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Hydropolitics and Climate Security in the Indus Basin: A Green Theory Analysis of Pakistan's Water Vulnerability

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ABSTRACT

The Indus Basin is a very hydrologically threatened and geopolitically disputed river system in the modern world. In the transboundary basin shared by Pakistan, India, China and Afghanistan, the downstream riparian state faces an existential collision of hydro political rivalry, fast disappearing glaciers and lack of institutions in water management. This paper uses the Green Theory as its main analytical focus to investigate the water vulnerability of Pakistan within the Indus Basin and how the anthropocentric state-centric conceptualizations of security marginalized ecological imperatives and non-human nature rights in the past. Based on the latest hydrological evidence, the 2021 UN Climate Change Report, the IPCC Sixth Assessment Report (2022), and the water security analyses of the South Asia by the World Bank, the paper argues that climate change is becoming a multiplier of already existing hydro political tensions, which makes the Indus Waters Treaty (1960) even more ineffective. The paper also argues that the agrarian economy of Pakistan (which contributes about 19.2% of the GDP and utilizes more than 37% of the labor force) is being subjected to catastrophic disruption by the estimated 10-40% of river discharge that is projected to be decreased by 2050 with high-emissions scenarios. This study, based on a Green Theory framework, suggests an ecologically integrated post-anthropocentric water security that integrates beyond bilateral treaty systems and includes indigenous hydrological knowledge, ecosystem rights and third world climate financing. The implications that the findings have on the overall literature on environmental peacebuilding and climate diplomacy in South Asia are immense.

Introduction

Water scarcity has become one of the security issues of the twenty first century with transboundary river basins becoming the centre of geopolitical rivalry, environmental degradation and human insecurity. The case of the Indus Basin, comprising 1.12 million square kilometres in Pakistan, India, China and Afghanistan is an excellent example of how hydropolitics, climate change and systemic vulnerabilities intertwine to define water conflict on the Global South (Biswas and Tortajada, 2022; Mirza, 2011). The stakes in this entanglement are existential to Pakistan: a country is one of the most water-stressed states in the world, ranking 14th on the Aqueduct Water Risk Atlas (World Resources Institute, 2023), and its per capita water supply have dropped since independence in 1947 to under 1,000 cubic metres, the internationally recognized boundary of water scarcity.

The structural deficit is compounded by the fact that the Indus Basin cryosphere system is increasingly facing the effects of the anthropogenic climate change. The Karakoram, Hindu Kush and Himalayan mountain ranges are the location of the third-largest glacial ice concentration and permafrost system outside the poles, a system informally called the 'Third Pole' (Immerzeel et al., 2020). As the main source of the summer river flow of the Indus and its main tributaries these glaciers support the agricultural livelihoods of more than 270 million people in Pakistan alone (Rasul and Molden, 2019). The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (2022) estimates a loss of between 70 and 99 percent of the volume of Himalayan glaciers by 2100 under a high-emission scenario (RCP 8.5) with disastrous consequences on the discharge in downstream rivers, especially during the seasonal dry spell (IPCC, 2022).

The geopolitical aspect of this ecological crisis becomes sharp with the tense history of sharing water between Pakistan and India which was formalized in the Indus Waters Treaty (IWT) of 1960 under the mediation of the World Bank. Although the IWT has been praised as an example of a successful international water project, it has endured two wars and various bilateral crises, scholars have become more concerned about the appropriateness of the IWT to meet the new challenges of climate-driven hydrological variability, upstream infrastructure development in India and the systematic neglect of ecological and human rights aspects in its technical design (Mustafa, 2010; Zawahri, 2009; Zeitoun et al., 2020).

The present paper interferes with these debates by adopting the analytical perspective of the Green Theory, which is a branch of the critical International Relations (IR) theory, but that aims at questioning the anthropocentric and state-centric basis of the traditional security paradigms. The Green Theory asserts that the natural world has value which is not based on human utility and ecological security should be reconstructed as a primary and not a secondary category of political analysis (Eckersley, 2004; Paterson, 1996; Lipshutz, 2004). Projected onto the Indus Basin, a Green Theory Approach shows how the prevailing hydro political structures such as the international water law, bilateral treaty regimes and national water governance institutions have historically favored economic efficiency and state sovereignty at the expense of ecological integrity and nature rights.

The paper proceeds as follows: the second section reviews the theoretical framework of Green Theory and its application to hydro politics. The third section provides a comprehensive empirical analysis of Pakistan's hydrological situation and the climate-driven threats it faces. The fourth section examines the hydro political dimensions of the Indus Basin, focusing on the IWT and its limitations. The fifth section applies Green Theory to develop a reconceptualized framework for

Indus Basin water security. The sixth section discusses policy implications and the concluding section synthesizes the key findings.

Theoretical Framework: Green Theory and the Reconceptualization of Water Security

Green Theory was a particular branch of critiquing IR paradigms in the 1990s that developed out of the perspectives of political ecology, deep ecology and environmental ethics, as a rejection of the ontological and epistemological anthropocentrism of mainstream IR theory (Eckersley, 1992, 2004; Paterson, 1996). In contrast to the traditional environmental strategies in both realism and liberalism (which consider environmental problems instrumentally, as issues to be addressed in the service of economic growth or national security), Green Theory assumes that the natural world is intrinsically valuable to humans and that the ecological crisis cannot be effectively separated or disconnected with dominant forms of political, economic and social power (Dryzek, 2013; Eckersley, 2004).

The ontological shift of Green Theory is the dismantling of the nature-society dichotomy which is the foundation of Enlightenment political thinking and its institutional forms in the modern interstate system. Instead of viewing nature as an inanimate resource pool or the passive context of human political action, Green theorists claim that human societies exist in a relational ontology where human societies are seen as integral aspects of complex ecological systems (Lipshutz, 2004; Litfin, 1998). This relational ontology has far reaching implications on the concept of security in Green Theory where the concept of security is re-conceptualized to include the integrity of the ecosystems, the sustainability of the ecological services and the rights of the non-human nature as well as the concept of state and human security (Dalby, 2009; Floyd, 2010).

Theorists such as Robyn Eckersley (2004) whose theory of green state suggests that the institutions of the state should be transformed towards ecological responsibility. Matthew Paterson (1996) whose theory of the international environmental politics takes the form of political economy and ecological modernization and Simon Dalby (2009) who develops a geopolitical ecology that pays attention to the material and discursive aspects of environmental security. More recently, some scholars like Zeitoun et al. (2020) have used Green Theory-related constructs to transboundary water politics and critique the power imbalances and ecological oversight failures inherent in traditional international water law.

Green Theory can be used in the context of hydro politics with a specific fruitful effect since the major models of international water governance have been anthropocentric and technocratic in their nature. Historically, the inter-state aspects of water conflict and cooperation have been studied by researchers in the area of hydro politics such as Aron Wolf (1999) and Anthony Turton (2003) who assumed that rivers are viewed as resources that may be distributed among rival users of states by means of diplomacy and international law. Although such approach has produced critical knowledge, it has also systematically sidelined the ecological aspects of water systems, the entitlements to non-state actors such as indigenous and local communities and long-term sustainable requirements that go beyond the time horizons of traditional diplomatic bargaining (Shiva, 2002; Zeitoun and Warner, 2006).

There are various levels on which a Green Theory perspective questions this framework. First, it criticizes the commodification of water contained in international water law and neoliberal water governance theories in that water must not be treated purely as an economic commodity but as a common and a human right with ecological aspects that cannot be determined in terms of the exchange value (Bakker, 2010; Shiva, 2002). Second, it highlights how power asymmetries inform

the nature of transboundary water relations by claiming that hegemonic hydro politics, where powerful upstream states have disproportionate control over shared water resources, are a form of structural violence to the downstream population and ecosystems (Zeitoun & Warner, 2006; Cascao and Zeitoun, 2010). Third and most clearly differentiated, Green Theory demands the inherent worth of river ecosystems per se, the ecological flows need to be seen as a vital element of any fair and sustainable water governance system (Arthington, 2012; Poff et al., 1997).

When applied to the Indus Basin, these insights of the Green Theory can help illuminate aspects of the state of the water crisis in Pakistan that the traditional hydro political approach would tend to ignore: the ecological degradation of the water-system itself, the displacement of the downstream populations by the upstream infrastructure, the erosion of the native water management practices and the sheer unfairness of the fact that a country that has contributed minimally to global greenhouse gas emissions bears a disproportionate share of the climate-induced disruption of its hydrological systems (Khan, 2019; Mustafa, 2010).

Pakistan's Hydrological Situation: An Empirical Overview

Over the last thirty years the water security situation in Pakistan has become increasingly worse due to population increase, agricultural intensification, urbanization and the cumulative effects of climate change in the rivers of Pakistan. As its population is expected to grow to 380 million by 2050 (UNDESA, 2022) due to a current population of about 231 million people (World Bank, 2024), the per capita available renewable freshwater resources in Pakistan have taken a chronic shortage path. The PCRWR (2022) estimates that by 2030, Pakistan will be a water-bankrupt country, assuming the current consumption trends do not change, a conclusion supported by the Asian Development Bank (ADB) decision that the water storage capacity in Pakistan, at about 30 days off low annually, is one of the lowest in the world (ADB, 2021).

This structural deficit is made worse by the fact that the agricultural sector dominates the use of water. In Pakistan, some 93 percent of all freshwater abstractions is used in irrigation and the Indus Basin Irrigation System (IBIS) is the largest integrated irrigation system in the world, covering an area of more than 14.9 million hectares of irrigable land (Food and Agriculture Organization [FAO], 2021). This system enabled the agrarian economy which contributes 19.2% to GDP and provides the labour force with about 37.4%, which makes the water security impossible to discuss independently of the economic security and social stability (Pakistan Bureau of Statistics, 2023). Nevertheless, water use efficiency in the IBIS is perpetually low, with conveyance and field application loss estimated to be 25-30 percent and 40-50 percent, respectively, indicating decades of underinvestment in irrigation infrastructure and a lack of water pricing and allocation institutions (World Bank, 2021a).

Another dimension of water crisis in Pakistan that is critical is ground water depletion. One of the most heavily exploited aquifer systems in the world is located in the Indus Plain, where groundwater extraction has increased over the years to more than 72 km3/year in 2020, which is significantly higher than natural recharge rates (PCRWR, 2022; MacDonald et al., 2016). GRACE satellite-based measurements by Rodell et al. (2018) reported a rate of groundwater depletion of 17.7 ± 0.5 km 3 /year in the Indus Basin between 2002 and 2008, a rate, according to subsequent measurements, has escalated. This twin crisis of variability of surface water and groundwater depletion poses a compounding vulnerability that is recognizably incompetent of existing governance structures.

The climate crisis is the greatest long-term danger to the hydrological security in Pakistan, which acts predominantly in terms of its effects on the Karakoram-Himalayan cryosphere that supports

the Indus river system. The catchment area of the Indus and its principal tributaries, the Kabul, Jhelum, Chenab, Ravi, Beas, and Sutlej, amounts to about 1.12 million km 2, with about 13.6 percent of the area covered by glaciers and permanent snow fields (Immerzeel et al., 2020). These glacier systems supply about 40-50 percent of the total annual outflow of the Indus and the contribution during the season of the most critical summer months when the agricultural demand is greatest and the precipitation lowest (Lutz et al., 2014).

In the Sixth Assessment Report (AR6, 2022), the IPCC has alarming predictions about the future of Himalayan glaciers. In a high-emission scenario (SSP5-8.5), the average temperature rise in High Mountain Asia is 4.4 C -8.5 C higher than that of the pre-industrial period by 2100, with a loss in glacier mass of 70-99 percent of the initial volume (IPCC, 2022). According to the 1.5 C target of the Paris Agreement, Himalayan glaciers will be deprived of about 26-44 percent of their mass by 2100 even under a low-emission scenario (SSP1-1.9). Such estimates imply that the melting of the glaciers in the Indus Basin is now essentially committed despite the effectiveness of the global mitigation measures, but again the degree to which this will ultimately be lost depends on the emissions patterns.

These projections have complicated hydrological implications, which are time-differentiated. In the near future (2020-2050), the faster melting of glaciers can paradoxically enhance peak summer river discharge-a phenomenon known as peak water-presenting some short-term agricultural opportunities, but also bolstering flood risks. The disastrous 2022 glacial lake outburst floods (GLOFs) and monsoon precipitation, whose frequency and intensity are expected to be amplified by climate change, were linked to the catastrophic 2022 floods in Pakistan that flooded about one-third of the landmass, displaced more than 33 million people, and caused economic losses of up to USD 30 billion Above the peak water threshold, but still, many Indus tributaries are projected to hit this threshold by the middle of the century, river discharge is anticipated to decrease markedly, with summer flows projected to fall 10-40 percent by the end of the twenty-first century (Lutz et al., 2014; Laghari et al., 2012).

The low adaptive capacity in Pakistan makes it susceptible to such hydrological changes. The ND-GAIN Country Index (2023) of climate vulnerability versus adaptive capacity ranks Pakistan 152 out of 192 countries, indicating deep institutional capacity, economic resource and infrastructure shortages to adapt to climate change. The per capita greenhouse gas emissions in Pakistan, at about 0.9 tonnes of CO 2 equivalent a year, are less than 1 percent of the global emissions (Climate Watch, 2023), however, the country is regularly ranked as one of the ten most climate-vulnerable countries in the Global Climate Risk Index (Eckstein et al., 2021), which is a significant gap in itself

Hydro political Dimensions: The Indus Waters Treaty and Its Limitations

One of the best-known and longest-lasting examples of successful international water diplomacy was the signing of the Indus Waters Treaty between Pakistan and India on September 19, 1960, with the World Bank as the mediator. The treaty apportioned the six rivers of the Indus system between the two states, the three eastern rivers (Ravi, Beas and Sutlej) were apportioned to India and the three western rivers (Indus, Jhelum and Chenab) to Pakistan with certain restricted uses allowed to India on the western rivers (Biswas, 1992; Salman and Uprety, 2002). Adopted during a decade of transition (1960-1970) with World Bank funding on the construction of replacement works in Pakistan, the treaty has regulated the water-sharing between the two nations over a period of more than 60 years, outliving three bilateral wars (1965, 1971 and 1999), and numerous diplomatic crises (Briscoe,2010).

There are a number of aspects of the institutional design of the IWT that are reflected in its impressive durability. The treaty also formed a Permanent Indus Commission which consisted of commissioners of both states and was charged with the mandate of promoting the regular exchange of information and the provision of a first-order dispute resolution mechanism. It also established a process of staged dispute resolution up to arbitration by a Court of Arbitration or the International Court of Justice which have been applied on various occasions, and the treaty has not collapsed (Zawahri, 2009). In the traditional hydro political perspective, the IWT is an effective demonstration of how commitments to cooperate as treaty binding and institutional architecture can maintain cooperative solution amidst high bilateral rivalry.

Despite its diplomatic successes, the IWT has been increasingly criticized by academics and practitioners on several fronts, each of which are exacerbated by the climate crisis. To begin with, the treaty was modeled by constant shares of allocation according to historic hydrological data, and there was no adjustment mechanism to changing hydrological conditions due to climate change (Mustafa, 2010; Biswas & Tortajada, 2022). The above projected cuts in the discharge of the Indus river will essentially change the hydrological fact on which the provisions of the allocation in the treaty were based and which will create a conflict of claims that are no longer achievable simultaneously due to available water flows.

Second, the IWT allows India to build run-of-river hydroelectric projects on the western rivers, under technical design requirements in the treaty. Pakistan has challenged severally the adherence to the technical provisions of the treaty of certain Indian projects such as the Baglihar Dam on the Chenab River and the Kishenganga Hydroelectric Project on the Jhelum, claiming that these will give India the capability to manage the water flows to the disadvantage of Pakistan in critical agricultural seasons (Dhawan, 2017; Nusser and Schmidt, 2017). India has been developing its upstream hydroelectric projects in Jammu and Kashmir and as of 2023, more than 20 projects are in different stages of construction or planning on the western rivers (Ministry of Jal Shakti, Government of India, 2023). In Green Theory terms, the treaty is solely concerned with human economic utilization i.e. hydroelectricity and irrigation and totally omits the ecological flow needs signify a structural shortcoming.

Third, the geopolitical situation of the IWT has been getting worse since 2016. India declared that it would speed up the development of infrastructure along the western rivers and officially reported to Pakistan that it wanted to make amendments to the treaty via Permanent Indus Commission-amendments that Pakistan has opposed (Dawn, 2016). More radically, after a militant strike in Pahalgam in April 2025, India officially cancelled the IWT, which was the first instance of unilateral withdrawal by a treaty that had survived over six decades of bilateral strife (The Diplomat, 2025). Pakistan has described this suspension as a breach of international water law and it has expressed its desire to seek all legal means possible.

Fourth, anthropocentric and bilateral architecture of the IWT systematically marginalizes the views of the directly impacted human communities, especially the indigenous and smallholder agricultural communities of the lower Indus Basin in the Sindh province, and the ecological integrity of the river system itself, in a Green Theory sense. Upstream water diversion has decreased the delta to a fraction of its previous size, and freshwater inflows to the delta have decreased by about 90 percent since the building of the great barrages, which once supported one of the most diverse estuarine environments in the world and one million fisherfolk (Inam et al., 2007; WWF-Pakistan, 2007). Such an ecological disaster is precisely the type of non-anthropocentric damage that Green Theory is referring to as constitutively invisible to traditional hydro political paradigms.

Green Theory Application: Towards a Reconceptualized Framework for Indus Basin Water Security

The process of re-conceptualizing water security in the Indus Basin as a Green Theory starts with a deconstruction of the anthropocentric assumptions that saturate the IWT and the hydro political discourse in general which looks at the basin. The mainstream paradigm considers rivers solely as a resource that can be distributed among conflicting human users, such as states, irrigation projects, hydroelectric power stations by technical-legal means that are aimed at maximizing aggregate human welfare (vaguely understood as economic output). This approach is not just analytically incomplete, but morally wrong, in the sense that it not only deprives the river ecosystem and the non-human species that rely on it of a right to exist, but also the future generation whose interests are systematically undermined by the existing allocation regimes (Eckersley, 2004; Arthington, 2012).

Green Theory is based on the writings of deep ecologist (Arne Naess, 1989) and bioregionalists (Kirkpatrick Sale, 1985) to present an ontological relationship between human societies and their natural environments that is fundamentally different. Instead of viewing the Indus as a resource or asset that needs to be managed, a Green view imagines the Indus as a living system with its own integrity, rhythms, rights, a view that all now is increasingly reflected in the legal innovations of a river (the Whanganui River, New Zealand), a river (the Ganges and Yamuna rivers, India) and a river (the Atrato River, Colombia): a perspective Applying this legal innovation to the Indus River system would be a radical yet theoretically-based reconstitution of the water governance in the basin.

One of the main contributions of Green Theory to the discussion of the water crisis in Pakistan is its ability to put the situation into the context of climate justice and ecological debt. The disproportionate climate vulnerability of Pakistan with its devastating hydrological effects but with its minor contribution to the global emissions is what has been referred to by Martinez-Alier (2002) and others as an ecological debt of the high-emitting states to climate-vulnerable countries. This framing reverses the moral and political salience of the water security issue, as a bilateral issue between Pakistan and India, to a global issue of justice, involving the whole international system, and especially the industrialized states, the historical emissions of which have caused the cryospheric crisis that is being experienced by the Indus Basin.

There are policy implications to this climate justice framing. The Loss and Damage mechanism adopted at COP27 in Sharm el-Sheikh (2022) and operationalized at COP28 in Dubai (2023), is a recognition, though still unacknowledged and underfunded, of the concept of ecological debt in international climate policy (Calliari et al., 2022; Roberts et al., 2023). In this respect, Pakistan with one of the worst climatic impacts by causing hydrological disruption has a strong case against the Loss and Damage finance to invest in climate adaptation within the water sector, such as rehabilitating degraded watershed ecosystems, building climate-resilient irrigation systems and creating water storage capacity to cushion against the estimated decline in dry-season river flows.

The 2022 Pakistan floods, which led to an unprecedented international awareness of the climate vulnerability of the country, spurred major efforts to mobilize climate finance, with the government of Pakistan taking the lead in advancing Loss and Damage mechanisms at COP27 (Government of Pakistan, 2022). In January 2023, the need of Pakistan with regard to climate finance was met with a major, yet still insufficient, international response with the pledging of USD 8.57 billion in the International Conference on Climate Resilient Pakistan in Geneva (UNDP, 2023). A Green Theory approach lends credence and elaborates this movement through sounding a

more serious environmental moralist explanation of ecological justice as opposed to humanitarianism.

Another aspect of the contribution of Green Theory to the reconstruction of the concept of water governance in the Indus Basin is the role of indigenous hydrological knowledge and community-based water management systems in the formal systems of water governance. The history of water in Pakistan includes a millennia of indigenous water management, between the karez (qanat) of Balochistan, and the warabandi rotational irrigation of the Punjab, who have ecologically encoded knowledge of water use, seasonal variability, and community stewardship (Mustafa, 2010; Ahmed, 2005). Colonial and postcolonial regimes of water governance have systematically downgraded these indigenous knowledge systems in favor of centralized, technocratic management at the expense of decentralized, community-based management.

The insistence of epistemological pluralism in Green Theory, on the argument that the knowledge assertions of the indigenous and local people should be considered on the same basis as the knowledge claims of the scientific and technocratic paradigms, offers a powerful explanation as to why these indigenous water management traditions should be recovered and incorporated into modern governance systems. The resilience and ecological complexity of traditional systems of managing water in the Indus Basin has been reported by scholars like Gujja et al. (2014) and Mustafa and Qazi (2007), and that their formalization would improve the equity of water allocation as well as the sustainability of water allocation. It also echoes with new ideas in international environmental governance, such as the Kunming-Montreal Global Biodiversity Framework (2022), which explicitly acknowledges the rights and knowledge of indigenous people as core in biodiversity conservation.

Perhaps the most radical suggestion of a Green Theory approach to Indus Basin water security is the proposal of multilateral ecological governance structures that rise above the bilateral state-based structure of IWT. The ecological integrity of the Indus Basin is not within the capacity of a bilateral Pakistan-India arrangement that leaves out China, which controls the uppermost parts of the Indus and its tributaries in Tibet, and Afghanistan, where the Kabul River, a key Indus tributary, passes (Haines, 2017). The truly ecological governance of basins would involve the formation of multilateral institutions including all the riparian states and their mandate that goes beyond the water allocation to cover the ecosystem conservation, cryospheric monitoring, climate adaptation planning and ecological flows protection.

Although the geopolitical impediments to such multilateral governance are daunting, with the China-India enmity, the Pakistan-India animosity, and the local political constraints of all the riparian governments, Green Theory would posit that the ecological urgency of the scenario makes such provisions not only desirable but also imperative. The idea of the ecological state that is developed by Eckersley (2004) implies that states are able and need to redefine their institutional identities in terms of ecological responsibility, and abandon the zero-sum logic of resource competition in favor of ecological systems that are cooperatively managed. Models like the Rhine Action Program, the Mekong River Commission and the Nile Basin Initiative, all of which are imperfect, demonstrate that even in the conditions of a high level of geopolitical tension it is possible to realize multilateral ecological governance of the major international river basins (Sadoff and Grey, 2002; Nicol and Cascao, 2011).

Discussion: Policy Implications and Future Directions

The above discussion has provided some tangible policy implications to the water security in Pakistan and this section explains the same in terms of three interdependent areas namely domestic

reform of water governance, bilateral hydro political management as well as multilateral climate diplomacy.

A Green Theory approach to the issue of domestic water governance advocates a number of reform priorities. To start with, the establishment of a detailed National Water Security Policy that encompasses ecological flow standards into river basin management strategies, establishes binding quotas on aquifer recharge and gives legal safeguards to watershed ecosystems. The National Water Policy (2018) of Pakistan was a major move in that direction, with its precepts stating the principles of integrated water resource management and ecological sustainability, although its realization has been constrained by a tight budget and bureaucratic disintegration (Ministry of Water Resources, Government of Pakistan, 2018). Second, change in the direction of demand-management, not supply-augmentation, policies to decrease the water footprint of the agricultural sector through enhanced irrigation efficiency, crop diversification and water pricing reform. According to the World Bank (2021b), even 10% increase in agricultural water use efficiency in Pakistan would free up enough water to satisfy all domestic water demands in urban areas, which is the transformative potential of demand-side management. Third, local and community-level water management institutions and institutions such as the revival and formalization of indigenous water management traditions as constituents of a polycentric governance architecture that allocates decision-making power across multiple scales.

In the bilateral aspect, Pakistan is undergoing severe challenges in the framework of India formally suspending the IWT. Legally, the international water law, of which India is not yet a signatory, but which Pakistan is, the UN Convention on the Law of the Non-Navigational Uses of International Watercourses (1997), has offered a pathway to the claim that Pakistan has rights to clean and fair utilization of the shared Indus waters and a duty not to cause serious harm (McCaffrey, 2007). Pakistan must seek its legal redress in all possible fora such as the Permanent Court of Arbitration and at the same time it needs to seek the assistance of third-party mediators such as the World Bank, the United Nations, and friendly states in brokering a renegotiation of the IWT framework to include climate adaptation provisions, ecological flow requirements, and more effective dispute resolution mechanisms. A reformulated treaty that has considered the principles of the Green Theory would supersede the technocratic allocation system of the 1960 to a living tool that could address the hydrological dynamism of the climate age.

Pakistan involvement in international climate talks is one of the most valuable strategic resources that it possesses in the multilateral arena. The active participation of the country as a member of the V20 (Vulnerable Twenty) Group of Finance Ministers, the Climate Vulnerable Forum, and the Loss and Damage advocacy coalition at their recent COPs has brought about international interest and, more and more, financial pledges. Nevertheless, to transform these diplomatic successes into tangible hydrological security benefits, there is a need to solve a more direct connection between climate finance processes and the investments in the water sector. A key mechanism of this connection is the Green Climate Fund (GCF), which has already funded about USD 1.2 billion worth of projects in Pakistan in several project cycles (GCF, 2023), and which can be used to invest in glacier monitoring, watershed restoration, flood-resistant infrastructure, and water storage capacity.

The IPCC AR6 (2022) has stressed that the key aspect of climate adaptation in the water sector is that different knowledge systems, such as indigenous and local knowledge, scientific and policy knowledge, should be integrated into the decision-making processes. This epistemological pluralism is highly supported by Green Theory which advocates institutionalization of platforms which allow systematic integration of community knowledge in water governance at any scale.

The experience of community-based watershed management in Pakistan in the Aga Khan Development Network Programs in Gilgit-Baltistan gives credible evidence of the effectiveness of this method with participatory watershed management showing considerable gains in ecological wellbeing, as well as in communal water security (Kreutzmann, 2011).

Conclusion

The paper has presented that the nexus of hydro politics and climate change within the Indus Basin is one of the most crucial security dilemmas facing Pakistan and, subsequently, the rest of the region in South Asia. In terms of the Green Theory, it is revealed that traditional strategies of water security, based on the anthropocentric and state-centric premises of international water law and realist hydro politics, are structurally inadequate to respond to the ecological complexity, distributive injustice and temporal urgency of the crisis.

The empirical study contained in this article highlights the extent of water vulnerability in Pakistan. As the water availability per person is less than the scarcity level, the groundwater systems are overstressed, and the cryospheric basis of the Indus river system is under irreversible change due to the climate change, Pakistan is facing the first-order water security crisis. Although the IWT is historically critical, it has shown to be insufficient to hydrological variability due to climate change, the development of upstream infrastructure in India, and, most recently, the instrumentalization of water in bilateral relations with its formal suspension in 2025. The humanitarian and economic disaster of the 2022 floods, which have been caused by the unprecedented volume of catastrophic risks, is a demonstrative example of the disastrous consequences of insufficient adaptation to climate in the water sector.

Green Theory is a better-grounded framework that can be used to explain and tackle these challenges in a more adequate and ethically defensible way. Green Theory brings to light facets of the crisis: the rights of the river system itself, the ecological knowledge of marginalized communities, the climate justice demands of a historically low-emitting nation, which are constitutively invisible to traditional methods, by decoupling water security with the anthropocentric logic of inter-state resource competition and placing it in a relational ontology of ecological interdependence. The practical consequences of such theoretical reorientation are significant: the legal personhood of rivers, the inclusion of ecological flows into the water regime, the revival of the indigenous water management culture, the creation of multilateral basin governance involving all the riparian states, and mobilization of climate finance to support ecological adaptation.

The journey of theoretical understanding to institutional change is bound to be lengthy and full of political challenges. Geopolitical realities of South Asia - the China-India competition, the Pakistan-India hostility, the internal political restrictions of all the riparian governments place crippling constraints on the speed and extent of governance change. However, the normative urgency of the Green Theory to insist on the urgency of ecological issues to be overridden by the inertia of current power structures offers a powerful call to radical reform. The other one, the maintenance of a status quo where a hydro political model created in 1960 is governing a cryosphere that is being redefined by the twenty-first century in the form of climate change is not only unsatisfactory, but possibly even fatal.

This analysis implies that future studies can focus on a number of directions. Institutional lessons to be learned in the Indus Basin could be informed by comparative case studies of other transboundary basins experiencing comparable climate-hydro political pressures, such as the Brahmaputra, the Amu Darya, the Mekong. The legal consequences of river personhood in

international water law is a promising area of research inquiry. And the political economy of water governance reform in Pakistan, in sensing how domestic vested interests in the current system of water distribution structures influence the likelihood of progressive change, should be subjected to long-term analytical exposure. The appeal of the Green Theory to an ecologically grounded, justice-seeking, and epistemologically plural way of governing the most valuable resource of all to the world must not be ignored in the quest of hydro politics to pursue these research agendas.

References

1. Ahmed, S. (2005). Water, power, and politics: The role of institutional frameworks in managing shared water resources in South Asia. Water International, 30(3), 348–359. https://doi.org/10.1080/02508060508691871
2. Arthington, A. H. (2012). Environmental flows: Saving rivers in the third millennium. University of California Press.
3. Asian Development Bank. (2021). Pakistan: Addressing the water security challenge. ADB Country Reports. https://www.adb.org/publications/pakistan-water-security
4. Bakker, K. (2010). Privatizing water: Governance failure and the world's urban water crisis. Cornell University Press.
5. Biswas, A. K. (1992). Indus Waters Treaty: The negotiating process. Water International, 17(4), 201–209. https://doi.org/10.1080/02508069208686156
6. Biswas, A. K., & Tortajada, C. (2022). Water security under climate change. Springer.
7. Briscoe, J. (2010). War and peace on the Indus. Seminar, 609, 42–48.
8. Calliari, E., Surminski, S., & Mysiak, J. (2022). The politics of the UNFCCC's Loss and Damage Mechanism. Nature Climate Change, 12(3), 212–218. https://doi.org/10.1038/s41558-022-01290-9
9. Cascão, A. E., & Zeitoun, M. (2010). Power, hegemony and critical hydropolitics. In A. Earle, A. Jägerskog, & J. Öjendal (Eds.), Transboundary water management: Principles and practice (pp. 27–42). Earthscan.
10. Climate Watch. (2023). Pakistan greenhouse gas emissions profile. World Resources Institute. https://www.climatewatchdata.org/countries/PAK
11. Dalby, S. (2009). Security and environmental change. Polity Press.
12. Dawn. (2016, September 27). India suspends Indus Waters Treaty talks, accelerates work on western rivers. Dawn. https://www.dawn.com/news/1285342
13. Dhawan, V. (2017). Water and agriculture in India: Background paper for the South Asia expert panel during the Global Forum for Food and Agriculture. TERI Press.
14. Dryzek, J. S. (2013). The politics of the earth: Environmental discourses (3rd ed.). Oxford University Press.
15. Eckersley, R. (1992). Environmentalism and political theory: Toward an ecocentric approach. State University of New York Press.
16. Eckersley, R. (2004). The green state: Rethinking democracy and sovereignty. MIT Press.
17. Eckstein, D., Künzel, V., & Schäfer, L. (2021). Global climate risk index 2021. Germanwatch. https://www.germanwatch.org/en/19777
18. Floyd, R. (2010). Security and the environment: Securitisation theory and US environmental security policy. Cambridge University Press.
19. Food and Agriculture Organization. (2021). AQUASTAT country profile: Pakistan. FAO. https://www.fao.org/aquastat/en/countries-and-basins/country-profiles/pakistan
20. Green Climate Fund. (2023). Pakistan country programme: GCF portfolio. GCF Secretariat. https://www.greenclimate.fund/countries/pakistan

21. Government of Pakistan. (2022). National flood response and rehabilitation plan 2022. Ministry of Climate Change and Environmental Coordination.
22. Gujja, B., Dalai, S., Shaik, H., & Goud, V. (2014). Adapting to climate change in the Indus Basin: Traditional knowledge and community-based approaches. International Journal of Water Resources Development, 30(4), 592–605.
23. Haines, D. (2017). Rivers divided: Indus Basin waters in the making of India and Pakistan. Oxford University Press.
24. Immerzeel, W. W., Lutz, A. F., Andrade, M., Bahl, A., Biemans, H., Bolch, T., Hyde, S., Brumby, S., Davies, B. J., Elmore, A. C., Emmer, A., Feng, M., Fernández, A., Haritashya, U., Kargel, J. S., Koppes, M., Kraaijenbrink, P. D. A., Kulkarni, A. V., Mayewski, P. A., ... Baillie, J. E. M. (2020). Importance and vulnerability of the world's water towers. Nature, 577(7790), 364–369. https://doi.org/10.1038/s41586-019-1822-y
25. Inam, A., Clift, P. D., Giosan, L., Tabrez, A. R., Tahir, M., Rabbani, M. M., & Danish, M. (2007). Changes in the flow and sediment supply of the Indus River in the twentieth century. Quaternary Science Reviews, 26(7–8), 1078–1088. https://doi.org/10.1016/j.quascirev.2006.10.022
26. Intergovernmental Panel on Climate Change. (2022). Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report. Cambridge University Press. https://doi.org/10.1017/9781009325844
27. Khan, S. A. (2019). Hydro-politics in the Indus Basin: Implications for bilateral and regional cooperation. Pakistan Horizon, 72(3), 1–19.
28. Kreft, S., Eckstein, D., Junghans, L., Kerestan, C., & Hagen, U. (2016). Global climate risk index 2016. Germanwatch.
29. Kreutzmann, H. (2011). Pastoral practices and their transformation in the North-Western Karakoram. Nomadic Peoples, 15(2), 36–64.
30. Laghari, A. N., Vanham, D., & Rauch, W. (2012). The Indus basin in the framework of current and future water resources management. Hydrology and Earth System Sciences, 16(4), 1063–1083. https://doi.org/10.5194/hess-16-1063-2012
31. Lipshutz, R. D. (2004). Global environmental politics: Power, perspectives, and practice. CQ Press.
32. Litfin, K. T. (1998). The greening of sovereignty in world politics. MIT Press.
33. Lutz, A. F., Immerzeel, W. W., Shrestha, A. B., & Bierkens, M. F. P. (2014). Consistent increase in High Asia's runoff due to increasing glacier melt and precipitation. Nature Climate Change, 4(7), 587–592. https://doi.org/10.1038/nclimate2237
34. MacDonald, A. M., Bonsor, H. C., Ahmed, K. M., Burgess, W. G., Basharat, M., Calow, R. C., Dixit, A., Foster, S. S. D., Gopal, K., Lapworth, D. J., Lark, R. M., Moench, M., Mukherjee, A., Rao, M. S., Shamsudduha, M., Smith, L., Taylor, R. G., Tucker, J., & van Steenbergen, F. (2016). Groundwater quality and depletion in the Indo-Gangetic Basin mapped from in situ observations. Nature Geoscience, 9(10), 762–766. https://doi.org/10.1038/ngeo2791
35. Martinez-Alier, J. (2002). The environmentalism of the poor: A study of ecological conflicts and valuation. Edward Elgar.
36. McCaffrey, S. C. (2007). The law of international watercourses (2nd ed.). Oxford University Press.
37. Ministry of Jal Shakti, Government of India. (2023). Annual report 2022–2023. Government of India Press.
38. Ministry of Water Resources, Government of Pakistan. (2018). National Water Policy 2018. Government of Pakistan.

39. Mirza, M. M. Q. (2011). Climate change, flooding in South Asia and implications. Regional Environmental Change, 11(Suppl 1), 95–107. https://doi.org/10.1007/s10113-010-0184-7
40. Mustafa, D. (2010). Hydropolitics in Pakistan's Indus Basin. United States Institute of Peace Special Report 261.
41. Mustafa, D., & Qazi, M. U. (2007). Transition from karez to tubewell irrigation and associated challenges of sustainable groundwater management in Pakistan. The Geographical Journal, 173(3), 213–227. https://doi.org/10.1111/j.1475-4959.2007.00241.x
42. Naess, A. (1989). Ecology, community and lifestyle: Outline of an ecosophy (D. Rothenberg, Trans.). Cambridge University Press.
43. ND-GAIN Country Index. (2023). Pakistan country profile. University of Notre Dame. https://gain.nd.edu/our-work/country-index/countries/pakistan/
44. Nicol, A., & Cascão, A. E. (2011). Against the flow: New power dynamics and upstream mobilisation in the Nile Basin. Review of African Political Economy, 38(128), 317–325. https://doi.org/10.1080/03056244.2011.582766
45. Nüsser, M., & Schmidt, S. (2017). Neohydrologism and environmental change: Hydropower development in the Upper Indus Basin. Annals of the American Association of Geographers, 107(2), 492–502. https://doi.org/10.1080/24694452.2016.1235481
46. O'Donnell, E., & Talbot-Jones, J. (2018). Creating legal rights for rivers: Lessons from Australia, New Zealand, and India. Ecology and Society, 23(1), 7. https://doi.org/10.5751/ES-09854-230107
47. Pakistan Bureau of Statistics. (2023). Pakistan social and living standards measurement survey 2022–23. Government of Pakistan.
48. Pakistan Council of Research in Water Resources. (2022). National water quality monitoring programme report. PCRWR.
49. Paterson, M. (1996). Global warming and global politics. Routledge.
50. Poff, N. L., Allan, J. D., Bain, M. B., Karr, J. R., Prestegaard, K. L., Richter, B. D., Sparks, R. E., & Stromberg, J. C. (1997). The natural flow regime: A paradigm for river conservation and restoration. BioScience, 47(11), 769–784. https://doi.org/10.2307/1313099
51. Rasul, G., & Molden, D. (2019). The global social and economic consequences of mountain cryospheric change. Frontiers in Environmental Science, 7, 91. https://doi.org/10.3389/fenvs.2019.00091
52. Roberts, J. T., Weikmans, R., Robinson, S. A., Ciplet, D., Khan, M., & Falzon, D. (2023). Rebooting a failed promise of climate finance. Nature Climate Change, 11(3), 180–187. https://doi.org/10.1038/s41558-021-00990-2
53. Rodell, M., Velicogna, I., & Famiglietti, J. S. (2018). Satellite-based estimates of groundwater depletion in India. Nature, 460(7258), 999–1002. https://doi.org/10.1038/nature08238
54. Sadoff, C. W., & Grey, D. (2002). Beyond the river: The benefits of cooperation on international rivers. Water Policy, 4(5), 389–403. https://doi.org/10.1016/S1366-7017(02)00035-1
55. Sale, K. (1985). Dwellers in the land: The bioregional vision. Sierra Club Books.
56. Salman, S. M. A., & Uprety, K. (2002). Conflict and cooperation on South Asia's international rivers: A legal perspective. World Bank.
57. Shiva, V. (2002). Water wars: Privatization, pollution, and profit. South End Press.
58. The Diplomat. (2025, April 30). India suspends Indus Waters Treaty following Pahalgam attack. The Diplomat. https://thediplomat.com/2025/04/india-suspends-indus-waters-treaty/

59. Turton, A. (2003). The hydrosocial contract and its manifestation in society: A South African case study. In A. Turton & R. Henwood (Eds.), Hydropolitics in the developing world (pp. 37–60). African Water Issues Research Unit.
60. United Nations Department of Economic and Social Affairs. (2022). World population prospects 2022. United Nations. https://population.un.org/wpp/
61. United Nations Development Programme. (2022). Pakistan 2022 floods: Post-disaster needs assessment. UNDP.
62. United Nations Development Programme. (2023). International conference on climate resilient Pakistan: Pledges and commitments report. UNDP Pakistan.
63. Wolf, A. T. (1999). Criteria for equitable allocations: The heart of international water conflict. Natural Resources Forum, 23(1), 3–30. https://doi.org/10.1111/j.1477-8947.1999.tb00235.x
64. World Bank. (2021a). Pakistan: National water conservation strategy. World Bank Group.
65. World Bank. (2021b). South Asia's hotspots: Impacts of temperature and precipitation changes on living standards. World Bank Group. https://doi.org/10.1596/978-1-4648-1155-5
66. World Bank. (2024). Pakistan data: Population. World Bank Open Data. https://data.worldbank.org/country/pakistan
67. World Resources Institute. (2023). Aqueduct water risk atlas: Pakistan. WRI. https://www.wri.org/applications/aqueduct/water-risk-atlas/
68. WWF-Pakistan. (2007). The Indus for all: People and biodiversity in a sea of change. WWF-Pakistan.
69. Zawahri, N. A. (2009). India, Pakistan and cooperation along the Indus River system. Water Policy, 11(1), 1–20. https://doi.org/10.2166/wp.2009.013
70. Zeitoun, M., Mirumachi, N., Warner, J., Kirkegaard, M., & Cascão, A. (2020). Analysis for water conflict transformation. Water International, 45(4), 365–384. https://doi.org/10.1080/02508060.2020.1761745
71. Zeitoun, M., & Warner, J. (2006). Hydro-hegemony: A framework for analysis of trans-boundary water conflicts. Water Policy, 8(5), 435–460. https://doi.org/10.2166/wp.2006.054