Ministry of Planning
Development &
Special Initiatives
Government of Pakistan

URAAN
PAKISTAN
توشاہیں ہے پرواز ہے کام تیرا

NATIONAL WATER SECURITY

UNDER URAAN PAKISTAN

2026

Planning Commission
Ministry of Planning, Development & Special Initiatives
Government of Pakistan

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The Planning Commission also acknowledges the valuable contributions of the Frontier Works Organization (FWO) and other implementing agencies for sharing practical perspectives on water infrastructure development, flood management and engineering interventions across the country.

The Planning Commission is also grateful to international development partners, particularly the World Bank (WB), the Asian Development Bank (ADB), United Nations Development Program (UNDP), and Food and Agriculture Organization (FAO) for their continued support to Pakistan's water sector and for providing global knowledge, analytical resources and international best practices that refined this report more statistically. The contributions, technical expertise and constructive engagement of these institutions have greatly enriched the analysis and strengthened the development of this report.

MESSAGE BY FEDERAL MINISTER

Bismillahir Rahmanir Rahim,

It gives me great pleasure to present this report on National Water Security under URAAN Pakistan, which outlines a comprehensive roadmap for strengthening one of the most critical pillars of Pakistan's economic transformation and national resilience.

Pakistan has now become a water-scarce country. At the same time, climate change is intensifying floods, droughts, glacier melt, and rainfall variability. The illegal unilateral abeyance of the Indus Waters Treaty by India has further elevated water security as a strategic national priority.

Meeting these challenges requires more than infrastructure alone. It requires national unity and provincial consensus. Transparent water governance, completion of the national telemetry system, and cooperative decision-making are essential to building trust among the provinces and ensuring the equitable and efficient management of our shared water resources.

Recognizing the strategic importance of the sector, the Planning Commission has consistently accorded high priority to water sector investments through the PSDP. The Government will continue to prioritize strategic investments in this sector as we advance the objectives of URAAN Pakistan.

I commend the Member (Infrastructure & Regional Connectivity) and his team for their diligence and professionalism in preparing this comprehensive report. I also acknowledge the valuable contributions of all stakeholders whose collective insights have enriched this national document.

With sustained investment, sound policies, and collective resolve, I am confident that Pakistan can build a water-secure, climate-resilient, and prosperous future for generations to come.

Pakistan Zindabad.

Prof. Ahsan Iqbal

Federal Minister for Planning, Development and Special Initiatives

EXECUTIVE SUMMARY

This report presents the National Water Security framework under URAAN Pakistan. Water security represents a fundamental pillar of Pakistan's economic transformation under the URAAN Pakistan National Economic Transformation Plan, anchored in the 5Es Framework. It is inextricably linked to economic growth, food security, energy security, and national stability. Currently, Pakistan ranks as the third most water-insecure country among the Asian Development Bank's 49 developing member countries, with per capita water availability having declined from over 5,000 cubic metres at independence to approximately 850 cubic metres today, well below the internationally recognized water scarcity threshold of 1,000 cubic metres per capita. This ranking reflects persistent challenges across infrastructure, governance, service delivery, and climate resilience, indicating substantial scope for coordinated reform.

This report examines five strategic objectives under URAAN Pakistan's water security agenda and presents an integrated roadmap for sustainable water management across flood management, storage development, equitable distribution, irrigation modernization, and water, sanitation, and hygiene (WASH).

Enhance Water Drainage Infrastructure and Flood Management: Pakistan's flood regime has become increasingly variable, with more frequent alternation between prolonged droughts and extreme flooding. The 2022 floods affected over 33 million people, causing economic losses exceeding US$30 billion, while the 2025 floods demonstrated compressed warning times at Marala Headworks, from 40 hours in 2014 to only 5.5 hours in 2025, due to abrupt upstream reservoir operations. Critical barrages including Sukkur, Rasul, Trimmu, and Qadirabad have experienced peak discharges well above their original design capacities. The report proposes a hybrid approach combining structural infrastructure with nature-based solutions, modeled on international experience from China's Sponge City Programme and Viet Nam's mangrove restoration. Priority actions include declaring water security a national security agenda, enacting the National Flood Protection Plan-IV, strengthening glacier monitoring through a National Glacier Protection Act, and revising design peak inflow assessments using updated hydrological data.

Enhance Water Storages and Implement Water Conservation: Pakistan's current live storage capacity of 15.318 MAF represents only 11 percent of annual Indus River flows—substantially below the global average of 40 percent, while carryover capacity of only 30 days compares unfavourably with India (170 days), Australia (600 days), Egypt (700 days), and the United States (900 days). During the 2025 monsoon alone, approximately 30.48 MAF flowed downstream of Kotri Barrage into the Arabian Sea within 92 days, twice Pakistan's total annual storage capacity, while minimum ecological flow requirements of 3.65 MAF annually remain unmet for an average of 285 days per year. Meanwhile, reservoir sedimentation has reduced Tarbela's storage by 40.5 percent and Chashma's by 56.6 percent. Ongoing projects under the PSDP will add 9.821 MAF of storage, while the strategic pipeline of proposed projects—including Akhori Off-Channel Storage Dam (6.0 MAF), Shyok Dam (5.5 MAF), and Skardu Dam (3.0 MAF)—would provide approximately 20 MAF of additional capacity. Water conservation requires implementation of the National Water Conservation Strategy 2023–27.

Ensure Equitable Water Availability and Distribution: The 1991 Water Apportionment Accord allocates 117.35 MAF of annual surface water among provinces, with Punjab receiving 55.94 MAF (47.7%), Sindh 48.76 MAF (41.6%), Khyber Pakhtunkhwa 8.78 MAF (7.5%), and Balochistan 3.87 MAF (3.3%). However, approximately 20.58 million acres of suitable agricultural land remain outside formal irrigation networks, representing significant expansion potential across all provinces. The national telemetry system—currently at 65 percent physical progress—will establish transparent digital water accounting at 27 strategic locations across the Indus Basin Irrigation System, supporting the transition toward managing major reservoirs as transparent "water banks." The proposed Sindh Barrage (2.2 MAF storage, US$750 million) would enhance downstream water availability and lower riparian security, while the strategic canal pipeline—including Greater Thal Canal (1.74 million acres), Kachhi Canal (713,000 acres), Rainee Canal (412,400 acres), and Chashma Right Bank Canal Lift Project (286,000 acres)—would expand irrigated command areas and enable provinces to fully utilize their apportioned water shares.

Modernize Irrigation Systems: Pakistan operates the world's largest contiguous irrigation system, with 18 major barrages, 45 canal commands extending over 56,073 kilometres, and approximately 107,000 kilometres of watercourses. However, water-use efficiency remains critically below international best practice at approximately 40 percent, with substantial conveyance losses through seepage, aging infrastructure, and flood irrigation practices. Agriculture accounts for approximately 95 percent of freshwater withdrawals, with rice, cotton, and wheat representing the largest shares of irrigation water consumption. The report proposes establishing a Water System Integrator function under IRSA to strengthen river-to-farm water accountability, accelerating adoption of High Efficiency Irrigation Systems (drip and sprinkler) through targeted financial incentives, reforming abiana to reflect actual operation and maintenance costs, and rationalizing cropping patterns to improve water productivity measured as economic value generated per unit of water consumed.

Promote Water, Sanitation and Hygiene (WASH): Approximately 53 percent of monitored urban water sources are unsafe for human consumption due to microbial contamination, excessive salinity, and other water quality concerns, with conditions particularly severe across southern Sindh and coastal Balochistan. Pakistan continues to treat and reuse only a small fraction of municipal wastewater, with untreated sewage routinely discharged into rivers and groundwater. The report recommends scaling up point-of-use water filtration systems and community-based purification facilities, modernizing urban Water and Sanitation Agencies through Advanced Metering Infrastructure and smart water meters, expanding municipal wastewater treatment with a target of recycling at least 25 percent of urban wastewater, and developing decentralized seawater desalination facilities along the Makran Coast to enhance coastal water security.

Climate Change, Transboundary Water, and Groundwater Management: Pakistan's high vulnerability—ranking 15th globally on the Climate Risk Index (1995–2024)—stands in sharp contrast to its limited contribution to global greenhouse gas emissions (147th globally in per capita emissions). Rising temperatures are accelerating glacier melt in the Upper Indus Basin, which contributes 60–70 percent of Indus River flows, while erratic monsoon patterns are increasing the frequency of both floods and droughts. India's unilateral abeyance of the Indus Waters Treaty in April 2025, rejected by the Permanent Court of Arbitration in May 2026, has heightened Pakistan's need for improved water management and sustained diplomatic engagement. Meanwhile, groundwater, meeting over 50 percent of irrigation requirements and 90 percent of rural domestic water, is being depleted at rates of 0.5–1 metre per year across Punjab, with the Indus Basin Aquifer identified by NASA GRACE as the second most overstressed aquifer system globally. Solarization of agricultural tubewells is emerging as a significant driver of over-extraction, operating at effectively zero marginal cost without accompanying water governance provisions. The report recommends initiating high-level diplomatic engagement on the Indus Waters Treaty, establishing a National Aquifer Mapping Program, enacting comprehensive groundwater legislation, mainstreaming Managed Aquifer Recharge into urban planning, and rationalizing agricultural tubewell solarization by linking subsidies to groundwater registration and sustainable abstraction limits.

Projected Economic and National Security Impact: Under the integrated framework presented in this report, by 2029, Pakistan is targeting water availability at the farm gate to increase from 58.3 MAF to 79 MAF, water storage capacity from 15.318 MAF to 23.54 MAF, and water-use efficiency from 40 percent to 70 percent. The 10-year indicative federal financing requirement for strategic water infrastructure is estimated at approximately

$18 billion, encompassing flood management, storage development, and canal modernization. Achieving these targets would position water security as a strategic enabler of economic growth, food security, climate resilience, and national stability, contingent upon coordinated implementation of the policy, regulatory, and infrastructure reforms outlined in this report.

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INTRODUCTION

National Water Security

Water security is the ability of a country to ensure sustainable access to adequate quantities of acceptable-quality water for its people, economy, and ecosystems, while protecting society from water-related disasters and preserving environmental resources for future generations. It extends beyond the physical availability of water. It also depends on effective governance, resilient infrastructure, sound institutions, efficient water use, and the capacity to manage climate and hydrological risks.

The Asian Water Development Outlook (AWDO) 2025, published by the Asian Development Bank (ADB), assesses national water security through five interdependent dimensions: rural household water security, economic water security, urban water security, environmental water security, and water-related disaster security. These dimensions provide one of the internationally recognized approaches for assessing water security across countries. The five dimensions of national water security under AWDO 2020 are illustrated in Figure 1.

Water is a strategic national resource. It supports agriculture, industry, energy production, public health, urban development, and environmental sustainability. It is equally important for food security, economic growth, and climate resilience. As water demand continues to increase and climate variability becomes more pronounced, ensuring water security has become a prerequisite for sustainable development and national stability.

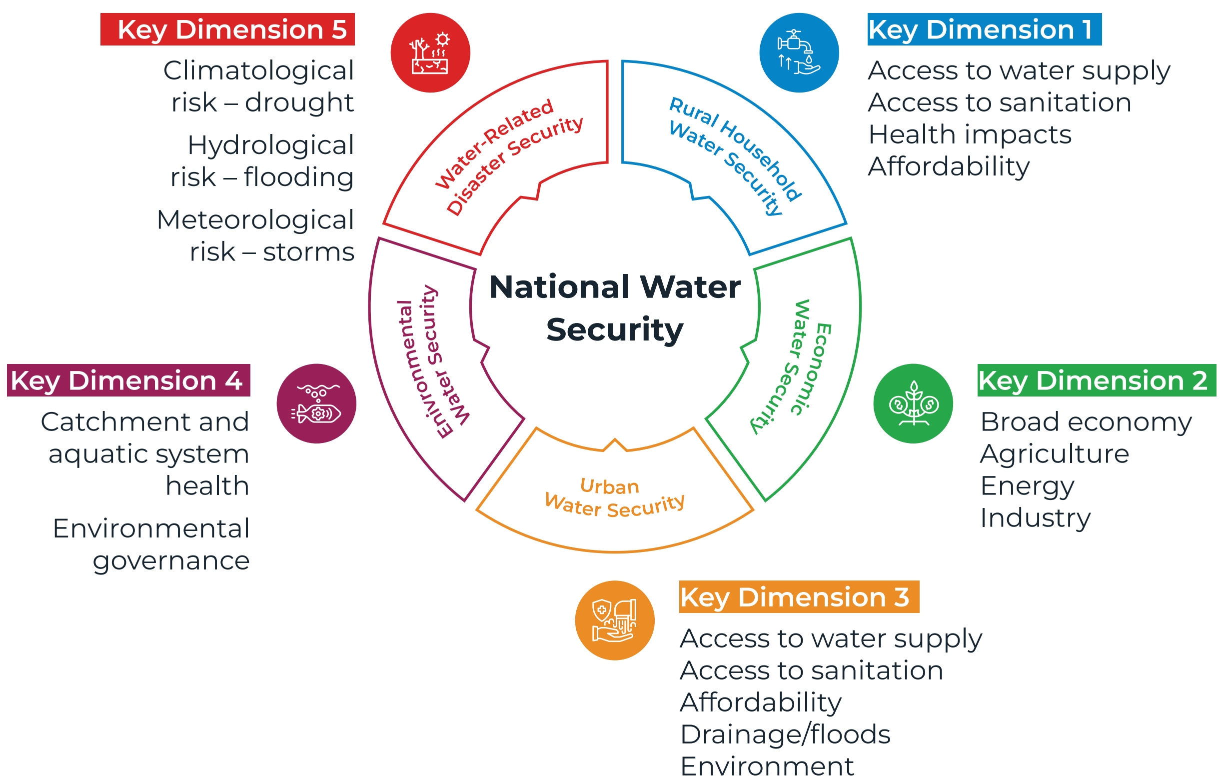


Figure 1: Key Dimensions of National Water Security (AWDO 2025)

Global Water Outlook

Water security has become one of the defining development challenges of the twenty-first century. Population growth, urbanization, industrial expansion, and changing consumption patterns are increasing pressure on finite freshwater resources. At the same time, climate change is altering the global water cycle. Many regions are experiencing more frequent floods, prolonged droughts, declining water quality, and increasing groundwater depletion. These trends are widening the gap between water demand and sustainable supplies.

Despite significant progress over recent decades, access to safe water and sanitation remains a major global challenge. According to the WHO/UNICEF Joint Monitoring Programme, around 2.2 billion people still lack safely managed drinking water services, while 3.5 billion people do not have access to safely managed sanitation. The United Nations further estimates that nearly half of the world's population experiences severe water scarcity for at least part of the year. These trends are expected to intensify as temperatures continue to rise and hydrological variability increases.

Climate change has emerged as a major driver of water insecurity. Rising temperatures are accelerating glacier retreat, changing the timing and intensity of precipitation, and increasing the frequency of floods and droughts. Coastal regions are also facing greater risks from sea level rise and sea intrusion. Together, these impacts threaten water supplies, agricultural productivity, infrastructure, ecosystems, and livelihoods.

Recognizing these challenges, countries are increasingly adopting Integrated Water Resources Management (IWRM) to improve water governance and strengthen climate resilience. Greater emphasis is being placed on water conservation, demand management, wastewater treatment and reuse, groundwater recharge, nature-based solutions, and climate-resilient water infrastructure. Advances in digital technologies, including remote sensing, telemetry, artificial intelligence, and real-time hydrological monitoring, are also improving water planning and resource management. For countries that share rivers and aquifers, transboundary cooperation has become an equally important component of long-term water security.

These priorities are reflected in Sustainable Development Goal 6 (SDG 6), which seeks to ensure the availability and sustainable management of water and sanitation for all by 2030. The goal extends beyond expanding access to drinking water and sanitation. It also calls for improving water quality, increasing water-use efficiency, protecting freshwater ecosystems, strengthening integrated water resources management, and enhancing international cooperation. Achieving these objectives will require sustained investment, stronger institutions, and evidence-based policymaking. Together, these measures form the foundation of modern water security strategies and resilient national water systems.

Pakistan's National Water Security Outlook

Pakistan's water security is shaped by a complex interaction of climatic, hydrological, institutional, and geopolitical factors. The country's water system is centred on the Indus River Basin, one of the world's largest integrated river basins. Stretching across Pakistan, India, China, and Afghanistan, the basin supplies almost all of Pakistan's surface water and supports the country's agriculture, hydropower generation, industry, and domestic water needs. More than 90 percent of food production and a significant share of the national economy depend directly on the efficient management of this river system. Any disruption to its flows therefore has far-reaching implications for economic growth, food security, energy security, and national stability.

According to Asian Water Development Outlook (AWDO) 2025, Pakistan's national water security score improved moderately from 2013 to 2025 by 6.4 points. However, the country is still experiencing a severe water stress situation mainly driven by population growth, climate impacts, and mismanaged infrastructure. Over 80% of citizens cannot access safe drinking water, fuelling widespread waterborne diseases. Pakistan's low ranking reflects persistent challenges across multiple aspects of water security and underscores the need for coordinated reforms spanning infrastructure, governance, service delivery, and climate resilience. The AWDO 2020 ranking of ADB's developing member countries and Pakistan's performance across the five dimensions are presented in Figure 2.

Climate change: It is amplifying almost every water-related challenge facing Pakistan. Rising temperatures are accelerating glacier melt in the Upper Indus Basin, which provides nearly two-thirds of the river system's annual flows. At the same time, changing precipitation patterns are increasing the frequency of both floods and droughts. Recent years have demonstrated this growing variability, with prolonged dry spells followed by extreme rainfall events that overwhelm existing drainage infrastructure. Climate change is therefore not an isolated challenge; it influences water availability, storage, irrigation performance, groundwater recharge, disaster risk, and ecosystem health across the entire water sector.

Water availability and storage: Pakistan is among the world's most water-stressed countries in terms of water available per capita. Per capita water availability has declined from more than 5,000 cubic metres at independence to approximately 850 cubic metres today, placing the country below the internationally recognized threshold for water scarcity at 1,000 cubic metres per capita. Although the Indus River carries an average annual flow of around 138 million acre-feet (MAF), Pakistan has the capacity to store only about 30 days of river flows. By comparison, major water economies maintain substantially higher carry-over storage, including around 170 days in India, 600 days in Australia, 1000 days in Egypt, and nearly 900 days in the United States. Limited storage reduces Pakistan's ability to capture surplus flows during the monsoon and glacier melt season, increases flood losses, and limits water availability during dry periods.

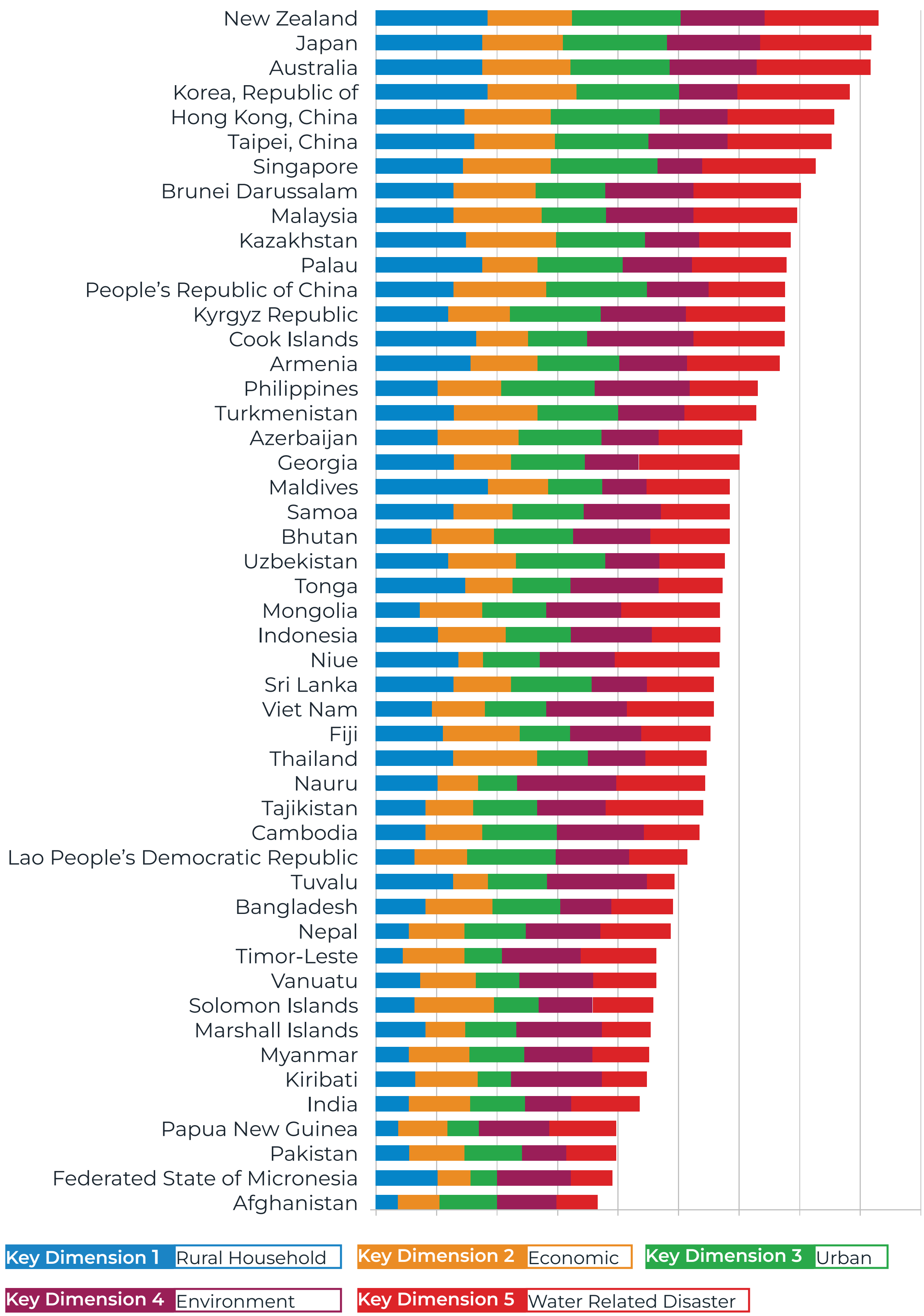


Figure 2: National Water Security Index (AWDO 2020)

Flood management: Pakistan's exposure to floods has increased significantly over the past two decades. Riverine floods, flash floods, glacial lake outburst floods (GLOFs), urban flooding, and hill torrents are becoming more frequent and more destructive. The floods of 2010, 2022, and 2025 demonstrated that many drainage systems, barrages, embankments, and flood protection structures are operating under conditions that exceed their original design assumptions. Strengthening flood forecasting, expanding drainage infrastructure, restoring natural floodplains, and improving disaster preparedness are becoming essential components of national water security.

Irrigation and water-use efficiency: Pakistan operates the world's largest contiguous irrigation system. Agriculture consumes around 90 percent of the country's freshwater withdrawals and remains the backbone of rural livelihoods and food production. However, substantial losses occur before water reaches the farm gate due to seepage, ageing infrastructure, and inefficient irrigation practices. Water-use efficiency remains critically below international best practice. Therefore, modernization of Indus-Basin River irrigation system by improving canal infrastructure, promoting high-efficiency irrigation technologies, and encouraging climate-smart cropping patterns will be critical for meeting future water demand without proportionately increasing water withdrawals.

Groundwater governance: Groundwater has become the country's strategic reserve for agriculture and urban water supply. Pakistan is now the fourth-largest groundwater abstractor in the world, yet abstraction significantly exceeds natural recharge. Falling groundwater tables, deteriorating water quality, and salinity are becoming increasingly common, particularly in Punjab, Balochistan, and coastal Sindh. Despite its growing importance, groundwater extraction remains majorly unregulated. Strengthening groundwater governance through aquifer mapping, licensing, monitoring, artificial recharge, and sustainable abstraction policies will be central to long-term water security.

Water, sanitation and hygiene (WASH): Access to safe drinking water, sanitation, and wastewater management remains uneven across the country. Rapid urbanization has outpaced investment in water supply and sewerage infrastructure, while many rural communities continue to face challenges related to water quality and sanitation services. Limited wastewater treatment has also contributed to the pollution of rivers, lakes, and groundwater. Expanding safe water supply, improving sanitation coverage, increasing wastewater treatment and reuse, and promoting better hygiene practices are essential not only for public health but also for protecting Pakistan's water resources.

Equitable water distribution: Ensuring equitable distribution of water among provinces remains one of the most important governance challenges in the sector. While the 1991 Water Apportionment Accord provides the legal framework for provincial allocations, disagreements continue over water availability, measurement, telemetry, and infrastructure development. The absence of adequate storage further limits operational flexibility during periods of shortage. Building confidence through transparent data systems, completing telemetry networks, and developing strategic storage and conveyance infrastructure will be necessary to strengthen inter-provincial water cooperation.

Transboundary water sharing: Pakistan's water security is closely linked to developments beyond its borders. The Indus River Basin is shared with India under the Indus Waters Treaty, while the Kabul River originates in Afghanistan before entering Pakistan. India's unilateral and illegal abeyance of the Indus Waters Treaty, together with upstream infrastructure on the western rivers, has heightened Pakistan's need for better water management, reliable hydrological monitoring, and sustained diplomatic engagement. At the same time, the absence of a formal water-sharing agreement with Afghanistan on the Kabul River presents an emerging challenge that requires timely policy attention.

These dimensions are closely interconnected. Greater storage capacity improves flood management and water availability during dry periods. Efficient irrigation reduces pressure on both surface water and groundwater resources. Better groundwater governance strengthens agricultural resilience and urban water supply. Improved WASH protects public health while reducing pollution of freshwater resources. Likewise, transparent water governance and effective transboundary cooperation strengthen long-term water availability and normal security for regional peace and stability.

NATIONAL WATER SECURITY UNDER

URAAN PAKISTAN

National Water Security Under URAAN Pakistan

URAAN Pakistan is the Government of Pakistan's national economic transformation plan that aims to double exports to USD 60 billion by 2029 and transform Pakistan into a USD 3 trillion economy by 2047. It is anchored in the 5Es Framework, comprising Energy & Infrastructure, Exports, E-Pakistan, Environment & Climate Change, and Equity, Ethics & Empowerment.

Within this framework, water security has been identified as a strategic priority under the Environment & Climate Change pillar. An illustration of the relationship between the 5Es Framework and the water sector is presented in Figure 3. URAAN Pakistan adopts the overarching objective of building a water-secure future for Pakistan through five strategic objectives, while pursuing three measurable national targets by 2029, as illustrated in Figure 4, and as follows:

- *Increase water availability at the farm gate from 58.3 MAF to 79 MAF*
- *Increase water storage capacity from 15.318 MAF to 23.54 MAF*
- *Increase water-use efficiency from 40 percent to 70 percent*

To achieve these targets, URAAN Pakistan focuses on the following strategic objectives:

1. *Enhance water drainage infrastructure and flood management systems*
2. *Enhance water storages and implement water conservation measures*
3. *Ensure equitable water availability and distribution across sectors and provinces*
4. *Modernize irrigation systems across the country*
5. *Promote water, sanitation and hygiene (WASH)*

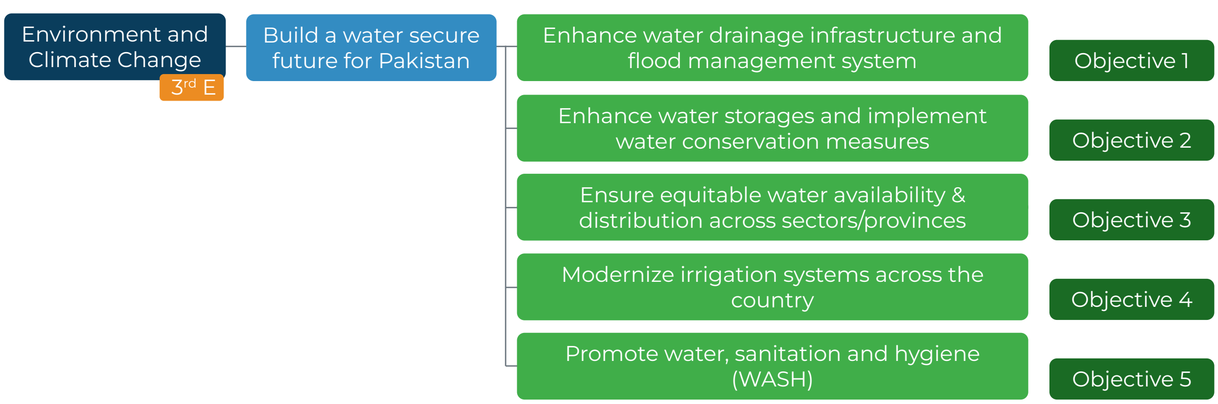


Figure 3: National Water Security relationship with URAAN Pakistan's objectives

TARGET 1
Increase water availability at farmgate from 58.3 MAF to 79 MAF
TARGET 2
Increase water storage capacity from 15.318 MAF to 23.54 MAF
TARGET 3
Increase water use efficiency from 40% to 70%

Figure 4: Water Sector Targets identified under URAAN Pakistan

IMPACT OF CLIMATE CHANGE ON NATIONAL WATER SECURITY

Pakistan's Climate Change Vulnerability

Climate change has emerged as one of the greatest threats to Pakistan's long-term water security. The impacts of climate change are already evident across Pakistan. More frequent and intense floods, prolonged droughts, heatwaves, erratic monsoon rainfall, and accelerated glacier melt are increasing pressure on the country's water resources and infrastructure. The 2022 floods, which affected more than 33 million people and caused economic losses exceeding US$30 billion, demonstrated the scale of climate-related risks facing the country. Consequently, many of the country's water security challenges can no longer be viewed in isolation from climate change.

Pakistan bears a disproportionately high share of global climate risks despite contributing very little to global greenhouse gas (GHG) emissions. According to the Climate Risk Index (CRI) 2025, Pakistan ranked as the 15th most affected country worldwide by extreme weather events over the period 1995–2024. The CRI ranking is based on a composite assessment of total fatalities, fatalities per 100,000 inhabitants, total population affected, population affected per 100,000 inhabitants, direct economic losses (US$), and losses as a percentage of gross domestic product (GDP). Pakistan's position on the index reflects its high exposure and vulnerability to recurring climate-related disasters. The global distribution of climate risk is illustrated in Figure 5.

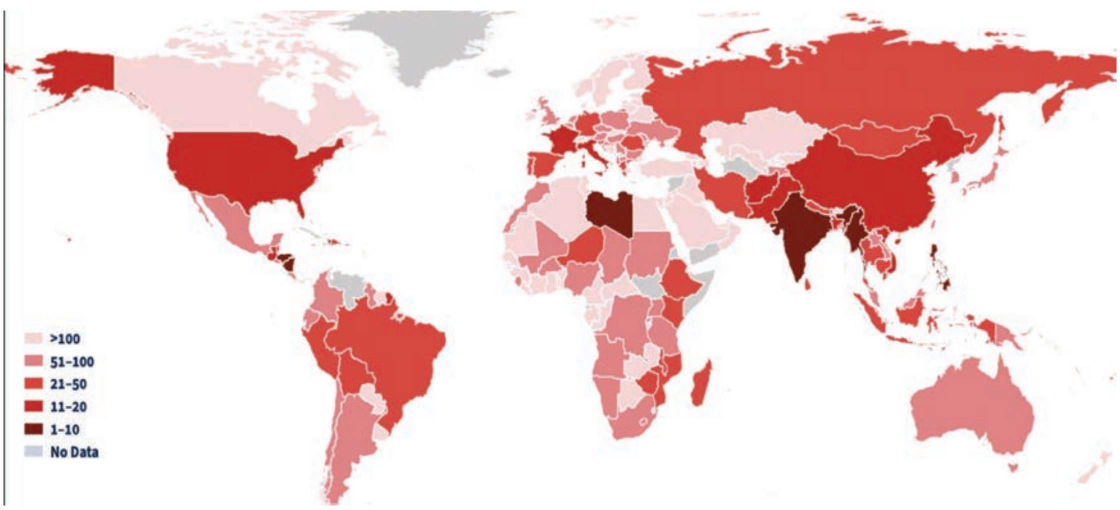


Figure 5: Climate Risk Index, Most Affected Countries 1995-2024 (Germanwatch)

South Asia is among the world's most climate-vulnerable regions due to its dependence on monsoon systems, glacier-fed river basins, densely populated floodplains, and high exposure to extreme weather events. As illustrated in Figure 6, several South Asian countries, including Pakistan, India, Bangladesh, Afghanistan, and Myanmar, ranked among the 15 most climate-affected countries during 1995–2024. The region therefore faces a shared challenge of strengthening climate resilience while safeguarding water, food, and energy security.

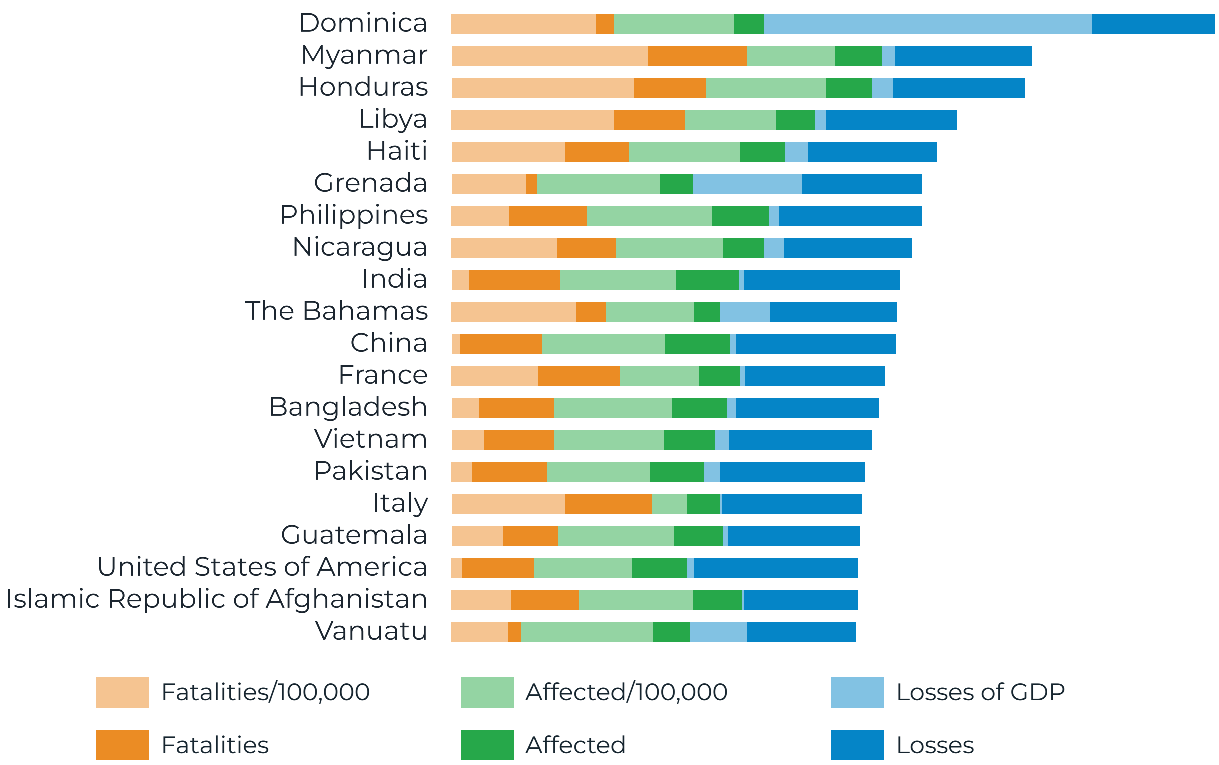


Figure 6: The 20 Most Affected Countries by Climate Change in 1995-2024 (Germanwatch)

Pakistan's high vulnerability stands in sharp contrast to its limited contribution to global climate change. According to the European Union's Emissions Database for Global Atmospheric Research (EDGAR), Pakistan is among the world's lowest per capita emitters of greenhouse gases, ranking 147th globally in per capita emissions. Pakistan's per capita GHG emissions stood at approximately 2.36 tonnes of CO_2 equivalent in 2024 and have shown a gradual declining trend since 2020. In comparison, per capita emissions remain substantially higher in many developed and high-income economies, including the United States (17.34 tonnes), Australia (22.26 tonnes), and Saudi Arabia (22.79 tonnes) per person annually. This disparity, which is expected to grow even more with the advent of AI and energy-intensive data centers, highlights the unequal distribution of responsibility for climate change and its impacts.

Pakistan's experience also reinforces the principle of climate justice. Despite its negligible contribution to global emissions, it continues to bear a disproportionate share of climate-induced losses and damages. This strengthens Pakistan's case for enhanced international climate finance, technology transfer, adaptation support, and access to loss-and-damage funding mechanisms under the United Nations Framework Convention on Climate Change (UNFCCC).

Rising Temperatures

Pakistan is experiencing a rapid rise in temperatures, with warming occurring at a faster rate than the global average. The effects of rising temperatures are already evident across the country. Pakistan is witnessing a shortening of the transitional spring and autumn seasons, more frequent and prolonged heatwaves, and a growing number of days with extremely high temperatures. Southern districts, particularly Jacobabad and Nawabshah, have repeatedly recorded temperatures exceeding 50°C, placing them among the hottest inhabited places in the world. Higher temperatures also increase water demand across agriculture, industry, and domestic sectors while accelerating evaporation losses from rivers, reservoirs, and soils.

For Pakistan's water sector, rising temperatures represent a systemic risk that extends well beyond heat stress. They directly influence snow accumulation, glacier melt, river flows, groundwater recharge, irrigation requirements, and the frequency of climate-induced disasters. The following section examines one of the most critical consequences of this warming trend: its impact on the cryosphere of the Upper Indus Basin, which serves as the principal source of Pakistan's freshwater resources.

Melting Cryosphere of the Upper Indus Basin

The cryosphere refers to the frozen components of the Earth's water system, including glaciers, snow cover, ice sheets, permafrost, and glacial lakes. In Pakistan, the cryosphere of the Upper Indus Basin (UIB) serves as a critical natural water reservoir and is central to the country's water security. Unlike many major river systems that are primarily dependent on rainfall, the Indus River system derives a significant proportion of its annual flows from snow and glacier melt originating in the Hindu Kush, Karakoram, and Himalayan mountain ranges. These frozen water reserves regulate seasonal river flows by storing water during colder months and releasing it during the summer melt season, supporting agriculture, hydropower generation, ecosystems, and domestic water requirements.

The Upper Indus Basin contains approximately 15,041 km^2 of glacier cover, with an estimated 2,738 km^3 of stored ice reserves. The region also contains around 2,420 glacial lakes, including 1,328 major glacial lakes, making it one of the largest concentrations of high-altitude freshwater reserves outside the polar regions. The importance of this system is particularly evident in comparison with other major rivers of the Indo-Gangetic Plain. As illustrated in Figure 7, snow and glacier melt contributes approximately 60–70 percent of the Indus River's mean annual discharge, significantly higher than the contribution in the Ganges and Brahmaputra systems, where snow and glacier melt contributes less than 20 percent of total flows. While these rivers receive substantial contributions from monsoon rainfall and lowland runoff, the Indus remains heavily dependent on mountain-derived water due to Pakistan's predominantly semi-arid climate. Further breakdown of water source composition of the three rivers is shown in Figure 8.

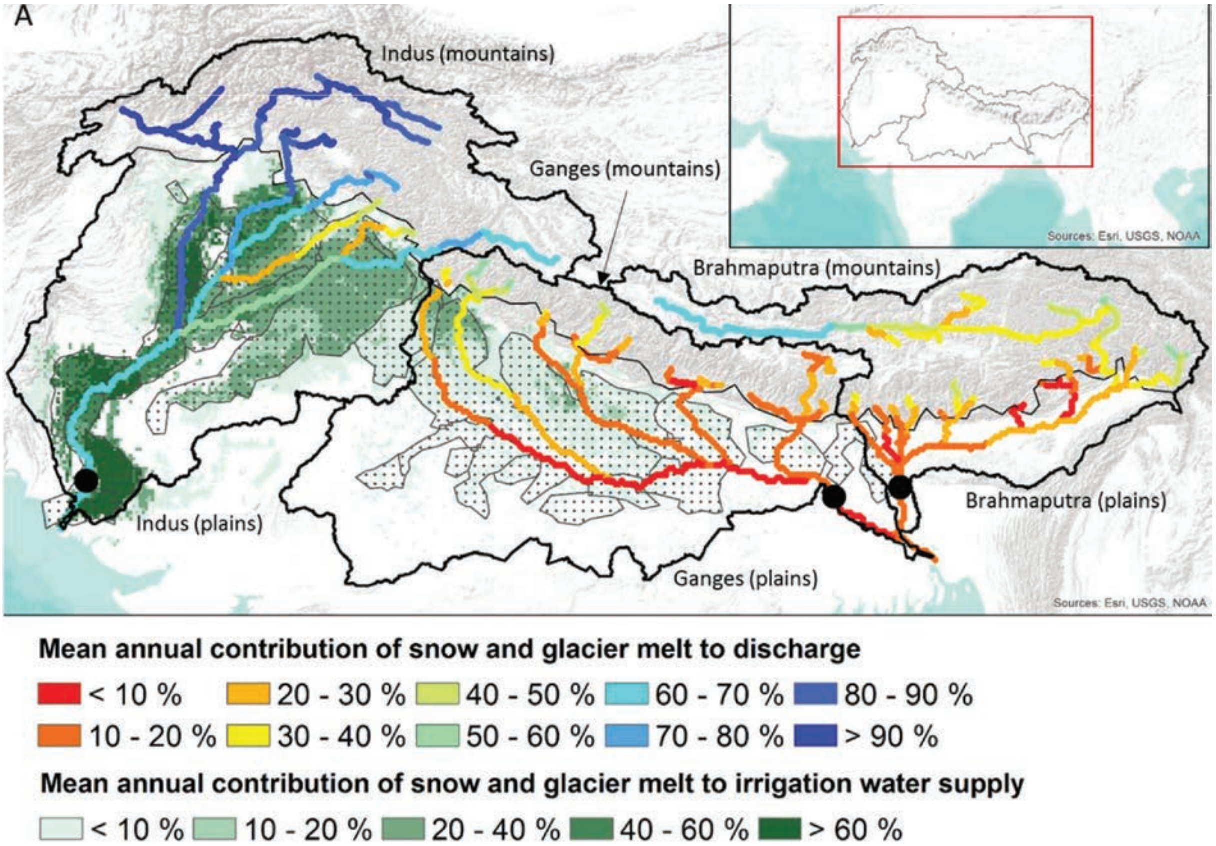


Figure 7: Mean annual contribution of snow and glacier melt to river discharge in the Indo-Gangetic Plains

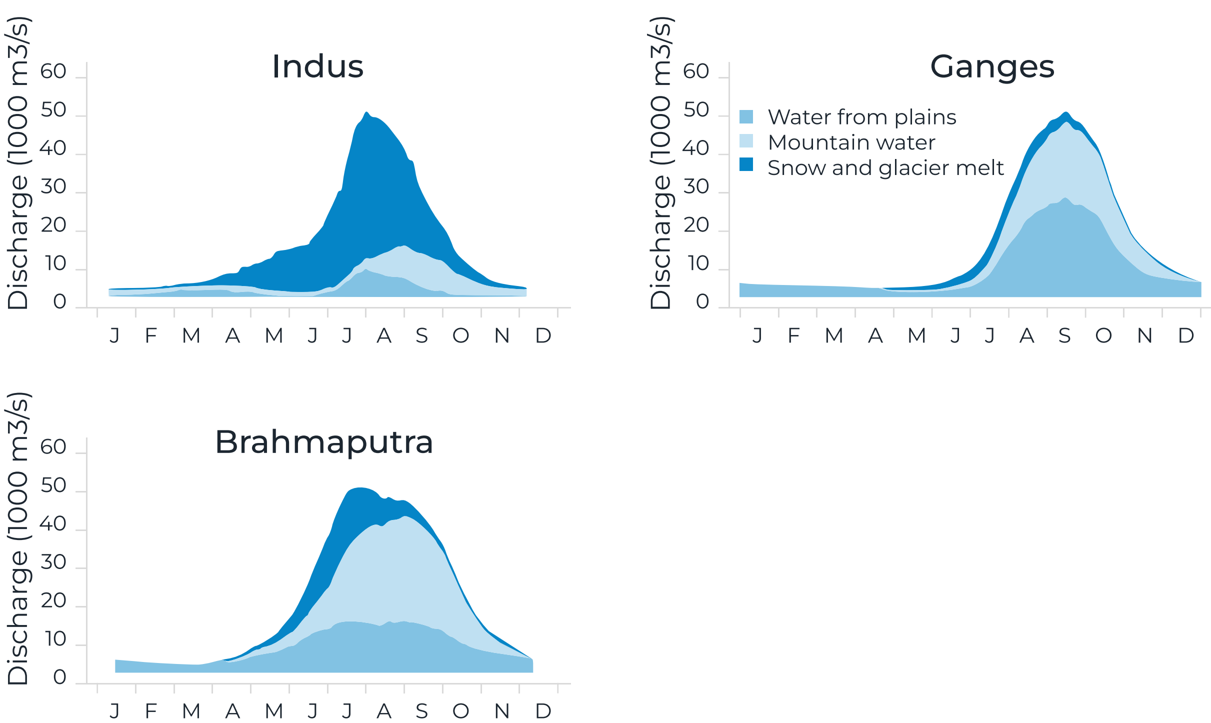


Figure 8: Water Source Composition of Indus, Ganges, and Brahmaputra Rivers

The Upper Indus Basin cryosphere also performs an important seasonal buffering function for Pakistan's water system. Snow and glacier melt sustain Indus River flows during the pre-monsoon period, when rainfall contribution is limited but irrigation demand begins to increase. This gradual release of stored water from the Hindu Kush–Karakoram–Himalayan cryosphere helps maintain river flows before the arrival of monsoon rains and supports agricultural production across the Indus Basin.

However, rising temperatures are altering the long-term dynamics of the Upper Indus Basin cryosphere. Accelerated glacier and snow melt is expected to increase Indus River flows in the short term, while also increasing the risk of floods and glacial lake outburst floods (GLOFs) in vulnerable mountain regions. Over time, as glacier reserves continue to decline due to their finite nature, the capacity of the cryosphere to sustain river flows will diminish, potentially resulting in reduced dry-season availability and greater variability in Indus River flows. This transition from increased meltwater contribution to long-term decline represents one of the most significant climate-related risks to Pakistan's future water security.

The changing cryosphere highlights the need for a coordinated national framework for climate adaptation and water resource management. Despite the strategic importance of glaciers to Pakistan's water security, the country does not currently have a dedicated National Glacier Protection Policy to guide glacier monitoring, conservation, research, and climate adaptation efforts. Establishing such a framework, supported by improved cryosphere observation systems and climate risk assessments, will be essential for informed decision-making. In parallel, strengthening water storage capacity, improving irrigation efficiency, and enhancing flood preparedness will be critical to manage increasing variability in Indus River flows and safeguard Pakistan's long-term water security.

Erratic Monsoon Patterns and Rainfall Volatility

Climate change is altering not only the intensity of Pakistan's monsoon, but also its spatial and temporal distribution. Rather than following historically predictable patterns, monsoon rainfall has become increasingly concentrated, localized, and erratic. This has increased the frequency of extreme precipitation events, cloudbursts, flash floods, and urban flooding, while making seasonal water planning considerably more difficult.

Figure 9 illustrates how the geographical centre of monsoon vulnerability has shifted across Pakistan during three major monsoon events. In 2010, exceptionally heavy rainfall was concentrated over northern Pakistan, generating large riverine floods that propagated downstream through the Indus River system. In 2022, the monsoon shifted southwards, with Sindh and Balochistan receiving more than three times their normal rainfall. This resulted in extensive flooding across the plains, widespread urban inundation, and one of the most devastating disasters in Pakistan's history. In 2025, the core monsoon zone migrated back towards the north, where localized areas of Khyber Pakhtunkhwa, Upper Punjab, and Azad Jammu & Kashmir received more than 1,000 mm of rainfall, triggering cloudbursts, flash floods, and landslides.

These recurring shifts demonstrate that Pakistan's hydrological regime is becoming increasingly volatile. The challenge is no longer confined to above-normal rainfall, but also to where, when, and how intensely that rainfall occurs.

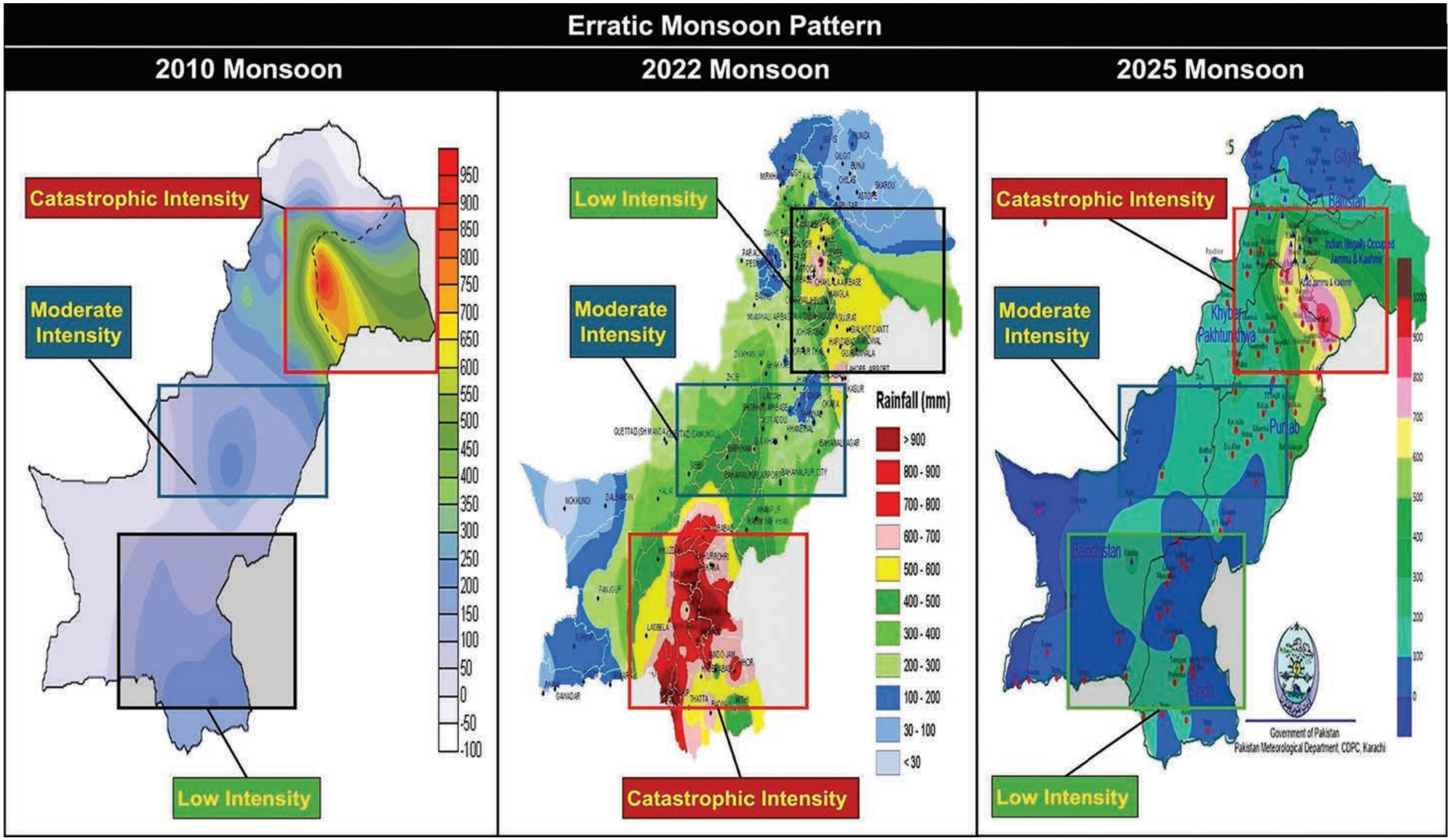


Figure 9: Changing Spatial Distribution of Monsoon across 2010, 2022 and 2025

TRANSBOUNDARY WATER SHARING

The Indus Waters Treaty

The Indus River Basin, as illustrated in Figure 10, is Pakistan's principal source of freshwater and the foundation of its agriculture, hydropower generation, and national water security. As the lower riparian state, Pakistan's economy and livelihoods depend upon the uninterrupted, predictable and cooperative management of rivers originating upstream.

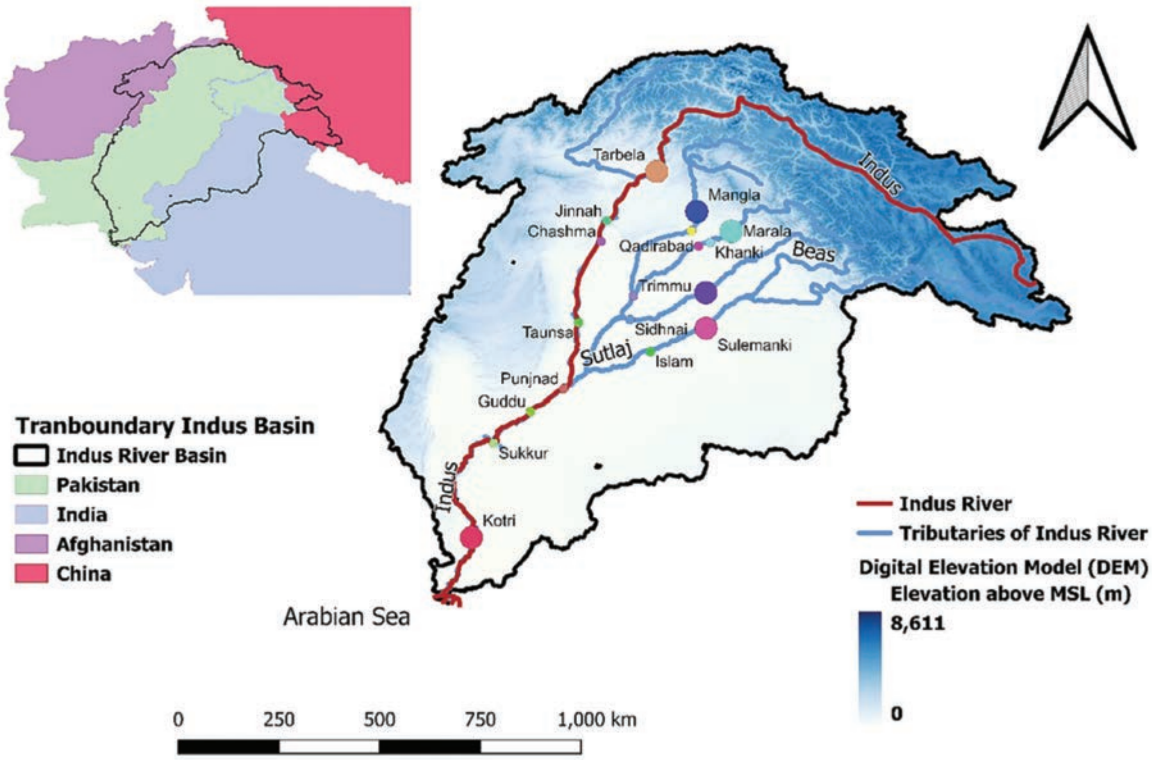


Figure 10: The Transboundary Map of Indus River Basin

Recognizing the strategic importance of these shared waters, Pakistan and India concluded the Indus Waters Treaty (IWT) on 19 September 1960 under the auspices of the World Bank. The Treaty was signed by President Field Marshal Muhammad Ayub Khan of Pakistan, Prime Minister Jawaharlal Nehru of India, and World Bank Vice President W.A.B. Iliff. Comprising twelve Articles and eight Annexures, the Treaty remains one of the world's most comprehensive transboundary water-sharing agreements.

The Treaty allocates the three Eastern Rivers (Ravi, Beas and Sutlej) for India's unrestricted use, while Pakistan enjoys unrestricted use of the three Western Rivers (Indus, Jhelum and Chenab), subject only to limited and carefully regulated uses by India. Over the decades, India has fully developed and diverted the Eastern Rivers while progressively expanding hydraulic infrastructure on the Western Rivers. On the other hand, the Western Rivers now constitute the lifeline of Pakistan's water economy, sustaining the overwhelming majority of the country's irrigation, hydropower generation and municipal water supplies.

The Treaty has endured numerous periods of political hostility and survived multiple wars between Pakistan and India. Its resilience has long been regarded as evidence that water cooperation should remain insulated from political and military disputes.

IWT's Legal Framework and Dispute Resolution Mechanism

The Indus Waters Treaty establishes a comprehensive institutional framework for the management of disputes between the two countries.

Technical issues are first considered by the Permanent Indus Commission, comprising Commissioners from both countries. Matters that cannot be resolved at this level may, for specified technical questions, be referred to a Neutral Expert. Legal disputes concerning interpretation or application of the Treaty may be referred to a Court of Arbitration under Article IX, with the World Bank performing defined procedural functions in both mechanisms.

Importantly, the Treaty provides an established legal pathway for resolving disagreements. It contains no provision permitting either Party to suspend or hold the Treaty in abeyance unilaterally. Article XII explicitly provides that the Treaty shall remain in force unless modified by mutual agreement between both Governments through a duly ratified treaty. Accordingly, neither Party possesses the legal authority to suspend, terminate or place the Treaty in abeyance through unilateral executive action.

India's Illegal Unilateral Abeyance of the Indus Waters Treaty

On 23 April 2025, India announced that it was placing the Indus Waters Treaty in abeyance. Pakistan rejected this announcement as illegal and inconsistent with both the Treaty and established principles of international treaty law.

The Treaty itself contains no suspension clause, no withdrawal mechanism, and no expiry provision. Instead, it establishes an elaborate dispute-resolution framework intended precisely to address disagreements while preserving the continued operation of the Treaty.

This legal position was reaffirmed in May 2026 when the Permanent Court of Arbitration at The Hague upheld its earlier findings supporting the continued validity of the Indus Waters Treaty. The Tribunal rejected the proposition that either Party may unilaterally suspend or withdraw from the Treaty and reaffirmed that the legal framework governing the Indus River System continues to bind both Pakistan and India. In an earlier award, the Tribunal had further affirmed Pakistan's right to the unrestricted use of the Western Rivers in accordance with the Treaty.

The Tribunal's findings reinforce the principle that international water-sharing arrangements cannot be unilaterally disregarded by an upper riparian state. Respect for treaty obligations remains fundamental to regional stability and the protection of downstream rights.

Lower Riparian Rights and Emerging Strategic Concerns

International water law recognizes that lower riparian states possess legitimate rights to equitable and predictable utilization of shared international rivers. The Indus Waters Treaty embodies this principle by establishing clear allocations, operational limitations and institutional mechanisms intended to protect downstream interests.

India possesses multiple major river systems beyond the Indus Basin, including the Ganges, Brahmaputra, Godavari, Krishna, Mahanadi, Narmada and Tapi basins. Nevertheless, the Indus Basin remains the only river system upon which Pakistan's national water security overwhelmingly depends. Consequently, unilateral actions affecting the Indus River System carry disproportionate implications for Pakistan compared with India.

This asymmetry reinforces the importance of strict adherence to treaty obligations, transparent reservoir operations, timely exchange of hydrological information and effective institutional cooperation between the two countries.

Weaponization of Water: The Marala Headworks Case Study

Since the illegal unilateral abeyance of the Indus Waters Treaty by India, Pakistan has repeatedly raised concerns that reservoir operations at upstream projects such as Salal Dam and Baglihar Dam are being weaponized resulting in increasing downstream damages due to abrupt and unpredictable flow fluctuations. Of particular concern is the apparent reduction in warning time given to downstream authorities during high-flow events, thereby complicating flood management, emergency response, and the operation of critical water infrastructure.

The evolution of flood hydrographs at Head Marala provides an illustrative case. Comparative analysis of the 2014 and 2025 peak flow events, as illustrated in Figure 11 and Figure 12 respectively, indicate a pronounced change in the rate at which flood peaks propagated downstream. During the September 2014 event, peak discharge at Head Marala reached 861,464 cusecs. The rise from the high flood alert threshold of 400,000 cusecs to the peak discharge occurred over approximately 40 hours, providing downstream authorities with sufficient time to monitor the situation, issue warnings, regulate barrage operations, and undertake evacuations where required.

By contrast, during the August 2025 flood event, Head Marala recorded a higher peak discharge of 917,525 cusecs, yet the interval between crossing the 400,000-cusec alert threshold and reaching the peak compressed dramatically to only 5.5 hours. The surge also occurred during nighttime hours, significantly reducing the effectiveness of the response. This demonstrates that the principal concern is not merely the higher peak discharge but the unprecedented rate of flow escalation.

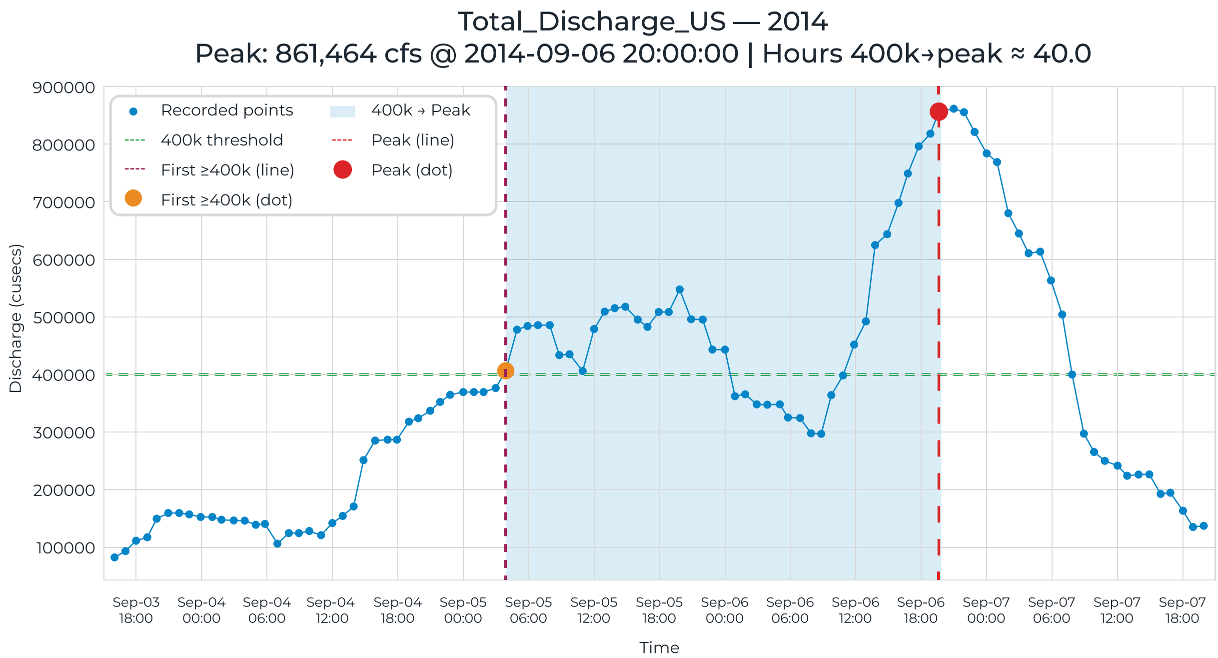


Figure 11: Marala Head Water Inflows Chart - Sept 2014 Floods

This pattern is consistent with repeated observations by Pakistan's water management authorities regarding sudden and without warning upstream reservoir releases from projects on the Eastern Rivers. Although individual flood events are influenced by meteorological conditions, the recurring compression of flood water release windows raises serious operational concerns regarding the timing and coordination of upstream reservoir releases. Such practices substantially increase downstream flood risk by denying authorities the reaction time available for emergency preparedness leading to substantial humanitarian, economic, and security consequences.

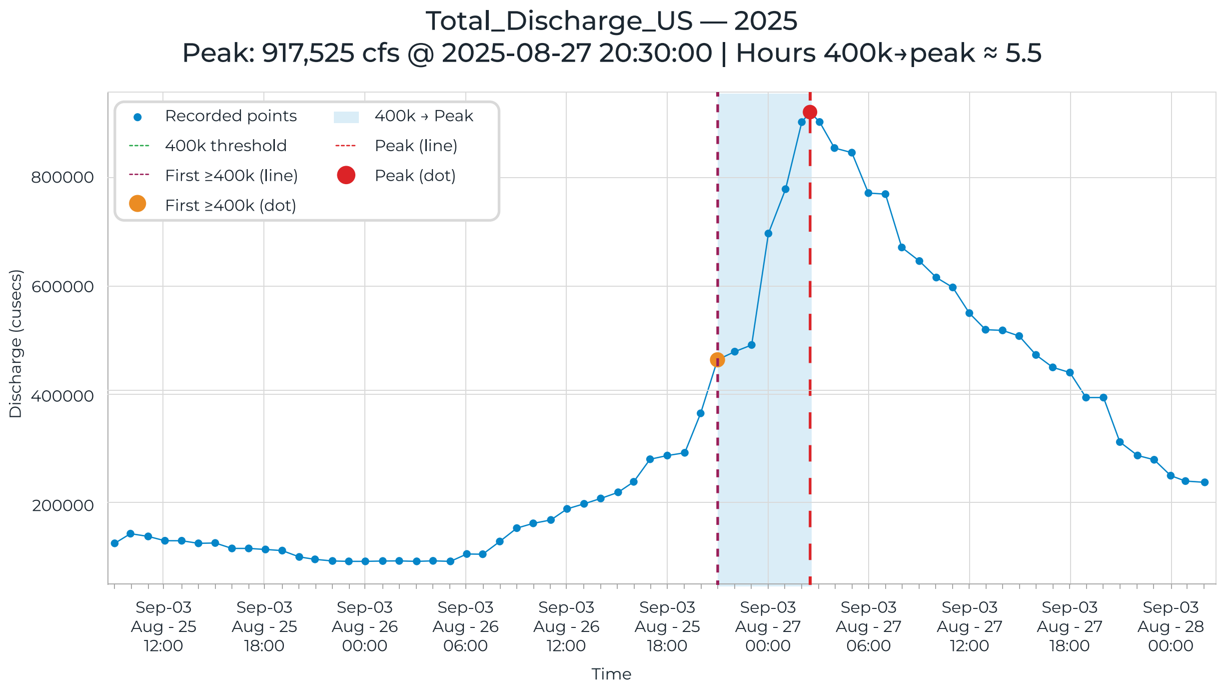


Figure 12: Marala Head Water Inflows Chart - Aug 2025 Floods

Implications for Pakistan's Water Security

While concerns regarding overall water availability remain significant, the more immediate strategic challenge arising from India's unilateral actions is the growing uncertainty surrounding river regulation and the timing of flows entering Pakistan.

1. *Pakistan's irrigation network, reservoirs, barrages and hydropower infrastructure were designed around relatively predictable seasonal inflows governed by decades of established operational practice under the Indus Waters Treaty. Any disruption to this predictability can have cascading consequences across the national water system.*

2. *During the dry season, when natural river flows are already substantially reduced, upstream storage assumes greater importance. Reservoir filling and operational decisions upstream can influence the timing of downstream flows, affecting irrigation scheduling, reservoir operations and hydropower generation within Pakistan.*

3. *Approximately four-fifths of Pakistan's agriculture depends upon the Western Rivers. Crop sowing calendars, canal rotations and irrigation allocations have evolved around established flow regimes over several decades. Unexpected shifts in river timing or reduced predictability can adversely affect agricultural productivity and food security.*

4. *Hydropower generation is similarly dependent upon timely and sustained river flows. Reduced or poorly timed releases diminish generation efficiency and complicate reservoir management.*

5. *At the national level, uncertainty in inflows also complicates provincial water allocations under the Water Apportionment Accord, increasing operational pressures on reservoir management and inter-provincial water distribution.*

Planned Dams on River Chennab

The River Chenab has emerged as one of Pakistan's most strategically significant rivers from both a flood management and national security perspective. After the Indus, it has experienced some of the country's most severe flood events while also remaining at the centre of repeated concerns regarding abrupt upstream reservoir operations by India. As demonstrated by the Marala Headworks case study, sudden flow surges and compressed warning times have increased the vulnerability of downstream populations and infrastructure. Despite these challenges, Pakistan's major reservoir development over the past several decades has remained concentrated on the Indus and Jhelum river systems, leaving the Chenab without any major storage infrastructure across the Punjab plains.

Recognizing this critical gap, the Government has identified three reservoir projects on the Chenab, Wazirabad Dam, Midh Ranjha Dam, and Chiniot Dam, to strengthen water security, enhance flood moderation capacity, and improve operational flexibility along one of Pakistan's most strategically exposed river systems. The locations of these proposed dams are shown in Figure 13.

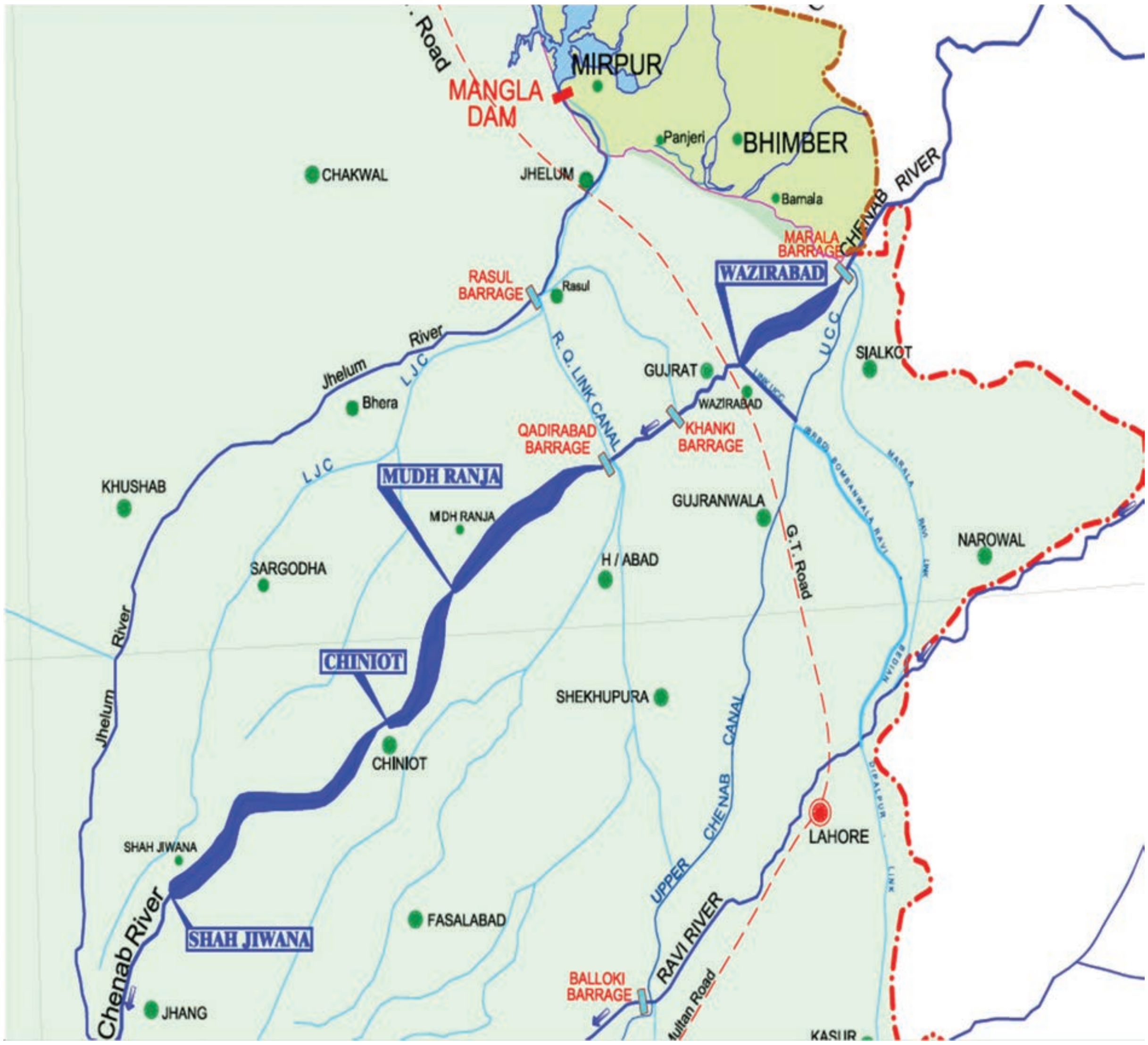


Figure 13: Location of Proposed Dams on River Chennab

As seen in Table 1, collectively, these three projects would provide approximately 3.0 MAF of additional storage capacity, increasing Pakistan's ability to regulate flood flows, retain surplus monsoon water, and improve water availability during dry periods. Besides strengthening national water security, the projects are expected to generate 250 MW of hydropower while contributing to grid stability through peaking generation. The combined estimated investment requirement is approximately USD 2.1 billion.

Project	Storage Capacity	Potential (MW)	Est Cost (USD Mn)	Progress
Wazirabad	0.9 MAF	80 MW	700	Pre-feasibility
Midh Ranjha	1.2 MAF	90 MW	588	Pre-feasibility
Chiniot	0.9 MAF	80 MW	820	Detailed Design Complete
Total	**3 MAF**	**250 MW**	**2,108**	**-**

Table 1: Proposed Dam Development on River Chenab

Among the proposed projects, Midh Ranjha Dam would provide the largest storage capacity at 1.2 MAF together with an installed generation capacity of 90 MW, making it the most significant individual storage addition on the Chenab. Wazirabad Dam and Chiniot Dam would each add 0.9 MAF of storage and 80 MW of hydropower generation. In terms of project readiness, Chiniot Dam is the most advanced, with its detailed design already completed, whereas Wazirabad and Midh Ranjha are presently at the pre-feasibility stage.

Beyond increasing storage capacity, these reservoirs would substantially strengthen Pakistan's ability to manage increasingly volatile flows on the Chenab. Intermediate storage would enable partial attenuation of flood peaks, improve regulation of downstream discharges, provide greater operational flexibility for barrages and irrigation infrastructure, and increase the time available for emergency response during high-flow events. While such infrastructure cannot entirely eliminate the impacts of sudden upstream releases, it would significantly enhance Pakistan's resilience against abrupt flow fluctuations and reduce downstream flood risk.

Pakistan–Afghanistan Water Sharing

Unlike the eastern rivers covered under the Indus Waters Treaty, no formal agreement exists between Pakistan and Afghanistan for the sharing or management of transboundary waters. Consequently, the Kabul River Basin remains without an institutional mechanism for water allocation, data sharing, or coordinated river operations.

The Kabul River Basin, shown in Figure 14, contributes approximately 18 MAF of annual flows to the Indus River system, including nearly 8 MAF originating from the Chitral River within Pakistan. These flows constitute an important component of the western river system and support irrigation, hydropower generation, and downstream water availability.

Figure 14: Kabul River Basin and Its Existing / Proposed Dams

Afghanistan has already completed three dams in the basin with a combined gross storage capacity of 0.67 MAF, live storage of 0.48 MAF, and an installed hydropower capacity of 186 MW. In addition, fourteen more dams are planned, which would increase total gross storage by 5.12 MAF, provide 4.0 MAF of live storage, and add 1,226 MW of hydropower capacity, as summarized in Table 2.

Status	No. of Dams	Gross Storage Capacity (MAF)	Live Storage Capacity (MAF)	Installed Capacity (MW)
Completed	3	0.67	0.48	186
Planned	14	5.12	4.00	1,226

Table 2: Existing and Planned Dam Development on the Afghan-Side of Kabul River Basin

The scale of planned upstream storage has important implications for downstream flow regulation and seasonal water availability in Pakistan. In the absence of a bilateral water-sharing framework, expanding infrastructure development on the Kabul River increases uncertainty regarding future flow regimes and highlights the need for sustained technical and diplomatic engagement on transboundary water management.

Recommendations – Transboundary Water Sharing

Sr.	Action	Timeline*
1	Initiate high-level diplomatic engagement with the guarantors and supporting countries of the Indus Waters Treaty, including the World Bank, Australia, Canada, Germany, New Zealand, UK and USA, to develop a coordinated international strategy and seek support for raising the issue at the United Nations General Assembly, with backing from OIC, SAARC and ECO member states	ST
2	Engage the international community on the humanitarian, economic and development implications of the unilateral abeyance of the Indus Waters Treaty, including its potential impact on Pakistan's water security, livelihoods, and commitments under SDG 6.5 on transboundary water cooperation	ST
3	Establish a comprehensive national monitoring and documentation mechanism for all existing, under-construction and planned upstream hydraulic structures on shared rivers, including run-of-the-river projects, diversion structures and dam sites, or any attempt on river-piracy on Indian side, and submit periodic technical reports to UN, World Bank and ICJ to safeguard Pakistan's water rights	ST
4	Commission an independent technical and legal assessment through an internationally credible consultant in coordination with experienced Pakistani engineering institutions to evaluate the implications of upstream developments and strengthen Pakistan's case at international forums	ST
5	Initiate negotiations with Afghanistan for a formal water-sharing and cooperation framework for the Kabul River Basin before further large-scale dam development, including provisions for hydrological data exchange, coordinated river management and protection of downstream interests	MT

**ST=Short Term, MT=Medium Term, LT=Long Term*

GROUNDWATER MANAGEMENT

Groundwater of Pakistan

Groundwater is the least visible and least governed component of Pakistan's water system, yet it underpins the greater part of the national water economy. It meets over 50 per cent of irrigation requirements, 90 percent of domestic water in rural areas of Pakistan, and 70 percent of domestic water nationally. Groundwater abstraction is estimated at 55 MAF annually, accounting for nearly one-quarter of total water use.

The resource itself is substantial. The Indus Plain aquifer extends across approximately 160,000 square kilometres and stores an estimated 400 MAF of freshwater, roughly eighty times the combined live storage capacity of all major reservoirs in the country. This scale explains both the aquifer's importance and the complacency that has surrounded its use.

The aquifer's present condition is largely a product of surface water development rather than natural endowment. Canal construction between 1870 and 1930 introduced sustained seepage across the Indus Plain. That accumulation initially manifested as waterlogging and salinity, which the Salinity Control and Reclamation Project of the 1960s addressed through large-scale tubewell installation. What began as a reclamation measure has become the principal mechanism of depletion.

The Scale of Extraction and Depletion

Pakistan ranks fourth in the world in annual groundwater abstraction after India, USA, and China. More significantly, the Indus Basin aquifer has been identified by the NASA GRACE satellite mission as the second most overstressed aquifer system in the world, after the Arabian Aquifer System, on the basis of the ratio between abstraction and natural replenishment.

The national balance is negative and structurally so. Abstraction exceeds the global average, as seen in Figure 15, and is estimated at approximately 65 cubic kilometres per year. On the other hand, natural recharge rate is lower than the global average, as illustrated in Figure 16, at approximately 55 cubic kilometres per year. This mismatch between recharge and abstraction leaves an annual overdraft in the order of 10 cubic kilometres. This deficit is met by drawing down aquifer storage accumulated over decades.

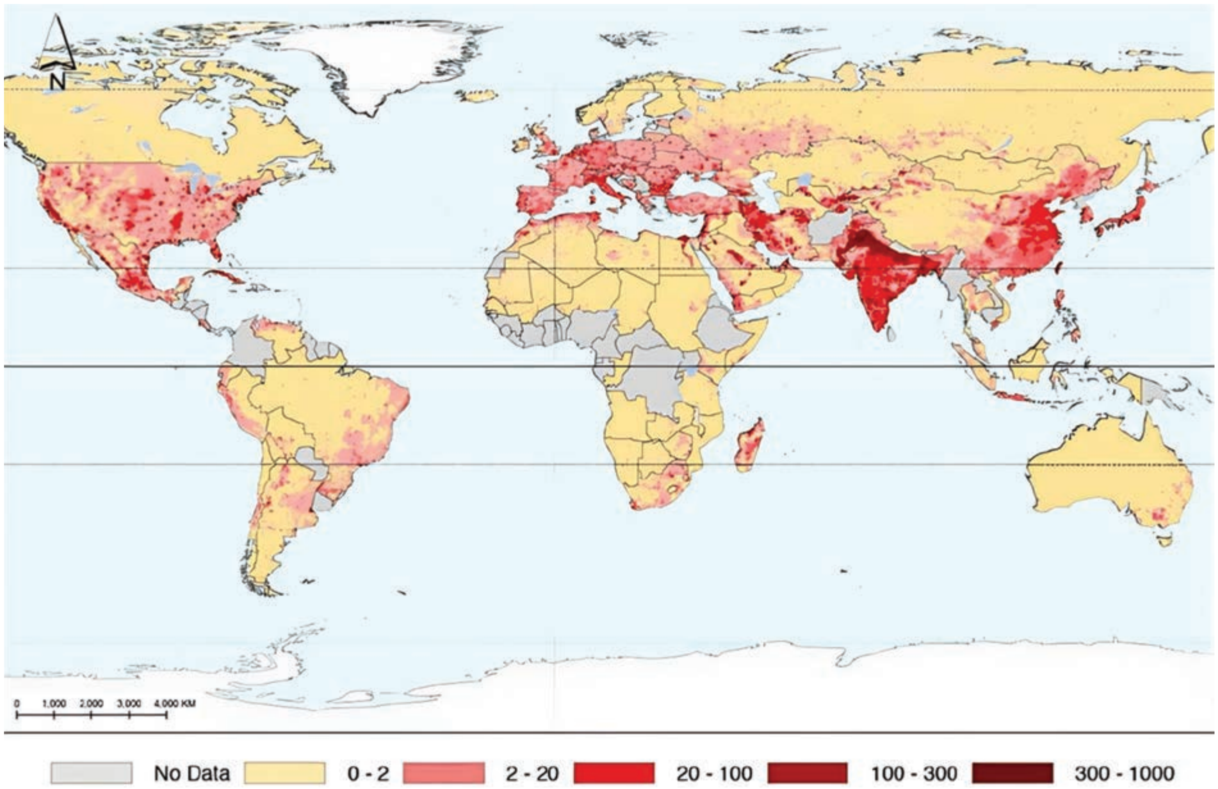


Figure 15: Average Global Groundwater Abstraction (in mm per year)

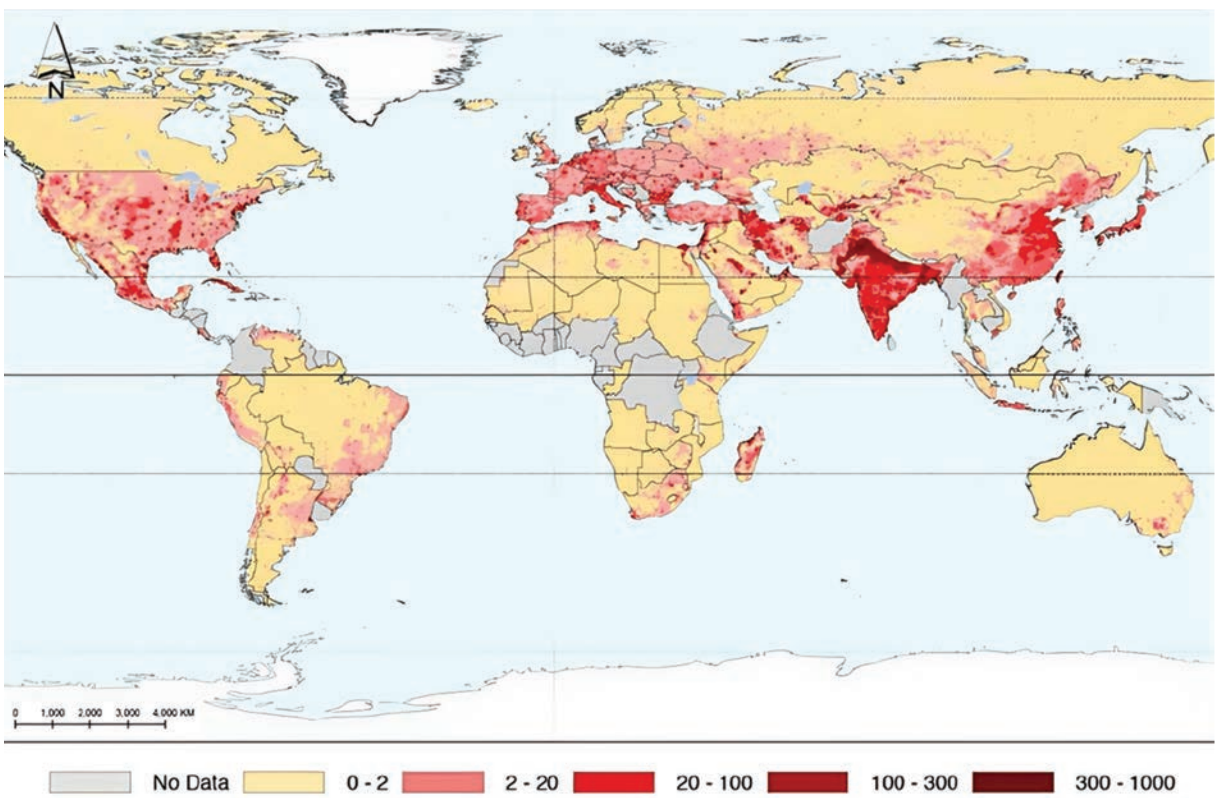


Figure 16: Average Global Groundwater Recharge (in mm per year)

Extraction is concentrated rather than distributed. More than 1.4 million tubewells are now in operation nationally, of which approximately 90 per cent serve irrigation, and Punjab alone accounts for over 90 per cent of total abstraction. Water table decline reflects this concentration. The water table in decreasing by around 1 m per year in the highly stressed Lahore whereas it is dropping on average by 0.5 – 1 m per year across Punjab. In Lahore, approximately 4.32 million cubic metres of groundwater are extracted daily through some 1,800 tubewells. Rates in Quetta and Bahawalpur are comparable, and water table declines in parts of Balochistan are considerably steeper, reflecting an arid climate in which natural recharge is minimal.

Water Quality Degradation

Declining water tables are accompanied by deteriorating water quality, and the two processes reinforce one another. As freshwater is withdrawn, saline water intrudes laterally and vertically into the abstracted zone, while contaminant concentrations rise in the remaining volume.

Arsenic contamination presents the most serious public health dimension. It is estimated that more than 50 million people in Pakistan are at risk of arsenic exposure through contaminated groundwater. Arsenic cannot be removed by boiling or conventional filtration and requires reverse osmosis or comparable treatment, which places remediation beyond the reach of most affected households. Elevated fluoride and nitrate concentrations are similarly documented, the latter associated with fertiliser application across irrigated areas.

Importantly, groundwater quality degradation is effectively irreversible on policy timescales. Salinity intrusion and contaminant accumulation cannot be reversed by reducing abstraction alone, which places a premium on prevention over remediation.

The Governance Gap

While surface water is governed through established institutions, allocation mechanisms and monitoring systems, groundwater extraction remains unregulated. Any landowner may drill, and no volumetric limit, licensing requirement or metering obligation applies in practice.

Several structural weaknesses sustain this position:

1. *No binding national groundwater law. No statutory instrument establishes abstraction rights, extraction limits or enforcement authority at the national level.*
2. *Weakened coordination following the 18th Amendment. Devolution assigned water to the provinces without establishing an effective mechanism for coordination across a shared aquifer system that does not follow administrative boundaries.*

3. *Absence of baseline data. No aquifer map exists at a scale adequate for management. Recharge zones, sustainable yields, abstraction patterns and quality distribution remain inadequately characterised.*

A resource cannot be regulated before it is measured, and the absence of hydrogeological baseline data has made every proposed regulatory instrument difficult to design and impossible to enforce.

Solarization: An Emerging Driver of Over-Extraction

Agricultural solarization has introduced a new and rapidly growing pressure on the aquifer, arising from energy policy rather than water policy. Diesel and grid electricity impose a marginal cost on every hour of pumping, and that cost has functioned as the principal, if unintended, constraint on abstraction. Solar pumping has removed it. Once installed, a solar tubewell operates at effectively zero marginal cost for the life of the equipment, and the economic brake on extraction disappears. Solar systems also operate independently of the grid, so no metering infrastructure records their abstraction.

The scale of the transition is significant. The Chief Minister's Solarization Programme for Agricultural Tubewells in Punjab intends in its first phase to cover 8,000 tubewells. Similarly, many projects both at federal and provincial level intend to convert / install solar pumping stations.

The fiscal and emissions rationale for these programmes is sound. The difficulty is that they have been designed as energy interventions without accompanying water governance provisions. Unregulated solar irrigation risks replicating the groundwater crisis observed in parts of India. Accordingly, solarization should be understood not as a peripheral concern but as the single fastest-moving variable in Pakistan's groundwater balance, and one currently operating without any regulatory instrument attached to it.

Managed Aquifer Recharge (MAR) and Rainwater Harvesting

Managed Aquifer Recharge (MAR) and rainwater harvesting offer significant potential to replenish depleted aquifers while simultaneously reducing urban flooding. While successful pilot initiatives have demonstrated the feasibility of recharge interventions in Pakistan, they currently operate as isolated demonstrations rather than as a system.

Islamabad provides a promising model for urban groundwater recharge. The Capital Development Authority (CDA) has incorporated rooftop rainwater harvesting into its building bylaws and is facilitating the development of recharge infrastructure, while multiple pilot recharge wells established in the city have demonstrated the viability of recharging aquifers using captured rainfall runoff.

From a policy perspective, Managed Aquifer Recharge should evolve from isolated pilot projects into a national groundwater management strategy. As a nature-based solution, integrating recharge infrastructure into urban planning, housing schemes and stormwater management systems can simultaneously improve groundwater availability, reduce urban flood risks and enhance climate resilience. However, expansion must be accompanied by robust water quality standards and regulatory oversight to ensure that only adequately filtered water is recharged, preventing long-term contamination of aquifers.

Recommendations – Groundwater Management

Sr.	Action	Timeline*
1	Commission a National Aquifer Mapping Program to delineate aquifer boundaries, recharge zones, groundwater potential, abstraction status and water quality	ST
2	Enact comprehensive groundwater legislation introducing groundwater licensing, abstraction permits, sustainable extraction limits and a clear allocation of federal and provincial responsibilities.	ST
3	Develop national standards for Managed Aquifer Recharge covering site selection, recharge design, water quality and long-term aquifer protection	ST
4	Mainstream Managed Aquifer Recharge (MAR) into urban planning, housing schemes and stormwater management through provincial building regulations	ST
5	Rationalize agricultural tubewell solarization by restricting new installations in overexploited aquifers and linking future subsidies to groundwater registration, metering and sustainable abstraction limits	ST
6	Integrate groundwater accounting into national water budgeting by reporting annual changes in groundwater storage alongside surface water availability and withdrawals.	MT
7	Establish a National Groundwater Information System and Registry integrating all groundwater abstraction points, monitoring networks and aquifer data to support real-time	MT

**ST = Short Term, MT = Medium Term, LT = Long Term*

OBJECTIVE # 1

ENHANCE WATER DRAINAGE INFRASTRUCTURE AND FLOOD MANAGEMENT SYSTEMS

Sector Overview

An effective water drainage and flood management system is essential for protecting lives, infrastructure, agricultural land, and economic activity from the adverse impacts of floods. It comprises the physical infrastructure, institutional arrangements, and operational systems required to safely convey, regulate, monitor, and manage excess water during periods of high flows. This includes rivers and floodplains, barrages, embankments, flood protection bunds, drainage channels, stormwater drainage systems, hill torrent management works, flood diversion structures, telemetry networks, flood forecasting systems, and early warning mechanisms.

Pakistan has developed an extensive flood management network over several decades to reduce flood risks across different parts of the country. However, increasing development within flood-prone areas, ageing hydraulic infrastructure, inadequate maintenance of drainage systems, and changing hydrological conditions have exposed significant weaknesses in the existing system. Urban flooding has become more frequent due to inadequate stormwater drainage and encroachments on natural waterways, while high river flows are increasingly placing pressure on barrages, embankments, and other flood protection infrastructure.

Strengthening water drainage infrastructure and flood management is therefore a key objective under URAAN Pakistan's water security agenda. The objective is to improve the country's capacity to safely manage floodwaters.

Provincial Flood Dynamics

Flood behaviour varies considerably across Pakistan due to differences in topography, river systems, and climatic conditions. As a result, the nature of flood hazards and the measures adopted to manage them differ across provinces.

In Khyber Pakhtunkhwa, steep mountain catchments and hill torrents generate high-velocity flash floods that frequently cause severe erosion and damage to settlements located along riverbanks. Flood protection therefore focuses on embankments, flood walls, and river spurs. More than forty spurs have been constructed along the Indus River in Dera Ismail Khan to protect vulnerable areas from erosion and shifting river channels.

In Punjab, flood hazards are dominated by the Indus River and its tributaries flowing through broad alluvial plains. The province relies on an extensive network of flood protection marginal bunds to contain high river flows during the monsoon season. These bunds include predetermined breaching sections that can be opened during exceptionally high floods to divert excess water into designated floodplains, thereby protecting major settlements and critical infrastructure.

Sindh faces a distinct challenge because large areas adjoining the Indus River lie below the level of the riverbed, which has gradually risen over time due to sediment deposition. To reduce the risk of widespread inundation, the province depends on double embankments along the river. Flood management in Sindh is also closely interconnected, as the effectiveness of protection measures in Upper Sindh directly influences flood conditions further downstream.

In Balochistan, flood hazards are primarily associated with seasonal hill torrents and ephemeral streams. Intense rainfall over the province's rugged terrain generates rapid runoff that can inundate settlements and agricultural land within a short period. Flood protection therefore relies on localized measures such as flood walls, river spurs, and delay-action dams, which reduce flood velocities while also promoting groundwater recharge.

In Azad Jammu & Kashmir (AJK) and Gilgit-Baltistan (GB), steep valleys, hill torrents, and alpine streams generate high-velocity flash floods that frequently damage settlements, roads, bridges, and agricultural land. Flood protection measures in these regions mainly consist of reinforced concrete retaining structures and gabion walls that stabilize riverbanks and protect vulnerable communities.

These provincial differences demonstrate that flood management in Pakistan cannot rely on a single approach. Riverine flooding in the Indus plains, flash floods in mountainous regions, hill torrents in arid areas, and urban flooding each require different engineering solutions and management strategies.

Changing Flood Dynamics

Pakistan's flood regime has become increasingly variable over the past several decades. Rather than experiencing isolated flood events, the country is now witnessing more frequent alternation between prolonged droughts and extreme flooding. Figure 17 illustrates that periods of severe water scarcity are increasingly being followed by exceptionally wet years, reducing the interval between major flood events and making water management considerably more challenging.

This pattern is evident from the nationwide "extreme to severe" drought conditions experienced during 2000–2002, the most severe drought in nearly five decades, and again in 2018. Both episodes were followed by periods of exceptionally intense rainfall. The 2022 floods represent the clearest example of this changing hydrological regime. Torrential rainfall over the Kirthar and Suleman mountain ranges, combined with the highest rainfall recorded in Sindh since 1967, approximately 726 percent above its long-term average, generated unprecedented river flows that propagated throughout the Indus Basin.

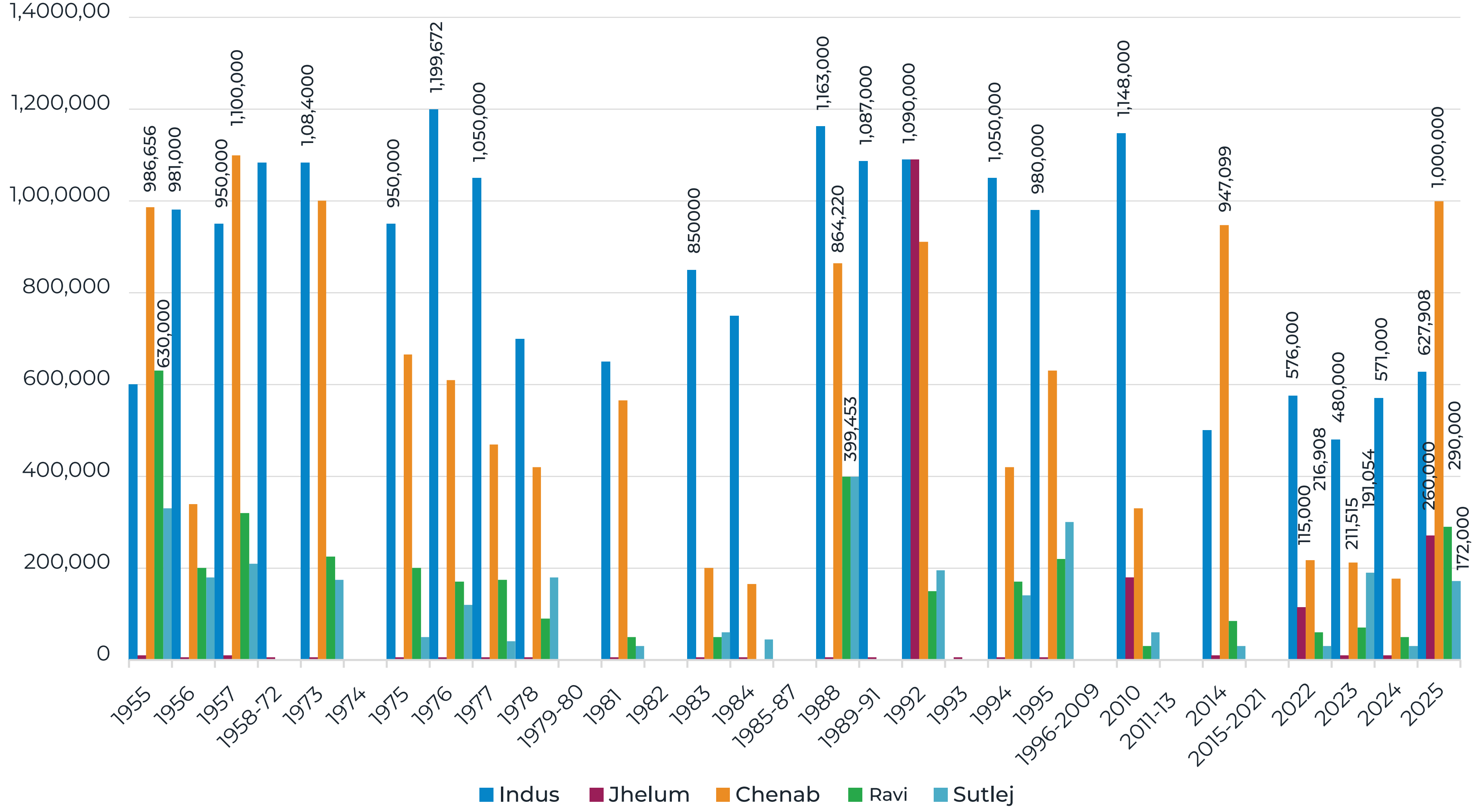


Figure 17: Historical Peak Discharges of 5 Rivers of Pakistan

The historical record also indicates changing flood behaviour across Pakistan's major rivers. The Indus and Chenab rivers have continued to experience recurring high, very high, and exceptionally high floods over several decades. The Jhelum River has remained comparatively stable, with its last major flood occurring in 1992. In contrast, the Ravi and Sutlej rivers had experienced relatively few major floods in recent decades before significant flood activity re-emerged. The Ravi recorded major floods in 1955, 1988 and again in 2025, while the Sutlej, which had not experienced major flooding after 1995, has recorded significant flood events since 2023. The recurrence of major floods across all major rivers since the late 1980s, together with the recent resurgence of flooding in the Ravi and Sutlej systems, suggests that Pakistan's flood regime is becoming increasingly unpredictable.

Historical Peak Discharges at Barrages

The Indus Basin Irrigation System (IBIS) contains an extensive network of hydraulic structures including reservoirs, barrages Link canals and main canals that regulate river flows, supply irrigation water, and provide an important degree of flood moderation. The design capacities of these structures were established using hydrological records at the time of their construction. However, changing rainfall patterns and increasingly intense flood events are placing these structures under growing pressure.

As shown in Figure 18, several barrages have already experienced peak discharges well above their original design capacities. Sukkur Barrage, designed for approximately 900,000 cusecs, recorded a peak discharge of 1,161,000 cusecs during the 1976 floods. Rasul Barrage, with a design capacity of 850,000 cusecs, experienced flows exceeding 952,000 cusecs, while Trimmu Barrage, designed for 875,000 cusecs, recorded peak flows of over 943,000 cusecs. More recently, Qadirabad Barrage, with a design capacity of 9,00,000 cusecs, on the Chenab River recorded a peak discharge of approximately 1,078,000 cusecs during August 2025.

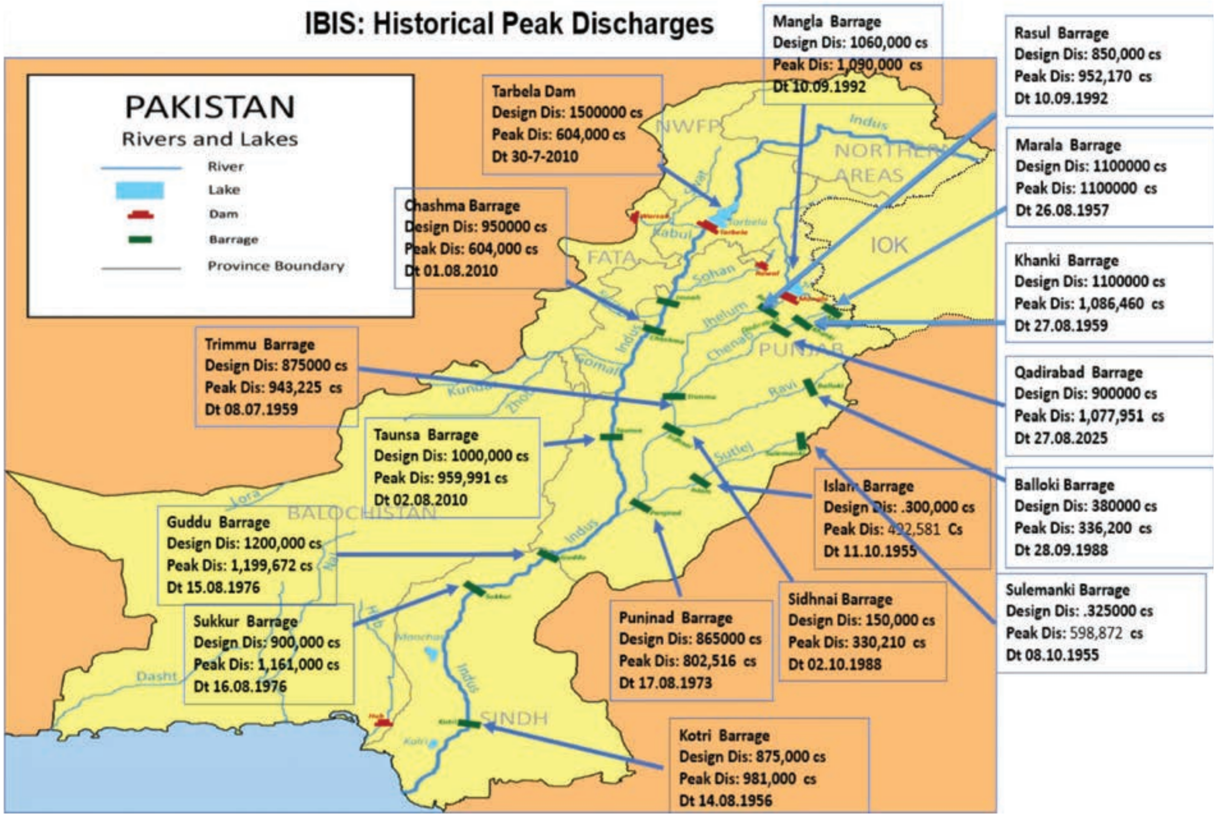


Figure 18: Historical Peak Discharges at Major Barrages

The increasing frequency with which these structures are being subjected to extreme inflows highlights the need to reassess existing hydraulic design assumptions. Infrastructure that was planned using historical flood frequencies is now required to accommodate a more volatile hydrological regime characterised by higher peak discharges, shorter return periods between major flood events, and greater uncertainty in future flood behaviour. This necessitates not only the rehabilitation of ageing infrastructure, but also the incorporation of updated hydrological projections into the planning and design of future flood management investments.

Disaster Preparedness Gaps

Despite experiencing recurring floods over several decades, Pakistan's flood preparedness remains constrained by a combination of infrastructure, planning, technological, and institutional shortcomings. Existing flood management systems have largely evolved in response to past disasters, while investment in preparedness and risk reduction has not kept pace with the increasing frequency and intensity of extreme weather events.

From an infrastructure perspective, Pakistan has limited water storage capacity to regulate flood peaks and retain excess flows during high rainfall events. Many hydraulic structures are ageing, while drainage systems in both urban and rural areas remain under-capacity or inadequately maintained.

Encroachments on natural waterways and drainage channels have further reduced their ability to safely convey floodwaters. At the same time, potential locations for temporary stormwater storage and flood retention have not been systematically identified or incorporated into flood management planning.

Rapid urbanization has further increased flood risk. Most cities have expanded without integrating flood protection and stormwater management into land use planning. As a result, intense rainfall frequently overwhelms drainage networks, resulting in widespread urban flooding and prolonged disruption to economic activity and public services. In the upper Indus Basin, population growth, land degradation, and deforestation have also reduced the capacity of natural watersheds to absorb rainfall, increasing runoff into rivers and downstream floodplains.

Preparedness is also constrained by technological limitations. Although flood forecasting capabilities have improved, significant gaps remain in real-time monitoring and early warning systems. The country has limited capability to accurately forecast localized cloudbursts and flash floods, particularly in mountainous catchments and hill torrent systems where flood events develop rapidly. Early warning coverage for smaller rivers and hill torrents also remains inadequate, reducing the time available for evacuation and emergency response.

Institutional and governance challenges further weaken preparedness efforts. Comprehensive assessments of water demand and availability remain limited, while feasibility studies for Nature-based Solutions (NbS) have not been undertaken at the scale required to support national planning. Financial resources are often directed towards post-disaster recovery rather than long-term risk reduction and resilience. In addition, differences among provinces regarding water distribution and infrastructure development continue to delay coordinated action, while weak implementation of provincial river legislation has limited the enforcement of floodplain zoning and protection of natural waterways. Strengthening preparedness will therefore require a more integrated approach that combines resilient infrastructure, improved forecasting, better land-use planning, and stronger intergovernmental coordination.

Lessons from International Experience

Countries exposed to frequent flooding have adopted different approaches to manage flood risks, depending on their geography, level of development, and institutional capacity. Broadly, these approaches can be grouped into three categories: nature-based solutions, structural flood protection, and hybrid approaches that combine both. Figure 19 illustrates these three approaches.

The **nature-based approach** focuses on restoring natural ecosystems that help absorb and slow floodwaters. This includes protecting wetlands, reconnecting rivers with their floodplains, restoring forests, and rehabilitating mangroves along coastal areas. Viet Nam provides a notable example. Following decades of mangrove loss, the country restored around 9,000 hectares of mangrove forests through the Viet Nam Red Cross programme. Besides protecting nearly 100 km of coastal dykes, the programme significantly reduced maintenance costs and weakened storm surges before they reached populated areas. Nature-based solutions are generally cost-effective and provide additional benefits such as groundwater recharge, biodiversity conservation, carbon sequestration, and improved livelihoods. However, on their own they are not sufficient to manage the large river flows of major systems such as the Indus Basin.

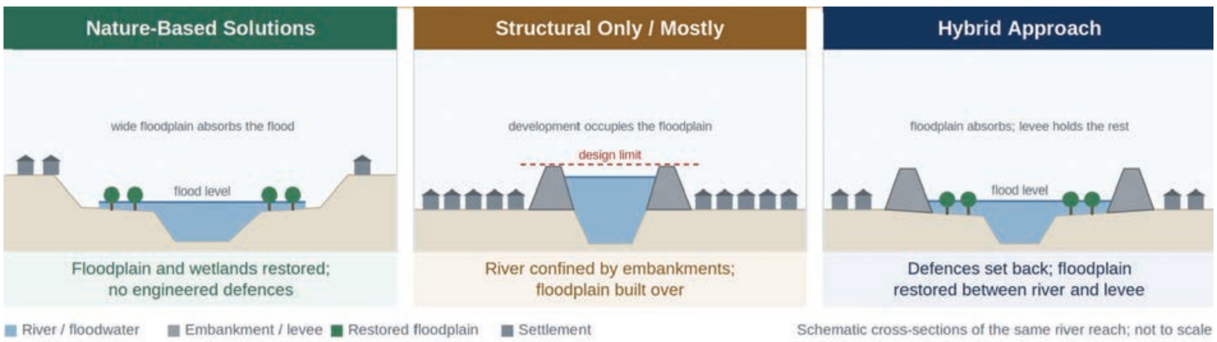


Figure 19: The Three Adaptation Approaches

The structural approach relies on engineered infrastructure such as dams, barrages, embankments, floodwalls, drainage channels, and diversion structures to control floodwaters. These measures provide a high degree of protection when designed and maintained appropriately. However, they are only effective within their design limits. As flood magnitudes increase and development expands into floodplains, the risk of catastrophic failures also increases. Many countries have therefore found that structural measures alone cannot provide long-term resilience, particularly under changing climatic conditions. Besides, such measures need huge financial resources and time.

The hybrid approach combines structural infrastructure with nature-based solutions and improved flood management practices. China has adopted this model through its Sponge City Programme, launched in 2015 across 30 pilot cities. The programme integrates conventional drainage systems with green infrastructure such as permeable pavements, rain gardens, wetlands, bioswales, and green roofs to absorb, store, and gradually release stormwater. The objective is for urban areas to retain and reuse a substantial proportion of rainfall while reducing urban flooding. Several pilot cities have already demonstrated significant improvements in stormwater management.

International experience indicates that the most effective flood management systems combine engineered infrastructure with ecosystem restoration, improved forecasting, land-use planning, and strong institutional coordination. For Pakistan, where both riverine and flash floods occur across diverse geographical settings, a hybrid approach offers the most practical path forward. Strengthening dams, barrages, embankments, drainage systems, and flood forecasting should therefore be complemented by watershed management, wetland restoration, protection of floodplains, and greater coordination across federal and provincial institutions.

Recommendations – Objective # 1

Sr.	Action	Timeline*
1	Declare Water Security a National Security Agenda and assign top political backing to ensure coordinated implementation of flood management, drainage and water security reforms across all levels of government	ST
2	Obtain Council of Common Interests (CCI) approval of the National Flood Protection Plan-IV (NFPP-IV) and convene meeting of the National Water Council, including notification of the five pending technical and private-sector members since 2018	ST
3	Strictly enforce River Acts in Punjab, Sindh and KP, and enact River Acts in Balochistan, Gilgit-Baltistan and Azad Jammu & Kashmir to protect floodplains and regulate encroachments	ST
4	Complete multi-hazard vulnerability and flood risk assessments of districts affected by the 2010, 2022 and 2025 floods to guide future investments and preparedness planning	ST
5	Achieve 100% operationalization of District Disaster Management Authorities (DDMAs), establish urban and flash flood early warning centres at all divisional headquarters, strengthen community-based disaster response committees, and notify SOPs for urban flood management.	ST
6	Undertake nation-wide feasibility studies for flood diversion canals to safely convey excess floodwater to pre-identified low-risk areas, wetlands, reservoirs, or temporary retention basins, and implement priority schemes where found technically, economically, and environmentally feasible	ST
7	Strengthen glacier monitoring and adaptation by enacting a National Glacier Protection Act, upgrading the Glacier Monitoring Research Centre (GMRC), establishing a National Glacier & Climate Training Institute, and promoting a South Asian Glacier Risk Monitoring Network	MT
8	Revise design peak inflow assessments using updated hydrological data and upgrade critical barrages, dams and flood embankments to withstand revised flood estimates	MT
9	Implement the National Flood Drainage Plan through rehabilitation and de-silting of major canals, outfall drains, RBOD-I, RBOD-III and LBOD, while completing RBOD-II to improve drainage in lower Sindh	MT
10	Increase the conveyance capacity of the Ravi and Sutlej Rivers through strategic dredging during the dry season where technically and environmentally feasible	MT
11	Construct priority small dams and hill torrent management works in Punjab, Sindh, KP and Balochistan	LT

Timeline: *ST=Short Term, MT=Medium Term, LT=Long Term*

OBJECTIVE # 2

ENHANCE WATER STORAGES & IMPLEMENT WATER CONSERVATION

Indus Basin Water Infrastructure Overview

Pakistan's water security is fundamentally anchored in the Indus Basin, one of the world's largest and most complex river systems. The basin spans approximately 1.16 million square kilometres, extending across Pakistan, India, China, and Afghanistan. Pakistan constitutes the largest share of the basin area (47%), followed by India (39%), China (8%), and Afghanistan (6%). The basin is highly dependent on seasonal flows generated through snow and glacial melt, with a glaciated area of approximately 16,933 square kilometres providing a critical source of freshwater replenishment. The Indus Basin receives an estimated 2,738 cubic kilometres of surface water annually, supporting agriculture, hydropower generation, ecosystems, and domestic water requirements across the region.

The Indus Basin Irrigation System (IBIS) serves as the backbone of Pakistan's economy. The system comprises a vast network of reservoirs, barrages, canals, link canals, and watercourses designed to distribute river flows across the country's landscape. Key components of the system, illustrated in Figure 20, include:

- *18 major barrages regulating river flows and facilitating water diversion;*
- *45 canal commands extending over approximately 56,073 kilometres;*
- *12 inter-river link canals covering nearly 700 kilometres to redistribute water between river systems;*
- *Approximately 107,000 kilometres of watercourses forming the final stage of irrigation delivery to farms*

Despite the extensive irrigation infrastructure, Pakistan's water system remains highly vulnerable due to limited storage capacity. The country's ability to regulate seasonal variations in river flows remains constrained, resulting in substantial water availability during high-flow periods and shortages during dry seasons. Expanding reservoir capacity and improving water conservation efficiency are therefore critical to enhancing national water security, climate resilience, and agricultural productivity.

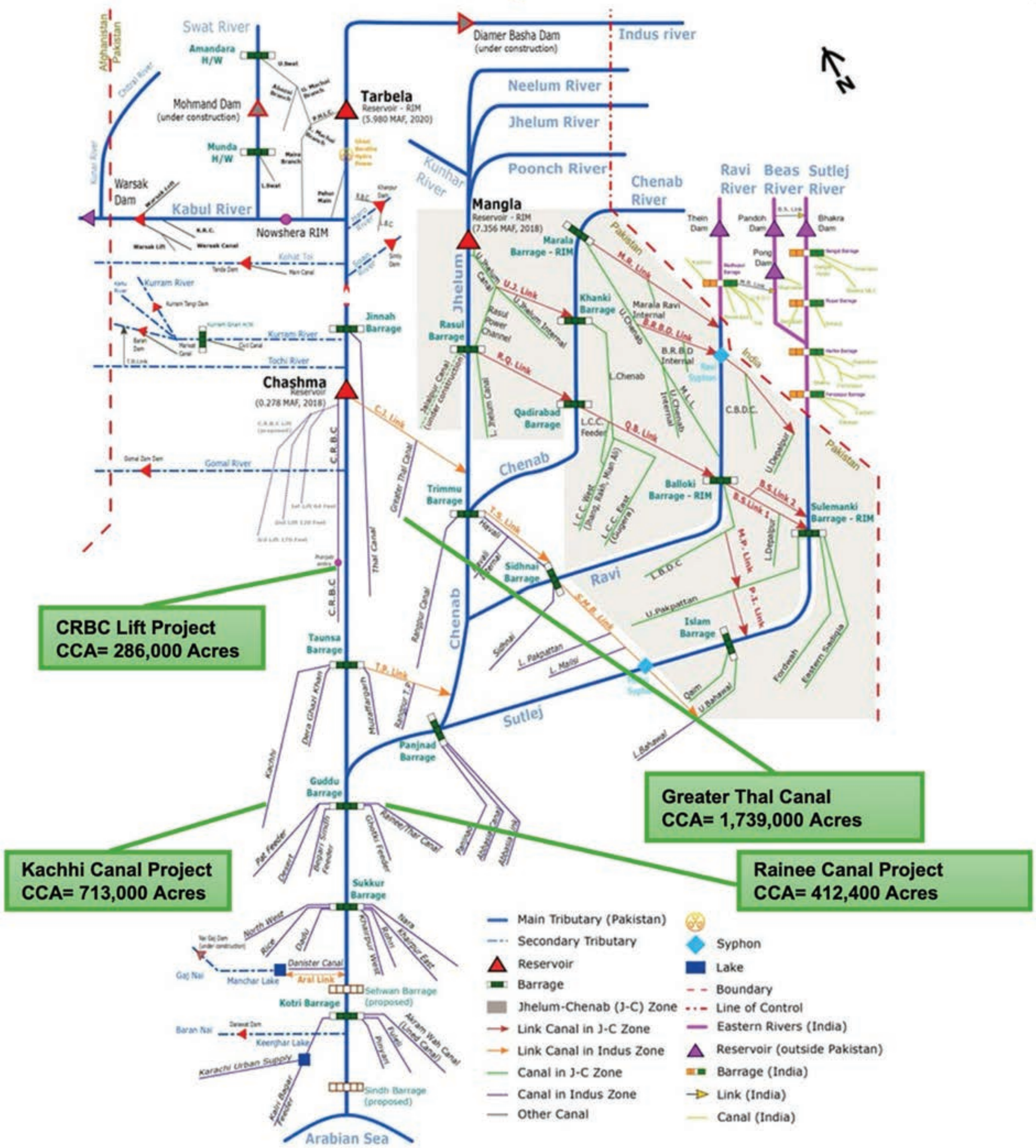


Figure 20: Schematic diagram of the Indus Basin Irrigation System and Proposed Strategic Canals

Pakistan's Water Storage Capacity

Pakistan's water storage infrastructure forms the backbone of the country's water security by regulating seasonal river flows, supporting irrigation supplies, generating hydropower, and reducing flood risks. Despite the presence of several reservoirs across the country, the national storage system remains heavily concentrated in a few large reservoirs. Tarbela and Mangla alone account for more than 85% of Pakistan's total live storage capacity, as seen in Table 3, making the country's water security heavily dependent on the performance and operational life of these two reservoirs. In addition to Tarbela, Mangla and Chashma, Pakistan also operates reservoirs including Hub, Gomal Zam, Mirani, and numerous smaller reservoirs constructed primarily for regional irrigation and water supply. While these smaller reservoirs are important for meeting local water demands, their storage capacities are relatively small and contribute only a limited share to the country's overall storage. In total, Pakistan present live storage capacity is 15.318 MAF.

Reservoir	Original Live Storage (MAF)	Present Live Storage (MAF)	Storage Loss (MAF)	Storage Loss (%)
Tarbela	9.69	5.77	3.93	40.51
Mangla	8.23	7.28	0.96	11.65
Chashma	0.72	0.31	0.41	56.62
Hub	0.76	0.65	0.11	14.47
Gomal Zam	0.892	0.892	-	-
Mirani	0.152	0.152	-	-
Other (Medium-Sized)	-	0.264	-	-
Total	**-**	**15.318**	**-**	**-**

Table 3: Live Storage Present and Lost Capacity of Pakistan's Reservoirs

Over the past several decades, however, the effective storage capacity of Pakistan's reservoirs has steadily declined due to sediment deposition. Rivers originating in the young and geologically active Himalayan, Karakoram and Hindu Kush mountain ranges carry exceptionally high sediment loads, making the Indus River system one of the most sediment-laden river systems in the world. These sediments gradually accumulate within reservoirs, reducing their live storage capacity over time. Chashma Reservoir has experienced particularly rapid sedimentation due to the heavy sediment loads transported by the Kabul River before it joins the Indus, while Tarbela continues to receive substantial sediment inflows from the upper Indus catchment.

Tarbela has experienced the largest absolute loss in storage, declining from 9.69 MAF to 5.77 MAF, a reduction of 3.93 MAF or over 40% of its original capacity. Chashma has experienced the greatest proportional decline, losing nearly 57% of its live storage due to its exceptionally high sedimentation rate, while Mangla has recorded comparatively lower losses owing to the raising of Mangla Dam and successful watershed management interventions in the Jhelum River catchment.

Addressing reservoir sedimentation requires both structural and non-structural interventions. Construction of upstream reservoirs remains one of the most effective long-term measures for intercepting sediments before they reach existing storage infrastructure. The ongoing Diamer Basha Dam is expected to extend the operational life of Tarbela Reservoir by approximately 35 years while simultaneously increasing national water storage and hydropower generation. Equally important are watershed management measures, including afforestation, slope stabilization, soil conservation, and catchment restoration to reduce erosion at source. The successful watershed management programme in the Mangla catchment demonstrates that integrated sediment management can substantially prolong reservoir life and preserve valuable storage capacity.

Global Comparison of Water Storage Capacity

Adequate storage capacity is a critical determinant of national water security, particularly for countries dependent on seasonal river flows. A comparison of major river basins in Table 4, demonstrates that Pakistan has one of the lowest storage-to-flow ratios among major water systems globally.

River Basins	Avg. Annual Flow (MAF)	Usable Storage (MAF)	% Storage
Colorado	15	59.62	497
Nile	47	132	281
Sutlej, Beas & Ravi	32	11.32	35
Indus Basin	**138**	**14.25**	**10**
World Average	20,000	8,000	40

Table 4: Global Comparison of River Basin Storage Capacity

The comparison highlights the structural weakness of the Indus Basin's storage capacity. The Colorado River Basin, despite having an average annual flow of only 15 MAF, possesses usable storage equivalent to nearly five times its annual flow (497%). Similarly, the Nile Basin, with an annual flow of 47 MAF, has storage capacity equivalent to 281% of annual flows, enabling countries dependent on the river to regulate multi-year variability and manage prolonged dry periods.

In comparison, the Indus Basin receives approximately 138 MAF annually but has only around 14 MAF of usable storage, equivalent to merely 10% of annual flow. This is substantially below the global average storage ratio of 40%, meaning that Pakistan stores only around one-fourth of the average proportion achieved globally. Even neighbouring river systems such as the Sutlej, Beas, and Ravi, with annual flows of around 32 MAF, maintain a higher storage ratio of 35%, highlighting Pakistan's relative storage deficit.

The storage challenge is further reflected in Pakistan's extremely low carryover capacity compared with other water-dependent countries. Countries with highly variable climatic conditions have invested extensively in storage infrastructure to create buffers against uncertain water availability, as shown in Table 5. The United States maintains approximately 900 days of carryover capacity, allowing significant resilience against prolonged droughts. Similarly, Egypt's 1000-day storage capacity provides substantial protection against fluctuations in Nile flows, while Australia maintains around 600 days despite being one of the world's driest continents.

Country	Carry over Capacity (Days)
USA	900
Egypt	1000
Australia	600
Pakistan	**30**

Table 5: International Comparison of Carryover Capacity

India, with a carryover capacity of approximately 170 days, possesses more than five times Pakistan's storage buffer, enabling greater flexibility in managing seasonal variability. In contrast, Pakistan's estimated 30-day carryover capacity represents a critical vulnerability, leaving limited room to absorb the impacts of failed monsoons, prolonged droughts, climate-induced variability, or disruptions in upstream flows.

Therefore, enhancing water storage capacity is not merely an infrastructure requirement but a strategic necessity for national water security. Expanding reservoir capacity, improving existing storage efficiency, adopting watershed management practices, and implementing demand-side conservation measures are essential to strengthen Pakistan's resilience against future water challenges.

Water Losses Downstream of Kotri

Despite facing increasing water scarcity, Pakistan continues to lose substantial volumes of freshwater downstream of Kotri Barrage into the Arabian Sea due to inadequate storage capacity and limited ability to regulate seasonal river flows. The magnitude of these losses is several times greater than the country's existing water storage capacity, highlighting the urgent need for expanding reservoirs to capture surplus flows during high-flow periods for use during water-deficit seasons.

During the period 1 July to 30 September 2025, approximately 30.48 MAF of water flowed downstream of Kotri Barrage into the Arabian Sea within only 92 days, as illustrated in Figure 21. This volume was twice the Pakistan's total annual live storage capacity of approximately 15.318 MAF. In contrast, the minimum downstream requirement to sustain the Indus Delta ecosystem and control seawater intrusion is estimated at only 3.65 MAF annually (equivalent to a continuous discharge of 5,000 cusecs).

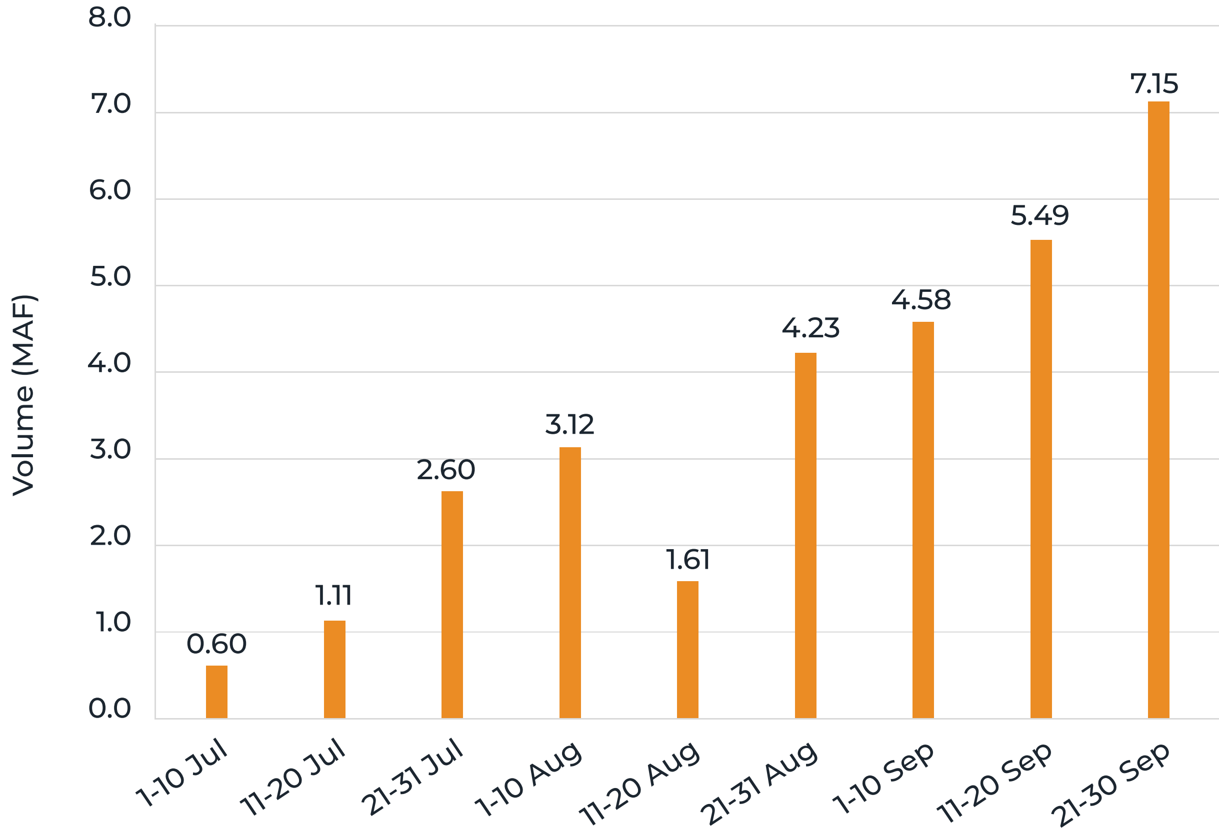


Figure 21: Water Flow Downstream of Kotri Barrage (1st July – 30th Sept 2025)

The scale of these losses demonstrates the mismatch between Pakistan's available water resources and its storage infrastructure. During periods of high river flows, surplus water cannot be effectively captured due to insufficient storage, resulting in significant freshwater losses to the sea. Conversely, during dry periods, inadequate storage availability contributes to severe water shortages across agricultural and ecological systems.

Historical flow analysis of no-flow days below Kotri Barrage over the past 25 years further illustrates this challenge, as seen in Figure 22 and summarized in Table 6. During the 25-year period from 1999 to 2023, downstream Kotri experienced:

- *No-flow conditions for an average of 219 days per year, representing approximately 60% of the period analysed;*
- *Flows below the required 5,000 cusecs threshold for approximately 285 days per year, representing nearly 78% of the period analysed*

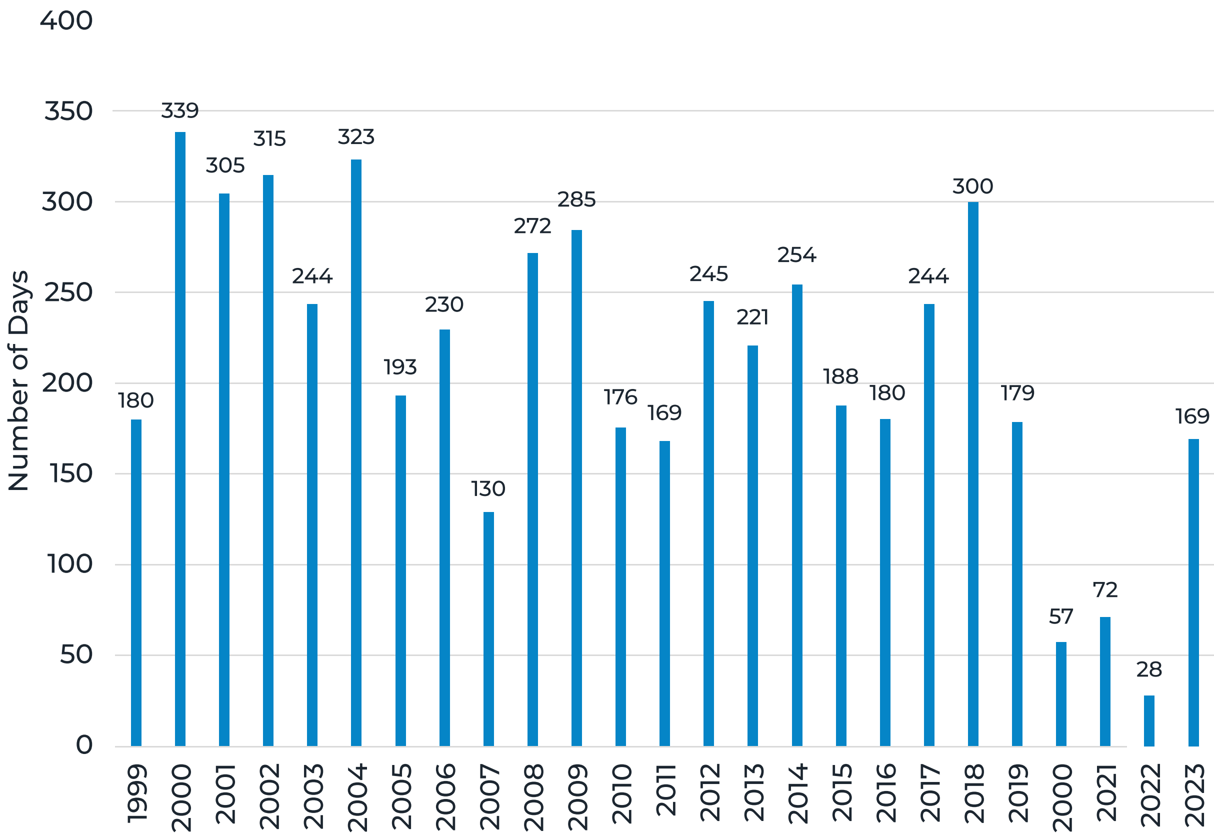


Figure 22: No Flow Days Count Downstream of Kotri Barrage (1999-2023)

Indicator	Quantity
Water discharged downstream (1 July–30 September 2025)	30.48 MAF
Equivalent to Pakistan's total annual storage capacity	2 times
Minimum downstream ecological requirement	3.65 MAF / year or 5,000 cusecs / day
Average annual no-flow days downstream Kotri (1999–2023)	219 days
Average annual days below 5,000 cusecs requirement (1999-2023)	285 days

Table 6: Downstream Kotri Water Losses and Ecological Flow Deficit (1999–2025)

The simultaneous occurrence of excessive freshwater outflows during high-flow periods and prolonged shortages during low-flow periods reflects Pakistan's inadequate capacity to regulate river flows. Increasing storage capacity is therefore essential not only for enhancing water availability but also for ensuring that downstream ecological requirements are met through controlled releases rather than dependence on unpredictable seasonal flows.

Natural Wetlands

Pakistan possesses an extensive network of natural wetlands that function as critical components of the country's water management and ecological systems. Covering approximately 10% of the national land area, these wetlands represent a significant natural infrastructure asset, providing water storage, groundwater recharge, flood attenuation, and ecosystem regulation services.

As seen in Figure 23, Pakistan hosts more than 240 significant wetlands distributed across diverse geographical zones, ranging from high-altitude alpine lakes and freshwater complexes to coastal lagoons and deltaic ecosystems. Recognizing their global ecological importance, 19 wetlands have been designated as Ramsar Sites (Wetlands of International Importance), with several also protected under the International Union for Conservation of Nature (IUCN) framework.

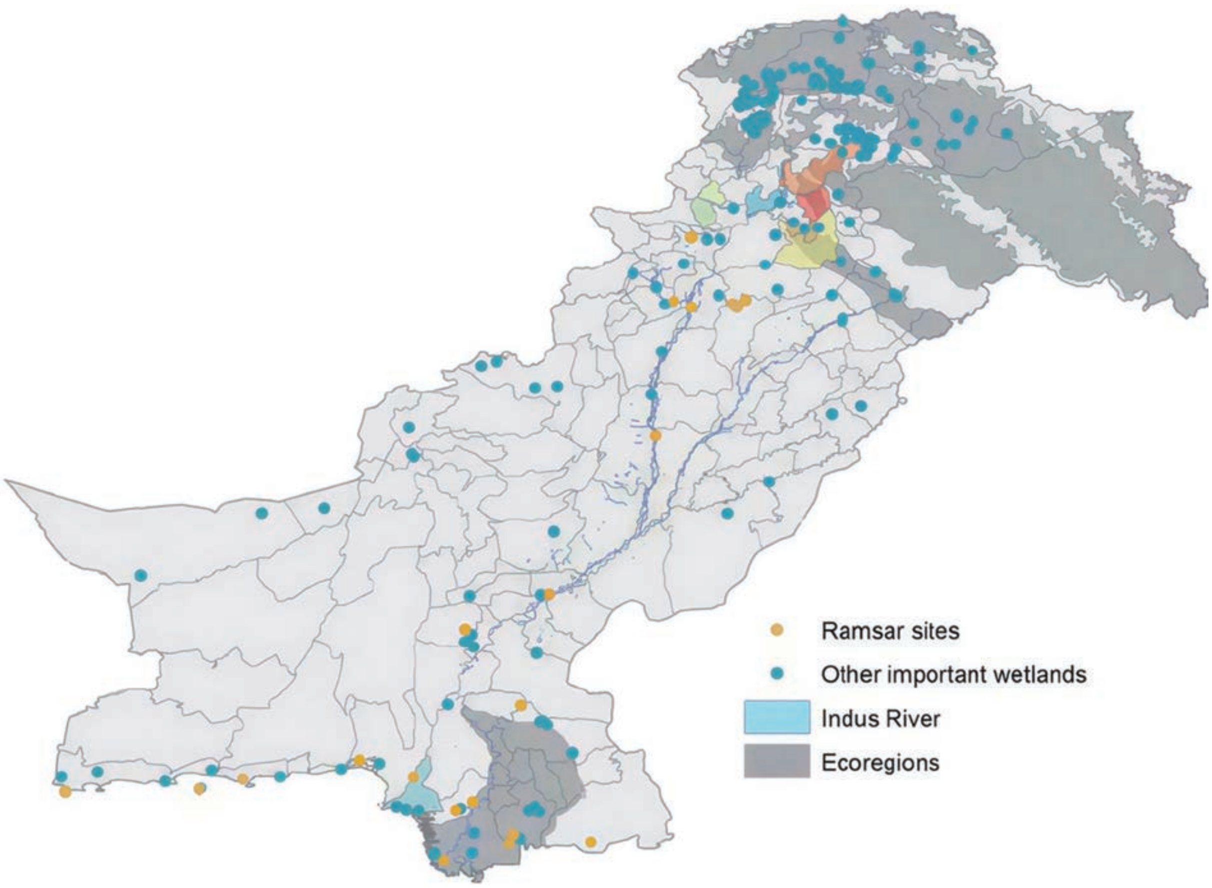


Figure 23: Wetlands of Pakistan

Pakistan's wetlands can broadly be categorized into two major groups based on their hydrological characteristics:

Inland Freshwater Wetlands

Inland freshwater wetlands, including lakes, reservoirs, and barrage-associated wetlands, serve as important natural water retention systems. These include Chashma and Taunsa Barrages, Hub and Tanda Dams, Kinjhar, Haleji and Drigh Lakes, and the Uchchali, Thanedar Wala, Indus Dolphin, and Deh Akro-II wetland complexes.

Beyond their ecological importance, these systems contribute to water security by:

- *storing and regulating freshwater flows;*
- *supporting groundwater recharge;*
- *reducing flood peaks during extreme rainfall events;*
- *maintaining aquatic ecosystems and biodiversity.*

Coastal, Marine and Deltaic Wetlands

Pakistan's coastal and deltaic wetlands represent another critical component of the national water ecosystem. These include the Indus Delta, Rann of Kutch, Miani Hor, Jiwani Coastal Wetland, Ormara Turtle Beaches, Astola Island, and Nurri and Jubho Lagoons.

These ecosystems provide essential coastal protection functions, including:

- *buffering against storm surges and coastal erosion;*
- *sustaining mangrove ecosystems;*
- *maintaining fisheries productivity;*
- *reducing the impacts of seawater intrusion in vulnerable coastal areas.*

To enhance ecosystem-based water management, Recharge Pakistan Project is being executed, supported through international climate financing. The project aims to integrate nature-based solutions into flood and water management by developing 127 groundwater recharge basins and restoring approximately 35,126 acres of degraded forests and wetlands across the Indus Basin.

By complementing conventional water infrastructure with natural storage systems, wetland restoration provides a cost-effective approach to enhance groundwater recharge, reduce flood risks, and improve long-term water security.

Prospects for Storage Enhancement Projects

With a current operational live storage capacity of 15.318 MAF, Pakistan's ability to regulate river flows, mitigate floods, sustain irrigation during dry periods and respond to transboundary water uncertainties is fundamentally constrained by its limited water storage capacity. Recognizing this strategic deficit, the Federal Government is implementing an ambitious programme of large storage infrastructure through the Public Sector Development Programme (PSDP). Currently, 20 major dam projects are under various stages of construction, with a combined live storage capacity of 9.821 MAF. These include nationally significant projects such as Diamer Basha Dam, Mohmand Dam, Kurram Tangi Dam, Naulong Dam and Nai Gaj Dam. Upon completion, these projects will increase Pakistan's national storage capacity by approximately two-thirds.

Similarly, provincial Annual Development Programmes (ADPs) collectively comprise a much larger number of projects; however, these are predominantly small dams and localized water retention structures. While valuable for local water supply, groundwater recharge and drought resilience, their combined storage contribution is only 0.377 MAF. The ongoing federal and provincial projects are summarized in Table 7.

Provinces	Total Projects	Capacity (MAF)
GB (Diamer Basha Dam)	1	6.400
KP (Mohmand, Kurram Tangi Dams etc.)	4	1.580
Balochistan (Naulong, Awaran, Kharan, Gishkaur, Winder Dams etc.)	14	1.681
Sindh (Nai Gaj)	1	0.160
Provincial ADP's	79	0.377
Total	**99**	**10.198**

Table 7: Ongoing Water Storage Projects under the PSDP and Provincial ADPs

To meet future water security requirements, the current construction programme is complemented by a long-term pipeline of strategic large-scale storage projects. Current proposals indicate a prospective storage portfolio of approximately 26.9 MAF, centred on high-capacity reservoirs in the Upper Indus Basin and additional regulation structures on the Chenab River.

Among these, the Akhori Off-Channel Storage Dam represents one of the most strategically significant projects. Designed to store surplus Indus flows bypassing Tarbela during the monsoon season, it would simultaneously augment national storage while reducing dependence on Tarbela, whose effective capacity continues to decline due to sedimentation. Together with Shyok Dam (5.5 MAF) and Skardu Dam (3.0 MAF), these projects alone would provide approximately 14.5 MAF of additional live storage, almost equivalent to Pakistan's current operational storage capacity.

Complementing these upstream reservoirs, the proposed cascade of Midh Ranja, Chiniot, Wazirabad and Shah Jewna Dams on the Chenab River would provide an additional 4.2 MAF of storage, improving seasonal regulation and strengthening irrigation reliability across Punjab's agricultural command areas. Accelerating the development of this strategic storage pipeline should remain a national priority to strengthen Pakistan's long-term water security. The proposed storage enhancement projects are summarized in Table 8.

Proposed Storage Projects		
Project	**River**	**Capacity (MAF)**
Shyok Dam	Shyok	5.5
Sakrdu Dam	Indus	3.0
Shigar Dam	Shigar	4.0
Kharmang Dam	Indus	3.0
Akhori Off-Channel Storage Dam	Indus	6.0
Chiniot Dam	Chenab	1.0
Midh Ranja Dam	Chenab	1.2
Wazirabad Dam	Chenab	1.0
Shah Jewna Dam	Chenab	1.0
Sindh Barrage	Indus	1.2
Total (Tentative)		**26.9**

Table 8: Strategic Pipeline of Proposed Water Storage Projects

Water Conservation and Demand Management

Pakistan is now classified as a water-scarce country, with per capita water availability having declined below the internationally recognized water scarcity threshold. As agriculture accounts for approximately 95 percent of total freshwater withdrawals, improving water-use efficiency in this sector is central to national water security. The modernization of irrigation infrastructure and on-farm water management is discussed separately under Objective 4; however, the broader challenge of water conservation is fundamentally linked to pricing, governance and societal behaviour.

A central weakness of Pakistan's water sector is that water is often treated as a near-free resource. In the irrigation sector, the traditional abiana system is based largely on area-based flat rates rather than volumetric consumption, resulting in poor cost recovery and weak incentives for conservation. Revenues collected from irrigation water charges remain insufficient to cover even the operation and maintenance costs of the Indus Basin Irrigation System. In urban areas, Water and Sanitation Agencies (WASAs) lose a substantial proportion of treated water as Non-Revenue Water (NRW) through leakages, illegal connections and the absence of universal metering, undermining both financial sustainability and service delivery. As a general principle, what is not priced cannot be conserved; sustainable water management therefore requires pricing mechanisms that reflect the economic value of water while safeguarding affordability for vulnerable users.

Recognizing these challenges, the Government of Pakistan has developed the National Water Conservation Strategy 2023–27, which provides a comprehensive framework for improving water-use efficiency across the agricultural, domestic, commercial and industrial sectors. Its strategic objectives include:

Agriculture Sector

- *Improve water productivity in agriculture by introducing pricing policy and water efficient technologies*
- *Optimize groundwater abstraction and balance with recharge*
- *Develop non-conventional water sources for agriculture (secondary treated sewage water, drainage effluent, rainwater, saline effluent, seawater) and undertake watershed management*
- *Promote the use of information technology for water resources management*

Domestic and Commercial Sector

- *Meter and price water in residential and commercial sectors*
- *Regulate groundwater abstraction for residential and commercial sectors*
- *Conduct water audits of water supply service providers, private housing societies and commercial settings on annual basis*
- *Introduce and promote water-saving technologies*
- *Formulate and enforce Zero Liquid Discharge (ZLD) Policy for residential and commercial settings*
- *Launch mass awareness programs for water conservation to reduce wastewater generation*

Industrial Sector

- *Formulate and enforce Zero Liquid Discharge (ZLD) Policy for industries*
- *Meter and price water for industries*
- *Conduct water audits on annual basis*
- *Launch awareness program for water conservation in industry*

The Strategy provides an important policy foundation for transitioning Pakistan from a supply-oriented approach towards integrated water demand management. Its implementation should be accorded the highest national priority, while work on the next National Water Conservation Strategy (2027–32) should commence to address emerging challenges.

Beyond pricing and regulation, long-term water conservation also requires a shift in societal attitudes towards water use. National awareness campaigns should reinforce that water is a finite national resource rather than an unlimited public good. Given Pakistan's social context, religious institutions and community organizations can play a transformative role in promoting water conservation as both a civic and moral responsibility, embedding responsible water use into everyday behaviour across households, agriculture and industry.

Recommendations – Objective # 2

Sr.	Action	Timeline*
1	Ensure timely completion of ongoing strategic storage projects, particularly Diamer Basha Dam and Mohmand Dam	ST
2	Implement the National Water Conservation Strategy 2023–27 and initiate preparation of the subsequent 2027–32 strategy to address emerging water security challenges	ST
3	Finalize and approve the National Watershed Management Plan with provincial ownership and make watershed management mandatory for all future dam projects	ST
4	Expand provincial construction of medium and small dams, particularly in water-stressed regions, to enhance local storage and drought resilience	ST
5	Ensure universal metering and volumetric pricing for urban, commercial and industrial water users to improve conservation incentives and financial sustainability of utilities	MT
6	Initiate Detailed Engineering Design (DED) of priority future mega storage projects including Akhori Off-Channel Storage Dam, Shyok Dam and Skardu Dam and undertake feasibility studies for additional strategic storage projects including Shigar, Kharmang, Midh Ranja, Wazirabad and Shah Jewna dams	MT
7	Launch catchment area rehabilitation and reforestation programmes in major river basins to reduce sedimentation and improve watershed resilience	MT

**ST = Short Term, MT = Medium Term, LT = Long Term*

OBJECTIVE # 3

ENSURE EQUITABLE WATER AVAILABILITY AND DISTRIBUTION ACROSS SECTORS AND PROVINCES

Overview

Pakistan's water resources are shared among four provinces, multiple economic sectors, and over 240 million people, making equitable distribution as important as augmenting overall water availability. While the country's river system is highly interconnected, its governance is decentralized as water is a provincial subject, requiring continuous coordination between the Federation and provinces to ensure that water is allocated fairly, efficiently, and in accordance with agreed legal and institutional frameworks. Equitable water distribution has become even more critical as water security concerns intensify due to population growth, climate variability, and rising agricultural and urban demand. In this context, sustained inter-provincial consensus is essential for enabling coordinated decision-making, advancing strategic water infrastructure and governance reforms, and ensuring that the country moves forward collectively to strengthen its long-term water security.

Equitable water distribution depends on three mutually reinforcing pillars: an accepted inter-provincial allocation framework, sufficient storage and conveyance infrastructure to regulate seasonal variability, and transparent digital water accounting capable of building confidence among all stakeholders.

Inter-Provincial Water Allocation and Governance

The equitable distribution of surface water in Pakistan is governed through the Water Apportionment Accord (WAA) of 1991, which remains the principal legal framework for allocating the waters of the Indus Basin among the four provinces. To implement the Accord, the Indus River System Authority (IRSA) was established under the IRSA Act, 1992 as an autonomous federal body responsible for regulating and monitoring inter-provincial water distribution. IRSA is mandated to assess seasonal water availability, determine provincial allocations, regulate reservoir operations, monitor river flows, and ensure implementation of the Water Apportionment Accord in a fair and transparent manner. The Accord and IRSA together constitute the institutional foundation of Pakistan's inter-provincial water governance framework.

Province	Kharif (MAF)	Rabi (MAF)	Total (MAF)	Share (%)
Punjab	37.07	18.87	55.94	47.7
Sindh	33.94	14.82	48.76	41.6
Khyber Pakhtunkhwa (including Civil Canals)	5.28	3.50	8.78	7.5
Balochistan	2.85	1.02	3.87	3.3
Total	**79.14**	**38.21**	**117.35**	**100.0**

Table 9: Annual Provincial Water Allocations under the Water Apportionment Accord (1991)

As shown in Table 9, WAA 1991 provides the basis for allocating approximately 117.35 MAF of annual surface water among the provinces. Punjab and Sindh together account for approximately 89 percent of the apportioned surface water. Khyber Pakhtunkhwa and Balochistan together receive about 11 percent of the allocation, including provisions for civil canals and future irrigation development. The Accord further distinguishes allocations between the Kharif and Rabi seasons, recognizing the significant seasonal variation in river flows and agricultural water demand. Over the past three decades, the WAA 1991 has provided a stable legal basis for water distribution and remains one of the most significant examples of cooperative federal resource management in Pakistan.

Challenges in Achieving Inter-Provincial Consensus

While the WAA 1991 provides the foundation for equitable water distribution, achieving consensus on water sector development and operational decisions remains a constant challenge. Pakistan's water system is highly interconnected, where decisions in one part of the basin can have implications for other provinces. As a result, maintaining confidence among all federating units is essential for advancing water infrastructure and ensuring that national water security objectives are achieved through a coordinated approach.

The major areas requiring greater inter-provincial consensus include water accounting and data transparency, development of new storage infrastructure, and expansion of irrigation networks. Differences in provincial perspectives on these issues have historically slowed decision-making and delayed investments required to improve the efficiency and resilience of the Indus Basin Irrigation System.

A key challenge relates to the availability and acceptance of reliable water data. Accurate measurement of river flows, canal withdrawals, and reservoir operations is fundamental for ensuring that provincial allocations are implemented transparently. However, differences in confidence regarding existing measurement mechanisms have contributed to disagreements over actual water availability and distribution. Strengthening transparent, real-time monitoring systems and establishing universally accepted hydrological data platforms are therefore essential for improving trust among stakeholders.

Similarly, achieving consensus on new storage and conveyance infrastructure remains critical for expanding Pakistan's water management capacity. Additional storage is required to regulate seasonal variability, capture surplus monsoon flows, and improve the reliability of provincial water allocations throughout the year. Likewise, strategic canal projects can enable expansion of irrigated agriculture and allow provinces to better utilize their allocated water shares. To preserve national harmony, the state has reaffirmed that no strategic canals or large-scale dams can move forward without unanimous, multi-provincial approval secured through the Council of Common Interests (CCI). This approach ensures that future water infrastructure development proceeds through collective ownership and remains aligned with the principles of equitable water distribution.

Moving forward, strengthening mechanisms for consultation, transparency, and evidence-based decision-making will be necessary to ensure that water sector development proceeds through collective ownership. Building consensus among provinces will remain central to achieving equitable water distribution while enabling Pakistan to expand storage, improve irrigation efficiency, and secure long-term water availability.

Digital Water Accounting and Transparency

Transparent and credible water accounting is fundamental to ensuring equitable distribution of water among provinces. Given the scale and complexity of the Indus Basin Irrigation System (IBIS), accurate measurement of river flows, reservoir storage, and canal withdrawals is essential for implementing provincial allocations under the WAA 1991 and building confidence among all stakeholders. Modernizing the water accounting framework is therefore a key requirement for strengthening inter-provincial trust and enabling evidence-based water management.

The advancements being made under the Digital Monitoring and Telemetry initiative represent a major transition from manual flow measurement practices towards automated, near real-time hydrological monitoring. The initative is being implemented under the Installation of Telemetry System for Real-Time Discharge Monitoring on IBIS project and aims to establish a transparent digital record of water flows across critical locations of the IBIS, reducing uncertainties associated with manual measurements and improving the reliability of water distribution decisions. The system will provide real-time discharge monitoring at rim stations including major barrages, river monitoring stations, and canal headworks, creating a common data platform for provincial and federal stakeholders.

The project involves installation of telemetry systems at 27 strategic locations across IBIS, supported by a central real-time data centre and regional monitoring facilities. Initially approved in 2022 and again approved with increased scope in 2024, it has a target completion date of June 2028. As of July 2026, the project has achieved 65 percent physical progress and 75 percent financial progress. Revalidation of discharge coefficients and rating tables at all 27 monitoring locations has been successfully completed, while telemetry equipment installation and associated civil works are underway at major barrages and canal headworks.

In the longer term, improved water accounting should enable a transition towards managing major reservoirs as transparent "water banks", where digitally monitored storage volumes allow provincial water entitlements to be tracked and managed on a volumetric basis throughout the year. Such a system would provide greater flexibility in aligning water releases with actual seasonal and crop requirements while ensuring that provincial shares remain transparently accounted for within the framework of the Water Apportionment Accord.

However, the effectiveness of digital water accounting depends not only on technological deployment but also on institutional acceptance of the data generated. Establishing agreed protocols for data verification, sharing, and operational use among federal and provincial stakeholders will be essential to ensure that telemetry serves as a trusted foundation for equitable water distribution and long-term water security.

Expanding Command Areas through Strategic Canal Development

Despite having one of the world's largest irrigation systems, significant areas suitable for irrigated agriculture remain outside formal irrigation networks due to limited conveyance infrastructure, incomplete command area development, and insufficient investment in water distribution systems.

Of Pakistan's total geographical area of 196.72 million acres, approximately 68.99 million acres are considered suitable for irrigated agriculture. Out of the 54.36 million acres under cultivation, 48.41 million acres are currently irrigated, leaving an estimated 20.58 million acres with potential for future irrigated agriculture expansion. As shown in Figure 24, significant opportunities for expansion of irrigated agriculture remain across all provinces, particularly in areas where suitable agricultural land exists but irrigation infrastructure is limited.

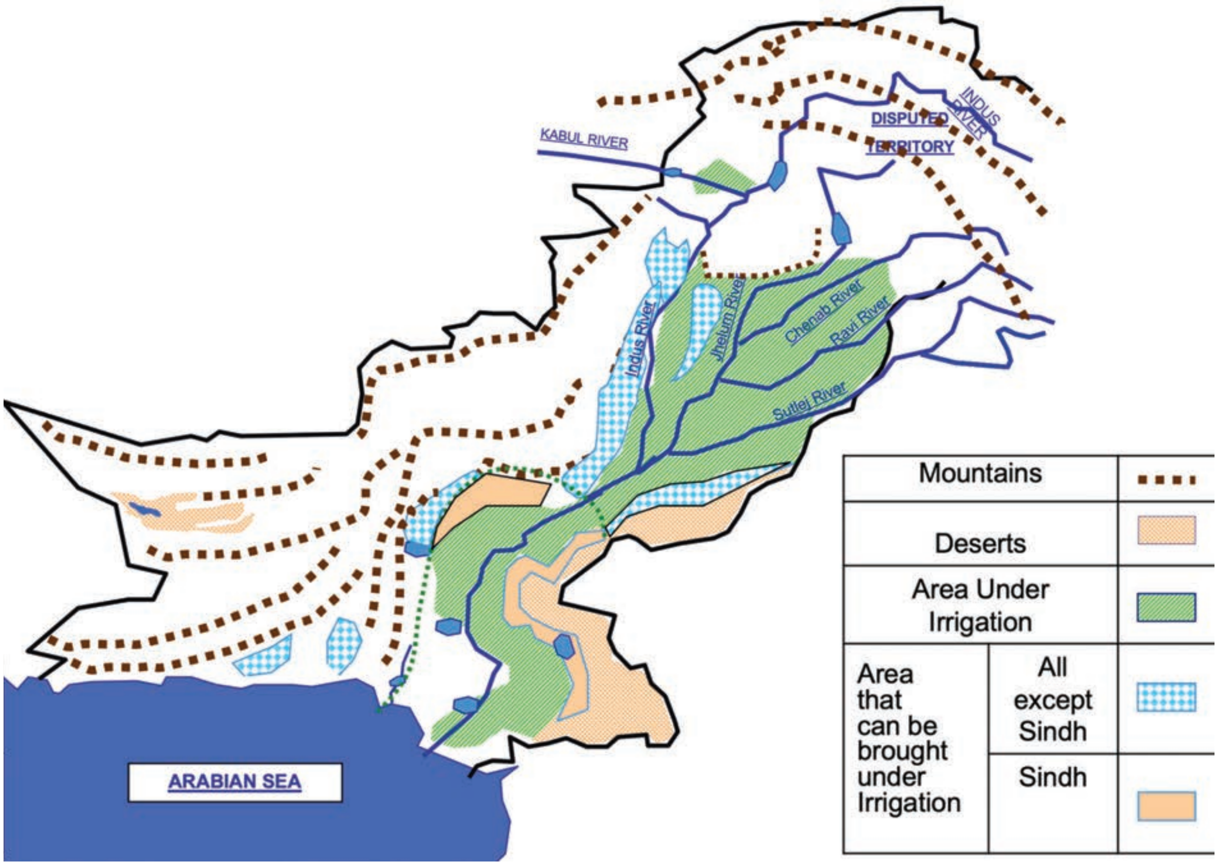


Figure 24: Existing and Potential Irrigated Areas of Pakistan

The provincial distribution of this potential, presented in Table 10, highlights considerable opportunities for expanding irrigated agriculture beyond existing command areas. Balochistan has the largest potential for additional irrigated agriculture at 9.88 million acres, followed by Punjab (4.03 million acres), Sindh (3.68 million acres), and Khyber Pakhtunkhwa (2.99 million acres). Realizing this potential requires development of conveyance networks and command area infrastructure to ensure that provinces can fully utilize their apportioned water shares under the WAA 1991.

Province	Potential Area that can be brought under irrigation (Million Acres)
Sindh	3.68
Punjab	4.03
Khyber Pakhtunkhwa	2.99
Balochistan	9.88
Total	**20.58**

Table 10: Provincial Potential for Expansion of Irrigated Agriculture

To improve water utilization and expand agricultural production, several strategic canal projects have been planned across the country. These projects are intended to develop new agricultural command areas while strengthening the physical capacity of provinces to utilize their allocated water shares under the WAA 1991. By expanding irrigation networks into previously underserved areas, these projects can contribute towards improved regional balance, agricultural productivity, and more effective utilization of available water resources.

Development of the Greater Thal Canal, Kachhi Canal, Rainee Canal, and Chashma Right Bank Canal Lift Project collectively represent a potential expansion of approximately 3.15 million acres of culturable command area. As summarized in Table 11, the Greater Thal Canal represents the largest initiative, designed to irrigate approximately 1.74 million acres through water drawn from the Chashma/Jinnah Barrage system. The Kachhi Canal Project, originating from Taunsa Barrage, is designed to develop approximately 713,000 acres in Balochistan. The Rainee Canal Project from Guddu Barrage is planned to irrigate approximately 412,400 acres in Sindh, while the Chashma Right Bank Canal Lift Project would expand irrigation coverage by approximately 286,000 acres.

Project	Source	Designed Culturable Command Area (Acres)
Greater Thal Canal	Chashma-Jehlum Link Canal	1,739,000
Kachhi Canal	Taunsa Barrage	713,000
Rainee Canal	Guddu Barrage	412,400
Chashma Right Bank Canal Lift Project	Chashma Barrage	286,000
Total	-	**3,150,400**

Table 11: Strategic Canal Projects and Designed Culturable Command Areas

However, the benefits of these investments depend on timely completion of both canal infrastructure and downstream command area development. Several projects have experienced prolonged delays, limiting their contribution to agricultural expansion and the utilization of provincial water allocations. Phase-I of both Greater Thal and Rainee Canals have been completed but further development is stalled and without command area development. Chashma Right Bank Canal Lift Project and Kachhi Canal are under implementation but are progressing at slow pace.

A similar challenge exists in other completed multipurpose projects where command area development has not kept pace with upstream infrastructure. The Gomal Zam Dam and associated hydropower facility were completed more than a decade ago; however, the full benefits of the investment remain unrealized due to incomplete development of its approximately 191,000-acre command area.

Accelerating strategic canal completion and command area development is therefore essential for maximizing returns from existing and future water infrastructure. Ensuring that provinces possess the necessary infrastructure to utilize their allocated shares, while simultaneously expanding productive agricultural capacity, will remain a key component of achieving equitable and sustainable water distribution across Pakistan.

Sindh Barrage: Enhancing Downstream Water Availability and Lower Riparian Security

Ensuring equitable water availability across provinces requires strengthening water infrastructure throughout the Indus Basin, including measures that safeguard the interests of lower riparian areas. For Sindh, enhancing freshwater availability, expanding irrigation potential, and protecting the Indus Delta are key requirements for strengthening water security. At the same time, a substantial volume of freshwater continues to flow downstream of Kotri Barrage and into the Arabian Sea during high-flow periods, exceeding Pakistan's existing national live storage capacity by two times on an annual basis.

The proposed Sindh Barrage is designed to address these challenges by providing additional storage and regulation capacity on the lower Indus River. Located approximately 45 km upstream of the Indus River outfall into the Arabian Sea and downstream of Kotri Barrage, the Sindh Barrage will enable improved utilization and management of downstream river flows. The location of the proposed barrage and associated ancillary developments is presented in Figure 25.

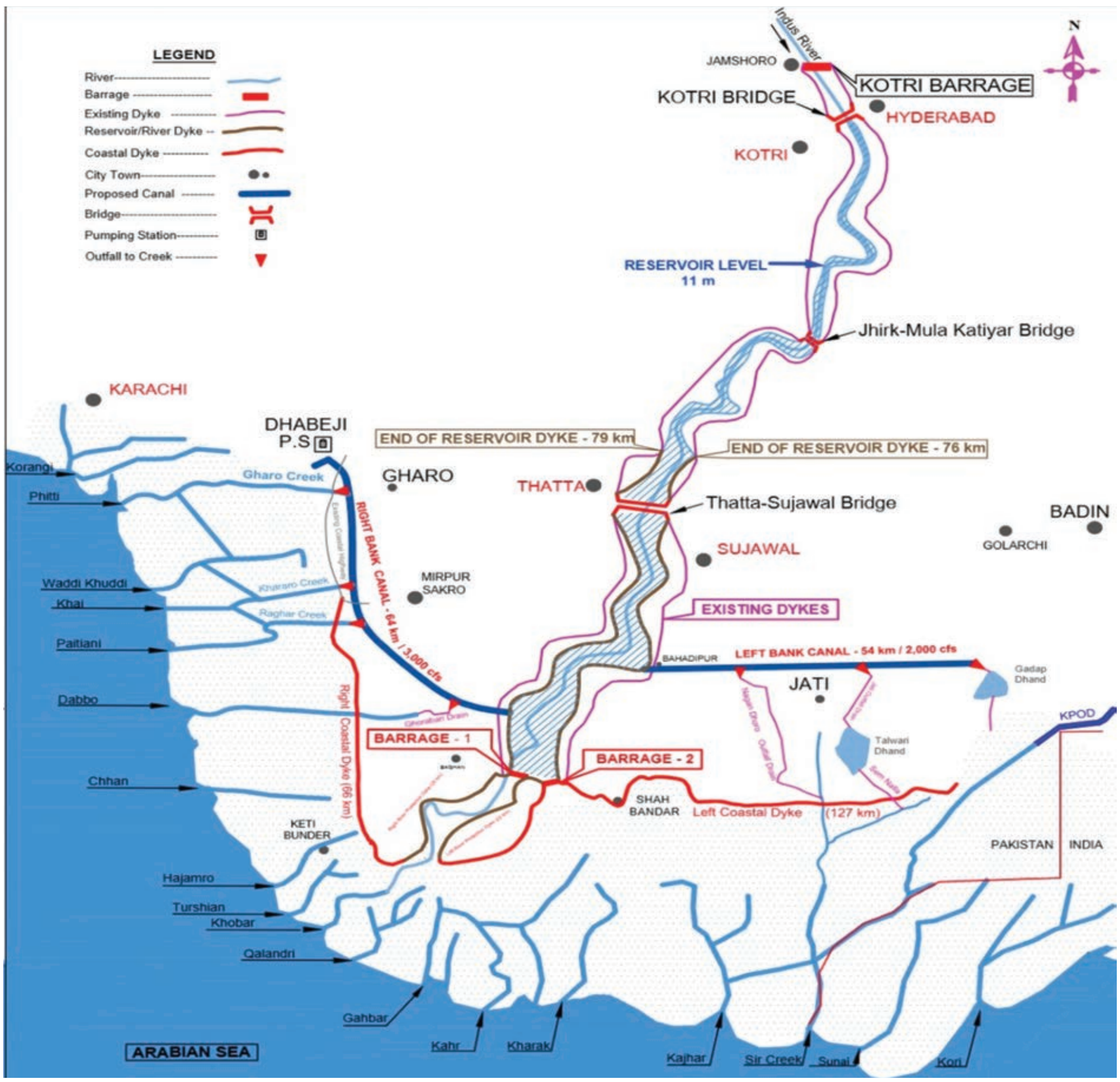


Figure 25: Location of Sindh Barrage and Associated Ancillary Developments

The project has an estimated cost of approximately USD 750 million and is designed with a storage capacity of 1.2 MAF. It includes two irrigation canals: a left-bank canal with a capacity of 2,000 cusecs and a right-bank canal with a capacity of 3,000 cusecs. These conveyance systems will enable expansion of irrigated areas, increase command area development, and improve utilization of stored water.

Sindh Barrage is expected to provide multiple benefits, including improved freshwater availability for the Indus Delta, reduction in seawater intrusion, groundwater recharge, ecological improvement, and expansion of irrigated command areas. By increasing storage capacity and improving regulation of downstream flows, the Sindh Barrage can contribute towards more balanced utilization of Indus Basin waters and strengthen equitable water availability across provinces.

Recommendations – Objective # 3

Sr.	Action	Timeline*
1	Prioritize development of the Sindh Barrage to enhance downstream water availability, support lower riparian water security, expand storage capacity, and improve regulation of Indus flows	MT
2	Develop consensus among provinces through the Council of Common Interests (CCI) for strategic water infrastructure	MT
3	Accelerate completion and operationalization of the national telemetry system	MT
4	Establish mutually agreed protocols among federal and provincial stakeholders for validation, sharing, and acceptance of to-be telemetry-generated data	MT
5	Develop and implement strategic canal and storage projects to enable provinces to fully utilize their apportioned water shares under the Water Apportionment Accord while expanding irrigated command areas and improving agricultural productivity	LT

**ST = Short Term, MT = Medium Term, LT = Long Term*

OBJECTIVE # 4

MODERNIZE IRRIGATION SYSTEMS ACROSS THE COUNTRY

Overview

Pakistan's irrigation system, while one of the country's greatest engineering achievements, was largely designed and constructed over a century ago to serve the hydrological, technological and agricultural realities of that period. Since then, water availability has become increasingly constrained, cropping patterns have changed, groundwater has emerged as a parallel source of irrigation, climate variability has increased the unpredictability of river flows, and digital technologies have fundamentally transformed how water systems are managed globally.

Yet much of Pakistan's irrigation infrastructure and institutional framework continues to operate using manual measurements, fixed operating procedures and fragmented administrative arrangements that have seen only incremental improvement over decades. Modernizing the irrigation system is therefore not merely a matter of rehabilitating aging infrastructure, but of transforming how irrigation water is measured, conveyed, allocated, monitored and paid for across the entire river-to-farm supply chain.

Fragmented River-to-Farm Water Governance

Pakistan possesses the world's largest contiguous irrigation network, yet responsibility for managing water is fragmented across multiple institutions with no single entity accountable for ensuring that allocated water ultimately reaches the farm efficiently. IRSA determines inter-provincial water allocations at the river system level but has no mandate to monitor conveyance losses downstream. Provincial Irrigation Departments operate barrages and canal networks but remain responsible primarily for water delivery rather than overall system efficiency. On-Farm Water Management (OFWM) departments improve tertiary infrastructure and promote water-saving technologies but have no authority over upstream canal operations. Consequently, the accountability chain breaks at every administrative level, with no institution responsible for monitoring water losses across the complete river-to-farm supply chain.

Establishing a River-to-Farm Water Accountability Chain

Another major challenge is the absence of an integrated water accountability framework from river allocation to end use. While water allocations are made at the basin level, volumetric tracking becomes increasingly fragmented across barrages, canals, distributaries, minors, watercourses and farms. Manual gauge readings, inconsistent record-keeping and the absence of real-time monitoring make it difficult to accurately quantify conveyance losses, identify unauthorized withdrawals and establish a transparent system-wide water balance.

The breakdown of accountability also weakens the integrity of Pakistan's warabandi system. Unauthorized abstractions and unaccounted conveyance losses disproportionately affect tail-end farmers, forcing them to increasingly depend upon groundwater abstraction to compensate for unreliable canal supplies.

To address this challenge, Pakistan should establish a Water System Integrator (WSI) function under the IRSA framework. Rather than creating another standalone institution, the WSI should function as a coordination and monitoring mandate embedded within existing institutions to provide continuous volumetric accounting across the entire river-to-farm supply chain. By integrating telemetry, digital flow measurement and centralized data management, the WSI would assign accountability for conveyance losses at every administrative level while publishing an automated, transparent national water balance. Such a system would improve operational efficiency, strengthen inter-provincial confidence and significantly reduce disputes arising from conflicting water accounting.

IRSA should be reformed with structural changes and appointment through a transparent competitive process rather than selective appointments by the provinces. The frequency of Advisory Committee of IRSA should be increased to maximum level to integrate the differences between provinces for water accounting, cooperation, efficiency and to win the provinces trust for transparent water distribution.

Improving Conveyance Efficiency

Conveyance losses remain one of Pakistan's largest sources of water inefficiency. Significant quantities of irrigation water are lost through seepage, leakage and poorly maintained conveyance infrastructure before reaching farms. The National Water Policy 2018 identifies accelerated watercourse improvement and lining programmes as key interventions to substantially reduce these losses.

However, canal lining should not be treated as a universal solution. While lining significantly improves conveyance efficiency in saline areas and locations with excessive seepage losses, seepage from unlined canals has historically played a critical role in recharging the Indus Basin Aquifer, which today supplies a substantial proportion of Pakistan's irrigation and drinking water. Indiscriminate lining of canals could therefore reduce groundwater recharge in areas already experiencing aquifer stress.

Future canal lining programmes should consequently be guided by detailed hydrogeological assessments, prioritizing reaches where conveyance losses exceed groundwater recharge benefits while preserving managed aquifer recharge in suitable locations.

Modernizing On-Farm Water Management

Despite significant advances in irrigation technologies globally, surface flood (inundation) irrigation remains the predominant method of irrigating crops in Pakistan. Under this practice, water is released across entire fields through open channels, resulting in substantial losses through evaporation, surface runoff and deep percolation beyond the crop root zone. While this method was appropriate when water was relatively abundant, it has become increasingly unsustainable under conditions of growing water scarcity. The continued reliance on flood irrigation therefore represents one of the largest opportunities for improving agricultural water productivity and conserving water.

The greatest gains in water conservation can be achieved by accelerating the transition from traditional flood irrigation to High Efficiency Irrigation Systems (HEIS), including drip and sprinkler irrigation, which deliver water directly to the crop root zone in controlled quantities. These systems significantly reduce water consumption while improving crop yields, enhancing fertilizer-use efficiency and lowering the energy costs associated with groundwater pumping. Complementary technologies such as laser land levelling, soil moisture sensors, automated irrigation controls, remote sensing and AI-enabled irrigation scheduling can further optimize irrigation timing and application rates according to crop water requirements and prevailing weather conditions.

Reforming the Abiana System

Pakistan's irrigation financing model remains heavily dependent on the Abiana system, yet current water charges recover only a small fraction of actual operation and maintenance costs. The prevailing acreage-based assessment bears little relationship to the volume of water delivered or consumed, providing virtually no incentive for efficient water use while limiting the financial sustainability of irrigation infrastructure.

The Abiana system should gradually transition towards volumetric pricing wherever reliable flow measurement becomes available. Water charges should progressively reflect actual operation and maintenance costs while protecting small farmers through targeted subsidies where necessary.

Rationalizing Cropping Patterns for Water Security

Pakistan's cropping patterns have evolved primarily in response to historical procurement policies, market incentives and price support mechanisms, rather than the availability and productivity of water. As a result, a significant proportion of the country's finite freshwater resources is allocated to water-intensive crops, placing increasing pressure on both surface water supplies and groundwater reserves. Improving irrigation efficiency alone will therefore not be sufficient to address Pakistan's water security challenges unless accompanied by a gradual transition towards more water-efficient cropping patterns.

As shown in Figure 26, snow and glacier melt remains the largest source of irrigation water during the summer season, while groundwater constitutes the second major source of irrigation supply. Both resources face increasing sustainability challenges. Glacier reserves are finite and highly vulnerable to rising temperatures and changing climatic conditions, while groundwater abstraction in many parts of the country already exceeds natural recharge. Continued dependence on these increasingly stressed sources without improving water productivity, expanding storage capacity and promoting efficient crop choices poses a significant long-term risk to national water security.

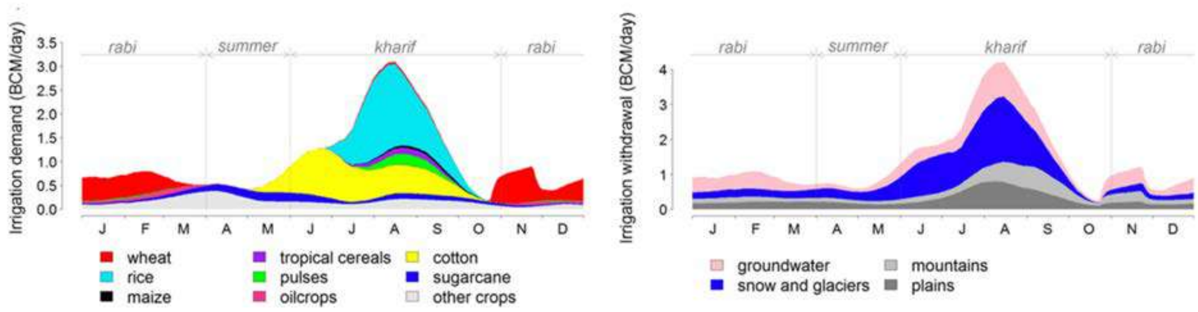


Figure 26: Irrigation withdrawal breakdown by source of Indus Basin

The same figure also illustrates that rice accounts for the largest share of irrigation water withdrawals, followed by cotton and wheat. While these crops are economically important, their water requirements are substantial and must increasingly be considered in the context of growing water scarcity. Sugarcane, in particular, is among the most water-intensive crops cultivated in Pakistan, requiring large quantities of irrigation water while serving primarily as a commercial cash crop. Given the country's worsening water constraints, the continued expansion of sugarcane cultivation is increasingly difficult to justify from a water security perspective. Future agricultural policy should therefore discourage further expansion of sugarcane cultivation in water-stressed regions and gradually promote less water-intensive alternatives where economically feasible.

Similarly, rice production should increasingly transition towards lower water-consuming varieties and cultivation practices that improve water productivity without compromising food security or export competitiveness. Adoption of improved seed varieties, alternate wetting and drying techniques, direct seeded rice and other climate-smart agronomic practices can substantially reduce irrigation requirements while maintaining yields. More broadly, cropping decisions should progressively be guided not only by economic returns per hectare, but also by water productivity, measured as the economic value generated per unit of water consumed.

Recommendations – Objective # 4

Sr.	Action	Timeline*
1	Provinces to launch programs to accelerate adoption of High Efficiency Irrigation Systems (drip and sprinkler irrigation), laser land levelling and precision irrigation technologies through targeted financial incentives	ST
2	Undertake a comprehensive asset condition assessment of IBIS and conduct modernization exercise based on its recommendations	ST
3	Establish a Water System Integrator (WSI) function under IRSA to strengthen river-to-farm water accountability through integrated water accounting, digital monitoring and transparent reporting	MT
4	Reform irrigation water pricing by gradually aligning abiana with actual operation and maintenance costs while introducing incentives for efficient water use	MT
5	Rationalize cropping patterns by promoting lower water-consuming crop varieties and gradually reducing cultivation of highly water-intensive crops, particularly sugarcane, in water-stressed regions	LT

**ST = Short Term, MT = Medium Term, LT = Long Term*

OBJECTIVE # 5

PROMOTE WATER, SANITATION AND HYGIENE (WASH)

Introduction

Access to safe drinking water, adequate sanitation and proper hygiene services remains one of Pakistan's most pressing human development challenges. Over the years, rapid urbanization, aging distribution networks, inadequate wastewater treatment and deteriorating groundwater quality continue to compromise the availability of safe water across much of the country. These challenges are particularly acute in rapidly expanding urban centres, where water supply systems struggle to keep pace with population growth, while many rural communities continue to rely on untreated groundwater sources that are increasingly vulnerable to microbial and chemical contamination.

The consequences extend well beyond water supply alone. Unsafe drinking water and poor sanitation remain major contributors to waterborne diseases, environmental degradation and declining economic productivity. Addressing these challenges therefore requires a comprehensive WASH strategy encompassing safe water supply, wastewater treatment and reuse, improved sanitation infrastructure, public awareness and innovative water supply solutions for water-stressed regions.

Strengthening Urban and Rural Water Supply

Pakistan's drinking water systems face both quality and access challenges. Rapid urbanization has placed immense pressure on municipal water utilities, many of which operate aging infrastructure characterized by high leakage rates, intermittent supply and limited water quality monitoring. At the same time, untreated municipal sewage and industrial effluents continue to pollute rivers, canals and groundwater, contaminating many of the country's primary drinking water sources.

According to the Pakistan Council of Research in Water Resources (PCRWR), approximately 53 percent of monitored urban water sources are unsafe for human consumption owing to microbial contamination, excessive salinity and other water quality concerns. In rural areas, safely managed drinking water coverage is considerably lower, with many communities relying on shallow hand pumps and local wells that remain highly susceptible to faecal contamination and geogenic pollutants. Conditions are particularly severe across southern Sindh and coastal Balochistan, where groundwater salinity, waterlogging and seasonal depletion of freshwater lenses severely constrain access to potable water.

Improving drinking water security will therefore require simultaneous investment in rehabilitation of municipal distribution networks, expansion of water treatment capacity, continuous water quality monitoring and decentralized water purification solutions for underserved rural communities.

Wastewater Treatment, Recycling and Reuse

Pakistan continues to treat and reuse only a small fraction of the wastewater generated by its urban centres. Consequently, untreated municipal sewage and industrial wastewater are routinely discharged into rivers, canals and other freshwater bodies, degrading water quality, threatening aquatic ecosystems and increasing public health risks.

International experience demonstrates that wastewater should increasingly be regarded as a valuable water resource rather than a waste product. Countries such as Singapore have successfully integrated advanced wastewater recycling into their national water strategies through the NEWater programme, supplying around 40 percent of national water demand through highly treated reclaimed water. Similarly, Jordan reuses over 90 percent of its treated wastewater for agricultural irrigation, preserving scarce freshwater resources for domestic consumption.

Pakistan should adopt a phased strategy to substantially expand municipal wastewater treatment capacity while promoting the safe reuse of treated wastewater for agriculture, landscaping, industrial processes and groundwater recharge. Establishing a national target for recycling at least 25 percent of municipal wastewater would significantly reduce pollution loads while augmenting available water resources.

Desalination and Coastal Water Security

Pakistan's 1,000-kilometre coastline presents a significant opportunity to strengthen long-term water security for coastal communities through seawater desalination. However, despite increasing water stress across coastal Sindh and Balochistan, the country's desalination capacity remains limited to a small number of industrial facilities and isolated municipal projects.

The recently commissioned 1.2 million gallons per day Reverse Osmosis (RO) desalination plant at Gwadar currently supplies approximately 0.9–1.0 MGD of potable water to Gwadar Port and the surrounding city. While this represents an important step towards improving local water security, existing freshwater sources—including Akara Dam and Shadi Kaur Dam—are unlikely to meet the city's rapidly growing domestic, industrial and port-related water requirements. Similar challenges exist across numerous settlements along the Makran Coast, where communities remain dependent on unreliable freshwater supplies transported over long distances.

Large-scale desalination therefore offers a strategic opportunity to decouple coastal water security from increasingly stressed inland freshwater resources while supporting urban growth, port development and the emerging blue economy. Given the energy-intensive nature of desalination, future facilities should be integrated with coastal wind and solar resources to reduce operating costs, improve energy security and lower the long-term cost of water production.

A Modern WASH Framework

Addressing Pakistan's water supply and sanitation challenges requires a transition from reactive service delivery towards integrated, technology-enabled utility management.

Urban Water and Sanitation Agencies (WASAs) should progressively adopt Advanced Metering Infrastructure (AMI) and IoT-enabled smart water meters to improve demand management, detect leakages in real time and reduce non-revenue water. Simultaneously, investments should prioritize expansion of wastewater treatment infrastructure, rehabilitation of aging distribution systems and deployment of decentralized filtration technologies in underserved communities.

In regions affected by saline groundwater, particularly across Sindh and Balochistan, specialized interventions such as skimming wells can improve access to freshwater by safely extracting shallow freshwater lenses overlying saline aquifers. These infrastructure investments should be complemented by sustained public awareness campaigns promoting safe water use, sanitation practices and water conservation through schools, community organizations and mass media. Strengthening WASH services ultimately requires not only improved infrastructure but also behavioural change, institutional capacity and long-term financial sustainability.

Recommendations – Objective # 5

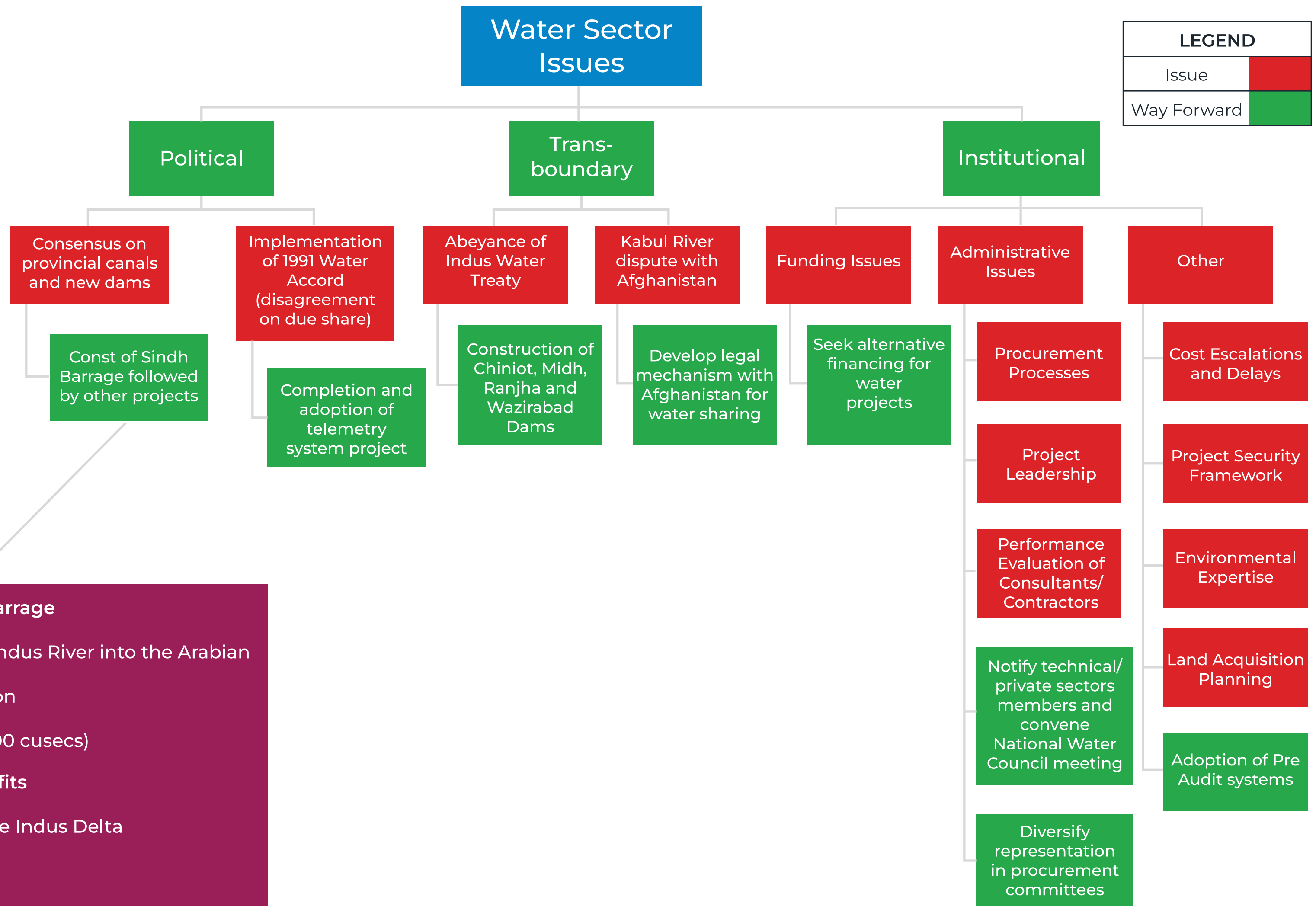
Sr.	Action	Timeline*
1	Expand access to safe drinking water by scaling up point-of-use water filtration systems and community-based water purification facilities in underserved urban and rural areas	ST
2	Undertake a comprehensive asset condition assessment of IBIS and conduct modernization exercise based on its recommendations	ST
3	Modernize urban Water and Sanitation Agencies (WASAs) through deployment of Advanced Metering Infrastructure (AMI), smart water meters and leak detection systems to reduce non-revenue water and improve service delivery	MT
4	Expand municipal wastewater treatment infrastructure nationwide with a target of recycling at least 25% of urban wastewater for non-potable uses such as agriculture, industry and landscaping	MT
5	Develop decentralized seawater desalination facilities along the Makran Coast to enhance water security for the coastal communities	LT

**ST = Short Term, MT = Medium Term, LT = Long Term*

SUMMARY

WATER SECTOR KEY ISSUES & INDICATIVE FEDERAL FINANCING REQUIREMENT FOR STRATEGIC WATER INFRASTRUCTURE (FY2027-36)

Water Availability	
80% of water is available in just 3 months.	
Type / Source	**Availability (MAF)**
All Rivers	138.4
G/water Extraction	55.0
Total Water Available	193.4
Canal Withdrawal	104.0
At Farmgate	61.0
Rainwater	8.5



Sindh Barrage

Location: 45 km upstream of Indus River into the Arabian Sea
Estimated Cost: USD 750 Million
Storage: 2.2 MAF
Canals: 2 canals (3000 and 2000 cusecs)

Benefits

Availability of fresh water to the Indus Delta
Prevent seawater intrusion
Improve ecology
Groundwater recharge

Figure 27: Water Sector Key Issues and Way Forward

<table>
<tr><th colspan="12">Indicative Federal Financing Requirement for Strategic Water Infrastructure (FY2027-36)</th></tr>
<tr><th>Projects</th><th>Cost (Bn)</th><th>FY27</th><th>FY28</th><th>FY29</th><th>FY30</th><th>FY31</th><th>FY32</th><th>FY33</th><th>FY34</th><th>FY35</th><th>FY36</th></tr>
<tr><td>Daimer Basha Dam</td><td>1360</td><td colspan="10">144 Bn / year</td></tr>
<tr><td>Mohmand Dam</td><td>666</td><td colspan="6">131 Bn / year</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Dasu HPP</td><td>1737</td><td colspan="10">145 Bn / year</td></tr>
<tr><td>Sindh Barrage</td><td>224 (112)</td><td colspan="6">19 Bn / year (50-50 cost sharing)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Chinoit Dam</td><td>299 (150)</td><td colspan="6">25 Bn / year (50-50 cost sharing)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Nai Gaj Dam</td><td>86</td><td colspan="3">20 Bn / year</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Naulong Dam</td><td>40</td><td colspan="6">8 Bn / year</td><td></td><td></td><td></td><td></td></tr>
<tr><td>K-IV</td><td>175</td><td colspan="5">27 Bn / year (Completion in 2026)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Chashma RBC</td><td>190 (124)</td><td colspan="5">25 Bn / year (65-35 cost sharing)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Telemetry System</td><td>24</td><td colspan="2">3 Bn / year</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rehab of NJHPP</td><td>35</td><td>-</td><td colspan="9">FY27 rehabilitation through self-financing / insurance – Rev generation: 70 Bn / year</td></tr>
<tr><td>Funds Required</td><td>4876</td><td>547</td><td>547</td><td>544</td><td>524</td><td>524</td><td>472</td><td>289</td><td>289</td><td>289</td><td>289</td></tr>
</table>

Figure 28: 10-year Indicative Federal Financing Requirement For Strategic Water Infrastructure (FY2027-36)

MEETING

URAAN PAKISTAN

TARGETS

The following infographic, Figure 29, illustrates how Uraan Pakistan's targets relating to water sector can be met:

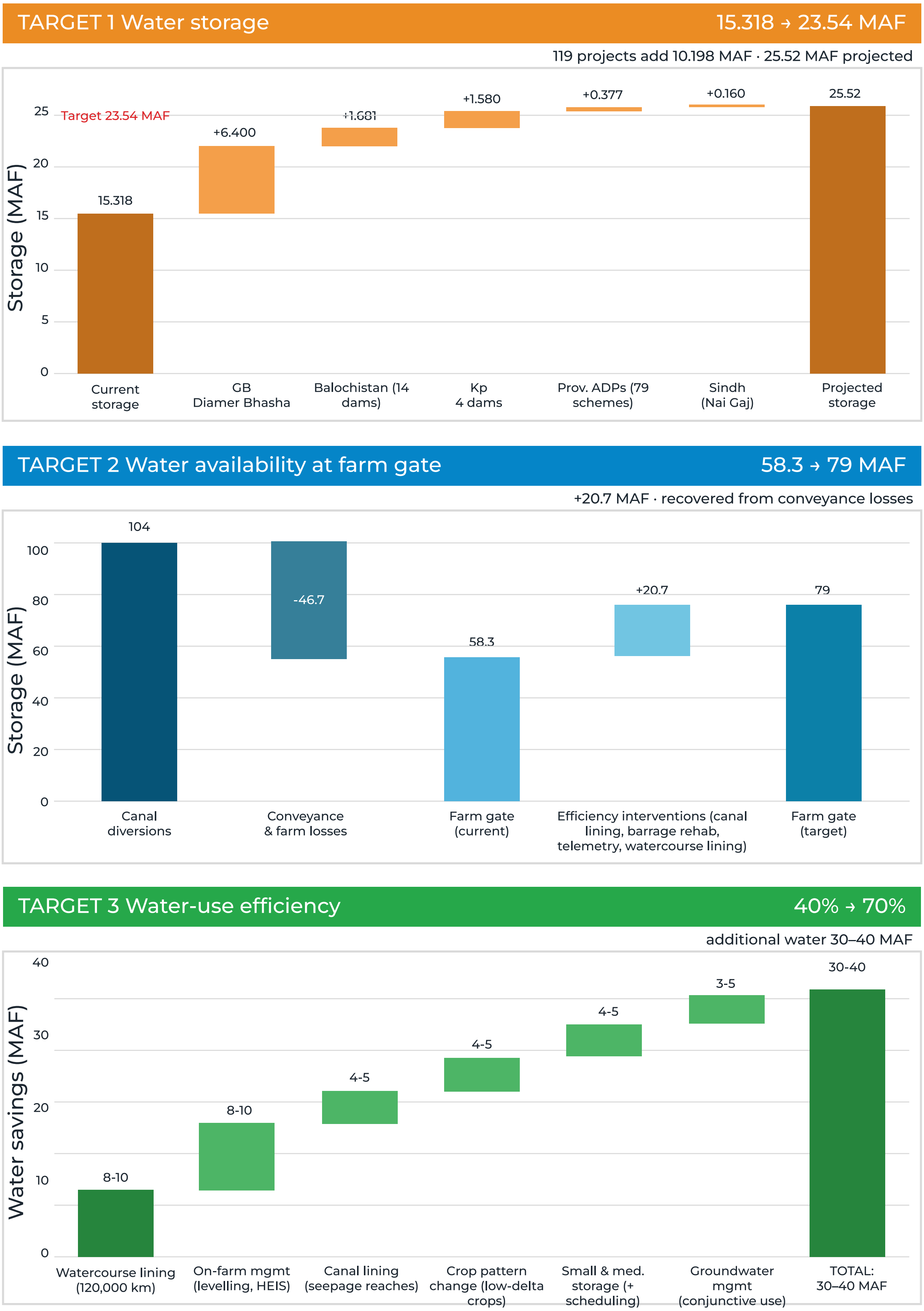


Figure 29: Meeting Uraan Pakistan Targets Relating to Water Sector

WAY FORWARD

CONSOLIDATED RECOMMENDATIONS

The recommendations of the report are consolidated as follows:

Trans-Boundary Water Sharing		
Sr.	**Action**	**Timeline***
1	Initiate high-level diplomatic engagement with the guarantors and supporting countries of the Indus Waters Treaty, including the World Bank, Australia, Canada, Germany, New Zealand, UK and USA, to develop a coordinated international strategy and seek support for raising the issue at the United Nations General Assembly, with backing from OIC, SAARC and ECO member states	ST
2	Engage the international community on the humanitarian, economic and development implications of the unilateral abeyance of the Indus Waters Treaty, including its potential impact on Pakistan's water security, livelihoods, and commitments under SDG 6.5 on transboundary water cooperation	ST
3	Establish a comprehensive national monitoring and documentation mechanism for all existing, under-construction and planned upstream hydraulic structures on shared rivers, including run-of-the-river projects, diversion structures and dam sites, or any attempt on river-piracy on Indian side, and submit periodic technical reports to UN, World Bank and ICJ to safeguard Pakistan's water rights	ST
4	Commission an independent technical and legal assessment through an internationally credible consultant in coordination with experienced Pakistani engineering institutions to evaluate the implications of upstream developments and strengthen Pakistan's case at international forums	ST
5	Initiate negotiations with Afghanistan for a formal water-sharing and cooperation framework for the Kabul River Basin before further large-scale dam development, including provisions for hydrological data exchange, coordinated river management and protection of downstream interests	MT

Groundwater Management		
Sr.	**Action**	**Timeline***
1	Commission a National Aquifer Mapping Program to delineate aquifer boundaries, recharge zones, groundwater potential, abstraction status and water quality	ST
2	Enact comprehensive groundwater legislation introducing groundwater licensing, abstraction permits, sustainable extraction limits and a clear allocation of federal and provincial responsibilities.	ST
3	Develop national standards for Managed Aquifer Recharge covering site selection, recharge design, water quality and long-term aquifer protection	ST
4	Mainstream Managed Aquifer Recharge (MAR) into urban planning, housing schemes and stormwater management through provincial building regulations	ST
5	Rationalize agricultural tubewell solarization by restricting new installations in overexploited aquifers and linking future subsidies to groundwater registration, metering and sustainable abstraction limits	ST
6	Integrate groundwater accounting into national water budgeting by reporting annual changes in groundwater storage alongside surface water availability and withdrawals.	MT
7	Establish a National Groundwater Information System and Registry integrating all groundwater abstraction points, monitoring networks and aquifer data to support real-time	MT

OBJECTIVE # 1 ENHANCE WATER DRAINAGE INFRASTRUCTURE AND FLOOD MANAGEMENT SYSTEMS		
Sr.	**Action**	**Timeline***
1	Declare Water Security a National Security Agenda and assign top political backing to ensure coordinated implementation of flood management, drainage and water security reforms across all levels of government	ST
2	Obtain Council of Common Interests (CCI) approval of the National Flood Protection Plan-IV (NFPP-IV) and convene meeting of the National Water Council, including notification of the five pending technical and private-sector members since 2018	ST
3	Strictly enforce River Acts in Punjab, Sindh and KP, and enact River Acts in Balochistan, Gilgit-Baltistan and Azad Jammu & Kashmir to protect floodplains and regulate encroachments	ST
4	Complete multi-hazard vulnerability and flood risk assessments of districts affected by the 2010, 2022 and 2025 floods to guide future investments and preparedness planning	ST
5	Achieve 100% operationalization of District Disaster Management Authorities (DDMAs), establish urban and flash flood early warning centres at all divisional headquarters, strengthen community-based disaster response committees, and notify SOPs for urban flood management.	ST
6	Undertake nation-wide feasibility studies for flood diversion canals to safely convey excess floodwater to pre-identified low-risk areas, wetlands, reservoirs, or temporary retention basins, and implement priority schemes where found technically, economically, and environmentally feasible	ST
7	Strengthen glacier monitoring and adaptation by enacting a National Glacier Protection Act, upgrading the Glacier Monitoring Research Centre (GMRC), establishing a National Glacier & Climate Training Institute, and promoting a South Asian Glacier Risk Monitoring Network	MT
8	Revise design peak inflow assessments using updated hydrological data and upgrade critical barrages, dams and flood embankments to withstand revised flood estimates	MT
9	Implement the National Flood Drainage Plan through rehabilitation and de-silting of major canals, outfall drains, RBOD-I, RBOD-III and LBOD, while completing RBOD-II to improve drainage in lower Sindh	MT
10	Increase the conveyance capacity of the Ravi and Sutlej Rivers through strategic dredging during the dry season where technically and environmentally feasible	MT
11	Construct priority small dams and hill torrent ma nagement works in Punjab, Sindh, KP and Balochistan	LT

OBJECTIVE # 2 ENHANCE WATER STORAGES & IMPLEMENT WATER CONSERVATION		
Sr.	**Action**	**Timeline***
1	Ensure timely completion of ongoing strategic storage projects, particularly Diamer Basha Dam and Mohmand Dam	ST
2	Implement the National Water Conservation Strategy 2023–27 and initiate preparation of the subsequent 2027–32 strategy to address emerging water security challenges	ST
3	Finalize and approve the National Watershed Management Plan with provincial ownership and make watershed management mandatory for all future dam projects	ST
4	Expand provincial construction of medium and small dams, particularly in water-stressed regions, to enhance local storage and drought resilience	ST
5	Ensure universal metering and volumetric pricing for urban, commercial and industrial water users to improve conservation incentives and financial sustainability of utilities	MT
6	Initiate Detailed Engineering Design (DED) of priority future mega storage projects including Akhori Off-Channel Storage Dam, Shyok Dam and Skardu Dam and undertake feasibility studies for additional strategic storage projects including Shigar, Kharmang, Midh Ranja, Wazirabad and Shah Jewna dams	MT
7	Launch catchment area rehabilitation and reforestation programmes in major river basins to reduce sedimentation and improve watershed resilience	MT

OBJECTIVE # 3 ENSURE EQUITABLE WATER AVAILABILITY AND DISTRIBUTION ACROSS SECTORS AND PROVINCES		
Sr.	**Action**	**Timeline***
1	Prioritize development of the Sindh Barrage to enhance downstream water availability, support lower riparian water security, expand storage capacity, and improve regulation of Indus flows	MT
2	Develop consensus among provinces through the Council of Common Interests (CCI) for strategic water infrastructure	MT
3	Accelerate completion and operationalization of the national telemetry system	MT
4	Establish mutually agreed protocols among federal and provincial stakeholders for validation, sharing, and acceptance of to-be telemetry-generated data	MT
5	Develop and implement strategic canal and storage projects to enable provinces to fully utilize their apportioned water shares under the Water Apportionment Accord while expanding irrigated command areas and improving agricultural productivity	LT

OBJECTIVE # 4 MODERNIZE IRRIGATION SYSTEMS ACROSS THE COUNTRY		
Sr.	**Action**	**Timeline***
1	Provinces to launch programs to accelerate adoption of High Efficiency Irrigation Systems (drip and sprinkler irrigation), laser land levelling and precision irrigation technologies through targeted financial incentives	ST
2	Undertake a comprehensive asset condition assessment of IBIS and conduct modernization exercise based on its recommendations	ST
3	Establish a Water System Integrator (WSI) function under IRSA to strengthen river-to-farm water accountability through integrated water accounting, digital monitoring and transparent reporting	MT
4	Reform irrigation water pricing by gradually aligning abiana with actual operation and maintenance costs while introducing incentives for efficient water use	MT
5	Rationalize cropping patterns by promoting lower water-consuming crop varieties and gradually reducing cultivation of highly water-intensive crops, particularly sugarcane, in water-stressed regions	LT

OBJECTIVE # 5 PROMOTE WATER, SANITATION AND HYGIENE (WASH)		
Sr.	**Action**	**Timeline***
1	Expand access to safe drinking water by scaling up point-of-use water filtration systems and community-based water purification facilities in underserved urban and rural areas	ST
2	Undertake a comprehensive asset condition assessment of IBIS and conduct modernization exercise based on its recommendations	ST
3	Modernize urban Water and Sanitation Agencies (WASAs) through deployment of Advanced Metering Infrastructure (AMI), smart water meters and leak detection systems to reduce non-revenue water and improve service delivery	MT
4	Expand municipal wastewater treatment infrastructure nationwide with a target of recycling at least 25% of urban wastewater for non-potable uses such as agriculture, industry and landscaping	MT
5	Develop decentralized seawater desalination facilities along the Makran Coast to enhance water security for the coastal communities	LT

**ST = Short Term, MT = Medium Term, LT = Long Term*

URAAN PAKISTAN

تو شاہیں ہے پرواز ہے کام تیرا

Planning Commission
Ministry of Planning, Development & Special Initiatives
Government of Pakistan

https://www.pc.gov.pk/uploads/pub/national-water-security-uraan-paki-stan.pdf