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Liquid Crisis: Exploring the Impacts of Water Insecurity in South Asia

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Abstract

Water insecurity has emerged as one of the most critical challenges facing South Asia, a region characterized by high population density, rapid urbanization, and transboundary river systems. This paper explores the complex drivers of water insecurity, including climate change, overexploitation of groundwater, pollution, and poor governance, and examines their far-reaching implications for agriculture, public health, socioeconomic development, and regional stability. Special attention is given to the geopolitical tensions surrounding shared rivers such as the Indus, Ganges, and Brahmaputra, which exacerbate interstate relations and hinder effective water management. The paper also analyzes the gendered dimensions of water access and the growing risks of internal displacement and social unrest. Drawing on regional case studies, the study advocates for Integrated Water Resource Management (IWRM), improved transboundary cooperation, and sustainable policy interventions to ensure water security for current and future generations in South Asia.

Keywords: climate change; poor governance; south asia; transboundary rivers; water insecurity

1. Introduction

Water security, defined globally understood as the reliable availability of an acceptable quantity and quality of water for human and ecological needs, is a fundamental pillar of sustainable development (Genesis Water Tech, 2024). This global challenge is particularly acute in South Asia, where a rapidly growing population, reliance on agriculture, and increasing vulnerability to climate change create a complex interplay of environmental, social, and economic factors. (UNICEF, 2023). Water insecurity in South Asia manifests as a

"deficiency in the availability and access to adequate safe and clean water for the common man that is not only important for his physical and mental well-being but also for performing daily, healthy living activities and household chores". This scarcity extends beyond mere drinking water, impacting basic hygiene practices in homes, offices, and schools. The ramifications are extensive, affecting all aspects of life, from minor health issues to major societal disruptions, including political tensions, hindered child development, and the spread of epidemics (Ahmad et al., 2022). Understanding water insecurity requires distinguishing between water availability, the physical presence of adequate water supplies, and water access, the ability of people to obtain clean freshwater (Inouye, 2025). Both aspects are critical in the South Asian context, where geographical factors and the effectiveness of water management infrastructure play crucial roles. Furthermore, the severity of the situation can be categorized using the frameworks of water stress, occurring when a country's annual water supplies drop below 1,700 cubic meters per person, potentially leading to occasional shortages, and water scarcity, when supplies fall below 1,000 cubic meters per person, posing a threat to food production, economic growth, and ecosystem health (John, 2011). Several South Asian nations are either experiencing water scarcity or are rapidly approaching this critical threshold.

The indicators of water insecurity in South Asia paint a stark picture. A significant 74% of the population in the region faces high to extremely high water stress, positioning South Asia as one of the most affected areas globally (Asia Society, 2023). The vulnerability of children is particularly alarming, with a staggering 347 million children under the age of 18 exposed to high or extremely high water scarcity, the highest number in the world. In 2022, 169 million children in South Asia faced extreme water vulnerability, a condition combining high water scarcity with low levels of drinking water service (Unicef, 2023). Moreover, a concerning 68% to 84% of water sources in the region are estimated to be contaminated, raising serious public health concerns (Tachev, 2024). The declining per capita water availability in countries like Pakistan, which has seen a reduction from 1500 cubic meters in 2009 to 1017 cubic meters in 2021, further underscores the escalating crisis (John, 2011). Furthermore, Women are disproportionately affected by water insecurity because they do the majority of household chores linked to water, including carrying and distributing water within the home, particularly among households with low socioeconomic status and those in rural areas.

Table 1: Child Vulnerability to Water Scarcity in South Asia (2022)

Indicator	**Number of Children (<18 years)**	**Source(s)**
Exposed to High or Extremely High Water Scarcity	347 million	(UNICEF 2023)
Facing Extreme Water Vulnerability	169 million	(UNICEF 2023)
Lacking Access to Basic Drinking Water Services	45 million	(UNICEF 2023)

While the crisis is multifaceted, recent scholarly work has also focused on innovative technological and policy solutions. Studies on advanced water management systems, such as

smart irrigation wastewater recycling, offer a promising counter-narrative to the prevailing discourse of scarcity. This paper incorporates these recent developments to provide a comprehensive and forward-looking analysis of water insecurity in South Asia.

2. Objectives of the Study:

The goal of this research is to present a thorough examination of the extensive effects of water scarcity in South Asia. The main goal is to fully examine the complex effects of this crisis on the socioeconomic structure of the area and the welfare of its people. A number of particular goals have been set in order to accomplish this overall objective.

- First, the study will critically analyze the main factors and root causes of South Asia's growing water insecurity dilemma, including the important contributions of demographic changes, climate change, and unsustainable resource management techniques.
- Second, the study will thoroughly examine how water insecurity affects the agriculture sector, which is the foundation of many South Asian countries, and how it affects livelihoods, food security, and regional economic stability.
- Third, the study will examine in detail how water insecurity affects public health, paying special attention to vulnerable groups like children, and how it contributes to the incidence of malnutrition and waterborne illnesses.
- Fourth, the study will examine the effects of water scarcity and variability on the energy sector, including the operation of thermal power plants that need water for cooling and hydropower generation, which are essential in some South Asian nations. It will also analyze the possibility of conflicts related to energy that may arise from water shortages.
- Fifth, the study will assess the wider economic effects of water scarcity, such as how it affects commerce, industrial output, and general economic expansion in South Asian countries.
- Sixth, the research will examine the complex social and human aspects of water insecurity, such as its influence on migration and displacement trends, the escalation of social inequality, and the possibility of intra- and inter-state conflicts over dwindling water supplies.
- Seventh, in order to lessen the effects of water insecurity and advance sustainable water management in South Asia, the study will critically examine both current and suggested technological advancements, legislative initiatives, and community-based strategies.

It's critical to comprehend how successful various remedies are. The study's final goal is to develop evidence-based policy recommendations that take into consideration the distinct socioeconomic and environmental context of South Asia in order to address the region's complex water insecurity issues. The goal of these suggestions is to advance equitable and sustainable water management techniques.

3. Methodology: Outlining the Approach to Data Collection and Analysis

This research employs a comprehensive qualitative methodology centered on a systematic review and synthesis of existing scholarly literature and reports from international organizations and government agencies. The study primarily relies on secondary data to provide a broad and in-depth analysis of water insecurity in South Asia. The Data collection process involves a thorough search of peer-reviewed academic journals indexed in prominent databases such as Web of Science, Scopus, JSTOR, and Google Scholar. The search strategy utilizes relevant keywords, including "water security", "water scarcity", "climate change", "agriculture", "public health", and specific country names within South Asia. This ensures the identification of scholarly articles that provide rigorous analysis and empirical evidence related to the research objectives.

In addition to academic literature, the study incorporates grey literature, which includes policy briefs, reports, and working papers published by key international organizations. These organizations include the United Nations and its various agencies such as UNICEF and UN Water, the World Bank, the Asian Development Bank, and the Food and Agriculture Organization of the United Nations (FAO). These organizations possess extensive data and expertise on water-related issues in developing countries, including South Asia. Furthermore, the research considers relevant reports and statistical data from government agencies within South Asian countries to provide country-specific context and insights into the unique challenges and responses to water insecurity at the national level.

The collected data undergoes a thematic analysis to identify recurring themes, patterns, and key arguments related to the causes, impacts, and potential solutions to water insecurity in South Asia. This process involves systematically coding and categorizing information extracted from the reviewed sources to discern the major trends and critical issues. Comparative analysis is also employed to examine the similarities and differences in the experiences and responses to water insecurity across the diverse nations of South Asia. This comparison considers various factors, including geographical location, levels of economic development, and prevailing political systems, to understand the nuances of the crisis in different contexts. Moreover, the study synthesizes quantitative data, such as statistics on water stress levels, the population affected by water scarcity, and economic losses attributed to water-related disasters, with qualitative information derived from case studies, expert opinions presented in the literature, and policy recommendations. This integration of different types of data aims to provide a nuanced and comprehensive understanding of the complex issue of water insecurity in South Asia.

4. Primary Causes of Water Insecurity in South Asia

Water insecurity in South Asia is a complex issue driven by a confluence of interconnected factors, ranging from environmental changes to human activities and governance challenges. Understanding these primary causes is crucial for formulating effective strategies to mitigate the crisis.

Climate change stands out as a significant driver of water insecurity in the region. Alterations in climate patterns, characterized by increasingly unpredictable rainfall regimes, more frequent and prolonged droughts, and intensified extreme weather events such as floods and cyclones, are significantly disrupting the availability and reliability of water resources across South Asia. For instance, many South Asian countries are experiencing more frequent and severe droughts that last for longer periods due to climate change and increased water demand (UNICEF, 2023). The rapid melting of Himalayan glaciers, often referred to as the "Third Pole" and the source of major rivers like the Indus, Ganges, and Brahmaputra, poses a critical threat. Scientists project a substantial loss of 10% to 30% of their mass by 2030, jeopardizing the stability of these life-sustaining waterways for billions of people downstream (Asia Society, 2023). Black carbon emissions, originating from sources like brick-making kilns and home cookstoves, are accelerating this glacial melt (World Bank Group, 2025). Furthermore, the intensification of monsoons and the rise in erratic rainfall patterns due to climate change are leading to devastating floods, as evidenced by the catastrophic floods in Pakistan in 2022, which caused immense damage to infrastructure and livelihoods (Asia Society, 2023). The compounding effects of rising temperatures and sea levels are also contributing to the contamination of freshwater reserves through saltwater intrusion, particularly in vulnerable coastal regions like Bangladesh (Tachev, 2024).

The sheer scale of population growth and the rapid pace of urbanization in South Asia exert immense pressure on the region's water resources. Home to over a quarter of the world's children, South Asia's burgeoning population drives an ever-increasing demand for water for domestic consumption, agriculture, and industrial activities (John, 2011). Projections indicate a further increase in the South Asian population, potentially reaching around 2 billion with a 1.5°C rise in global temperature, further straining water resources (Rashid et al., 2022). Simultaneously, accelerating rates of urbanization across South Asia lead to a concentration of water demand in urban centers, placing significant pressure on urban water supply and sanitation infrastructure (Vishwanath, 2022). This often results in economic water scarcity, where poorer residents lack the means to access available water, even in cities with abundant resources (Sathre et al., 2022). Rapid urban development can also interfere with natural drainage systems, obstructing waterways and exacerbating the risk of urban flooding, which further impacts water security (Idrica, 2023).

Agricultural practices are another primary cause of water insecurity in South Asia. Agriculture remains the dominant water user in the region, accounting for a vast majority of freshwater consumption, with some countries like Pakistan using as much as 97% of their water for this sector (John, 2011). The prevalence of inefficient traditional irrigation methods leads to significant water wastage, contributing to high levels of freshwater consumption in agriculture (ADB, 2025). In contrast, modern technologies like drip irrigation offer the potential for significantly improved water efficiency (Asia Society, 2025). The unsustainable over-extraction of groundwater for irrigation is causing a rapid depletion of aquifers across the region, particularly in the heavily exploited Indo-Gangetic Basin (UNICEF, 2023). For example, the state of Punjab in India has experienced a 63% decline in groundwater tables due to rice procurement policies that encourage the cultivation of water-intensive crops (Chaudhary, 2024). Government policies, such as subsidized electricity for agricultural

pumping, can inadvertently incentivize excessive water use and contribute to this groundwater depletion (John, 2011).

The rapid pace of industrialization in many South Asian countries contributes to water insecurity through increased water demand for industrial processes and the widespread problem of water pollution. Industrial development necessitates significant water usage, further straining already limited resources. The discharge of untreated industrial wastewater containing harmful chemicals and pollutants, along with untreated sewage from urban areas, into rivers and other water bodies severely degrades water quality, rendering it unfit for other uses (Genesis Water Tech, 2024). A United Nations Environmental Programme study highlighted that 80% of river water in the Asia-Pacific region is polluted (IDRICA, 2023). Additionally, groundwater contamination with substances like arsenic and fluoride, often exacerbated by over-extraction, poses serious health risks to millions (Ahmad et al., 2022). For instance, in Bangladesh, natural arsenic contamination in groundwater affects 60 out of 64 districts (Tachev, 2024).

Finally, mismanagement and governance issues play a critical role in perpetuating water insecurity in South Asia. Inadequate investment in essential water infrastructure, including water treatment facilities, distribution networks, and drainage systems, coupled with poor maintenance and operational inefficiencies, limits access to safe drinking water and increases vulnerability to floods (John, 2011). Government mismanagement, characterized by a lack of long-term strategic planning, policy inconsistencies, and insufficient awareness regarding water conservation, further exacerbates the crisis. The pervasive issue of corruption within the water sector can lead to the misappropriation of funds, inequitable water distribution, and the non-enforcement of crucial water regulations (National Intelligence Council, 2021). Moreover, the lack of integrated water resources management, where different government agencies with overlapping responsibilities may have conflicting priorities, hinders the implementation of effective and coordinated solutions (Hansaz, 2014). For example, the decline in water availability in Pakistan stems from government mismanagement, lack of awareness, and political issues between provinces (Ahmad et al., 2022).

5. Impacts of Water Insecurity on Key Sectors

The pervasive issue of water insecurity in South Asia casts a long shadow over various critical sectors, hindering socio-economic progress and impacting the lives and livelihoods of millions.

Agriculture and Food Security: The agricultural sector, a cornerstone of South Asian economies, is profoundly affected by water scarcity, directly threatening food security in a region heavily reliant on agriculture. Reduced access to irrigation water leads to decreased crop yields and livestock productivity, potentially resulting in food shortages and undermining long-term food supply (Genesis Water Tech, 2024). The situation is projected to worsen, with the demand for food expected to increase by 50% by 2030, while the demand for freshwater is likely to rise by 30%. This escalating agrarian crisis can render millions of farm owners and workers jobless, pushing them towards urban centers in search of alternative livelihoods (John, 2011). Furthermore, 55% of the world's hungry people live in Asia, according to the most recent edition of the United Nations' State of Food Security and

Nutrition in the World (SOFI) Report. The region also has the largest populations of undernourished and moderately-to-severely food insecure individuals (approximately 401 million and 1.4 billion, respectively) (Tan, 2024).

Public Health: Public health is another sector severely impacted by water insecurity. The lack of access to safe and clean water and adequate sanitation facilities creates an environment conducive to the spread of waterborne diseases such as diarrhea, cholera, and typhoid, particularly affecting vulnerable populations like children (UNICEF, 2023). South Asia has suffered a startling loss due to water-related illnesses. Due to a lack of clean water, diarrhea alone claims the lives of around 300,000 children under the age of five every year (gfa WORLD, 2025). Water scarcity also hinders basic hygiene practices, further increasing the risk of infections (Ahmad et al., 2022). Tragically, water insecurity contributes to high child mortality rates, and repeated bouts of diarrheal diseases among young children can impair their cognitive development and school performance (Luby, 2008). The contamination of groundwater with arsenic in regions like Bangladesh poses long-term health risks, including reduced child survival, cognitive impairment, cardiovascular diseases, and cancer. Healthcare systems in the region face significant challenges in managing the increased burden of water-related illnesses amidst water shortages (UNICEF, 2023).

Energy and Economic Development: The energy sector is also vulnerable to the impacts of water insecurity. Water scarcity can directly affect hydroelectric power generation, potentially leading to energy crises in countries that rely heavily on hydropower (Ahmad et al., 2022). Additionally, thermal power plants require substantial amounts of water for cooling, and shortages can result in significant energy outages, disrupting industrial and domestic activities. For instance, a lack of water to cool thermal power plants in India between 2017 and 2021 resulted in a loss of 8.2 terawatt-hours of energy (Kuzma et al., 2023). The broader economy of South Asian nations is significantly impacted by water insecurity. Water shortages affecting agriculture, industry, and energy production can trigger overall economic crises (UNICEF, 2023). Inadequate water management could lead to substantial GDP losses in India, China, and Central Asia (Kuzma et al., 2023). Financial hardships faced by farming families due to water scarcity can negatively impact children's education and potentially push them into child labor. The lack of access to safe water and sanitation can undermine overall economic development by affecting the health and productivity of the workforce (UNICEF, 2016).

Social and Human Consequences: Beyond the sectoral impacts, water insecurity in South Asia has profound social and human consequences, affecting individuals and communities in numerous ways. Displacement and migration are significant outcomes of water scarcity, droughts, and floods in the region (UNICEF, 2023). When water resources become unsustainable, populations are often forced to leave their homes and livelihoods, leading to displacement both within countries and across borders. Climate change is expected to exacerbate this trend, with increasing instances of climate-induced migration due to water-related disasters (Fruman & Roome, 2022).

Gender disparities are often amplified by water insecurity. In many South Asian societies, women and girls bear the primary responsibility for fetching water for their households, a

task that can consume significant amounts of time and expose them to safety risks (Gupta, 2025). The lack of safe water and sanitation facilities in schools also disproportionately affects adolescent girls, leading to increased absenteeism during menstruation (Metzner, 2022). Water insecurity also exacerbates existing social and economic inequalities. Poorer segments of the population often face economic water scarcity, lacking the financial means to access sufficient safe water, even in urban areas with relatively abundant resources (UNICEF, 2016). Several studies also show a link between water insecurity and gender-based violence, highlighting the psychological and physical risks women encounter (Tallman, Paula.S., Collins, Shalean., Mulanovich Salmon, Gabriela., Rusyidi, Binahayati., Kothadia, Aman., Cole, Stroma., 2022). According to data gathered in 90 countries between 2001 and 2019, women spend 2.5 times as much time as men doing unpaid caregiving and housework, and this percentage has increased since the pandemic. Furthermore, almost one in three women (736 million) experience violence of some kind, according to the SDG Report 2021, which shows that violence against women is still at unacceptable levels.

These indicators collectively highlight the urgent need for comprehensive action to address the growing liquid crisis in South Asia.

6 Water Insecurity and its Impact on South Asian Nations Relations :

Competition for increasingly scarce water resources can also lead to conflict at various levels. This can manifest as disputes within communities over access to limited supplies, tensions between regions vying for water allocation, and even international conflicts between countries sharing transboundary rivers. Unequal power dynamics among riparian countries further complicate water-sharing arrangements, often leading to hydro-political tensions (Asia Society, 2023). As water security diminishes and geopolitical competition grows, shared water resources are increasingly likely to become flashpoints (Global Trends, 2021). South Asia's major transboundary rivers- the Indus, Ganges, and Brahmaputra- are central to the water security of multiple nations, making them focal points for disputes (World Bank Group, 2023).

- **Indus River System (India and Pakistan):**

The Indus Water Treaty, brokered by the World Bank in 1960, is a landmark water-sharing agreement between India and Pakistan. It allocates the waters of the Indus, Jhelum, and Chenab rivers to Pakistan, and the Ravi, Beas, and Sutlej rivers to India. While often hailed as one of the most successful water treaties, disputes have frequently arisen, primarily concerning India's construction of hydroelectric projects on the Western Rivers (allocated to Pakistan) (Climate Diplomacy). Pakistan often objects to India's dam designs and storage capacities, fearing a reduction in water flow. Recent disputes have involved projects like Baglihar and Kishenganga hydroelectric plants. India maintains that its projects are run-of-the-river and within the treaty's provisions for non-consumptive use and power generation (Jamal, 2025). These disputes strain already tense India-Pakistan relations, impacting regional harmony and cooperation on other matters. The agricultural sectors, vital to both economies, are particularly vulnerable to these water issues (Sahana, 2025; John, 2011).

While often hailed as one of the most successful water treaties, disputes have frequently arisen, primarily concerning india's construction of hydroelectric projects. These disputes strain already tense India-Pakistan relations, impacting regional harmony and cooperation on other matters. The agricultural sectors, vital to both economies, are particularly vulnerable to these water issues. The strategic importance of the treaty is underscored by instances where political tensions, such as the 2016 Uri attack and the 2019 Pulwama incident, led to calls for its review, through the treaty itself has not been abrogated (DH Web Desk, 2025). Furthermore, a recent and significant escalation occurred following the Pahalgam terror attack in April 2025. After militants linked to Pakistan carried out a deadly attack on tourists in Jammu and Kashmir, India's Cabinet Committee on Security announced the suspension of the Indus Waters Treaty. This move was part of a broader set of diplomatic and security measures, including the closure of the Attari border and the recall of diplomatic staff (Banerji & Sitaraman, 2025).

In response, Islamabad declared that any attempt to stop or divert the flow of water belonging to Pakistan will be considered an act of war and denied any involvement in the attack.While the unilateral suspension of the treaty is a significant diplomatic escalation, legal experts note that the treaty does not contain a unilateral exit clause. The action, therefore, is widely seen as a political signal to exert pressure on Pakistan rather than a permanent abrogation. The incident underscores the fragility of transboundary water agreements in the face of ongoing geopolitical conflict and highlights how water can be weaponized in political rhetoric, even if not physically in practice (Kestler-D'Amours, 2025).

- **Ganges River (India and Bangladesh):**

The Ganges river is a crucial transboundary river for both India and Bangladesh. The Ganges Water Sharing Treaty was signed in 1996, aiming to address Bangladesh's concerns over dry-season water flow, which was significantly reduced after India constructed the Farakka Barrage in the 1970s (Yett, 2025). Despite the treaty, Bangladesh frequently claims that it does not receive its agreed-upon share of water, especially during the critical dry season (January to May). The Treaty's reliance on historical flow data from 1949-1988 at the Farakka Barrage is a point of contention, as Bangladesh argues it doesn't account for increased climate variability and upstream water withdrawals by India. The lack of a minimum "guarantee clause" in the treaty also leaves Bangladesh vulnerable (Nishat & Faisal, 2000). The large river-linking project that India is undertaking is another contentious matter between Bangladesh and India. The Inter-River Linking project presents complex problems and difficulties relating to financial, ecological, and social consequences. Moreover, India has made plans to work on a river-linking project that will move water from "water-surplus areas" to "water-deficit areas." While the southern and western regions have been classified as having a water deficit, the main river reservoirs in the eastern part, including the Ganges and Brahmaputra basins, have been classified as slightly surplus and surplus areas, respectively. India plans to divert a significant amount of water under this project from its eastern part (the Ganga-Brahmaputra basin) to its southwestern and western regions. Bangladesh has expressed its grave concern to India, which has taken it seriously (Mehta & Mehta, 2013). Bangladesh believes that its response to India thus far has been

"discouraging to initiate a productive dialogue on the issue," and it was hoped that India's transition from the NDA to the UPA government would aid in the review of its plan. Additionally, the UPA administration, led by Manmohan Singh, not only chose to endorse the proposal but also reinforced it at the beginning of 2014, and at the same time, India promised Bangladesh that it would not decide on the Himalayan portion of their projected river interlinking project unilaterally (Haque, 2018).

Moreover, water scarcity in the Ganges basin affects agricultural output, fisheries, and navigation in Bangladesh, impacting livelihoods and environmental health, particularly in the ecologically sensitive Sundarbans Delta. Recently, the Ganges Water Treaty, which was signed in 1996 and is set to expire in 2026, is to be renewed, according to a decision made by the governments of Bangladesh and India. No new agreement between the two nations has been ratified, and talks in this area have not yet begun (Ministry of External Affairs, 2024).

- **Brahmaputra River (China, India, and Bangladesh):**

The Brahmaputra (known as Yarlung Tsangpo) originates in Tibet, flows through India, and then into Bangladesh. The absence of a formal water-sharing treaty among these three nations makes it a significant potential flashpoint. China, as the upstream riparian, holds a significant advantage. Its extensive dam-building activities and water diversion plans on the Brahmaputra in Tibet raise considerable concern in India and Bangladesh. There is a trust deficit due to China’s reluctance to share detailed hydrological data consistently. Both India and Bangladesh fear that these upstream projects could alter natural river flows, potentially leading to reduced water availability during dry seasons or increased flooding during monsoons. India is also building its own hydropower projects on the Brahmaputra within its borders (Mustafa, 2024; Deka, 2024). Any unilateral actions by China on the Brahmaputra could have severe consequences for India’s northeastern states and Bangladesh, impacting agriculture, flood management, and hydropower generation. The strategic implications are also significant, with concerns about China’s ability to manipulate water flow during times of political tension (Mishra, 2025; Chowdhury, 2025).

6. Sustainable Solutions and Technological Advancements

To effectively address the multi-faceted water crisis in South Asia, a combination of policy reforms, technological innovation, and transboundary cooperation is essential. The promotion of Integrated Water Resource Management (IWRM) stands as a critical strategic priority. IWRM seeks to coordinate the development and management of water, land, and related resources to maximize economic and social welfare without compromising the sustainability of vital ecosystems (GWP, 2022). This approach is crucial for improving transboundary cooperation and ensuring more equitable water sharing among nations. Beyond policy, recent studies highlight the potential of innovative technological solutions to mitigate scarcity and improve water quality.

In urban areas, smart water management systems are emerging as a powerful tool. These systems use a network of Internet of Things (IoT) sensors and data analytics to monitor water pressure, detect leaks in real-time, and forecast demand, which can significantly reduce water loss (Frost & Sullivan, 2023). For instance, cities are piloting Ai-powered systems that

analyze water usage patterns to optimize distribution and conserve resources. Furthermore, the development of advanced wastewater treatment and recycling technologies offers a sustainable way to meet non-potable water needs for industry and agriculture. The case of Chennai, India, which has implemented large-scale wastewater recycling, serves as a successful model for other urban centres grappling with water stress (World Bank Group, 2023).

For the agriculture sector, where a vast majority of water is consumed, precision agriculture and modern irrigation techniques are essential. Technologies like drip and sprinkler irrigation, which deliver water directly to plant roots, can dramatically increase water efficiency compared to traditional flood irrigation. Remote sensing and satellite imagery also allow farmers to monitor soil moisture and crop health, enabling them to make more informed decisions about water application (FAO, 2023). Lastly, to combat increasing water contamination, the adoption of new purification technologies, such as advanced filtration and low-cost solar-powered water purifiers for rural communities, is critical for safeguarding public health (UNICEF, 2024).

7. Case Studies of Water Insecurity in South Asia

Examining specific country examples within South Asia reveals the unique challenges and responses to water insecurity across the region.

Pakistan faces severe water scarcity, with per capita water availability nearing the threshold of becoming a water-scarce country. Mismanagement, a lack of long-term policy, and significant infrastructure deficits contribute to this crisis (John, 2011). Groundwater levels in Lahore are declining at an alarming rate of 1 meter per year, and a substantial portion of the population is at risk of exposure to high levels of arsenic in drinking water. The Thar region experiences acute water shortages, leading to high child mortality rates due to drought, malnutrition, and insufficient WASH facilities (Ahmad et al., 2022).

India is grappling with high to extreme water stress, affecting a large portion of its population (John, 2011). Over-exploitation of groundwater, particularly for irrigation, is a major concern, with regions like the Indo-Gangetic Basin being heavily exploited (UNICEF, 2023). Water sources are also facing contamination issues (UNICEF, 2016). However, some cities, like Chennai, have implemented innovative solutions such as large-scale wastewater recycling to meet industrial water needs (World Bank Group, 2023). Efforts are also underway to rejuvenate major rivers like the Ganges through the Namami Gange Programme, a flagship initiative that integrates pollution abatement with river conservation. Furthermore, community-led initiatives such as Jalyukta Shivar Abhiyan in Maharashtra showcase a shift towards decentralized, participatory groundwater management (World Bank Group).

Bangladesh experiences challenges related to highly variable water flow and poor water quality. A significant portion of the country faces natural arsenic contamination in groundwater (Tachev, 2024). Additionally, Bangladesh's low-lying geography makes it highly vulnerable to floods and cyclones, which can severely impact water and sanitation infrastructure (Gupta, 2025). Despite these challenges, the country has undertaken initiatives

to improve water safety, including community-led efforts to install safer, arsenic-free tube wells and investments in climate-resilient water infrastructure in coastal areas.

Furthermore, Nepal faces water scarcity issues stemming from insufficient investment in water storage and supply infrastructure, particularly impacting the ability to meet dry-season demands (FAO & Australian Water Partnership, 2023). As a Himalayan nation, Nepal is also vulnerable to the impacts of melting glaciers on river flows, which are crucial for its water resources (Asia Society, 2023).

Table 2: Case Studies: Challenges and Responses to Water Insecurity

Country	**Key Water Insecurity Challenges**	**Notable Responses/Initiatives**
Pakistan	Severe water scarcity, mismanagement, groundwater depletion, arsenic contamination	Limited long-term policy; infrastructure deficits; ongoing efforts for public awareness
India	High water stress, groundwater over-exploitation, water contamination	Wastewater recycling in Chennai; Namami Gange Programme, community-led groundwater management, Jalyukta Shivar Abhiyan
Bangladesh	Variable water flow, poor water quality, arsenic contamination, vulnerability to floods/cyclones	Coastal embankment projects, community-based water purification systems, and international cooperation on transboundary rivers
Nepal	Insufficient water storage and supply infrastructure, dry-season demand, glacial melt impacts	Development of small-scale irrigation systems, community-managed water supply projects

8. Solutions and Mitigation Strategies

Addressing the complex challenges of water insecurity in South Asia requires a multi-pronged approach encompassing technological innovations, policy interventions, and community-based strategies.

Technological innovations offer significant potential for improving water management and enhancing water security. In agriculture, adopting improved irrigation technologies such as drip irrigation can dramatically increase water use efficiency (Asia Society, 2025). Advancements in water treatment technologies can enhance water quality and enable the use of unconventional water sources, such as treated wastewater, for various purposes (World Bank Group, 2023). Implementing water metering in urban areas can lead to structural improvements in water management and billing, although ensuring access for the poorest residents is crucial (Asian Development Bank). Promoting rooftop rainwater harvesting and capture-enhanced groundwater recharge can augment local water supplies in some areas (Suneja, 2018). Furthermore, investing in and utilizing early warning systems for floods and droughts can help communities and authorities prepare for and mitigate the impacts of extreme weather events (World Bank Group).

Effective policy interventions are essential for long-term water security. Implementing integrated water resources management (IWRM) policies that consider the interconnectedness of different water uses and sources is crucial (Ahmad et al, 2022). Establishing and enforcing robust regulatory frameworks for groundwater extraction and

industrial pollution are necessary to prevent over-exploitation and contamination of water resources. (Global Trends, 2021). Designing water tariffs that reflect the true cost of service delivery while ensuring affordability for low-income households can promote more efficient water use and support the financial sustainability of water utilities (World Bank Group). Strengthening regional cooperation and establishing effective agreements for the management of transboundary water resources are vital for ensuring equitable and sustainable water sharing among South Asian nations (Global Trends, 2021). Increased government investment in the development and maintenance of water infrastructure is also paramount for improving access and reliability of water services (John, 2011).

To address water conservation, the Indian government has launched a number of projects. In order to guarantee that all rural families have access to safe drinking water by 2024 through tap connections, the Jal Jeevan Mission was started in 2019 along with the formation of the Ministry of Jal Shakti. Furthermore, the government started the Jal Shakti Abhiyan, a nationwide initiative to conserve rainwater. Additionally, the Atal Bhujal Yojana, a community-led government initiative for efficient groundwater management, has been implemented in a number of water-stressed Indian states, including Rajasthan, Madhya Pradesh, Uttar Pradesh, Gujarat, Karnataka, Haryana, and Maharashtra. The South Asia Water Initiative (SAWI) was also created by the South Asian Association for Regional Cooperation (SAARC) to encourage collaboration and ease communication among its member nations over matters pertaining to water. In order to improve water management in the area, SAWI seeks to promote the exchange of best practices, information, and experiences, and manufacturing procedures. These regulations emphasize how important it is to include all relevant parties in discussions on water management, including farmers, fishermen, and indigenous groups. Furthermore, the need for sustainable management of shared water resources is specifically emphasized in the Sustainable Development Goals (SDGs) of the UN (Madaan, 2024). Instead of causing conflict, these global factors might encourage cooperation among South Asian nations. In addition, the South Asia Water Cooperation (SAARC-WC) is also playing its important role. Facilitating informal contact and information sharing is the main purpose of the South Asia Water Cooperation (SAARC-WC), which aims to foster understanding and collaboration. Notable instances of collaborative initiatives are the Joint Flood Control Plan and the Bangladesh-Indo-Gangetic Water Agreement (Madaan, 2024).

Community-based approaches play a significant role in fostering sustainable water management. Engaging citizens in participatory local governance of groundwater resources can lead to more effective and equitable outcomes (Suneja, 2018). Raising public awareness through education campaigns about the importance of water conservation and promoting responsible water use can encourage behavioral changes at the individual and community levels (Ahmad et al., 2022). Supporting community-led initiatives for groundwater management has proven effective in some areas (World Bank Group). Recognizing and leveraging the potential of nature-based solutions, such as the conservation and restoration of wetlands and marshes, can provide cost-effective and sustainable approaches to water management and flood control (World Bank Group, 2024).

9. Conclusion and Recommendations:

The 'liquid crisis' in South Asia is a complex and urgent challenge with profound implications for the region's people, economies, and geopolitical stability. This paper has demonstrated how a confluence of factors, including climate change, rapid population growth, unsustainable agricultural practices, and poor governance, drives water insecurity. The consequences are far-reaching, from threatening food security and public health to escalating tensions between nations over shared rivers. The paper has underscored the disproportionate impact on vulnerable populations, including women and children, who are often at the forefront of this crisis.

While the challenges are immense, a path toward water security is possible through coordinated and sustainable interventions. This implementation of robust IWRM frameworks, particularly for transboundary rivers, is essential to foster cooperation and stability. Furthermore, leveraging innovative technologies-from smart water networks and wastewater recycling to precision agriculture-will be crucial for improving efficiency and expanding access to safe water. Ultimately, addressing water insecurity in South Asia requires a commitment to long-term strategic planning, equitable policy implementation, and investment in resilient infrastructure and technology. A failure to act will not only exacerbate human suffering but also jeopardize the region's sustainable development and collective future.

To address this escalating crisis and ensure a water-secure future for South Asia, comprehensive and collaborative action is urgently needed. Based on the findings of this review, the following recommendations are proposed:

- **Strengthen Water Governance:** Implement integrated water resources management policies that promote coordination across different sectors and levels of government. Enhance transparency and accountability within water institutions and actively combat corruption in the water sector.
- **Promote Sustainable Agriculture:** Incentivize the adoption of water-efficient irrigation technologies, such as drip and sprinkler systems, and promote the cultivation of drought-resistant crops. Reform agricultural subsidies to discourage the overuse of water and encourage water-wise farming practices.
- **Invest in Water Infrastructure:** Significantly increase public and private investment in the development and modernization of water treatment plants, efficient water distribution networks to reduce leakage, and adequate water storage facilities, including reservoirs and groundwater recharge infrastructure.
- **Enhance Water Use Efficiency:** Implement measures to reduce water losses in both urban and rural areas through infrastructure upgrades and leak detection programs. Promote water recycling and reuse for industrial, agricultural, and even domestic purposes where feasible and safe. Encourage water-wise behaviors through public awareness campaigns and pricing mechanisms that incentivize conservation.

- **Address Climate Change Impacts:** Develop and implement robust climate change adaptation strategies specifically for the water sector. This includes improving flood management systems, enhancing drought preparedness measures, and investing in climate-resilient water infrastructure.
- **Foster Regional Cooperation:** Strengthen existing transboundary water management agreements and actively promote collaborative approaches to the sustainable and equitable management of shared water resources among South Asian countries. Establish platforms for regular dialogue and data sharing to build trust and facilitate joint solutions.
- **Empower Communities:** Engage local communities in the planning and management of water resources, recognizing their traditional knowledge and empowering them to take ownership of water security efforts. Promote awareness about water conservation and hygiene practices through community-based education and outreach programs. Support community-led initiatives for water harvesting, storage, and efficient water use.
- **Prioritize Public Health:** Ensure universal access to safe drinking water and sanitation facilities, particularly for vulnerable populations. Implement effective water quality monitoring and treatment programs to prevent waterborne diseases. Strengthen public health infrastructure to address the health consequences of water insecurity.
- **Invest in Research and Innovation:** Support research and development of water-efficient technologies, climate-resilient water management practices, and sustainable water resource management strategies tailored to the specific context of South Asia. Encourage innovation in water treatment and desalination technologies to augment water supplies.

Addressing the liquid crisis in South Asia requires a concerted effort from governments, international organizations, civil society, and local communities. By implementing these recommendations, the region can move towards a more water-secure future, ensuring the health, prosperity, and stability of its people and ecosystems.

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