, with no measures towards possible changes drawn. This is particularly the case in the recent years especially due to India's projects of hydroelectric power on the western rivers, this has made Pakistan to doubt the existence of water since the Himalayan glacial mass is receding and monsoon seasons are unpredictable and thus irregular (Tabassum, 2018).

In addition, the "Hydro-Hegemony Framework" by Menga (2016) provides further definition into how power relations translate into the politics of water. "Hydro-hegemonic upstream power" according to Zawahri (2009), refer to structures within water infrastructure projects that regulates water flow to Pakistan over India's shared rivers. Finally, they substantiate their assertion that for Pakistan, relying on these rivers is an environmentally frail proposition and also socially and economically contentious owing to its agricultural foundation. Based on the theory of common-pool resource management which was developed by Elinor Ostrom, they proposed cooperative solutions that may enable co-users of water flow to engage in collective monitoring and dealing with emergent effects (Choe & Yun, 2017). Such conclusions imply that if cooperative frameworks are formed and constructed in the context of generic environmental concerns and security considerations that foster mutual trust, then environmentally based conflicts may be dampened. Therefore, the background to water cooperation between Pakistan and India comprises of legal aspects as well as political and physical aspects. The IWT can be seen as a baseline legal framework; however, widening climate fluctuations and growing water demand call for the flexible and collective management approach.

The Indus River, with a catchment area of 1, 120,000 sq. Kilometers, is of the central geographical, Political, economic and social concern for both Pakistan and India that feeds nearly 300 million people in both the countries (Clift, 2002). The Indus River provides almost 65% of Pakistan's irrigation water and is instrumental in nearly 90% of its crop production (Mustafa, 2010). This river forms from Tibet and traverses through India before reaching Pakistan upon which it is important for food security and economic stability of the country. There are the two rivers of Jhelum and Chenab which forms the boundary line between India and Pakistan and enters into Pakistan and there are some important rivers which are very important for irrigation as well as domestic purposes.

In India, the Sutlej and Beas river basins are important for maintaining the productivity of agricultural land in the two northern states of Punjab and Haryana (Thakur, 2004). These rivers cater for about 80% of the irrigation needs for basic crops such as wheat and rice as identified by Chandel et al. (2023). Besides irrigation, these rivers are of ecological importance for the re-charge of ground water which is about 60% of the total re-charger water in the region (Afzal et al., 2000). Moreover, these waterways preserve important habitat connectivity that is crucial for species whose survival relies on wetland ecosystems. Again, according to Taylor et al. (2013), climate change and increased water abstraction have led to a decline in water flow by 20% for the past twenty years. Any effect of downwards trend poses severe risks to agriculture since decrease in water availability could lead to projected crop yield reduction of 15-20% by 2030 (Kirby & Ahmad, 2022). The Water-Energy-Food Nexus Theory formulated by Hoff in 2011 outlined that water resources are connected to food production and energy requirements, argued that scarcity in river flows poses threat to food security and economic performance of nations in the region (Leck et al., 2015).

It is noteworthy that water is considered as an essential geopolitical object in South Asia and more specifically between India and Pakistan; the balance of power dependent on water supplies (Wirsing & Jaspardo, 2007). The hydro-politics map is structured by the idea of India's upstream control, that is controlling the water flow into Pakistan, a power, as Aslam (2022) indicates that can be used as a 'soft power' political pressure instrument. This dynamic is more pronounced during most years' dry season or periods when river flows are reduced because of glacier melt; the Indus basin supplies 90% of Pakistan's freshwater (Hasson et al., 2014).

In his work, Wolf (2007) said that the dependence on the water resource bar intensifies the need for developed joint water regimes since heightened water stress may deepen existing animosities. In their view, Grey & Sadoff (2007) opine that water security and national sovereignty and economic prosperity are linked, as the region is mainly agricultural. For instance, agriculture is Pakistan's chief earner contributing about 20% to the GDP and it is very sensitive to water changes; Indus is thus a geopolitical asset (Zaman & Arslan, 2014). This analysis demonstrates that although the IWT has become a stabilizing influence, it is the ecology and economy of the Transboundary Rivers that underpin ongoing cooperation in the region. Still, the opportunities for cooperation are hampered by power imbalance and security considerations underlying the water problem, reinforcing the strategic importance of water security to South Asia's stability.

As for the future, analysts suggest that ability to respond to climate change impacts in the region will largely depend on the capability of both countries to cooperate in water sharing and climate change. Haddeland et al. (2014) also argued that climate change adaptation should be incorporated into water supply and demand models and its implications for sharing water resources. These are, for instance, enhancing water storage, water use efficiency, and the infrastructure necessary for utilization of water in the long term. Link et al. (2016) identify that the water management can be

done in cooperation with other countries and possible solutions can be joint reservoirs or development of irrigation systems with adaptation to climate changes. Moreover, there is a call by Liebenguth (2020), for more regional discourses promoting sustainable water management for enhancing understanding of water in the context of national security.

3. Theoretical Framework

The Theory of Environmentalism in International Relations (TEIR) is still an ongoing theory that highlights the importance of environmental aspects in international politics; especially how scarcity of resources in the natural environment can cause or foment international conflicts (Haluza-DeLay, 2008). This theory is well applicable to the South Asian region where the Indus water divide has turned into a contentious as well as cooperative territory between Pakistan and India. Hazards in TEIR have styled environmental degradation and climate-induced resource scarcity for international cooperation especially where there is regional insecurity (Homer-Dixon, 1994). From the paper by Hariri et al. (2023), TEIR also focuses on the fact that common assets can be a source of cohesion and conflict, depending on how the former is approached. Due to the volatile political structure, TEIR argues that the pursuit of sustainable and cooperative resource management is crucial to avoid environmental security threats to turn into conflict (Barnett, 2001).

In addition, TEIR looks at the concept of ‘environmental peace-land building’ whereby it is argued that the management of transboundary resources can act as a catalyst for reconciliation between warring states (Ide et al., 2021). For example, Pakistan and India, two historically hostile countries have been signing the Indus Waters Treaty (IWT) for over sixty years because of its role in ecological and political management of water resources in the area (Jamir, 2016). However, critics opine that the impacts resulting from climate change are not addressed in the treaty and thus there are areas of concern in trying to apply principles of environmentalism within the TEIR in management of trans-boundary water resources in conflicted regions (Zeitoun & Warner, 2006).

TEIR ideas can help in transboundary environmental management include developed transboundary environmental management, common pool resources, and transboundary resources. Common pool resources are those that are found in two or more countries for instance a forest or a river and hence are accessible by many people (Ostrom 1990). Adhikari (2021) defined common-pool resources (CPRs) as those natural resources that are highly vulnerable for exhaustion due to over exploitation hence call for collective management structures to avert tragedy of the commons. Two countries involved in the Indus Water Basin are India and Pakistan, both of which use water from the Indus River to support the process of irrigation, to produce electricity, and for human consumption; therefore, it is an example of CPR that is vulnerable not only to over-exploitation but also pollution (Mustafa, 2010).

Transboundary environmental management relates to the measures and structures needed for effective management of environmental resources that cut across borders (Kliot et al., 2001). According to Muboko (2017), successful transboundary environmental management entails: the development of shared normative frameworks, legal arrangements, as well as institutions. For instance, the IWT offers a legal vehicle for the allocation of water resources despite the fact that it is not adequately equipped to address emerging issues such as climate change effects on glacial melt and seasonality (Mallick, 2020).

Governments, international organizations, and local communities share power in decision making regarding transboundary water policies. According to Zeitoun & Warner (2006), hydro-hegemony is a situation where upstream states such as India exercises political influence over water resources in a trans-boundary water system. India having the advantage of the upper riparian position has to

control the Indus water flow, often leading to tensions with downstream Pakistan, the analysis of which reveals how power is key in water management of international rivers. This is further worsened by issues of national sovereignty that make states safeguard control of these resources and other matters for the benefit of their countries sometimes at the expense of stability of the entire region as pointed out by Crow & Singh (2009).

The strategies of TEIR that state that the fair distribution of resources is preferred are viewed as leading to peace and security. In his Environmental Scarcity Theory of 1994, Homer-Dixon argued that presidency of resources such as water will increase conflict, most apparent in regions experiencing political instability (Mahlakeng & Solomon, 2017). Both India and Pakistan get their source of water, as well as income and agricultural produce from the Indus; therefore, the equitable sharing of this important asset reduces tensions. The IWT has been established to facilitate water sharing, but fails to accommodate for the new requirements in relation to water with population growth and climate change, and thus underlines the issue of equity (Mustafa, 2010).

Therefore, TEIR draws attention to the context of the fair treatment of distribution of resource, the multi-dimensional involving stake holders and the necessity of appropriate legal frameworks in the management of transboundary environment. This theory is especially germane to South Asia given that climate change and resource limitation necessitate the adaptation measures which serve the countries' interests and Regional security to preserve peace between threatened neighbour states.

4. Climate-Induced Variability and Its Impacts on River Water Resources

Globally, climate change has altered temperatures and precipitation regimes regionally in South Asia affecting water availability in the Indus Basin (Archer et al., 2010). On average, mean temperature in Pakistan has increased by 0.6°C to 1°C over the region since the beginning of the twentieth century (Karim et al., 2023). Temperature rise by 2100 in South Asia is further expected to rise from 1.4 °C to 5.8 °C based on the developed emission pathways that are; towards augmenting the evapotranspiration rates and reducing the river inflows (Zaman et al., 2023). Analysis carried out by Xu et al. (2009) revealed that even if the temperature rises only minimally, the rains will reduce and the snow that occurs will melt and hence water availability will reduce by 30% Indus together with other factors like rising temperature lowering the snow pack in the Indus Basin.

In addition, there has been a change in the seasonal distribution of precipitation, with the monsoon period becoming characterized by long periods of drought accompanied by shorter, more intense monsoon rains (Jeswani et al., 2008). Pakistan meteorological department has recorded that the annual rainfall distribution has grown more unequal with increase of 15-20% in variability over the last twenty years. This shift affects the reliability of available water and disrupts agriculturally and water reservoirs (Rahman et al., 2022). The Vulnerability Theory in environmental studies posits that areas dependent on accurately forecast weather conditions are most likely to suffer from climate change because they lack the structures that enable them to cope with variability (Kelly & Adger, 2000).

Impact indicators	Value
Glacier Retreat in Upper Indus Basin (1980-2020)	23% loss
Projected Glacier Loss by 2050	40% further loss
Population Dependent on Indus River Basin	~300 million
Water Supply from Glaciers in Indus Basin	70% of river flow during summer
Increase in Extreme Weather Events (2000-2020)	25% increase in floods and droughts
Projected Temperature Increase by 2050	1.5 to 2°C
Annual Water Demand in Punjab & Haryana	55 billion cubic meters
Percentage of Water-Related Conflicts in South Asia	40% of all conflicts over 60 years
Decreased River Flow due to Climate Change	15-20% reduction by 2050

Table 1: *Impact indicators*

The Himalayas that account for up to 70% of the total flow the Indus River has is characterized by accelerated glacier melt as temperatures rise (Bolch et al., 2012; Sharma et al., 2022). Environmental Determinism Theory holds the view that societal conditions are enclosed by environmental changes including glacial melting (Fekadu, 2014). Glaciers in the Upper Indus basin have receded by about 23% since 1980, and according to the current climate change models, they are expected to lose a further 40% by 2050 assuming reasonable global warming (Bocchiola et al., 2011; Romshoo et al., 2015). This glacial loss impacts river flows on a seasonal basis but reduces base flows throughout winter months and over the long term, but during the summer melt seasons there may be increased flows above normal (Immerzeel et al., 2013).

According to the Bronselaer et al. (2018), the impact of melt water by middle of this century will rise by slightly above 15% in the short term. As populations continue to demand more water in the region, this is likely to be succeeded by a 35 % reduction in flows after 2050 as glaciers are used up hence water scarcity is expected to be severe (Piracha & Majeed, 2011). In Pakistan, nearly 90% of the basin water is used for irrigation, thus implying that these fluctuations in river flow will have major impacts on crop growing (Nasreen & Ashraf, 2020; Janjua et al., 2021). According to the Adaptation Theory, there is a need to make infrastructure and resources more resilient to climate change, nevertheless, the adaptation attempt in the region is still insufficient (Davoudi et al., 2012).

Currently, climate change gives rise to extreme weather events including floods, droughts and heat in a more frequent and in severe manner that disrupts water scarce regimes and communities (Ahmed & Schmitz, 2011). Pakistan is fifth on the Global Climate Risk Index 2021 and floods alone cause losses of about \$18 billion to the economy annually (Athar et al., 2021). The Environmental Stress Theory propose that any event that triggers stress within the society specifically in environmentally sensitive region, puts a strain on the system that supports the society and natural systems (Hoffmann & Hercus, 2000).

With the huge deficits that the region experienced in recent years due to climate induced droughts, the projections for the future will be worse, with drought projected to rise by 20 percent in intensity by 2050 and further exacerbate water stress for rain fed crop dependent regions (Hina et al., 2021).

However, monsoon fluctuations have resulted in the emergence of more flash floods; a confirmed observation in Punjab & Sindh where more than 2000 people affected by flood in the fiscal year 2020 (Wang et al., 2024). Wada et al. (2013) also assert that Heatwaves are also on the rise and future modeling shows that 40% of the population of South Asia; will be subjected to Heatwaves above the threshold of human endurance for multiple days every year by the mid of this century. Often these conditions exacerbate the difficulties of water management with in the Indus Basin, putting pressure on infrastructure, agriculture yields and rural populations (Rehman et al., 2020).

Again, Pakistan agriculture contribution in GDP is 20% and occupies 42% of population and due to these climatic shift of precipitations this sector has been heavily influenced (Rehman et al., 2017; Amjad, 2023). According to the Agricultural Systems Theory, there is existence of a positive correlation between agricultural production and environmental stability, whereby whenever, there is a change in the climate cycle, it affects food production (Watts & Scales, 2015; Windsor et al., 2021). According to studies, for instance, down scaling the flows in Indus River by a tune of 10%, generic wheat production risks being cut by 15% leading to higher food insecurity in a water scarce populace (Akhtar, 2010; Najman et al., 2024).

According to the NASA Earth Science Division's data the incidences of floods and droughts in South Asia has risen to about 30% in the last two decades from year 2000 to year 2020. This increase is associated with changes in climate characteristics that cause both flash flooding and extended River water deficits (Atif et al., 2021). Here, the hypothesis of the Environmental Kuznets Curve (EKC) may come to play with the idea that, while development does indeed harm the environment at first, it can be mollified with growth-sensitive environmental policies over time (Dinda, 2005).

In addition, unpredictability of water due to changes in glacier melt and precipitation has led to variation in yield especially in crops such as wheat, rice and sugarcane-dependable crops (Lutz et al., 2014). Qureshi et al. (2010) indicate that the Punjab where irrigation is largely reliant on Indus water is realizing a 5% annual loss in rice yields thanks to changes in water supply patterns. With regard to challenges, increased glacial melt and poor precipitation rates will lead to crop failure and an expected increase of about 30% to crop insecurity by 2040 to approximately 80 million people (Ahmad et al., 2021).

Livelihood impacts are also significant in Pakistan, 75% of the rural population remains involved with agriculture and due to climate variability water scarcity contributes to poverty and migration exponentiation (Khayyam, 2020). There are indications that, migration has occurred; rural residents migrating towards urban areas at an estimated rate of 2.3 percent annually owing to falling agricultural earnings (Satriawan & Swinton, 2007). On the other hand, in India especially in Punjab states, farmers also have limited water availability from changes in river flow and over extraction of water from the ground (Rosencranz et al., 2022). This has led to similar trends in rural distress and migration as well. The impacts of these changes are felt in places like Rajasthan wherein access to water has been associated to low crop yields and propensity of people to migrate from rural to urban settings. For instance, in 2014, it was estimated that millions of farmers in northern India were fleeing their homes due to water scarcity and crop failure (Agarwal & Shah, 2017). The efficacy of this proposition is evident from the Livelihoods Framework, initiated to study how changes in environment destabilize social and economic stability and the fact that climate variability endangering water resources will continue to jeopardize rural livelihoods and force population and workforce mobility in affected regions (Khan et al., 2011).

Conclusively, climate variability that affects the Indus Basin has extensive effects in water and food security, agriculture and stability in the region. Climate change through increased temperature, fluctuations of precipitation, glacial meltage and volatile weather patterns affecting water conditions in relation to farm produce yields and food security. Lacking such changes in policy and infrastructure development, climate change is likely to affect the food security, livelihood, & regional security in the South Asian region; due to the chances of rising tensions between Pakistan & India for better cooperative water resource management.

5. Power Dynamics in Transboundary Water Management

Between Pakistan and India management of transboundary waters is largely shaped by power imbalances. India has economic dominance over Pakistan, its economy is almost ten times greater than that of Pakistan (Siddiqui, 2011); India applies its economic and geo-political might to dictate terms during negotiations (Scott, 2008). Of particular interest is the Power Transition Theory which posits that dominant states (in this case, India) use their power to dominate access to resources and dictate how these resources will be used while minimally accommodating less powerful states (Lebow & Valentino, 2009; Pop & Brînză, 2017).

According to statistics, India is about to control around 80% of water flow in the Indus River basin which provides Pakistan vital upper hand, and Pakistan's agriculture sector relies heavily on the Indus river system water about 90% (Sitharam, 2017). India's control and storage infrastructure especially multifaceted projects such as Kishanganga Dam appearing immensely dominant over Pakistan takes the inequity to the next level (Godara et al., 2024). The Resource Dependence Theory ascertain that the actor with more control over resources is in powerful position to dictate bargaining terms which in this case India has set the conditions that Pakistan may have no option than to accept to have access to water (Chinyoka, 2020).

Nevertheless, the Indus Waters Treaty (IWT) of 1960 assigned control over the Indus River system and on theories gave Pakistan rights in the western rivers those are Indus, Jhelum and Chenab yet Indian infrastructure on these rivers have created constant conflicts. From the information derived from the World bank which was the broker of the treaty Indian law has established several hydropower projects on the western rivers despite Pakistan's apprehensions that the dams are injurious to its water security and bear violation of the treaty. Moreover, the Hydraulic Society Theory argues that where a society has an advantage both in the technical and hydrological sense it controls water resources and uses them in support of politics and the management of the economy (Ingold, 2009).

Both water resources' political authorities are greatly shaped by national security imperatives and sovereignty principles, as both India and Pakistan see control over water resources as means of enhancing national stability and security. Pakistan's economy, heavily dependent on agriculture and using the water of the Indus Basin for around 25% of its GDP, has existential water risks. Therefore, this study uses the Defensive Realism paradigm essentially an international political theory that guides state actions in the water negotiations by focusing on sovereignty and territorial integrity perceived as threatened (Long, 2003).

India, however, is an Offensive Realism (Gill, 2020) which prioritizes for developmental goals and aims to dominating in South Asian region; therefore, it tends to construct the large-scale hydropower projects for upcoming energy needs. Indian policies include the National Water Policy of 2012 which follow the water resource as a key component to national development with specific goals of developing more dams on the IWT Rivers (Cronin et al., 2014). This is a national policy

which looks at water management as both a means of producing domestic energy and applying pressure on other nations (Kumar & Saleth, 2018).

This national-centric approach to water management further avails the assertion of the Tragedy of the Commons Theory whereby individualistic self-interests (here nationalism) necessarily breed resource exhaustion and essentially ruination, as evident through individual country unilateral dam construction (Sharma, 2001; Copeland & Taylor, 2009). Its infrastructure projects on the shared rivers of India are a good example of this; through these activities Pakistan argued that these acts could physically obstruct the flow of water downstream and thus threaten its food and water security (World Bank, 2018). Current statistics reveal that the water availability in Pakistan has been declining by about 70% since 1950 – mainly due to upstream water thefts and climatic change fluctuations (Van Steenberg & Oliemans, 2002; Azizullah et al., 2011).

In addition, sovereignty considerations prevent both countries from seeking third party determination even though the Indus Waters Treaty Containing provision for neutral third party determination through the World Bank. India for instance at times choose to not use third party mediation as it is seen as infringement on its sovereignty while Pakistan is founded on it as a way of leveling the odds given India's power over it (Khattak, 2008). Such dynamics can be explained by the fact that sovereign interstate actors are self-helping and following the Realist Theory of International Relations to bring maximum control over decisions (Ray, 2003).

The Hegemonic Stability Theory is relevant to this case since a dominating power (in this case, India) can shape an international system and may also have policies that perpetuate its dominance (Gavris, 2021). These power plants along with numerous dams like Baglihar Dam and Kishanganga Hydroelectric Plant depict India's huge investment on water infrastructure which further solidifies its position in the region (Riffat & Iftikhar, 2015). These projects are meant not only to satisfy its increasing appetite for energy resources but to gain control over the water flow and hence have a strategic advantage over Pakistan. It is reported that the Indus Basin contributes about 65 % of Pakistan's irrigated land and therefore, is quite vital to the country's food requirements. In recent decades India has been constructing dams at a rapid pace with an incremental increase in the storage capacity of about 35% while on the other side Pakistan has been only able to construct dams of symbolic capacity due to financial and geopolitical conditions pertaining to the region which limit storage capacity to more than 5% (Ranjan, 2020). This numerical imbalance further reveals the discrepancy in the capacity to dictate what resources can be exploited and where the infrastructure can be constructed.

Another theory involved is the Zero-Sum Game Theory of conflict that shows how every gain made by one state (India) is at the cost of the other state (Pakistan) (Skerry, 2005). This theory is evident when India uses the construction of projects like the Tulbul Navigation Project, which according to Pakistan hinders water flow affecting its annual agriculture production estimated to be shortened by 15-20% during key planting seasons as stated by Zawahri (2009).

The Political Ecology Theory is another useful theoretical framework which concentrates on how political, social, and economic power affects access to resources and environmental decision-making (Paulson et al., 2003). For example, through the issues described in sources, India's use of water as part of wider strategies implies that control of resources is influenced by state goals embedded in societal/ economic relations (Robbins, 2004). According to the World Resources Institute, it is estimated that in areas where politics regulates water access, there is a comparison of 30% more conflict as compared to regions with impartial administrative frameworks (Bakker et al., 2008).

Therefore, it can be argued that the process of managing transboundary water resources of Pakistan and India is influenced by existing mechanism of power relations, national interests and concerns regarding sovereignty, as well as the theoretical interpretations acknowledging how the water resource control is used as a tool of power by the dominant actor. India's economic power and better hydro geographic endowment ensures that it has the political leverage to unilaterally determine water policies that are unfavorable to Pakistan and each country's security-seeking policies ensure competitive rather than cooperative management of the trans-border Indus Basin resources. Such power-driven dynamics call for the development of fairly and sustainably shareable resource base in order to reduce chances of conflict within the region.

6. Adaptive Capacity, Policy Responses and Conclusion

The adaptive capacities of a system or country-mainly deals with its capability to successfully deal with external changes and pressures like those that climate change poses on water sources on a system or country. In the case of Pakistan and India, the Indus Basin which provides water for irrigation, power generation and domestic consumption remains the problem for both countries. These three components are technical, social, and institutional that enable flexibility of use of water given the availability issues. Power disparities have also been established: though India has an elaborate irrigation system – it covers around 65% of cultivated area – whereas Pakistan's irrigation densities are approximately 90% for agricultural lands, hence a high dependency on the Indus water, resulting in more susceptibility to climate changes.

India has constructed key infrastructure in hydro development in dams and reservoirs like the Kishanganga and Baglihar, which help it counter the variability of supply in seasons but otherwise pose geopolitical concerns to Pakistan (Hill, 2013). Pakistan water storage though is very low at a about 30 days while India's is estimated to be about 170 days addressing its adaptive capacity for water stock requires a massive investment (Shah, 2009). More water reserves could help Pakistan manage the changes in river inflows and enhance measures of drought mitigation (Pomee et al., 2005). An example is Tarbela Dam, which is one of the major reservoirs in present Pakistan context. The construction of the second part of the Tarbela Dam was done in 2017 and increased the dam's water storage capacity to 1.3 MAF. The expansion of the dam provides the ability to better control the flow of water and the water supply, especially in the driest seasons. It has also played a crucial role in improving Pakistan's ability to cope with both floods and droughts through the better management of river inflows (Tate & Farquharson, 2000).

Ministerial and agency structures are also important institutional engagements, and both countries have provided organizational frameworks for water resources management. For example, The Ministry of Jal Shakti, established in India in 2019 along with joining of the Ministry of Water Resources, River Development and Ganga Rejuvenation is the core center for making and implementing of the water policies. This ministry deals with the control and development of water in India; water resources, control of river basins and distribution of water. The ministry cooperates with similar institutions in state level in order to deal with the regional issues such as water issues in the Indus waters. Namely, the Central Water Commission (CWC) and the National Water Development Agency (NWDA) help to plan, develop and utilize water resources in India (Sachdev & Panigrahi, 2023). Yet better collaboration between these institutions and upgraded communicative relations may increase adaptability. In accordance with the Resilience Theory (Holling 1973) which posits that more versatile organizations are helpful in complex environments where conditions disrupt institutions, both countries would benefit adaptive organizations that could effectively adapt to climate impacts of the river systems (Greene et al., 2004).

As mentioned above, cooperation-based policy responses have focused diplomatic agreements, development projects, and legal documents that have with limited success addressed transboundary water challenges. The IWT was signed in 1960 to partition the use of water between Pakistan and India; this treaty survived even political rivalry. However, as those cynical about politics point out, the treaty requires updating to accommodate the issue of climate change, which was not an option when the treaty was drawn up. Reduced glacier flows and changes of precipitation patterns are not captured in the present treaty and may require the treaty to be modified or renewed.

Both countries have policies on water at the national level that are meant to achieve their water security objectives. Official policy in India National Water Policy identification updated in 2012 looks at the design of structures of water storage and flood control, while opponents claim that there is a lack of special attention to the topic of environmental responsibility. The Pakistani National Water policy 2018 underpins the saving of water resources but the country's policy has lack of implementation because of lack of institutions and funding (Pakistan Ministry of Water Resources, 2018). Mainstreaming climate adaptation into national water policies for natural resource management can encourage resilience and reduce conflict.

In addition to the IWT, the two nations share diplomatic consultations through the Permanent Indus Commission (PIC) through which the two sides discuss issues of mutual concern concerning use of water. Although these forums have enhanced sharing of views, scholars assert that entrenched water cooperation—perhaps through a facilitator, or an independent person or an international organization could enhance water-sharing arrangements, especially as climatic impacts pervade, (Wolf et al., 2003).

The IRBM process adopted and encouraged by the United Nations and the World Bank is all about multidisciplinary and transnational river management. Analyses have shown that through provision of information on the environmentally sensitive aspects such as precipitation, glacial melt and river flows through information sharing instruments such as IRBM, basically Pakistan and India will enhance on the economic aspects of mutual benefits in a given a period during or after droughts or floods events (Sadoff & Grey, 2002).

Stresses created by climatic changes mounted on the transboundary water resources between Pakistan and India are important to adopt less sensitive strategies and policies. Due to temperature increase, unpredictable precipitation and melting of glaciers which affect the Indus Basin both countries have similar threat that require joint efforts to overcome challenges and ensure stability. The quality of water infrastructure; the capacity of institutions; and policies & strategies with climate resilience improve the level of adaptive capacity. These policy responses, mainly through engaging with the Indus Waters Treaty, have strong policy actions in their national water policies, and by applying practical integrated water management to facilitate both countries to deal with climate change.

Collectively, power dynamics, sovereignty issues, and adaptive capacities regarding climate change call for the transition to cooperative water management in South Asia. Climate change continues to affect water availability in the region; therefore, development of adaptive capacities and formulation of sound policies to compliment the current climate pressures is crucial to contribute towards water security and stability, Environmental Security as well as promoting stability and healthy relations in the region.

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