FEATURE

Addressing the Diversity of Water Challenges in the Indo-Pacific

Need for Broad Cooperative Approaches

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Abstract

This article examines the diversity of water challenges across the Indo-Pacific region resulting from climate change, geography, population growth, and other factors. It argues that collaborative, cooperative approaches involving both technological/scientific and political/governmental perspectives are needed to address threats to water security and resilience at scales from the individual to the transnational. After outlining key axes along which water challenges manifest, including scale, time, causation, quantity, and quality, examples of internal national and cross-border tensions tied to water are explored. The article then discusses current usage patterns in the agricultural, industrial, and domestic sectors, noting inefficiencies and lack of conservation. It advocates melding scientific and technological means for gathering, storing, distributing water with equitable political agreements among stakeholders that mandate transparent data sharing on water availability and quality. Only through such synergistic blending of science and policy, the article concludes, can solutions prove effective over the long term in the face of climate disruption impacts.

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Clean, fresh water plays a pivotal role in ensuring the survival and well-being of individuals, bolstering the resilience and sustainability of local communities, fortifying national security, and fostering international commerce and stability. Throughout the expansive Indo-Pacific region, climate disruption poses a significant threat to water security at individual, community, national, and international levels, carrying far-reaching implications for political stability, interstate tensions, and US interests.

The diverse landscapes of the Indo-Pacific region present a spectrum of water-related challenges, spanning from individual human security to transnational interactions. These challenges are shaped by the region's varied climatic, environmental, and geopolitical conditions, manifesting along multiple axes. While some challenges stem from natural factors, such as variations in surface and groundwater availability, others are influenced by human activities, including agriculture and industry, and, increasingly, climate and weather patterns. These water challenges can be internal, affecting residents of a single country, or they can contribute to and intensify transnational tensions.

Asia, in particular, faces pronounced water challenges, being home to 60 percent of the world's population yet having less fresh water per capita than any other continent. With freshwater availability at 2.7 m3/person/year— less than half the global average of 5.8 m3/person/year—Asia experiences some of the world's most rapid growth in freshwater withdrawals from rivers, lakes, and aquifers.[1]

Addressing geopolitical water challenges involves a spectrum of approaches, leaning either toward mitigation or adaptation. Such actions should, but unfortunately do not, consistently include collaborations to enhance water conservation and stewardship. Scientific and technological methodologies frequently come into play to tackle water challenges, alongside political negotiations that can occur within a single country or across borders. Given the swift changes induced by climate disruption in the Indo-Pacific and globally, future strategies for addressing water challenges will inevitably require a synergistic blend of innovative technical and scientific solutions, coupled with collaborative political and governmental efforts, to effectively advance water security and resilience.

Axes of Challenges

Water challenges encompass issues related to scale, time, and causative factors, along with concerns about quantity and quality, often addressable through scientific and technological means. These dimensions are interconnected, and multiple factors may be at play simultaneously in a given time or place.

In terms of scale, water challenges span from the individual level, where dehydration and the risk of death are tangible threats in certain areas, to local community levels, where water shortages can lead to illness, migration, and social disruption. These challenges extend to broader regional, national, and transboundary levels, introducing issues such as population migration, social tensions, and conflict. It is noteworthy that challenges at larger group levels carry the same risks as those at more individual levels. Additionally, financial aspects are prevalent across all scales, with the costs of treating, storing, and distributing water often proving unaffordable. Whether charging individual consumers for drinking water or constructing a dam, reservoir, or water treatment plant for a nation, basic economics frequently hinders access to sufficient quantities of suitable quality water for those with limited means.

Water challenges also unfold over a wide time scale. Immediate threats, such as drowning in a flood or succumbing to dehydration after three days without water,

[1] Brahma Chellaney, "Water shortages pose a threat to Asia's peace and stability," *Nekkei Asia,* 11 January 2018, https://asia.nikkei.com/.

pose risks for individuals. Commonly, challenges related to water quantity, like droughts or floods, occur over longer periods of weeks to months. However, climate disruption is accelerating some of these challenges; the emergence of *flash droughts* and the increasing speed of development of tropical cyclones illustrate this shift.[2] Gradual climatic shifts over years to decades can lead to persistent water-related challenges. Similar to challenges of scale, those related to time may have impacts ranging from basic individual health security, through local or regional unrest, to national or transnational resilience and stability.

The underlying *causative factors* contributing to water challenges include climate disruption, land usage, pollution, and economics. The significance of the first factor extends not only across the Indo-Pacific but globally. A prevailing trend of more prolonged and severe droughts interspersed with torrential rainfall seems to be supplanting the traditional, more predictable pattern of consistent wet and dry seasons in numerous regions. Examples such as the 2022 floods that submerged one-third of Pakistan after a severe drought and the 2019 drought that left Chennai, India (a city of nearly 12.5 million people), without water highlight this shift. While neither case escalated into kinetic revolutionary action, the scale of both instances underscores the potential for catastrophic social and/or political impact.

The impact of altered climate on water resource availability cannot be overstated. Warming oceans contribute to intensified tropical storms that generate extraordinary rainfall. Additionally, the increased heat in oceanic waters alters patterns such as the El Niño/La Niña cycle and the Atlantic Meridional Overturning Circulation (AMOC), leading to changes in regional precipitation that can persist over years. Notably, the warming-induced melting of Greenland's glaciers has weakened the AMOC to an estimated thousand-year low; while some view this slowdown as having the potential for global catastrophic impacts, others believe these systems may possess inherent resilience.[3]

Land use patterns influence water availability, with deforestation and desertification altering local water resources, often as direct outcomes of unsustainable rates of tree felling or poor farming practices. Climate change frequently plays a pivotal role in land usage, impacting crop yields and, consequently, local and regional

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[2] National Oceanic and Atmospheric Administration, "Flash Drought," *National Integrated Drought Information System*, 2023, https://www.drought.gov/ and Yi Li et al., "Recent increases in tropical cyclone rapid intensification events in global offshore regions," *Nature Communications* 14 (24 August 2023): 5167, https://doi.org/.

[3] Rémy Bonnet et al., "Increased risk of near-term global warming due to a recent AMOC weakening," *Nature Communications* 12 (20 October 2021), 6108, https://www.nature.com/; and Sacha Sinet, Anna S. von der Heydt, and Henk A. Dijkstra, "AMOC Stabilization Under the Interaction With Tipping Polar Ice Sheets," *Geophysical Research Letters* 50 (2023), e2022GL100305, https://doi.org/.

economies over just a few years. Persistent shifts may necessitate significant changes in agricultural practices, leading to social and economic disruption that can strain and destabilize governments, potentially resulting in cascading effects. Pollution, linked to land usage, can directly degrade water quality through discharges into surface drinking water sources or indirectly, such as through aquifer contamination. This degradation can occur immediately, as in the case of chemical spills, or unfold over the long term.

As previously highlighted, economic factors restrict access to clean water, especially in developing countries. The construction of water infrastructure, particularly in rapidly expanding urban centers, is a costly and intricate undertaking. The associated expenses encompass not only providing adequate quantities and quality of water but also the means to dispose of and treat the inevitable wastewater. Neglecting or short-changing either aspect of the process can result in significant health costs.

The considerations of both water quantity and quality are best addressed collectively, as both are integral to any pragmatic approach to drinking water challenges. These aspects are of particular interest, as scientific and technical approaches can often offer at least partial solutions. (It is important to note that both aspects may also be influenced by climate change.) Insufficient water, especially in the form of rainfall, can lead to devastating droughts, while excessive water, particularly in short time frames, results in flooding, one of the most destructive natural disasters.[4] Technology-based solutions, such as drilling wells and damming rivers, are frequently employed to build up water reserves, with the latter also playing critical roles in flood control. Rainwater catchment, utilized since ancient times, continues to evolve with associated technologies. Inducing rainfall, for instance, through cloud seeding with halide salts, has been practiced since the mid–twentieth century, while rain-stimulating technologies involving electrical charges and laser pulses are currently under exploration. These dynamics could directly and negatively impact regional security and geopolitical stability.

Similarly, the quality of available water can be a matter of life or death. If the water designated for consumption contains more than very limited amounts of various contaminants, it is deemed nonpotable, requiring technological approaches ranging from low-tech to high-tech to address quality issues. Pollutants such as simple dirt or suspended matter may be removed through settling or basic filtering. Excess salt, an increasingly common contaminant in coastal regions due to rising sea levels, necessitates more sophisticated methods like reverse osmosis (RO) or

[4] Hannah Ritchie and Pablo Rosado, "Natural Disasters," *Our World in Data*, January 2024, https://ourworldindata.org/.

distillation. Chemicals such as pesticides and herbicides require RO or carbon block filtration, while heavy metals demand specialized decontamination methods like precipitation, cryogel filtration, or treatments based on adsorption, chemicals, electricity, or photocatalysis.[5]

Microbial contamination calls for chemical (e.g., halogens, silver) treatment, RO, distillation, or exposure to sufficiently prolonged and intense heat or ultraviolet radiation. As with other water quality issues, the specific approach employed may depend on the local context. For instance, in many Pacific island situations where municipal water supplies are unreliable or nonexistent, and microbial contamination of stored rainwater is a major challenge for residents, an innovative point-of-use approach emerged around 2012—the Madidrop®, an inexpensive, porous, silver-infused ceramic cake placed in a 5–10-gallon dispenser (topped off each night with untreated catchment water) provides microbe-free water for a year.

Central to the matter of quality, regardless of the water quantity within a state's boundaries or its cleanliness, those fortunate enough to have inherited abundant water resources do not have the right to waste or pollute it. Water is a limited resource; the water molecules we have today are essentially the same as those present on this globe about four billion years ago. Realistically, we cannot create more water, and we all bear a responsibility to exercise stewardship over the water we control.

Indo-Pacific Water Challenges: Internal

Several examples will illustrate the diversity of water challenges in the Indo-Pacific, although they by no means encompass the breadth of water issues within a country's borders.

Climate Change: Ongoing climate disruption is subjecting small Pacific Islands, particularly atolls like Pohnpei, Kosrae, and Majuro, to increasingly prolonged droughts. Dry seasons, once of moderate intensity and predictable length, are now more intense and extended beyond historical norms, compounded by higher temperatures. Atoll islands, highly dependent on rainfall, face devastating consequences, damaging their agro-forest food bases and threatening basic potable water supplies. In some cases, families and communities are forced to evacuate entire islands due to the severity of the impact.[6] (Numerous other climate-change-based water challenges could be cited.)

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[5] Naef A. A. Qasem, Ramy H. Mohammed, and Dahiru U. Lawal, "Removal of heavy metal ions from wastewater: a comprehensive and critical review," *npj Clean Water*, 4 (2021), 36, https://doi.org/.

[6] *Republic of the Marshall Islands: Disaster Management Reference Handbook* (Honolulu: Center for Excellence in Disaster Management & Humanitarian Assistance, December 2022), https://www.cfe-dmha.org/.

Natural Contamination: In Bangladesh, the shift to tubewells in the 1970s led to a decrease in waterborne contaminant diseases. However, tubewells currently used by approximately 50 million residents tap into water with significant levels of arsenic, causing arsenicosis and various health issues. Arsenic levels in many areas are sufficient to induce cancer through long-term consumption of low-dose, arsenic-laden water.[7] (Beyond Bangladesh, at least 90 million people from around 50 countries, including Argentina, Chile, China, Hungary, India, Mexico, Nepal, Taiwan, and the United States, are exposed to arsenic through contaminated groundwater, according to World Health Organization.) Various technologies, including coagulation, sedimentation, and others, can remove arsenic from water.[8]

Human-Caused Pollution: China's "economic miracle," lifting millions out of poverty, has come at the cost of its water quality. Half of China's population lacks access to safe drinking water; two-thirds of rural residents rely on tainted water. Between 80 and 90 percent of China's groundwater is unfit for drinking, and half is too polluted for industry or farming.[9] Widespread wastewater discharge by factories into local waterways, enabled by poor environmental regulations, weak enforcement, and/or local corruption, contributes to toxic levels of arsenic, fluorine, and sulfates. China's water pollution is linked to high rates of cancer, and some villages near factory complexes are labeled 'cancer villages' due to elevated cancer and death rates. The World Bank warns of "catastrophic consequences for future generations" due to water pollution in China.[10] Many scientific and technological approaches are available to control water pollution, with on-site treatment or capture being most effective for point sources, though challenging for widely dispersed pollutants like fertilizers and pesticides.

Cross-border Water Tensions and Conflicts

Conflicts over water resources on an international scale have a long history, dating back to at least 2500 BCE.[11] The recognition of the necessity for geopolitical

[7] Sk Akhtar Ahmad, Manzurul Haque Khan, and Mushfiqul Haque, "Arsenic contamination in groundwater in Bangladesh: implications and challenges for healthcare policy," *Risk Management and Healthcare Policy* 11 (2018): 251–61, https://doi.org/.

[8] Sushil R. Kanel et al., "Arsenic Contamination in Groundwater: Geochemical Basis of Treatment Technologies," *ACS Environmental* 3, no. 3 (2023): 135–52, https://doi.org/.

[9] Henry Storey, "Water scarcity challenges China's development model," *The Interpreter*, 29 September 2022, https://www.lowyinstitute.org/.

[10] Carolyn Gibson, "Water Pollution in China Is the Country's Worst Environmental Issue," *Borgen Project*, 10 March 2018, https://borgenproject.org/.

[11] "Water Conflict Chronology," Pacific Institute, 2024, https://www.worldwater.org/.

entities to collaborate on water issues also has deep roots, extending to that same era and is sometimes credited as the subject of the earliest international treaties.[12]

Both conflicts and treaties persist today, with the frequency and persistence of conflicts seemingly outweighing the occurrence of treaties. Similar to the "internal" examples mentioned earlier, the following summaries are not exhaustive but aim to highlight key aspects of cross-border water tensions and attempts at resolution.

One of the most well-known water treaties is the Indus Water Treaty (IWT). Concluded in 1960, after the 1947 partition of India and Pakistan and water suspensions in 1948 (when the East Punjab province of India shut off water to the West Punjab province of Pakistan), and supported by approximately USD 1 billion from the World Bank, the IWT has withstood three wars between India and Pakistan. The IWT established a straightforward, physical division of watersheds, allocating the flow from three eastern tributaries of the Indus (Ravi, Sutluj, and Beas) to India, while the flow from three western tributaries (Indus, Jhelum, and Chenab) goes to Pakistan. The IWT lacks provisions or incentives for collaboration or data sharing. The designated flows may not be interrupted by either side (except for "customary use" and "limited agricultural diversion"), and any violation of the treaty is considered an act of war.[13] Canals built ostensibly for agricultural purposes also have security implications, serving as defensive barriers against invasion, illustrating how water rights agreements can spill over into other sectors. Recently, a renegotiation of the IWT has been proposed, but the process appears complicated, and concrete action has not materialized.[14]

The IWT serves as an illustration of both the strengths and weaknesses inherent in collaborative water agreements. On one hand, it has likely played a pivotal role in preventing kinetic conflict over water. However, as the populations of both nations continue to grow and the demand for water increases, the treaty's failure to address fundamental issues of conservation and data sharing seems likely to undermine its effectiveness. Given the historical hostilities between India and Pakistan and the projected decline of Indus watershed flows due to the shrinking glaciers (attributed to climate change), it is reasonable to question the long-term viability of the IWT.[15]

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[12] United Nations Department of Economic and Social Affairs, "Transboundary waters," International Decade for Action 'WATER FOR LIFE' 2005–2015, n.d., https://www.un.org/.

[13] Daanish Mustafa, "Hydropolitics in Pakistan's Indus Basin," United States Institute of Peace, Special Report 261, November 2010, https://www.usip.org/.

[14] Rahul Mahadeo Lad and Ravindra G. Jaybhaye, "Troubled Waters: India, Pakistan, and the Indus Water Treaty 2.0," *The Diplomat*, 11 April 2023, https://thediplomat.com/.

[15] "Water conflict and cooperation between India and Pakistan," *Climate Diplomacy*, n.d., https://climate-diplomacy.org/.

Equally noteworthy is the Mekong River, which exemplifies both the presence and absence of transboundary water agreements. With its headwaters and approximately one-fifth of its total watershed within its borders, China holds an undeniable upstream advantage over its downstream neighbors—Cambodia, Laos, Thailand, and Vietnam—all dependent on the river's resources. Without consulting or establishing agreements with these neighbors, China has constructed 11 major dams on the upper Mekong, with a combined capacity roughly two-thirds of the Chesapeake Bay. Primarily utilized for hydroelectric power, China restricts flows during the wet season to fill reservoirs, releasing stored water during the dry season. This disrupts the annual monsoon-driven flood pulse under which the Mekong and its ecosystems have evolved for millennia. Consequences include a drastic reduction in the river's fish stocks, a primary food source for many of the 60 million downstream residents, and a significant decline in sediment flow, altering the ecology of the river's delta and affecting agriculture and fisheries. Despite downstream countries forming the Mekong River Commission in 1955 and achieving positive outcomes in resource sharing through agreements, the lack of Chinese engagement limits their options.

The Mekong is a clear example of how the absence of transboundary agreements detrimentally impacts an entire region. Existing data enable close and continuous monitoring of rainfall and ground moisture conditions throughout the river's watershed.[16] Utilizing this data, along with historical figures, reveals the profound and possibly irreparable damage inflicted by China on the river and its dependent communities. The annual flooding-and-drying cycle is disrupted at both extremes, with downstream peak flows below historical norms, limiting natural expansion and 'defusing' annual fish population explosions. During the "dry" season, downstream forests, adapted to a period of drying, remain inundated from water released thousands of miles upstream. The downstream watersheds' ecologies, economies, and societal structures are being devastated. It is not an exaggeration to state that the absence of transboundary water agreements for the Mekong poses a threat to the political stability of Southeast Asia as a whole.

Iran, Afghanistan, and the Helmand River: Originating in the central highlands of Afghanistan, the Helmand River flows southwest, eventually forming part of the border with Iran, including Lake Hamoun and adjacent wetlands. Both the river and the lake have been crucial water sources in the arid region for both coun-

[16] Alan Basist, "Releases from China's Xiaowan Dam Significantly Impact Flow," *Eyes on Earth* (blog), 15 January 2023, https://monitor.mekongwater.org/.

tries, and various agreements and treaties have addressed them since at least 1939.[17] Amid governmental overthrows, dam construction, water diversion from the lake, and the impact of climate change, available water resources along the border have diminished.[18] Accusations of water "weaponization" have surfaced, leading to clashes between Iranian and Afghan forces earlier in 2023, sometimes involving mortar and machine-gun fire.[19] Given the likelihood of increased climate disruption impacting water availability in the upcoming years, urgent political negotiations are essential to avoid further violence.

Here, the weakness of transboundary water agreements becomes glaringly evident. Despite more than 80 years of such pledges, on-the-ground needs for water seem to prevail, with lethal force being employed in conflicts over access to this essential resource.

China, India, and the Brahmaputra River: Originating on the Tibetan plateau, the Brahmaputra River provides China with the "upstream advantage" over India and Bangladesh, through whose territories the downstream portions flow. However, the Chinese-controlled portion of the watershed contributes only a relatively small proportion of the river's flow, with figures of 7 percent and 30 percent commonly cited and debated.[20] China has built ~20 dams on tributaries and the further upstream portions of the Brahmaputra, and both China has constructed approximately 20 dams on tributaries and the further upstream portions of the Brahmaputra. While both China and India have announced plans to build mega-dams near their shared border, they have more often sought to "desecuritize" the issue, "moving of issues off the 'security agenda' and back into the realm of public political discourse and 'normal' political dispute and accommodation."[21] Despite maintaining memoranda on hydrological data sharing, they lack a formal treaty or agreement on water usage.[22] However, especially with deteriorating relationships between the two countries, the river remains a potential flashpoint for conflict.

[17] Holly Dagres, "Iran and Afghanistan are feuding over the Helmand River. The water wars have no end in sight," *IranSource* (blog), 7 July 2023, https://www.atlanticcouncil.org/.

[18] Ruchi Kumar, "On the Afghanistan-Iran border, climate change fuels a fight over water," *Science*, 4 August 2023, https://www.science.org/.

[19] Jon Gambrell, "Iran, Taliban exchange heavy gunfire in conflict over water rights on Afghan border," *PBS News Hour*, 27 May 2023, https://www.pbs.org/.

[20] Mark Giordano and Anya Wahal, "The Water Wars Myth: India, China and the Brahmaputra," United States Institute of Peace, 8 December 2022, https://www.usip.org/.

[21] Michael C. Williams, "Words, Images, Enemies: Securitization and International Politics," *International Studies Quarterly* 47, no. 4 (2003), 523, https://doi.org/.

[22] Selina Ho, "The China–India Water Dispute: The Potential for Escalation," *Indo-Pacific Perspectives,* June 2021, https://www.airuniversity.af.edu/.

This presents an intriguing case where the absence of a formal transboundary water agreement does not appear to be detrimental and may even contribute to the situation's stability. Both sides have taken precautions to de-escalate potential water conflicts around the Brahmaputra River. Whether this fortuitous state of affairs is due to the lack of any formal covenant or caused by various external factors can be debated. The duration of this peaceful condition is also uncertain.

Even with positive intentions on all sides, establishing international water agreements can be challenging. Case in point: The Teesta River, a Brahmaputra tributary flowing through several Indian provinces before entering Bangladesh, is a vital water source for regional farmers in both countries. Despite repeated negotiations and the apparent imminent agreement in 2011, where Bangladesh's Prime Minister Sheikh Hasina and India's former Prime Minister Manmohan Singh were set to sign, West Bengal (India) Chief Minister Mamta Banerjee refused to sign at the last minute, citing concerns for West Bengal's farmers.[23] Despite ongoing efforts since then and the signing of other agreements on nearby transboundary rivers, no further progress has been made in advancing Teesta cooperation.

In these examples, a range of issues with transboundary water agreements becomes apparent. While they may have real value, as seen with the IWT, and may be desirable, as evident in the Teesta River negotiations, it is evident that such understandings have limited power. The basic human need for water or larger-scale geopolitical motivations may at times override any such pact. Given (1) the rapid shrinkage of Tibetan glaciers, the ultimate source of most major rivers in south, southeast, and east Asia due to climate change, and (2) the lack of built-in mechanisms in many agreements reflecting this declining dynamic, it is fair to question the efficacy of existing regional transboundary water agreements for the upcoming decades.

Water Usage

While it is both common sense and widely acknowledged that conservation, stewardship, and cooperation must be central themes in virtually any "solution" to water-related challenges, these attributes seem sadly lacking in the utilization and management of fresh water, both in the Indo-Pacific region and globally.

Worldwide and across the Indo-Pacific, approximately 70 percent of fresh water is used for agricultural purposes, primarily irrigation. In countries like India

[23] Seema Guha, "The Failure to Sign Teesta Water-Sharing Pact Remains a Blot in India-Bangladesh Ties," *Outlook India*, 7 February 2023, https://www.outlookindia.com/.

and Pakistan, this figure can exceed 90 percent.[24] Throughout much of the Indo-Pacific, farm irrigation systems often rely on outdated, highly inefficient techniques instead of modern, efficient drip irrigation. The loss of water through evaporation and run-off contributes to needlessly high levels of freshwater consumption.[25] Globally, about 60 percent of water used for irrigation is wasted.[26] The sensible conservation practice, supported by technological advances, of using treated wastewater for irrigation is rarely employed. Instead, the continued and excessive pumping of groundwater for irrigation remains common, negatively impacting groundwater levels, especially in areas like the Punjab region, the "breadbasket of India," and contributing to soil salinization in coastal regions.

Clearly, this is an area where the application of scientifically and technologically informed approaches could be of tremendous value. Improved irrigation systems are generally not politically controversial; it is largely an economic matter that hinders their adoption. Small-scale farmers, facing uncertainties related to climate, weather, and market conditions for their products, routinely lack the capital to invest in more efficient irrigation systems, despite the clear advantages that such systems offer.

Manufacturing industries account for the next largest share of global water usage, approximately 17 percent. However, this figure varies widely across Asia, ranging from about 2 percent in heavily agriculturally-based countries like India, Bangladesh, and Myanmar, to 22 percent in China, 29 percent in Malaysia, and 51 percent in highly industrialized Singapore.[27] Globally, industrial water use efficiency increased by 15 percent from 2015 to 2021.[28] As noted earlier, manufacturing can be a significant source of persistent, severe, and challenging-to-eradicate contamination of both surface and groundwater resources.

Domestic water use, accounting for about 12 percent of global consumption, also varies across the Indo-Pacific, depending on countries' economic bases. The differences are less pronounced than in the manufacturing realm. It is noteworthy that the two largest domestic water consumers by quantity, China at nearly 80 billion m3/yr and India at 56 billion m3/yr, use roughly the same amount of water

[24] Hannah Ritchie and Max Roser, "Water Use and Stress," *Our World in Data*, July 2018, https://ourworldindata.org/.

[25] "Water in Asia and the Pacific: Your Questions Answered," Asian Development Bank, 2024, https://www.adb.org/.

[26] Rob Campbell, "More Food, Less Water: Top 6 Farming Practices to Better Manage Water Use," *foodtank*, March 2013, https://foodtank.com/.

[27] Ritchie and Roser, "Water Use and Stress."

[28] Marta Rica et al., *Progress on Change in Water-use Efficiency* (Rome: United Nations Water, 2021), https://www.unwater.org/.

domestically as the United States, 62 billion m3/yr, despite have populations more than three times as large.[29] This case of water use illustrates the larger issue of global inequities in contributions to climate and environmental disruption.

As demographic trends inexorably increase the population of Asia over the coming decades, water use and the inherent challenges it brings seem certain to increase both within and among nations. How can the region prevent rising tensions from erupting into kinetic conflict, as has been predicted?[30] Clearly, no one-size-fits-all solution exists; as should be evident from the preceding examples, the multiplicity and diversity of factors and situations across the extensive Indo-Pacific region deny any single, simple approach.

Approaches to Possible Solutions

From this brief analysis, we can begin to grasp the complexities involved in addressing water challenges. Approaches to meet these challenges can involve mitigation—such as shifting to more efficient agricultural irrigation technologies to reduce overconsumption of water—and/or adaptation, such as growing crops that require less water in the face of regionally declining rainfall. Both approaches are valuable, and the line between them may be blurred, but the promotion of water conservation and stewardship is a fundamental prerequisite for advancing water security and resilience at all scales.

Technological and scientific advances can be applied to a wide range of water challenges, including the gathering/storing of water resources, efficiency of use, and decontamination. Despite often being useful, and in many cases necessary, sci/tech "solutions" alone are often insufficient to address underlying political and governmental issues. Due to its necessity and limited accessibility, water all too often becomes a political tool or an instrument of power; water decisions are not, in many cases, made with the greatest good for the greatest number of people in mind, nor are they driven by what would be the ecologically sound and environmentally sustainable choice. Instead, water is controlled to serve industrial/economic and/or nationalistic purposes. Such politicization of water access is the reality, and most often the poor and powerless pay the price.

Given its central role in everything from basic human survival to national and international security, it seems peculiar that water is often overlooked in foundational government documents and policies. A notable exception to this can be

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29 Ritchie and Roser, "Water Use and Stress."

30 David A. Andelman, Benjamin Pauker, and Jackie Simon, "Water Wars?: A Talk with Ismail Serageldin," *World Policy Journal* 26, no. 4 (2009): 25–31, http://www.jstor.org/.

found in the constitution of the State of Hawai'i, where Article XI, Section 7, mandates the creation of "a water resources agency" with broad responsibilities:

> The State has an obligation to protect, control and regulate the use of Hawai'i's water resources for the benefit of its people. The legislature shall provide for a water resources agency which, as provided by law, shall set overall water conservation, quality and use policies; define beneficial and reasonable uses; protect ground and surface water resources, watersheds and natural stream environments; establish criteria for water use priorities while assuring appurtenant rights and existing correlative and riparian uses and establish procedures for regulating all uses of Hawai'i's water resources.[31]

Such a clear, explicit statement acknowledges the central role of clean water in all levels of security and could serve as a model for other jurisdictions to recognize and assign responsibility for water stewardship.

When dealing with larger geopolitical and transboundary water challenges, international water agreements have proven invaluable. Over 3,600 of these agreements have been made during the past two millennia.[32] Yet, nearly half the world's international river basins lack cooperative management agreements that can reduce tensions among neighboring states.[33] While many agreements have doubtlessly helped avert conflict, they routinely have flaws or deficiencies that render them less than entirely successful, as seen in the case of the IWT; these shortcomings become particularly obvious in the face of rapid river flow and aquifer alterations due to climate change and increased population pressures.

While by no means a 'silver bullet,' such accords can help desecuritize water issues, as noted above in the brief description of the China, India, and the Brahmaputra River situation. Such approaches have the potential to resolve, or at least set aside, often long-standing issues tied to politics/nationalism and allow the focus to remain appropriately on clean water as a necessary resource for human health and communities' economic well-being.

Moving forward, the approaches to resolving water challenges should concentrate on synergizing the various aspects that advance water security and resilience for all. In many cases, this will require a blending of scientific/technological perspectives with those of political/governmental entities. Examples of such international

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[31] Constitution of the State of Hawai'i, https://lrb.hawaii.gov/.

[32] United Nations Department of Economic and Social Affairs, "Transboundary waters."

[33] National Intelligence Council, "Climate Change and International Responses Increasing Challenges to US National Security through 2040," *National Intelligence Estimate*, 2021, https://www.dni.gov/.

agreements can be found in the International Environmental Agreements Database,[34] the ECOLEX database of international laws,[35] and NASA's Environmental Treaties and Resource Indicators (ENTRI) Datasets and Service.[36]

On the Scientific/Technological Side:

For optimum impact, all such agreements must be grounded in the best available scientific evidence about the water resources involved. Understanding how many people are using how much water, for what purposes, where, and over what time frames is crucial. Historical data should be incorporated into these indicators, as should future modeling that considers the impacts of climate disruption and population shifts. Agreements should stipulate the maximum possible transparent sharing of all relevant data among all stakeholders involved; failure to include such provisions will only lead to suspicions of nefarious motivations.

These agreements must address both the quantity and quality of the water involved, ensuring that parties neither divert nor degrade their water to the extent that it harms their neighbors. This is particularly important and especially challenging for upstream/downstream water sharing. The devastatingly obvious costs of not having such provisions in place are evident across the Mekong basin, highlighting the potential benefits of transparent data sharing.[37]

For the Political/Governmental Aspects:

Agreements must be equitable. They must explicitly recognize the fundamental human need for and right to clean water. At the end of the day, this is where water security matters most. If individuals do not have sufficient, reliable, ready access to adequate quantities of fresh, potable water, water security is absent, and discord and tensions are bound to arise.

At the same time, such agreements must acknowledge the realities of the situation—some locales are more richly endowed with freshwater resources than others. They can and will grow more water-intensive crops, have greater agricultural output, and be more insulated from water shocks (e.g., droughts). Water is a valuable resource, conferring power to its possessors.

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[34] Ronald R. Mitchell, "International Environmental Agreements Database Project," University of Oregon, 2024, https://iea.uoregon.edu/.

[35] "ECOLEX," 2024, https://www.ecolex.org/.

[36] NASA SEDAC, "Environmental Treaties and Resource Indicators (ENTRI) Datasets and Service," 2024, https://www.ciesin.columbia.edu/.

[37] Stimson Center, "Mekong Dam Monitor," 2024, https://www.stimson.org/.

Agreements must involve the full range of stakeholders. While political leaders, water experts, and major economic players (e.g., industries) will contribute, so must the less-advantaged whose voices are all too often ignored. All people, rich and poor alike, are affected by drinking water availability, and all must have a say in water governance. Here, too, maximum transparency is needed to ensure that everyone understands who can access what water at what cost, and who has what responsibilities for cleaning wastes from their water.

Conclusion

In summary, addressing the complex water challenges in the Indo-Pacific region demands a comprehensive and collaborative approach. Scientific and technological advancements, coupled with political and governmental perspectives, are indispensable in navigating the intricate landscape of water security. While the scientific community provides crucial insights, political and governmental entities play a pivotal role in implementing effective policies and agreements.

The case studies presented underscore the significance of international water agreements and the need for equitable, transparent, and inclusive solutions. Water security goes beyond mere resource availability; it is intricately linked to human rights, geopolitical dynamics, and environmental sustainability.

The Indo-Pacific's diverse water challenges require a nuanced understanding that transcends borders and engages all stakeholders. The melding of scientific knowledge with political realities is not just a necessity; it is the cornerstone for developing resilient, adaptive, and enduring solutions. As we navigate a future marked by climate change, population growth, and geopolitical shifts, fostering collaboration between science and governance becomes imperative for ensuring the sustainable management of water resources and securing a better future for the entire region. ✪

Dr. Ethan Allen

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