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# WATER INSECURITY IN SOUTH ASIA: STRUCTURAL DRIVERS, SYSTEMIC CONSEQUENCES, AND THE POLITICAL ECONOMY OF TRANSFORMATIVE GOVERNANCE

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**ABSTRACT**

***South Asia ranks among the world's most acutely water-stressed regions, confronting a compounding crisis arising from the convergence of hydrological scarcity, agrarian political economy, climatic disruption, institutional fragmentation, and deep social inequality. This paper advances a structured analytical argument across ten thematic sections: water insecurity in South Asia is not a discrete resource management problem amenable to technocratic or infrastructural resolution, but rather a crisis of political economy and governance systematically sustained by entrenched elite interests, subsidized over-extraction, and the failure of transboundary cooperative institutions. Drawing on interdisciplinary scholarship spanning hydrology, political ecology, international law, development economics, and climate science, the paper examines the structural drivers of water stress, including Himalayan cryospheric retreat, accelerating groundwater depletion across the Indo-Gangetic Plain, and monsoon intensification and analyzes their cascading consequences for food security, public health, gendered vulnerability, and regional geopolitics. Existing governance frameworks, including the Indus Waters Treaty, the Ganges Waters Treaty, and the nascent South Asian regional architecture, are subjected to critical political economy analysis. Their fundamental limitations are shown to be not primarily technical but structural: rooted in asymmetric power relations between riparian states, the capture of water institutions by entrenched agricultural interests, and the persistent absence of climate-adaptive mechanisms. The paper concludes by proposing a transformative governance agenda organized around four interlocking pillars: institutional reform of water subsidy structures, climate-adaptive transboundary treaty revision, gender-mainstreamed community governance, and scaled climate finance directed toward the most water-insecure populations. Without such reform, South Asia faces compounding water crises capable of undermining development progress, triggering mass displacement, and heightening interstate tensions in a nuclear-armed region.***

***KEY WORDS** : Water Insecurity, South Asia, climate-change, political economy of water, groundwater governance, Himalayan cryosphere, , gender and water, climate- adaptive governance.*

## INTRODUCTION

### *The Political Economy of Water Insecurity*

Water insecurity in South Asia defies simple characterization. The region is not uniformly water-scarce in a hydrological sense: the South Asian monsoon delivers substantial annual precipitation, and the Hindu Kush-Himalayan (HKH) cryosphere feeds ten of the world's most significant river systems. Yet access to safe drinking water remains highly unequal. UNICEF reports that more than 134 million people in South Asia still lack access to improved drinking water sources, while global estimates indicate that 2.2 billion people lacked safely managed drinking water services in 2022.(UNICEF, 2022). India withdraws more groundwater annually than any country in the world, and Pakistan's per capita water availability has collapsed from over 5,000 cubic metres in 1951 to fewer than 1,000 cubic metres today, approaching the threshold of absolute scarcity as defined by international norms (Qureshi, 2011, p. 254). This paradox, abundant precipitation, extreme water insecurity, is the central analytical problem this paper addresses.

The conventional framing of South Asian water insecurity as primarily a technical or infrastructural problem, to be resolved through dam construction, irrigation efficiency improvements, or water pricing reforms, is both empirically inadequate and analytically misleading. This perspective treats water insecurity as a consequence of insufficient intervention. In reality, however, it is deeply rooted in a historically embedded political economy. Water insecurity is reproduced through subsidized agricultural overextraction that serves powerful rural constituencies, transboundary governance

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institutions that have struggled to adapt to changing geopolitical realities, caste and gender based exclusion from water access, and a development-financing architecture that has consistently prioritized large-scale infrastructure over community-based and demand side reforms. The paper advances a political economy interpretation of South Asian water insecurity as its central theoretical contribution. This interpretation foregrounds key distributional questions: who controls water, who bears the costs of scarcity, who captures the rents generated by water infrastructure, and whose interests shape water governance institutions. Technical approaches often obscure these questions. At the same time, political economy analysis must remain grounded in rigorous hydrological and climatic science. Structural drivers of water stress including glacial retreat, groundwater depletion, monsoon variability, impose real physical constraints that political will alone cannot overcome. The paper therefore integrates structural critique with empirically grounded policy analysis.

The stakes are high in ways that extend beyond the subcontinent. South Asia is home to approximately 25 per cent of the global population yet it possesses only about 4 per cent of the world's freshwater resources (UNEP, 2008). The region includes the world's second and sixth most populous countries, two nuclear-armed states between which water has increasingly been framed as a security issue, and several countries that are highly vulnerable to climate-driven hydrological disruption. Consequently, the success or failure of water-governance reforms in South Asia will have implications far beyond the region itself.

## HYDROLOGICAL CONTEXT, STRUCTURAL DRIVERS, AND THE ARCHITECTURE OF SOCIETY.

South Asia's water systems are constituted by the intersection of three physical systems, the South Asian monsoon, the HKH cryosphere, and the subcontinent's groundwater architecture, each of which is undergoing anthropogenic and climatic transformation on timescales that now challenge the adaptive capacity of existing governance institutions.

### *The South Asian Monsoon*

The South Asian monsoon delivers approximately 70 to 80 percent of annual precipitation within a concentrated four month window (June and September), creating hydrological regimes characterized by extreme seasonal asymmetry (Turner & Annamalai, 2012). This temporal concentration is compounded by severe spatial heterogeneity: Cherrapunji records more than 11,000 mm of annual rainfall, whereas parts of interior Balochistan in Pakistan receives less than 200 mm, illustrating the extreme spatial variability of precipitation across South Asia. Traditional water harvesting systems, johads in Rajasthan, tanks in peninsular India, khals in Bangladesh, developed over centuries as sophisticated institutional adaptations to monsoon variability (Agarwal & Narain, 1997). Their systematic neglect from the mid-twentieth century onward reflected a development paradigm that privileged large-scale, state-controlled hydraulic infrastructure over community-based management, creating institutional path dependencies that persist today and serve particular political interests in the concentration of water control. Ostrom's (1990) foundational insights on the successful community management of common-pool resources have remained underutilized in South Asian water policy. This neglect partly reflects the fact that decentralized governance models challenge the interests of actors who benefit from centralized systems of water allocation and control.

### *The Hindu Kush-Himalayan Cryosphere: A System Under Accelerating Stress*

The Hindu Kush-Himalayan mountain system, containing approximately 60,000 $km^2$ of glacial coverage, forms the headwaters of ten major Asian river basins and supports the water security of roughly 1.4-1.9 billion people living both within and downstream of the region (Wester et al., 2019, pp. 5-7; Immerzeel et al., 2020, pp. 364-366). Himalayan glaciers and snowpack perform a critical buffering function: by releasing meltwater during warm, dry periods, they stabilize river flows precisely when monsoon contributions are absent and agricultural water demand is at its peak. Immerzeel et al. (2020) characterized the HKH system as among the world's most critical 'water towers' while simultaneously highlighting its increasing vulnerability to anthropogenic climate change. This combination of strategic hydrological importance and environmental fragility constitutes a fundamental challenge for contemporary water governance institutions across South Asia.

### *Groundwater: the Crisis Beneath the Surface*

Groundwater has become the primary buffer against seasonal water variability for hundreds of millions of South Asians. India, Pakistan, and Bangladesh collectively account for approximately 35 percent of global groundwater withdrawals (Siebert et al., 2010, pp.1863-1865). GRACE satellite gravimetry documented groundwater storage losses averaging 17.7 $km^3$ annually across northwestern India between 2002 and 2008, a rate exceeding natural recharge (Rodell et al., 2009, pp. 999-1001). The political economy dimension of this depletion is fundamental: Shah et al. (2008) and Shah (2009) document how heavily subsidized agricultural electricity tariffs have created structural incentives for groundwater over-extraction that are extraordinarily difficult to reform given the electoral importance of farming constituencies. The result resembles a large-scale common-pool resource dilemma in which

individually rational responses to existing subsidy structures collectively generate unsustainable groundwater extraction. Governments often recognize the long-term economic and environmental costs of this trajectory, yet reforms remain politically difficult because of the electoral significance of agricultural constituencies.

Table 1: Comparative Water Stress and Groundwater Indicators, South Asia

| Country | Renewable FW ($km^3$/yr) | Per Capita ($m^3$/yr) | WRI Stress Level | Key Groundwater Challenge |
|---|---|---|---|---|
| India | 1,911 | 1,418 | High | Critical aquifer depletion in the Indo-Gangetic Plain; subsidy-driven overextraction |
| Pakistan | 246 | 1,072 | Extremely High | Groundwater salinization; Unsustainable aquifer abstraction |
| Bangladesh | 105 | 622 | Medium-High | Arsenic contamination; coastal saltwater intrusion |
| Nepal | 198 | 6,622 | Low | Uneven groundwater access; limited infrastructural development |
| Afghanistan | 65 | 1,527 | High | Institutional capacity deficits; conflict-related degradation. |
| Sri Lanka | 52 | 2,376 | Medium | Fluoride contamination in dry zones; aging irrigation infrastructure |

*Sources: FAO AQUASTAT Database; World Resources Institute (WRI), Aqueduct 3.0; World Bank, World Development Indicators (2022-2023).* ***Note:*** *Per capita figures based on 2022 population estimates.*

## CLIMATE CHANGE AS A THREAT MULTIPLIER

Climate change amplifies pre-existing structural vulnerabilities, accelerating groundwater depletion, intensifying monsoon variability, and undermining the cryospheric buffers upon which current water systems critically depend. The IPCC (2021) projects South Asia will experience warming between 1.5 and 4.0°C by 2100 alongside intensified hydroclimatic extremes. Kraaijenbrink et al. (2017, pp. 257-259) estimate that under a 1.5°C warming scenario, approximately 36 percent of HKH glacier volume would be lost by 2100; increasing to more than 64 per cent under a 4°C scenario. Lutz et al. (2014) documented a consistent trend of increasing runoff during the current phase of peak melt, while modeling a subsequent inflection toward long-term flow decline. The Indus River faces the most severe long-run exposure, with glacial and snowmelt contributing approximately 40 per cent of total annual discharge.

A critical governance implication of this 'peak water' phenomenon is that the current phase, of increasing or stable meltwater flows may systematically reduce the perceived urgency of adaptation action. This temporal trap, where the moment most cost-effective for investment coincides with the moment of weakest political incentive, represents a governance failure that existing South Asian water institutions are largely unequipped to address. Climate models project an intensification of mean monsoon precipitation, but this intensification is projected to occur alongside greater inter-annual variability and more intense but shorter precipitation events (Turner & Annamalai, 2012). More episodic rainfall produces surface runoff and flash flooding rather than gradual groundwater recharge, creating the paradox of 'more rain, less water.' Rising temperatures additionally elevate evapotranspiration rates. Across South Asia, higher temperatures are projected to intensify irrigation demand and place additional pressure on already stressed water resources, particularly in the groundwater-dependent agricultural systems of the Indo-Gangetic Plain. Climate change is expected to exacerbate existing water scarcity by increasing agricultural water demand while simultaneously affecting the availability and reliability of water supplies. Furthermore, elevated water temperatures can negatively affect aquatic ecosystems by reducing dissolved oxygen concentrations, increasing the occurrence of algal blooms, and degrading surface water quality, thereby posing significant challenges to environmental sustainability and human water security (IPCC, 2022; Ahmad et al., 2023; Lutz et al., 2014).

## AGRICULTURAL WATER USE AND THE POLITICAL ECONOMY OF FOOD-WATER CRISIS

Agriculture accounts for approximately 90 percent of total water withdrawals across South Asia (FAO, 2020), making agricultural water reform both the largest opportunity for demand-side reduction and the most politically formidable governance challenge the region faces. India's Punjab and Haryana states together producing approximately 30 percent of the country's wheat and 20 percent of its rice, have experienced substantial groundwater depletion associated with intensive irrigation under the rice-wheat production system (Rodell et al.,

2009; Asoka et al., 2017). Shah et al. (2008) warned that if depletion trends continued without meaningful policy intervention, South Asia could face a 'groundwater-driven food crisis' within decades: groundwater currently underpins approximately 60 per cent of irrigated crop production in India and around 42-50 per cent in Pakistan. This crisis, however, is not reducible to hydrological scarcity alone. Free or heavily subsidized electricity for agricultural pump sets has become structurally embedded as a constitutive element of the political economy of South Asian agrarian states, while minimum support prices for water-intensive crops, particularly wheat and rice, create guaranteed markets that suppress the price signals which would otherwise incentivize diversification toward less water-intensive alternatives. Together, these interlocking policy frameworks actively reproduce the conditions of overextraction, situating the food-water crisis as an endogenous outcome of state-mediated political economy rather than an exogenous environmental shock.

The structural consequences of this political economy are borne disproportionately by smallholder households. Agriculture employs approximately 40-45 per cent of South Asia's total labour force, with rural agricultural dependence considerably higher in countries such as Bangladesh and Nepal (World Bank, 2023; ILO 2022). The overwhelming majority of agricultural holdings are smallholder operations, typically less than two hectares, whose operators depend critically on reliable water availability for economic survival (FAO, 2014). The vulnerability of these households to hydroclimatic shocks is compounded by extremely thin asset buffers and limited access to formal credit and social protection (World Bank, 2020). Critically, as Hallegatte et al. (2016) demonstrate that droughts, floods, and other climate related shocks can rapidly erode household assets and reduce agricultural productivity in ways that are particularly devastating for asset-poor smallholders, thereby deepening the structural entrenchment of water-intensive farming as a risk-minimisation strategy, even as aquifer depletion accelerates.

## PUBLIC HEALTH DIMENSION: DISEASE BURDEN, CONTAMINATION, AND STRUCTURAL VIOLENCE

The public health consequences of water insecurity in South Asia constitute one of the most direct pathways through which inadequate water governance translates into human suffering, and one of the most compelling arguments for viewing water security as a human rights imperative. These consequences fall with systematic severity on children, women, the rural poor, and socially marginalized communities, in patterns that reflect broader structures of inequality constituting what Farmer (2004, pp.305-307) termed 'structural violence. Furthermore, According to WHO estimates, diarrheal disease was responsible for approximately 370,000 deaths among children under five worldwide in 2019, with a substantial proportion occurring in South Asia. Beyond immediate mortality, Humphrey (2009, pp. 1032-1034) demonstrated that repeated childhood exposure to diarrheal disease contributes to environmental enteropathy, a chronic condition characterized by intestinal inflammation that impairs nutrient absorption and contributes to stunting, wasting, and cognitive developmental delays. Consequently, the role of water insecurity in sustaining South Asia's persistently high rates of childhood malnutrition and stunting has often been underestimated within public policy frameworks.

Approximately 50-100 million people in Bangladesh, West Bengal, and neighboring areas face chronic arsenic exposure through drinking water (Mukherjee et al., 2019; Flanagan et al., 2012), creating significant long-term risks of arsenicosis and cancer. India also bears the world's largest burden of dental and skeletal fluorosis, with approximately 66 million people considered at risk (Amini et al., 2008, 3666-3667). These contamination crises reveal a deeper structural challenge: the persistent gap between the construction of water infrastructure and the institutional capacity required to ensure its long-term safety, monitoring, and maintenance. Urban water insecurity generates additional public health vulnerabilities. In cities where piped water supply remains intermittent, including Chennai, Karachi, and Dhaka, households frequently store water in uncovered containers that create favourable breeding conditions for Aedes aegypti mosquitoes. As a result, water insecurity can indirectly contribute to the transmission of vector-borne diseases such as dengue fever. Kennedy and King (2014,) further demonstrated that farmer suicide rates in India were strongly associated with indebtedness, marginal landholdings, and cash-crop cultivation, highlighting how agrarian distress emerges from broader political-economic structures rather than solely from individual circumstances. Their findings suggest that psychological distress among farmers is often socially produced through institutional arrangements that expose agricultural households to economic and environmental vulnerabilities.

## GENDERED AND SOCIAL EQUITY DIMENSIONS

The distributional structure of water insecurity in South Asia actively reproduces and deepens pre-existing social inequalities along lines of gender, caste, class, ethnicity, and geography. In the majority of South Asian rural and peri-urban communities, water collection, management, and use is culturally assigned as female reproductive labor, invisible in national accounting systems and systematically undervalued in water governance institutions dominated by male actors. UNICEF (2016) estimated that women and girls collectively spend approximately 200 million hours per day globally on water collection, with a disproportionate in South Asian water-

insecure communities. Recent evidence further demonstrates that women continue to bear the heaviest burden of global water shortages, with inadequate water access constraining educational attainment, economic participation, and health outcomes while increasing exposure to gender-based violence and insecurity (UN-Water, 2024). Time devoted to water collection competes directly with formal education and economic participation, imposing a systematic constraint on female human capital accumulation; carrying heavy water loads generates chronic musculoskeletal injury; and routes to distant water sources frequently traverse insecure terrain, creating documented exposure to harassment and sexual violence that conventional water security metrics fail to capture (UNDP, 2006). Meinzen-Dick and Zwarteveen (1998, pp. 340-344) demonstrated that higher female participation in water governance institutions correlates with more equitable water allocation, better infrastructure maintenance, and closer attention to domestic water needs.

In India and Nepal, caste hierarchy creates profound inequities in water access that persist despite formal constitutional prohibition. Human Rights Watch (2007) documented systematic patterns of Dalit exclusion from shared water sources and canal irrigation infrastructure controlled by dominant caste communities, exclusion sustained by caste-based social norms embedded in community institutions that formally neutral water governance frameworks cannot reach without targeted anti-discrimination interventions. Subsequent research has shown that Dalit women continue to face restricted access to common water sources, social exclusion, and discriminatory practices that intensify both physical and psychological burdens associated with water collection (Dutta, Sinha, & Parashar, 2018). Contemporary evidence suggests that caste-based disparities in access to basic water and sanitation services remain embedded within broader structures of social inequality despite decades of legal reform.

Informal settlement dwellers, who may represent 30 to 60 percent of rapidly expanding South Asian city populations, typically depend on water from informal vendors or unregulated tube wells, paying prices five to twenty times higher per litre than formally connected middle-class households for water of comparable or lower quality (ADB, 2016). Recent studies of peri-urban South Asia demonstrate that access to water is increasingly shaped by complex interactions between formal and informal institutions, producing highly uneven outcomes for marginalized populations living in rapidly urbanizing spaces (Narain, Vij, & Karpouzoglou, 2023). This “water poverty premium” constitutes a systematically regressive tax on the urban poor, crowding out investment in education, nutrition, and health, perpetuating the poverty that leaves households unable to afford formal water connections.

## HYDROPOLITICS AND INTERSTATE WATER CONFLICT

South Asia’s transboundary water systems constitute one of the most geopolitically sensitive domains in international relations, combining the physical interdependence of shared river basins with historical animosities, asymmetric power relations, and unresolved territorial disputes. The Indus Waters Treaty (IWT) of 1960, brokered by the World Bank after nine years of negotiation, remains the most significant international water treaty in South Asian history, having survived three full-scale wars, mutltiple diplomatic ruptures, and persistent bilateral hostility over more than six decades (Biswas, 2011, p. 664). However, a critical political economy reading reveals significant structural limitations that the treaty’s impressive longevity has obscured. Recent assessments suggest that climate change is fundamentally altering the hydrological conditions upon which existing transboundary water agreements were negotiated. The IPCC (2021) and ICIMOD (2023) project increasing glacier retreat, changing snowmelt dynamics, and greater variability in river flows across the Indus Basin. As a result, the treaty faces growing challenges because it was designed under relatively stable hydrological conditions and contains limited provisions for adaptive management under climate uncertainty. The instrumentalization of water in bilateral security discourse, particularly India’s post-Uri (2016) threat to review the treaty and its formal notice to Pakistan in 2023 seeking to modify treaty terms, represents a qualitative shift from technical water disputes to the strategic securitization of water diplomacy.

More broadly, climate change is likely to intensify the political challenges associated with transboundary water governance throughout South Asia. The Hindu Kush Himalayan region, often described as Asia’s water tower is experiencing accelerated glacier retreat, changing precipitation patterns, and increasing hydrologiocal variability that will affect the timing and distribution of river flows across the Indus, Ganges, and Brahmaputra basins (ICIMOD, 2023). The Ganges Waters Treaty of 1996 between India and Bangladesh illustrates the structural constraints on cooperative water governance between states with fundamentally asymmetric power and bargaining positions (Zawahri, 2009). Nepal presents a structural paradox: possessing substantial hydropower potential that remains largely underutilized, Nepal theoretically occupies an upstream position of considerable water leverage, yet its landlocked geography, routing any electricity export predominantly through Indian transmission infrastructure, creates a structural dependence that systematically limits its negotiating power. Furthermore, water conflicts in South Asia operate at multiple nested scales: the Cauvery conflict between Karnataka and Tamil Nadu, the Sutlej-Yamuna Link dispute, and

interprovincial tensions under Pakistan's 1991 Water Accord illustrate that a comprehensive governance strategy must simultaneously address multiple scales of institutional failure rather than focusing narrowly on headline bilateral treaty relationships.

## TECHNOLOGICAL INNOVATION AS CONDITIONAL RESPONSE

Technological innovation offers important complementary tools for addressing South Asian water insecurity, but technology alone cannot substitute for governance reform: technological solutions deployed in the absence of appropriate institutional frameworks tend to be captured by existing power structures, generating efficiency gains for better-resourced users while leaving the most water-insecure populations unserved. The GRACE satellite mission constituted a fundamental epistemological advance: before Rodell et al.'s (2009) landmark documentation of northwestern Indian groundwater storage losses, the scale and rate of aquifer depletion was largely unobservable to regional governance institutions. Contemporary satellite-based monitoring, IoT sensor networks, and real-time data platforms eliminate the technical excuse for invisibility without automatically eliminating its political functionality, creating data-to-governance translation challenges requiring explicit institutional design to overcome.

Precision irrigation technologies offer substantial potential to reduce agricultural water demand. Recent assessments by the Food and Agriculture Organization (FAO, 2016) and the World Bank (2023) indicate that micro-irrigation systems, including drip and sprinkler technologies, can significantly improve water-use efficiency while maintaining or increasing agricultural productivity. India's Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), particularly the Per Drop More Crop scheme, has expanded micro-irrigation coverage across millions of hectares, yet adoption remains limited relative to the country's total irrigated area (Ministry of Agriculture and Farmers Welfare, 2024). The principal barriers to large-scale diffusion are institutional rather than technological: high initial investment costs, unequal access to subsidized credit, fragmented landholdings, and policy regimes that continue to encourage water-intensive agricultural practices through electricity and irrigation subsidies. Moreover, urban water management presents a similar challenge. According to UN-Water (2024), large volumes of municipal wastewater across South Asia remain untreated or inadequately treated, representing both an environmental hazard and a missed opportunity for water recycling and reuse. Expanding wastewater treatment infrastructure could substantially augment available water supplies while reducing pollution pressures on rivers and aquifers. At the same time, traditional approaches such as rainwater harvesting and managed aquifer recharge continue to demonstrate significant potential. Community based initiatives in Gujarat, Rajasthan, and Sri Lanka have improved groundwater recharge, strengthened local water resilience, and complemented modern technological interventions. Their limited expansion reflects not technological constraints but shortcomings in institutional support, financing, and long-term governance capacity.

## GOVERNANCE REFORM AGENDA: A POLITICAL ECONOMY OF TRANSFORMATION

The governance reform agenda implied by the foregoing analysis is necessarily complex, multi-scalar, and politically demanding. It cannot be reduced to a set of technocratic policy recommendations that ignore the structural political economy constraints producing and reproducing current governance failures. The following five pillars constitute the architecture of the transformative governance agenda this paper proposes.

### *Subsidy Reform and Demand Management*

Dismantling the subsidized overextraction regime requires a political economy strategy as much as a policy prescription. A more politically viable approach involves sequencing reform with service quality improvements, demonstrating to framing communities that reliable, efficiently delivered power is worth paying for, and pairing volumetric water pricing with strong social protection floors that guarantee basic allocation affordability for smallholder households. The parallel reform of minimum support price structures to reward less water-intensive crops with compensatory income support during the transition period, addresses the crop choice dimension of the subsidy trap. Shah (2009) documented successful community groundwater management initiatives in Gujarat and Andhra Pradesh that achieved significant demand reduction through participatory institutions, suggesting that community-governed approaches can complement and partially substitute for politically blocked top-down regulatory reform.

### *Climate-Adaptive Transboundary Treaty Reform*

The structural inadequacy of existing South Asian transboundary water treaties designed for a stable hydrological world that climate change is rapidly dissolving, requires a systematic treaty revision agenda. Recent assessments by the IPCC (2021) and ICIMOD (2023) indicate that accelerating glacier retreat, altered precipitation regimes, and increasing hydrological variability are likely to transform the flow characteristics of the Indus, Ganges, and Brahmaputra river systems over the coming decades. These developments challenge the assumptions of hydrological stability embedded within many existing water-sharing agreements and reinforce

the need for adaptive treaty mechanisms capable of responding to climate-induced uncertainty. The minimum requirements of a climate-adaptive framework include: explicit provisions for adjusting allocation schedules in response to verified flow changes attributable to climate forcing; mandatory environmental flow provisions protecting downstream ecosystem functionality; established adaptive management protocols enabling pre-agreed responses to drought and flood extremes; joint monitoring infrastructure providing agreed data to all parties; and binding dispute resolution mechanisms not subject to unilateral exit. Developing multi-stakeholder coalitions, agricultural communities, hydropower developers, disaster risk managers, that have credible interests in treaty stability may provide the political constituency for reform that governmental actors alone cannot generate. A revitalized South Asian water governance institution would need explicit universal membership including China for the Brahmaputra system, an independent technical secretariat insulated from short-term political pressures, and progressive data-sharing obligations that build trust over time.

### *Gender-Transformative Water Governance and Community Based Groundwater Management*

Embedding gender equity as a core design principle requires systematic reform at multiple scales: water user association statutes mandating meaningful female membership; household level investments prioritizing reliable, close-to-home piped connections; and gender-responsive water budgeting that allocates resources based on gender impact analysis rather than historic expenditure patterns. Groundwater governance requires a fundamental reorientation from the current de facto open-access regime toward a framework recognizing groundwater as a common-pool resource subject to community-governed sustainable yield limits. Ostrom's (1990) framework has been extensively applied to groundwater contexts, and empirical studies across Gujarat, Andhra Pradesh, and Maharashtra document cases in which community-governed management institutions achieved sustainable extraction levels that market mechanisms and state regulation both failed to produce, though successful implementation requires enabling conditions that demand active state investment to create and maintain.

### *Climate Finance and International Support*

Bangladesh's Climate Change Trust Fund demonstrates the potential of nationally driven adaptation financing to support water security and climate resilience. Since its establishment in 2009, the fund has supported a wide range of adaptation initiatives, including community water management, coastal protection, and flood resilience measures. However, recent assessments indicate that adaptation financing across South Asia remains substantially below the level required to address escalating water-security challenges. The IPCC (2022) identifies significant adaptation finance gaps across developing regions, while UN-Water (2024) emphasizes that investments in water structure, groundwater management, wastewater treatment, and climate-resilient agricultural systems must increase considerably to meet the objectives of Sustainable Development Goal 6 and strengthen long-term water security. Aligning international development finance with water security objectives requires not only greater financial commitments but also improved allocation quality and governance effectiveness. Resources should be targeted toward the most water-insecure populations, climate projections should be systematically integrated into infrastructure planning, and investment decisions should explicitly consider social equity and distributional impacts. Equally important is the creation of participatory governance mechanisms that provide local communities with meaningful influence over investment priorities and implementation strategies. The SDG 6 framework offers a normative foundation for such an approach, yet current financing flows remain insufficient relative to the scale of the challenge. Closing this gap will require stronger coordination among national governments, multilateral development banks, international donors, and regional institutions to ensure that climate finance contributes not only to infrastructure development but also to institutional resilience, social inclusion, and sustainable water governance across South Asia.

## CONCLUSION

### *Structural Transformation or Compounding Crisis*

This paper has argued that water insecurity in South Asia is, at its core, a crisis of political economy and governance, not primarily a crisis of physical scarcity. The region receives abundant precipitation; its cryosphere stores enormous freshwater reserves; its groundwater systems are vast. What has produced and reproduced chronic water insecurity for hundreds of millions of people is a set of institutional configuration, subsidized overextraction, exclusionary governance, fragmented management, dysfunctional transboundary frameworks, that systematically allocate water to politically powerful actors while denying it to the most vulnerable, and that perpetuate patterns of use irreconcilably incompatible with long-run hydrological sustainability.

Climate change transforms this already critical situation by accelerating the depletion of the physical water endowments, glaciers, aquifers, monsoon reliability, on which the existing institutional configurations depend, while simultaneously creating new and more severe risks for the most exposed populations. The compound character of climate-driven hydrological change in South Asia, cryospheric retreat, monsoon intensification, sea-level rise, and rising

evapotranspiration operating simultaneously across a region already under severe ater stress, means that governance frameworks adequate to managing historical variability will be progressively inadequate for managing the intensified and novel risks that climate change is generating. The temporal urgency of reform is therefore not merely political but hydrological: the window for effective institutional adaptation is contracting as physical systems approach critical thresholds from which recovery is slow or impossible.

The governance reform agenda proposed in Section 9, structured around subsidy reform, climate adaptive treaty revision, gender-transformative governance, community based groundwater management, and scaled climate finance, is analytically grounded, empirically supported by evidence from successful pilots and comparable governance contexts, and normatively clear in its commitments to equity and sustainability. It is also politically formidable: each element confronts entrenched interests, agricultural constituencies benefiting from subsidized extraction, upstream states benefiting from treaty asymmetries, dominant castes benefiting from discriminatory water access, whose political resources are substantially greater than those of the water-insecure populations whose interests reform would serve. The theoretical contribution of this paper lies in its insistence that this political asymmetry, not technical complexity or resource scarcity, is the fundamental obstacle to South Asian water security. What is insufficient is the political will to pursue institutional transformations whose costs fall on concentrated, organized, and politically powerful interests while whose benefits accrue to dispersed, poorly organized, and politically marginalized populations. The stakes of success or failure are civilizational.. Without transformative governance reform, the compounding water crises documented in this paper will undermine decades of development progress and progressively degrade the physical water endowments on which South Asian civilization has been built over millennia.

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