

Pathways Towards Water Security in Pakistan

Outline

1. Introduction

- a. Thesis Statement: Pakistan despite being on the verge of water scarcity, can chart pathways towards water security through demand management, reuse, storage, governance reforms, ~~and~~ transboundary cooperation and other effective mechanisms

2. Water Status in Pakistan.

3. Conceptual Framework: Understanding Water Security (Sandra Postel's "water ethic" idea from LAST OASIS)

4. Drivers and Threats to water security in Pakistan

5. Pathways Towards Water Security

- a. Integrated Basin Management (IWRM)
(Israel's national water system (World Bank report)).
- b. Storage and managed Aquifer Recharge (MAR)
(California aquifer building model can be followed)
- c. Irrigation Modernization and crop shifts
(Singapore's NEwater - reusing water)
(Last Oasis Book)
- d. Wastewater Treatment and Reuse
(Singapore's NEwater model)
- e. Desalination

f. Water Pricing and Incentives
(Murray-Darling Basin water markets (Australia)).

g. Nature-Based Solution
(supported by WWF-Asia/UN WWDR).

h. Glacier and Mountain Protection
(Pakistan's GLOF-II (UNEP/Green Climate)

i. Urban Non-Revenue water Reduction and
Decentralized supply

j. Transboundary Cooperation and Diplomacy.
(Ismail Serageldin - "The wars of the next
century will be fought over water - unless
we change the way we manage it").

6. A comparison with Pakistan's Regional counterparts.

7. Conclusion.

The Essay

In the blistering summer of 2025, Ali, a farmer from Tharparkar, walked 10 kilometers with two goats and an empty clay pot in search of water. The village well had dried weeks ago, and the nearest hand pump yielded only muddy drops. "Everyday I wonder if the land is dying with us," he said quietly. His crops had withered, his children missed school to fetch water from far flung areas, and survival had become a daily negotiation with thirst. For millions like Ali, the scarcity of water is not a static but a lived crisis, where every drop determines life, livelihood and dignity. The narration above is very much a depiction of Pakistan's water crisis, that is edging closer day by day to becoming a water scarce country. Water has long been regarded as the foundation of civilizations, shaping economies, cultures and even political stability. From the Nile in Egypt to the Indus in South Asia, access to fresh water has determined whether societies flourish or collapse. Yet in the 21st century, as global demand grows and climate pressures intensify, the very resource that sustains life is under unprecedented stress. The United Nations has already warned that by 2030, nearly half the world's population will

face severe water scarcity. For Pakistan, this looming threat has already become a lived reality. Once a water abundant country, it now ranks among water scarce states, with per capita availability falling below 1000 cubic metres. The crisis manifests in parched farmlands of ^{and Thal} Thar, rapidly depleting aquifers in Punjab, shrinking glaciers in the north, and unsafe and contaminated drinking water in the urban centres. Threats such as unchecked population growth, climate change, droughts, inefficient irrigation, and mismanagement of the Indus Basin amplify the emergency. Yet, the pathway to security is neither absent nor impossible. Integrated water resource management, investment in efficient irrigation systems, regional cooperation, and learning from global models like Singapore recycling strategies offer hope. Water, therefore, is no longer just a development issue, it is a question of survival. Securing it demands not only awareness of the threats but also decisive adoption of pathways that ensure resilience and sustainability.

"Water is life's matter and matrix, mother and medium" (Albert Szent). At the time of independence in 1947, Pakistan was considered a water abundant country with a population of barely 32 million, per capita water availability was estimated at more than 5000 cubic metres annually, fed generously by the Indus and its tributaries. The river system was the backbone of agriculture, enabling the new state to secure food

and livelihoods for its people. Today, the picture has dramatically shifted. With a population exceeding 240 million, availability has dropped below 1000 cubic meters (Pakistan Economic Survey 2024-2025), pushing Pakistan into the category of "water-scarce" nations. Agriculture still consumes around 90% of withdrawals (FAO), but inefficiencies and losses cripple productivity. According to the UN World Water Development Report 2024, Pakistan's water stress index now exceeds 70% placing it among the world's most vulnerable states.

"Water crises are primarily crises of governance" - (Ismail Serageldin, former WB vice president). Pakistan's water insecurity is not merely the result of scarcity, but of multiple intersecting threats. Climate change is shrinking Himalayan glaciers that feed the Indus, while glacial lake outburst floods (documented under UNDP-Green Climate Fund's GLOF-II Program), intensify hazards. At the same time population growth and rapid urbanization strain already fragile supplies, with cities like Karachi experiencing both flooding and water shortages in 2025. Governance gaps also remain a critical weakness including fragmented provincial institutions and weak regulation that prevent integrated water management. Scholars like Tony Allan, through the concept of "virtual water" argue that water intensive crops and poor trade choices deepen the crisis. Together, these drivers expose Pakistan to a dangerous cycle where natural stress combines with human inefficiency. Unless addressed holistically, these threats risk transforming scarcity

into outright insecurity.

"No water, no energy, no food, — no security." This succinct reminder from the World Economic Forum captures the essence of the Water-Energy-Food (WEF) nexus. The idea popularized in Nexus literature by Hoff (2011), emphasizes that water cannot be managed in isolation, it is tied to agriculture, energy and ecosystems. In Pakistan, where 90% of freshwater is used in irrigation, electricity is heavily dependent on hydropower and food security rests on water-intensive crops like rice and sugarcane, the nexus is especially critical. Yet, policies remain fragmented across ministries and provinces, weakening coordination. The concept of water security must therefore be broadened that include reliable supply, safe quality, equitable access across regions, and environmental flows to sustain ecosystems. Integrated policies that account for this interdependence can help Pakistan break the cycle of crisis. Without embedding the WEF nexus into planning, Pakistan risks undermining all three pillars of survival simultaneously.

The water crisis faced by Pakistan can be revived by following certain pathways. The first pathway for Pakistan's water security lies in integrated basin management, where the Indus is treated not as a fragmented provincial resource but as a single living system. Scholars in the "Water Security in South Asia" emphasize that without a unified authority, piecemeal responses will continue to waste scarce supplies. Lessons can be drawn from Australia's Murray-Darling Basin, where institutional reforms allowed competing states to coordinate

withdrawals and restore ecological balance. The World Bank's Pakistan Water Security Outlook similarly stresses the urgency of basin-wide data sharing and governance reforms. Such approaches not only strengthen domestic resilience but also reinforce transboundary cooperation under the Indus Water Treaty. If managed properly, the Indus could shift from being a contested resource to a foundation for collective survival. Pakistan can also adopt Israel's national water system model, which combines drip irrigation, desalination and wastewater recycling to achieve near self-sufficiency in water.

If basin-wide governance offers the blueprint, the next pathway must be investment in storage and groundwater recharge. Pakistan currently stores barely 30 days of water compared to India's 220 and Egypt's 700, leaving it dangerously exposed to droughts and seasonal shocks. Small dams and managed aquifer recharge (MAR) systems could bridge this gap, capturing floodwaters and replenishing underground reserves. California's experience with aquifer banking shows how excess flows can be stored underground and later withdrawn during scarcity. ~~while local water is abundant~~. As Sandra Postel argues in "Replenish: The Virtuous Cycle of Water and Prosperity", "We must learn to bank water in nature's savings account - the aquifers." For Pakistan, expanding MAR alongside decentralized storage would not only stabilize supplies but also revive ecosystems. Without this, precious floodwater will keep flowing wastefully into the sea while drought-prone communities remain thirsty.

Building upon storage and recharge solutions, another pathway lies in transforming irrigation practices and agricultural choices, since farming consumes nearly 90% of Pakistan's freshwater. Traditional flood irrigation wastes up to half the water applied, while water thirsty crops like rice and sugarcane dominates fields even in arid regions. As Sandra Postel warns in ^{her} book, *Last Oasis: Facing Water Scarcity*, "The ~~era~~^{era} of cheap water is over; efficiency must replace excess". Countries like Australia have modernized irrigation systems with precision sprinklers and soil-moisture monitoring, saving both water and energy. Similarly Morocco's Plan Maroc Vert promoted a shift from cereals to less water intensive crops through subsidies and farmer training, yielding higher incomes with lower water footprints. For Pakistan, adopting drip and sprinkler system while incentivizing crop diversification can dramatically ease pressure on the Indus Basin. Without such reforms, technological and storage improvements alone cannot ensure long-term water security.

Moreover, no pathway to water can ignore the vast untapped potential of wastewater treatment and reuse. In Pakistan's cities, more than 90% of wastewater is discharged untreated into rivers and canals, contaminating both drinking supplies and farmland. Redirecting this liability into an asset is possible. ~~Singapore's~~ Singapore's NEWater Program, highlighted in the World Bank's *Beyond Scarcity Report*, treats sewage through advanced microfiltration, reverse osmosis and UV disinfection, recycling it into ~~pos~~ potable-grade water that now meets upto 40% of the nation's demand. As Peter Rogers argues

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in "Running out of water," wastewater is not waste, but water on its second cycle." For Pakistan treated urban wastewater could irrigate peri-urban ~~culture~~ agriculture, reducing pressure on the Indus while improving food safety. Establishing decentralized treatment plants, combined with public private partnerships, would allow cities to reclaim million of cubic meters annually turning an environmental hazard into a strategic water reserve.

Furthermore, one of the most overlooked but necessary pathways is the adoption of desalination for coastal regions, particularly Karachi. With a population surpassing 20 million, Karachi faces chronic shortages as its demands far outpace the supply from the Indus. Instead of overburdening upstream resources, targeted desalination powered by renewable energy could provide a sustainable alternative. A useful reference here is Spain's Alicante desalination program, which successfully combined solar energy with seawater treatment to provide reliable urban supply while keeping costs manageable. The UN World Water Development Report 2023 also highlights desalination as a key adaptation tool for water-scarce coastal states. As Maude Barlow notes in Blue Future, "water security will increasingly depend on how wisely we innovate in reusing, recycling, and creating new sources." For Pakistan a public-private partnership model (similar to Spain's) ^{can} ~~lead~~ pilot medium scale plants in Karachi, ensuring both climate resilience and reduced dependence on Indus flows.

In addition, beyond infrastructure solutions, Pakistan must confront the challenge of water pricing and incentives, which shapes how water is valued and consumed. Currently, irrigation

is charged through nominal flat rates (abiana), encouraging overuse and waste. Moving toward volumetric tariffs, charging for the actual amount used, could promote efficiency and fairness. Peter Gleik in his influential book, *The Soft Path for water*, reminds that "the soft path rethinks how we use water, not just how much we can take." This approach emphasizes conservation, efficiency, and equitable distribution over endless expansion.

Pakistan can also tailor simple models such as tiered pricing structures or incentives for farmers adopting drip systems. By linking cost to consumption, Pakistan would encourage stewardship, reduce waste in irrigation, and create resources for reinvestment in water infrastructure and rural resilience.

Similarly, another pathway that deserves attention is the promotion of nature-based solutions^(NBS), which restore ecosystems to regulate water naturally rather than relying solely on engineering projects. Pakistan's rapid deforestation, wetland degradation and encroachments on Indus floodplains have weakened the environment's capacity to store and purify water. Reforestation in upper catchments could enhance groundwater recharge and reduce soil erosion, while wetland restoration along the Indus may act as natural filters, improving water quality. The UN World Water Development Report 2025 emphasizes that NBS are not alternatives but essential complements to conventional infrastructure. As the WWF Asia report highlights, revitalizing floodplains can both mitigate floods and replenish aquifers. Echoing this, Fred Pearce in his book "When the Rivers Run Dry" argues, "Rivers must be given space

to breathe if they are to continue sustaining us." For Pakistan scaling up NBS would build climate resilience while safeguarding long term water scarcity in harmony with nature. 5

Equally urgent is the challenge posed by Pakistan's melting glaciers, where glacial lake outburst floods (GLOFs) periodically devastate mountain communities, as seen in Gilgit Baltistan's Shisper Valley in July 2025 while the risk is severe, the pathway forward lies in building robust adaptation frameworks. Pakistan's GLOF-II project, backed by UNDP and Green Climate Fund, has pioneered early warning systems and community training, but this must be scaled up nationwide. Nepal's model of community based glacier monitoring offers a practical template, where local volunteers track glacial lakes and share real-time data. Moreover investment in artificial glaciers, as experimented in Ladakh, can provide seasonal water storage for downstream farmers. Integrating glacial melt forecasting into Pakistan's water policy would help planners optimize dam operations and irrigation schedules. As Saleemul Huq stresses, "Adaptation begins with protecting those most exposed." Strengthening resilience in the mountains is therefore the key to water security downstream.

Moreover, addressing urban water management is a critical pathway toward water security - cities like Karachi and Lahore lose over 30-40% of their water as Non-Revenue water (NRW) through leakage, theft, and outdated distribution networks. This inefficiency means that even when supply is available, millions remain without access. The Asian

Infrastructure & Investment Bank's \$250 million loan for Karachi water and Sewerage services Improvement Project-II (2023) signals recognition of this crisis, aiming to modernize pipelines, reduce NRW, and enhance service delivery. However, long term resilience requires decentralization; rainwater harvesting at household and community levels can supplement municipal supply, as demonstrated in Chennai, India, where mandatory rooftop systems recharge groundwater and reduce dependency on external sources. Scholars like David Sedlak, in *Water 4.0* argues that future urban water systems must combine centralized grids with decentralized solutions to withstand shocks. ~~For~~ Pakistan, blending infrastructure upgrades with localized harvesting offers a sustainable pathway. Last but not the least, transboundary water cooperation remains a decisive pathway for Pakistan's long term water security. The ^{Indus Water Treaty} IWT has survived wars and political turbulence, yet climate change, population growth and India's upstream projects test its durability. As Ismail Serageldin warned, "The wars of the next century will be fought over water, unless we change the way we manage it." The real challenge however, is less about conflict and more about missed opportunities for joint management. Scholars like Thomas Beernaer argue that water scarcity often pushes states towards cooperation rather than confrontation, because both sides recognize mutual dependence. For Pakistan, strengthening data sharing mechanisms, joint flood forecasting, and basin-wide climate adaptation strategies with India, Afghanistan, and even

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China could transform a zero sum narrative into a cooperative framework. Regional bodies like SAARC or obscure platforms under the World Bank ~~can~~ can help facilitate this. In essence diplomacy and trust building are as crucial as dams and canals.

"Water is the driving force of all nature" (Leonardo Da Vinci). Across South Asia, water scarcity is becoming a shared challenge, but Pakistan's position is especially precarious. While Nepal and Bangladesh still benefit from ~~relatively~~ relatively higher per-capita flows, Pakistan and Afghanistan fall into the "Extremely High" water-stress category (World Resource Institute 2025). This is not only because of climatic volatility but also because Pakistan's economy is overwhelmingly irrigation dependent. The UN has already warned that without urgent reforms, Pakistan may fail to achieve SDG 6 (Sanitation and Clean Water), ~~and~~ undermining other dependent development goals like health, food and energy etcetra. The opportunities lie for Pakistan in learning from Singapore's "Four National Taps" model, which ~~consists~~ contains desalination, recycling, imported water and rain capture. Pakistan can adopt integrated approaches alongside other pathways to foster a sustainable future.

In a nutshell, the challenge of water security is no longer a distant concern but an immediate reality that shapes its survival, development and stability. From the shrinking Indus Basin and receding glacial floods to

urban mismanagement, the threats are multifaceted. Yet the pathways to resilience are equally diverse. The strategies and pathways, when aligned with the vision of ~~Sustainable~~ SDG 6 represent not just technical reforms but moral imperatives also. As analysis portrays water is not merely a resource but the foundation of security, prosperity and dignity. Pakistan's journey towards water security is arduous but with political will, innovation, and collaboration, the crisis can be transformed into an opportunity for national renewal and regional leadership that will lead Pakistan towards a sustainable future.