CHAPTER FIVE

SHARED WATERS, SHARED FUTURES: COOPERATIVE APPROACHES TO WATER SECURITY IN THE INDO-PACIFIC

Ethan Allen

Water is the driving force of all nature.

— Leonardo da Vinci, 1452-1519

Abstract

The Indo-Pacific region is grappling with escalating water security challenges driven by climate change, rapid population growth, and increasing pollution, all of which threaten fundamental human needs and regional stability. This chapter explores the interconnectedness of water resources in the region, emphasizing the need for collaborative and adaptive approaches to address these challenges. Through the analysis of key transboundary river systems, including the Indus, Mekong, Helmand, and Brahmaputra, this chapter critically evaluates the strengths and limitations of current water-sharing agreements. Additionally, it explores the transformative role of technological innovations, such as artificial intelligence, satellite monitoring, and sensor networks, in improving water resource management and forecasting. The chapter concludes by advocating for comprehensive and integrated water management solutions that prioritize equity, active community engagement, robust governance structures, and international cooperation. It offers a set of best practices and policy recommendations aimed at ensuring long-term water security and sustainable development in the Indo-Pacific.[1]

Introduction

Access to clean, fresh water is essential for individual survival and community resilience, yet over 500 million people in the Indo-Pacific lack access to even a basic water supply.[2] A staggering 2.5

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billion regional residents, roughly two-thirds of the population, do not have safely managed drinking water services, primarily due to contamination by fecal coliform bacteria.[3] Water security is not just a matter of daily survival; it is a critical component of national security, impacting everything from subsistence farming to high-tech manufacturing, from remote villages to urban megacities. Water is fundamental to every aspect of our lives, from the food we eat to the energy we use to the stability of our societies.

Today, the Indo-Pacific faces unprecedented water challenges driven by climate disruption, population growth, and pollution. These issues have profound implications for political stability, inter-state tensions, and U.S. interests in the region. The diverse landscapes of the Indo-Pacific—from glaciers and deserts to tropical rainforests—illustrate the vast array of water-related challenges shaped by both natural variations and human activities such as agriculture and industry.

Asia, home to 60% of the world's population, has less freshwater per capita than any other continent, with just 2.7 m^3/person/year (cubic meters per person per year) compared to the global average of 5.8 m^3/person/year. This scarcity is exacerbated by the region's rapid economic and population growth, leading to increased freshwater withdrawals from rivers, lakes, and aquifers.[4]

Given that water is a finite resource—essentially the same water molecules present on Earth four billion years ago—and the escalating needs of a growing and urbanizing population, everyone must take responsibility for water stewardship. Yet solutions to water challenges have rarely focused on conservation and care.

The universal need for potable water necessitates collaborative and cooperative approaches to water management. However, internal and transboundary politics often dictate water distribution patterns. Scientific and technological advancements have boosted water availability and offer new ways to enhance access. Paired with transparent and equitable political negotiations, these approaches

present our best hope for advancing water security and resilience in the face of rapidly changing freshwater availability in the Indo-Pacific.

This chapter explores the theoretical framework of integrated water resource management (IWRM) and cooperative water governance to address water security challenges in the Indo-Pacific. The primary research question guiding this analysis is: How can scientific, technological, and political strategies be effectively integrated to enhance water security and mitigate water-related conflicts in the Indo-Pacific region? By examining various case studies and regional initiatives, this chapter aims to identify best practices and policy recommendations for sustainable water management and conflict resolution.

Internal Water Challenges and Climate Disruption

The Indo-Pacific region faces diverse water challenges exacerbated by the growing impacts of climate disruption. Extreme weather events, such as droughts, floods, and heat waves, are becoming more frequent and severe, posing significant threats to water security within individual countries. These disruptions strain existing water resources and destabilize ecosystems and livelihoods, highlighting the urgent need for adaptive and resilient water management strategies. Moreover, rising sea levels, another consequence of climate change, are increasingly threatening freshwater resources in coastal areas and island nations through saltwater intrusion into aquifers and wells, further exacerbating water scarcity.

Droughts and Floods

Climate disruption intensifies global droughts, particularly impacting small central-Pacific Islands like Pohnpei, Kosrae, and Majuro.[5] Historically, moderate dry seasons are now longer, hotter, and more intense, threatening agro-forest food systems and potable

water supplies. These prolonged droughts have forced entire communities to relocate.[6]

Mainland Asia is also grappling with extreme weather events. Record-breaking events in recent years, such as the 2022 floods that submerged a third of Pakistan, have displaced millions and caused widespread waterborne disease outbreaks.[7] Even densely populated cities like Hong Kong are experiencing unprecedented rainfall events.[8]

Heat Waves and Water Scarcity

In 2024, the Indo-Pacific and many other parts of the globe faced a series of unprecedented heat waves, with temperatures soaring to record-breaking levels.[9] These extreme heat events, once rare, are now frequent and more severe, significantly straining already limited water resources. In 2023, Thailand, Laos, and Vietnam experienced unprecedented high temperatures. The Philippines, meanwhile, recorded a record-breaking heat index of 60°C (140°F) that same year,[10] highlighting the dangerous combination of high temperatures and humidity and underscoring the widespread effects of climate disruption on water availability.[11]

Beyond Climate Disruption: Natural and Industrial Contamination

Compounding the challenges of climate disruption, natural and industrial contamination pose significant threats to water security in the Indo-Pacific. For example, according to the World Health Organization, at least 90 million people in around 50 countries—including Bangladesh, China, India, and the United States—are exposed to arsenic-contaminated groundwater at levels above ten µg/L (micrograms per liter). While various technological solutions are available to remove arsenic, the widespread nature of the problem and lack of resources often hinder effective implementation.[12]

Industrial pollution is another pressing concern, particularly in rapidly industrializing countries like China. Unregulated industrial waste discharge has contaminated water sources, leading to widespread health issues and ecological damage. Nearly half of China's population struggles to access safe drinking water,[13] with approximately 86% of its groundwater being unsuitable for human consumption.[14] The World Bank warns of potential "catastrophic consequences for future generations" if pollution is not addressed.[15] Despite the availability of technological solutions to mitigate industrial pollution, weak environmental regulations, enforcement challenges, and corruption often impede progress.

Addressing Internal Water Challenges

Addressing these internal water challenges requires a multifaceted approach that combines technological solutions with effective governance and environmental regulations. Investments in infrastructure, such as water treatment plants and wastewater management systems, are crucial. Public awareness campaigns and education programs can promote water conservation and responsible use. Furthermore, strengthening environmental regulations and enforcement mechanisms can help control industrial pollution and protect water resources for future generations.

Transboundary Water Tensions and Conflicts

The need for cooperation over shared water resources is not new. The earliest international treaties on water date back to 2500 BCE, focusing on the Tigris and Euphrates rivers. However, history also reveals a long-standing pattern of conflicts over water that continues today.[16] The following examples illustrate the complex interplay of cooperation and conflict in transboundary water management, highlighting both the potential for collaboration and the persistent challenges.

The Indus River Basin: Cooperation and Conflict

One of the most well-known water treaties is the Indus Waters Treaty (IWT), established in 1960 after the partition of India and Pakistan led to water disputes. Backed by the World Bank, the IWT has survived three wars, mainly due to its clear division of the Indus River's tributaries: three eastern rivers for India and three western rivers for Pakistan. The treaty prohibits either side from interrupting the designated flows with violations considered acts of war.[17]

However, the IWT's simplicity is also its weakness. The treaty lacks collaboration or data-sharing provisions, hindering adaptive management due to climate disruption and growing water demands. The treaty's focus on preventing conflict has arguably come at the expense of fostering cooperation. Recent calls for renegotiation highlight the need to update the IWT to address evolving challenges and promote sustainable water management for both nations.

The IWT illustrates both the strengths and weaknesses of collaborative water agreements. On the one hand, it has likely been a key factor in preventing kinetic conflict over water. However, as the populations of both nations grow and their water needs increase, the treaty's failure to address fundamental issues of conservation and data sharing threatens to erode its long-term viability. Given the persistent hostilities between India and Pakistan and the projected decline of Indus watershed flows as glaciers shrink due to climate disruption, it is reasonable to question how long the IWT will hold.[18] The future of the IWT depends on the willingness of both countries to adapt to changing circumstances and prioritize collaborative water management.

The Mekong River: The Case for Transboundary Cooperation

The Mekong River illustrates both the presence and lack of transboundary water agreements. With its headwaters and

approximately a fifth of its total watershed within its borders, China holds an undeniable upstream advantage over its downstream neighbors—Cambodia, Laos, Thailand, and Vietnam—all of whom depend on the river's resources.

Without consulting these neighbors or establishing any agreements with them, China has built 11 major dams on the upper Mekong,[19] with a combined capacity of roughly two-thirds that of Chesapeake Bay. Using these dams primarily for hydroelectric power, China restricts water flow during the wet season to fill its reservoirs and releases the stored water during the dry season. This pattern effectively counteracts the annual monsoon-driven flood pulse under which the Mekong and its ecosystems have evolved for millennia.

The consequences include a drastic reduction in the river's fish stocks, which feed many of the 60 million downstream residents, and a significant decline in sediment flow, altering the ecology of the river's delta and impacting agriculture and fisheries.

While the downstream countries have banded together since 1955 in the Mekong River Commission, and their agreements have positively affected resource sharing, the lack of Chinese engagement significantly hampers their ability to effectively manage the river's resources. This lack of cooperation threatens the Mekong's ecological health and jeopardizes regional stability and economic development.

The Mekong River is a stark example of how the absence of transboundary agreements can devastate an entire region. Data reveal the profound ecological damage caused by China's upstream damming activities,[20] which have dramatically altered the natural ebb and flow of the river. This annual shifting is crucial for the river's ecosystems and the communities that depend on it. Reduced peak flows during the wet seasons limit the river's expansion into floodplains essential for fish spawning cycles, leading to a

significant decline in fish stocks vital for the nutrition and livelihoods of millions of people.

During the dry season, the sustained high water levels caused by dam releases inundate downstream forests, suffocating their root systems and permanently altering the delicate ecological balance. The resulting damage to the river's ecosystem has cascading effects, undermining the downstream communities' economies and social structures. This environmental crisis threatens livelihoods and destabilizes the entire region as water scarcity and resource competition escalate tensions between nations.

The Helmand River: A Flashpoint on the Iran-Afghanistan Border

The Helmand River, originating in Afghanistan's central highlands, forms part of the border with Iran, feeding into the vital Lake Hamoun and its surrounding wetlands. The river and the lake are crucial water sources in this arid region, subject to numerous agreements and treaties since 1939.[21] However, these agreements have not prevented conflict. Political instability, dam construction, water diversions, and climate disruption have all contributed to shrinking water resources,[22] sparking accusations of water "weaponization" and escalating tensions. In 2023, clashes between Iranian and Afghan forces erupted, highlighting the potential for water scarcity to ignite violence.[23] The looming threat of future climate-induced water shortages underscores the urgent need for renewed political negotiations to avert future conflict.

The Helmand River crisis exposes the fragility of transboundary water agreements. Despite decades of formal pledges, the fundamental need for water often overrides these agreements. The situation underscores a stark reality: communities may resort to violence to secure their essential resource when water becomes scarce. This case serves as a cautionary tale, highlighting the importance of establishing agreements and building robust

mechanisms for cooperation, conflict resolution, and adaptive management in changing environmental conditions. International organizations, such as the United Nations, can play a crucial role in facilitating dialogue and cooperation between countries, providing technical expertise, and promoting the peaceful resolution of water disputes.

The Brahmaputra River: Strategic Restraint Amidst Tensions

The Brahmaputra River, originating in the Tibetan Plateau, flows through China, India, and Bangladesh. While China's upstream position might suggest an advantage, its control over the watershed contributes a relatively small proportion of the river's total flow—estimates vary between 7% and 30%.[24] Despite China and India constructing dams on the Brahmaputra and its tributaries, with plans for further development near their shared border, the two nations have largely avoided overt conflict over water.

Instead of escalating tensions, both countries have sought to "de-securitize" the issue, moving it from a security concern to political discourse and negotiation.[25] This is evident in their ongoing exchange of hydrological data through memoranda, even without a formal water-sharing treaty.[26] However, the deteriorating relationships between the two nations and the potential for upstream water diversion mean the river remains a potential flashpoint.

The Brahmaputra presents a unique case where the lack of a formal treaty has not necessarily led to conflict. Both sides have demonstrated a degree of restraint, actively working to de-escalate potential water disputes. Whether this stems from the absence of a formal agreement, other geopolitical factors, or a combination of both remains to be determined. The sustainability of this approach in the face of growing water demands and escalating regional tensions remains to be determined.

The Teesta River: Stalled Cooperation

Forging international water agreements can be challenging, even with goodwill and shared interests. Case in point: The Teesta River dispute exemplifies this complexity. This tributary of the Brahmaputra, crucial for farmers in India and Bangladesh, has been the subject of numerous negotiations. An agreement seemed imminent in 2011 but was ultimately derailed by objections from the Indian state of West Bengal,[27] citing concerns for its farmers' interests. Despite ongoing efforts, no further progress has been made on Teesta River cooperation.

This impasse highlights the limitations of transboundary water agreements. While agreements like the IWT have proven valuable in preventing conflict, they often need more flexibility and comprehensiveness to address evolving challenges. The basic human need for water, coupled with regional politics and competing interests, can easily override even the most well-intentioned agreements. Furthermore, the rapid shrinking of Tibetan glaciers, the source of virtually all major Asian rivers, due to climate disruption adds another layer of complexity. This raises serious questions about the long-term efficacy of existing regional agreements, many of which need to account for the dynamic and unpredictable nature of water resources in climate disruption.

Technological Innovations for Water Security and Resilience

Addressing water challenges in the Indo-Pacific requires a dual approach: mitigation, which aims to reduce the drivers of water insecurity, and adaptation, which focuses on adjusting to the changing water landscape. Mitigation strategies include transitioning to more efficient agricultural irrigation technologies to reduce water consumption. Adaptation strategies involve cultivating crops that require less water in the face of declining rainfall. While both approaches are crucial, promoting water conservation and

stewardship remains fundamental to advancing water security and resilience at all levels.

Scientific and technological innovations offer diverse solutions to water challenges, from resource acquisition and storage to efficient utilization and decontamination. Traditional methods like well-drilling and rainwater harvesting have been refined over time. Modern approaches such as dam construction offer large-scale water storage and flood control, albeit with potential ecological consequences.

Emerging technologies further expand the possibilities. Cloud seeding, practiced since the mid-20th century, and newer techniques involving electrical charges or laser pulses aim to induce rainfall. However, their long-term effects and potential for geopolitical tensions remain under scrutiny.

Technological solutions for addressing water quality issues range from simple to complex, depending on the type and extent of contamination. Basic filtration techniques, such as settling or filtering, can effectively remove dirt and suspended matter. Addressing more complex contaminants like excess salt, increasingly prevalent in coastal regions due to rising sea levels, necessitates more sophisticated methods like reverse osmosis or distillation. Similarly, chemical pollutants like pesticides and herbicides require specialized treatments such as reverse osmosis or carbon block filtration. Heavy metal contamination often demands more advanced approaches, including precipitation, cryogel filtration, or adsorption-based, chemical-based, electric-based, or photocatalytic-based treatments.[28]

A simple yet innovative solution has emerged in many Pacific Island communities where municipal water systems are unreliable or absent, rainwater harvesting is common, and microbial contamination is a significant threat. The MadiDrop®,[29] an inexpensive, porous ceramic tablet infused with silver, can be placed in rainwater storage containers. It slowly releases silver ions,

disinfecting the water without altering its taste or smell. This point-of-use technology provides a year's worth of safe drinking water, making it a practical and affordable solution for communities facing microbial contamination challenges.

Artificial intelligence (AI), particularly with advanced sensor networks, holds immense potential to transform water management practices. AI enables real-time water quality and quantity monitoring and can optimize water usage patterns. It also serves as an early warning system, predicting floods and facilitating rapid response.[30]

Such emerging technologies offer unprecedented solutions as centralized water systems expand and become increasingly vulnerable to climate-related disruptions. Integrating machine learning with low-cost, versatile sensors enables precise tracking of water needs, usage, and quality across diverse environments. In agriculture, sensors can monitor soil conditions, while machine learning algorithms, combined with satellite data, can provide farmers with actionable insights for optimal planting, irrigation, and harvesting. In urban areas, sensor networks can detect leaks, infrastructure deterioration, and treatment plant failures, enabling proactive maintenance and preventing costly disruptions.

These technologies enhance efficiency and promote sustainability and resilience. AI and sensor networks can transform water management by adjusting water use, detecting problems early, and facilitating data-driven decision-making, ensuring a more secure and sustainable water future for the Indo-Pacific region. However, ensuring equitable access to these technologies and building local capacity for implementation remain critical challenges.

Governance and Cooperation: The Political Dimensions of Water Security

Water security is not just a technical challenge; it is deeply intertwined with politics and governance. The equitable and sustainable management of water resources requires robust institutions, transparent decision-making processes, and commitment to cooperation at both national and international levels. This section explores the political dimensions of water security, examining the roles of governance structures, international agreements, and community participation in shaping a more water-secure future for the Indo-Pacific.

Constitutional Recognition: A Model for Water Stewardship

The need for strong governance structures that prioritize water security is evident. The Hawai'i state constitution, uniquely among U.S. states, explicitly mandates the creation of a water resources agency with broad authority to protect and manage water for the benefit of its people. This model underscores the value of recognizing water as a fundamental right and assigning responsibility for its stewardship at the highest levels of government.

The Mixed Record of International Water Agreements

International water agreements have a long history, with over 3,600 established in the past two millennia.[31] However, their effectiveness varies, and nearly half of the world's international river basins lack cooperative management agreements.[32] While some agreements, like the Indus Waters Treaty, have successfully prevented conflict, they often fail to address evolving challenges like climate disruption and growing populations. The Teesta River dispute exemplifies the fragility of these agreements in the face of political tensions and competing interests.

De-Securitizing Water: A Path to Cooperation

Despite these challenges, international agreements remain crucial for de-securitizing water issues, shifting them from conflict to collaboration. By fostering dialogue, promoting transparency, and establishing mechanisms for dispute resolution, these agreements can help ensure that water resources are managed equitably. The case of the Brahmaputra River, where India and China have exchanged hydrological data despite not having a formal treaty, demonstrates the potential cooperation even without binding agreements. However, the long-term sustainability of such informal arrangements remains to be determined.

The Way Forward: Balancing Interests and Ensuring Equity

Political solutions must prioritize equity, transparency, and stakeholder participation, including recognizing the human right to water and balancing competing interests. All affected communities should be involved in decision-making processes, ensuring their voices are heard and their needs are considered. Notably, the meaningful inclusion of women in water management decision-making is vital, as they are often disproportionately affected by water scarcity and play a crucial role in household water use and conservation. While international agreements remain essential, their success hinges on their ability to adapt to changing environmental conditions, incorporate scientific knowledge, and address the root causes of water conflict. Ultimately, the success of political solutions depends on the willingness of governments and stakeholders to collaborate, prioritize equitable access to water, and adapt to the evolving challenges of water scarcity and climate disruption.

Shared Waters, Shared Futures: A Call for Collective Action and Innovation

The water security challenges facing the Indo-Pacific region are complex and multifaceted, requiring integrated solutions that address both technical and political dimensions. Science and technology offer a powerful toolkit for enhancing water availability, improving quality, and optimizing resource management. Political will and cooperation are essential for establishing equitable and sustainable water governance frameworks that protect the human right to water and promote regional stability.

The future of the Indo-Pacific is inextricably linked to its shared waters. As the region grapples with the growing impacts of climate disruption, population growth, and pollution, collaborative approaches to water management are not just desirable; they are essential for survival and prosperity. Recognizing this interconnectedness is the first step toward building a shared future where water is a source of cooperation, not conflict.

A Call to Action

To achieve a water-secure future for all in the Indo-Pacific, we must:

- *Prioritize Investment*: Increase investment in water infrastructure, research, and development, focusing on technological innovation and capacity building.
- *Foster Collaboration*: Strengthen regional cooperation mechanisms, such as the Mekong River Commission, and promote data sharing, joint research, and technology transfer.
- *Empower Communities*: Engage local communities in decision-making, ensuring their voices and needs are heard.
- *Promote Conservation*: Encourage sustainable water use practices in agriculture, industries, and households while protecting and restoring critical ecosystems.

- *Strengthen Governance*: Develop and enforce equitable water policies that prioritize the needs of vulnerable populations and promote transparency and accountability.

Building a Shared Future

Beyond these immediate actions, several areas warrant further exploration and collaboration:

- *Innovative Financing:* Explore innovative financing mechanisms, such as water bonds or impact investing, to mobilize resources for water projects.
- *Data-Driven Solutions*: Leverage the power of artificial intelligence, big data, and remote sensing to improve water management and predict water-related risks.
- *Transboundary Cooperation*: Strengthen legal frameworks for transboundary water cooperation and establish conflict resolution and dispute settlement mechanisms.
- *Capacity Building*: Invest in education and training programs to build local water management and technology implementation capacity.

The path to shared prosperity in the Indo-Pacific runs through its shared waters. By embracing innovation, collaboration, and a commitment to equitable and sustainable water management, the region can secure a future where water resources are not a source of tension but a catalyst for cooperation and resilience. The future of the Indo-Pacific depends on our ability to recognize that water is a shared resource that requires collective responsibility, innovation, and collaboration. Together, we can ensure a water-secure future for generations to come.

Endnotes

[1] Note: Parts of this chapter were previously published as an article in the *Journal of Indo-Pacific Affairs*. See: Ethan Allen, "Addressing the Diversity of Water Challenges in the Indo-Pacific: Need for Broad Cooperation and Multidisciplinary Approaches," *Journal of Indo-Pacific Affairs* (2024), https://www.airuniversity.af.edu/JIPA/Display/Article/3703733/addressing-the-diversity-of-water-challenges-in-the-indo-pacific-need-for-broad/.

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