WATER MANAGEMENT IN PAKISTAN: CHALLENGES AND WAY FORWARD TO SUSTAINABILITY

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Abstract

Pakistan's water resources, anchored in the Indus River System and supplemented by monsoon rainfall and groundwater, are facing intensifying stress from population growth, reservoir sedimentation, outdated conveyance infrastructure, and fragmented governance. Synthesizing four decades of hydrological data, policy analysis, and stakeholder interviews, this paper reveals the decline in Indus flows (by 12.5%), loss in reservoir storage (by 26%), and persistent low irrigation efficiency (of 39%). National Water Policy targets remain largely unrealized (achievement less than 15%) five years post-promulgation. Preferred way forward includes raising storage capacity to 21 MAF, modernizing conveyance (lining, pipelining, smart metering), instituting volumetric pricing, and establishing a unified Water Management Information System. A phased awareness campaign and interagency coordination will be critical. These measures aim to conserve at least 17% of available water, bolster food–energy–climate security, and mitigate non-traditional threats to national security.

Key Words: Water Security, Indus Basin, Irrigation Efficiency, National Water Policy, Institutional Reform

Introduction

Pakistan's water resources are overwhelmingly tied to the Indus River Basin, which supplies approximately 80% of the nation's water needs while rainfall and internal runoff contribute the remaining 20%. As global per capita freshwater availability declines due to population growth, Pakistan's per capita share has fallen below critical thresholds[1]: although above the UN minimum of 500 m³ per year for basic human needs, it remains far below the 1,700 m³ per capita per year[2] - comprehensive requirement for agricultural, industrial, and environmental uses. Geographic and temporal variability further exacerbate scarcity, with 86% of flow concentrated in three monsoon months and the rest distributed unevenly across the year.

This article synthesizes Pakistan's hydroscape, governance frameworks, conservation practices, and the systemic inadequacies that undermine water security. It concludes with a multi-temporal policy roadmap aimed at enhancing storage, improving efficiency, and fostering institutional coordination to secure the nation's water future.

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Hydroscape of Pakistan

(Water Resources, Storage, Conveyance, Distribution, and Consumption)

Water management encompasses the planning, development, allocation, conservation, and governance of a nation's water resources. In Pakistan, this function is vital to ensuring sustainable availability for agriculture, domestic use, industry, and ecological preservation. Given Pakistan's agro-based economy and increasing water stress, effective water management is central to national resilience and economic viability. The ensuing paragraphs will briefly cover the Hydroscape of Pakistan to set the stage for deeper analysis.

The Indus Basin: Lifeline of Pakistan

Pakistan is predominantly a single river basin country, relying on the Indus River and its tributaries. Originating in the Tibetan Plateau and fed by the Himalayan and Karakoram ranges, the Indus traverses the entire length of Pakistan before discharging into the Arabian Sea. This system supports the country's vast irrigation network, sustains domestic water supplies, and feeds industrial sectors.

Precipitation and Rainfall

Rainfall and snowfall constitute the primary sources of fresh water[3]. The national average annual rainfall is approximately 37 million acre-feet (MAF), contributing nearly 13.5% to the Indus Basin Irrigation System (IBIS). Climate forecasts suggest increased monsoon precipitation but reduced winter rainfall, accompanied by spatial shifts in rainfall zones and intensifying unpredictability[4]. Remarkably, the ten highest rainfall events in Pakistan's history have all occurred post-2001[5], indicating an escalating impact of climate change.

Glacial Meltwater

The glacier-rich region of Gilgit-Baltistan, housing the largest non-polar glacial mass, supplies 65–75% of the Indus River's annual flow through meltwater[6]. These glaciers are melting at an alarming rate (globally, among the fastest[7]), potentially reducing river flows by up to 40% in the latter half of the 21st century[8].

Surface and Groundwater

Surface water is mainly sourced from rivers, streams, lakes, and reservoirs. River inflows show seasonal variability, particularly declining during Kharif and remaining steady during Rabi, while groundwater serves as a critical buffer.

The Indus Basin Aquifer is the world's largest artificially recharged system[9], mitigating fluctuations in canal supplies and rainfall, thus enhancing cropping stability[10].

Seawater Potential

Pakistan's extensive coastline provides access to abundant seawater resources. However, desalination efforts remain limited, primarily restricted to select urban coastal areas. This underutilized potential could offer strategic relief to freshwater scarcity, particularly in urban zones.

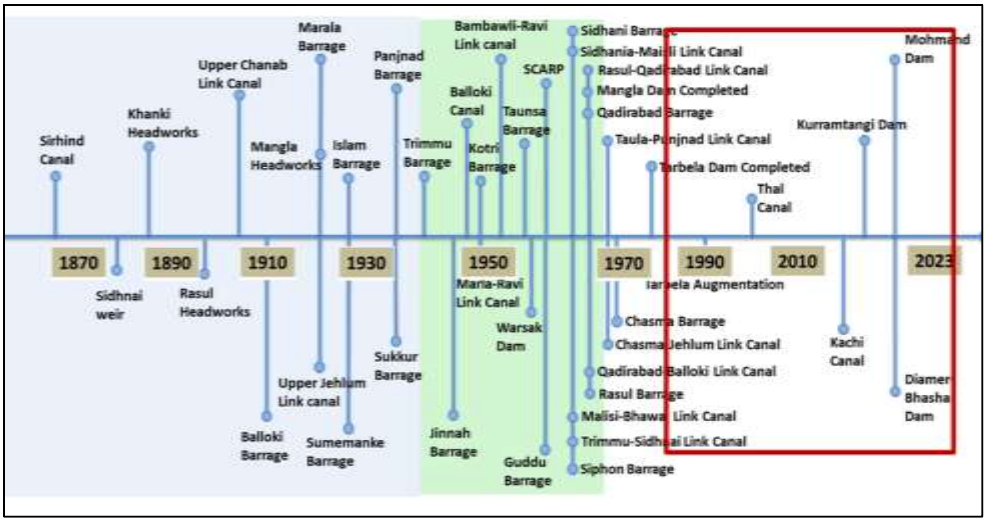
Water Storage Capacity

The IBIS includes three major reservoirs (Tarbela, Mangla, and Chashma) along with 143 other storage structures. These collectively hold a current capacity of 13.7 MAF[11], a reduction from their original design of 18.6 MAF due to sedimentation. River inflows contribute approximately 60.5% of Pakistan's total water availability, groundwater 22.3%, and rainfall 16.5%[12].

Conveyance and Distribution Infrastructure

The IBIS comprises an extensive water distribution system that includes 19 barrages, 12 inter-river link canals, 45 major irrigation canals, and over 120,000 kilometers of watercourses[13]. This infrastructure, primarily developed during the 1960s to 1980s, reflects an era of visionary leadership and development focus. However, the stagnation of new projects between 1990 and 2018 illustrates the decline in political prioritization and public awareness around water infrastructure.

Figure - 1: Absence of worthwhile water storage projects between 1990 and 2018



Consumption by Agriculture Sector

Agriculture consumes over 90% of Pakistan's total water[14]. Within this, four major crops (wheat, rice, sugarcane, and cotton) absorb 80% of irrigation supplies, while contributing just 7.5% to the GDP. Traditional surface irrigation dominates (84%), with pressurized systems like drip and sprinkler accounting for a mere 1.75%[15].

Domestic and Industrial Use

The domestic sector utilizes 5–7% of water, while industry consumes about 2%[16]. The lack of wastewater treatment exacerbates environmental degradation, adding further stress to already depleting freshwater resources.

Analytical Insights

Pakistan's hydroscape sustainability is increasingly threatened by glacial retreat, erratic precipitation, outdated infrastructure, and inefficient usage. Despite being endowed with diverse sources (rainfall, glacial melt, groundwater, and seawater) management practices remain suboptimal. The persistent delay in building new reservoirs since the 1970s has weakened national water security. Climate change, while not yet drastically reducing inflows, is altering precipitation zones and timing complicating water governance. Agriculture remains the dominant consumer, necessitating a transformative shift towards water-efficient irrigation techniques.

Water Governance

Water governance in Pakistan is characterized by a complex framework of transboundary agreements, interprovincial accords, and institutional mechanisms. Key treaties, like the Indus Waters Treaty with India and the ongoing water dynamics with Afghanistan, play a pivotal role in managing shared water resources. Domestically, the 1991 Inter-Provincial Water Accord and the 2018 National Water Policy aim to regulate equitable water distribution and foster efficient management. The details will be further explored in subsequent paragraphs to clarify the gaps in the water governance of Pakistan.

Indus Waters Treaty (1960)

The Indus Waters Treaty (IWT), signed in 1960 under World Bank auspices, is a foundational water-sharing agreement between Pakistan and India. It allocates eastern rivers (Ravi, Beas, Sutlej) to India and western rivers (Indus, Jhelum, Chenab) to Pakistan.

Despite political tensions and conflict, the treaty has remained operational. However, Pakistan objects to India's hydropower developments on western rivers, citing concerns over poundage limits, structural designs, and potential flow diversion.

Pakistan-Afghanistan Water Dynamics

The Kabul River brings approximately 20 MAF of water into Pakistan annually, while Afghanistan utilizes around 4 MAF. Pakistan is both an upper and lower riparian in this context. Afghanistan has identified 12 new dam sites on the Kabul River with a storage potential of 4.7 MAF, raising concerns for Pakistan's downstream supply. Attempts at formal cooperation have seen minimal progress; the last bilateral discussion occurred in August 2013. Technical committees established by the government of Pakistan in 2003 to draft a water treaty with Afghanistan did not make any headway due to a lack of data on the Kabul River Basin[17].

Inter-Provincial Water Accord (1991)

Signed by all four provinces and the federal government, the 1991 Accord remains the key instrument for domestic water sharing. It applies the principle of "**No Appreciable Harm**" for historical uses and "**Equitable Utilization**" for future development[18]. The Indus River System Authority (IRSA), established to enforce the accord, has representatives from all provinces. While functional, IRSA lacks enabling provisions to accommodate emerging claims from regions like Gilgit-Baltistan and Azad Jammu & Kashmir.

National Water Policy (2018–2030)

The National Water Policy (NWP) lays out a 12-year roadmap for integrated water resource management. It outlines strategic goals such as minimizing conveyance losses, increasing storage, introducing efficient irrigation (drip/sprinkler), enforcing realistic pricing, upgrading telemetry, and standardizing data mechanisms. It commits 10% of the federal Public Sector Development Programme (PSDP) budget to water-related projects, with proportional increases expected from provinces. Despite its ambition, tangible progress remains limited, confined largely to large dam projects like Diamer-Bhasha and Mohmand.

Punjab and Sindh have formalized provincial water policies aligned with the NWP. Punjab, Sindh, and Khyber Pakhtunkhwa have passed water legislation and established Provincial Water Commissions. Balochistan, however, has yet to legislate or form a commission, highlighting uneven policy execution.

Institutional Mechanisms

Pakistan's water governance framework is supported by a multi-tiered institutional structure that includes both federal and provincial bodies. At the federal level, the National Water Council and the Ministry of Water Resources oversee strategic planning, while provincial water commissions are expected to manage local water resources and ensure effective implementation of water policies at the provincial level.

- **The National Water Council (NWC)**, led by the Prime Minister and comprising all Chief Ministers, provides the apex platform for water governance. It is supported by a Steering Committee chaired by the Federal Minister for Water Resources and composed of provincial irrigation secretaries.
- **Federal Ministry of Water Resources** is the central policymaking entity responsible for strategic planning and execution through attached departments. It coordinates national projects, donor engagement, and transboundary negotiations.
- **Provincial Water Commissions** (in Punjab, Sindh, and KPK), led by respective Chief Ministers, are tasked with the allocation, conservation, and augmentation of provincial water resources. Their role is pivotal in decentralizing water governance.
- **Provincial Irrigation Departments** handle the operational and maintenance responsibilities of irrigation networks and flood systems. They regulate canal flows and ensure implementation of provincial water strategies.

Analytical Insights

Pakistan's water governance is shaped by a combination of international treaties, interprovincial accords, and evolving institutional frameworks. The IWT continues to secure critical western river flows despite upstream developments by India. The lack of a formal agreement with Afghanistan on the Kabul River remains a strategic vulnerability. Internally, while the 1991 Accord provides an equitable sharing framework, IRSA faces jurisdictional limitations regarding non-provincial stakeholders. The National Water Policy (2018) envisioned robust reforms, but its execution has lagged—reflected in the slow formation of provincial commissions and inconsistent legislative adoption.

Local and Contemporary Water Conservation Techniques

Effective water conservation techniques are essential for sustainable water management. Exploring modern methods and global practices of water conservation, having potential for local adaptation may assist in formulating optimized solution for Pakistan. Few pertinent water storage, conveyance, distribution, and conservation techniques will be examined in subsequent paragraphs to assess their potential applicability and adaptability to the context of Pakistan.

Sediment Control in Reservoirs

Effective sediment management is crucial for extending the lifespan of dams. The Three Gorges Dam in China exemplifies advanced techniques including upstream sediment trapping, watershed management, flushing, dredging, bottom outlets, and adaptive water level controls. These practices maintain storage capacity and ensure downstream flow continuity.[19]

Rainwater Harvesting

India has made substantial progress in rainwater harvesting through methods like rooftop collection, farm ponds, and watershed development, effectively recharging aquifers and supporting agriculture[20]. In Pakistan, the Cholistan Desert hosts over 110 rainwater harvesting ponds that offer localized water storage solutions.

Groundwater Recharge Initiatives

Pakistan has undertaken localized efforts such as the installation of 100 recharge wells in Islamabad and construction of 64 check dams in Balochistan. These dams irrigate approximately 25,850 acres while contributing to aquifer replenishment.[21]

Pipeline Conveyance Systems

Shifting from open channels to pipelines reduces seepage, evaporation, and leakage losses. Egypt, for instance, has halved its irrigation losses by adopting pipeline-based water conveyance[22]. Similar models can be replicated in Pakistan to modernize water delivery systems.

Figure - 2: Irrigation Pipelines – Egypt

High-Efficiency Irrigation Systems (HEIS)

HEIS technologies like drip, sprinkler, and center pivot systems improve water use efficiency by 30–95%, boost yields, and reduce weed growth. Despite subsidies, adoption in Pakistan remains limited due to cheap surface and groundwater availability and insufficient policy enforcement.

Figure - 3: High-efficiency irrigation systems (HEIS)

Global Innovations in Agricultural Efficiency

Advanced agricultural techniques have been successfully implemented in various countries to optimize water use and enhance crop productivity. In **Israel**, the adoption of advanced drip irrigation and fertigation systems has significantly maximized crop yields while minimizing water consumption. In **India**, the System of Rice Intensification (SRI) has increased rice yields by over 30% while reducing water use by 40%. Meanwhile, in **Australia**, the development of drought-resistant barley varieties, such as Capstan, has allowed crops to thrive in saline and dry soils, outperforming traditional varieties by up to 30%.

Crop Substitution Strategies

Egypt has replaced water-intensive crops like rice and sugarcane with wheat, corn, and soybeans, reducing agricultural water consumption by 25% while raising farmers' incomes by 30%.

Resource Conservation Technologies (RCT) in Pakistan

The Pakistan Council for Research in Water Resources (PCRWR) has promoted bed planting, precision land leveling, zero tillage, and irrigation scheduling. Bed planting alone has shown water savings of 56% for wheat and 47% for rice compared to traditional methods[23].

Public Awareness and Demand Management

Cape Town's 2015 water crisis was averted through campaigns like the "**50 Litre Life,**" reducing daily demand from 1.1 billion to 500 million litres by 2018[24]. Pakistan can benefit from similar behavioral change strategies.

Water Reuse and Recycling

Israel reuses nearly 50% of its wastewater in agriculture[25]. In Pakistan, Gwadar has initiated limited-scale wastewater recycling plants. Expanding such systems can ease pressure on freshwater supplies.

Water Pricing and Metering Systems

Germany employs full-cost water pricing and household smart meters, resulting in an average annual bill of €400[26] (Rs. 125,300). In contrast, Pakistan's average urban water bill remains around Rs. 6,000 per year[27]. Revising tariffs and metering could foster conservation and sustainable usage.

Analytical Insights

Pakistan stands at a critical juncture where water conservation is no longer optional but imperative. While isolated efforts-like rainwater harvesting ponds in Cholistan. Recharge wells in Islamabad, and HEIS pilot projects-demonstrate technical feasibility, systemic adoption remains sparse. The success stories of countries like Israel, Egypt, and India offer replicable models emphasizing drip irrigation, crop substitution, wastewater reuse, and water pricing. However, their success hinged on coherent policy frameworks public awareness, and state-level commitment-elements still lacking in Pakistan.

Analysis of Inadequacies in Water Management

Building on the examination of Pakistan's hydroscape, policy framework, and conservation practices, we will now critically assess the existing shortcomings in the management of water resources.

Water Resources and Storage

Sedimentation has reduced Pakistan's reservoir capacity from 18.6 to 13.7 MAF and is projected to fall to 10.3 MAF by 2050, undermining storage resilience. Upstream diversions on the eastern rivers have significantly cut ecological flows, while downstream of Kotri Barrage, annual releases average 15.6 MAF versus the optimal 8.6 MAF, wasting nearly 7 MAF to the sea due to inadequate storage. Excessive groundwater pumping—especially in Punjab, where deep piezometers (>80 ft.) rose from 52 to 1,868 between 2010 and 2020, resulting in lowering of water tables and heightened saline intrusion risks. Rainwater harvesting remains minimal, forfeiting an estimated 10.5 MAF annually. Climate variability concentrates 86 percent of flow in three monsoon months, indicating the need to expand buffer capacity to about 21 MAF for year-round supply stability[28].

Conveyance and Distribution

The Indus Basin Irrigation System operates on a supply-driven model (fixed release schedules) rather than responding to actual demand. Unlined canals and deferred maintenance result in seepage and evaporation losses that limit irrigation efficiency to an estimated 39 percent[29]. Distribution is further impeded by obsolete telemetry and the absence of a unified data authority. IRSA's mandate excludes representation for Azad Jammu & Kashmir and Gilgit-Baltistan, leaving these regions without formal water-sharing provisions.

Consumption Patterns

Flood irrigation, covering most cropland, incurs application losses of 35–40 percent and contributes to waterlogging and salinity on nearly one-quarter of arable land. High-efficiency irrigation remains cost-prohibitive despite subsidies, keeping Pakistan's water productivity at $1.6 per m^3 versus a global average of $21. Water-intensive crops such as rice, cotton, and sugarcane dominate due to market incentives, while wastewater treatment is virtually non-existent, exacerbating pollution. Underpriced water tariffs fail to discourage wasteful use. With the population set to exceed 250 million by 2025, per capita availability is expected to drop from 858 to below 800 m^3, intensifying scarcity. Limited desalination capacity further restricts alternative supplies.

Policy and Institutional Gaps

The lack of a bilateral water-sharing agreement with Afghanistan on the Kabul River poses a strategic threat as new dams proceed upstream. Domestically, the incomplete implementation of the National Water Policy (2018) has led to uneven provincial compliance and weak horizontal and vertical coordination. Provinces continue to struggle with policy execution, while IRSA's ability to integrate emerging demands is constrained by its legislative remit.

Analytical Insights

Overall inflows from western rivers remain stable, but flows from eastern tributaries have declined markedly. National water consumption is outpaced by substantial losses through seepage, evaporation, and delta discharge, while outdated irrigation practices further erode on-farm water availability. These trends highlight the persistent mismanagement of a finite resource.

Way Forward

The issue of limited water availability is rooted in **mismanagement of water**, **population growth** and **climate change**, with its solution lying in water management based on the principles of 'Enhancing **Water Storage** Capacity', 'Water **Efficiency** - More from A Drop of Water', and 'Learn to **Live with Austerity**'. A detailed roadmap expanding on these cardinal principles has been deliberated in subsequent paragraphs.

Awareness Campaign

Ministry of Information & Broadcast in conjunction with all stake holders should run comprehensive awareness campaign on National Water Security with the objectives to transform nation's psyche from '**water luxury**' to '**water austerity**', **sensitize leadership** through seminars and foster **acceptability of difficult political decisions** concerning water management with optimum utilization of social media, electronic media and schools/ institutions.

Furrow & Bed Irrigation Techniques

Furrow and bed irrigation techniques may be instituted universally by provincial irrigation departments in two phases. Phase I (Short Term) may include policy formulation, education, and demonstration of furrow & bed techniques for major crops, especially rice and wheat, for farmers. While Phase-II (Medium to Long Term) may include imposing complete restrictions on flood irrigation, with implementation by Provincial On-Farm Management Departments.

Comprehensive Water Pricing Mechanism

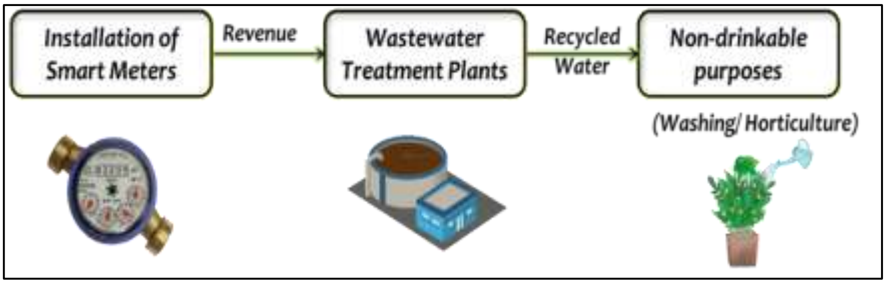
Provinces should review water pricing and their mechanisms for the domestic, industry, and agriculture sectors. A phased strategy for **agricultural water management** should begin with registration and geo-tagging of existing tube wells, authorizing abstraction rates according to aquifer health, and implementing artificial recharge in critically depleted areas (through inverted wells and infiltration ponds). In the medium to long term, volumetric meters must be installed, and excess groundwater extraction must be charged on a volumetric basis. PCRWR should be mandated to monitor abstraction at the national level. Concurrently, surface-water tariffs should be restructured from a uniform rate (Rs. 125–440/acre[30]) to the following suggested slabs *(however, existing rates may continue for 1 acre or less of land)*:-

Crops	No of Watering	Drip Irrigation	Bed & Furrow	Flood Irrigation
Per Watering	1	50	100	200
Wheat	4	**200**	400	800
Cotton	10	500	1000	2000
Sugarcane	16	800	1600	3200
Rice	20	1000	2000	**4000**

Finally, irrigation monitoring and billing systems must be digitized through mobile applications, GIS mapping, drone surveillance, and an e-Abiana platform to enhance transparency and cost recovery.

A consensus on volumetric metering policy for domestic and industrial users is essential. This should be followed by the deployment of smart meters and the application of volumetric charges, with generated revenues earmarked for wastewater treatment infrastructure. Treated effluent must be repurposed for non-potable uses such as cleaning and horticulture. To institutionalize reuse, building regulations should mandate wastewater treatment plants and rooftop rainwater harvesting systems in all new residential and industrial developments, reducing reliance on freshwater supplies. The option of public-private partnership may be explored for the distribution of water, service delivery, and cost recovery (for agriculture, domestic & industrial users).

Figure - 4: Phase-II Domestic & Industrial Sectors Regulation



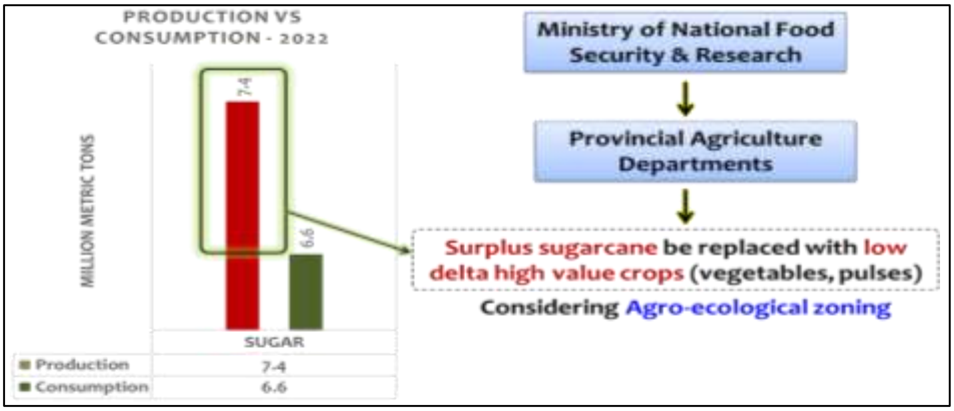
Climate Change Resilience

Besides the construction of small dams already proposed by provinces, Provincial Irrigation Departments, assisted by PCRWR and Pakistan Meteorological Department, should identify sites of **hill torrents, delay action dams, reservoirs, and small dams** vis-à-vis the changing pattern of monsoon consequent to climate change. Development of new water resources will enhance resilience against climate change while augmenting provincial water resources. WAPDA to fast-track the project of Sindh Barrage to address the issue of sea intrusion and enhance storage by 2 MAF.

Replacement of High Delta Crops

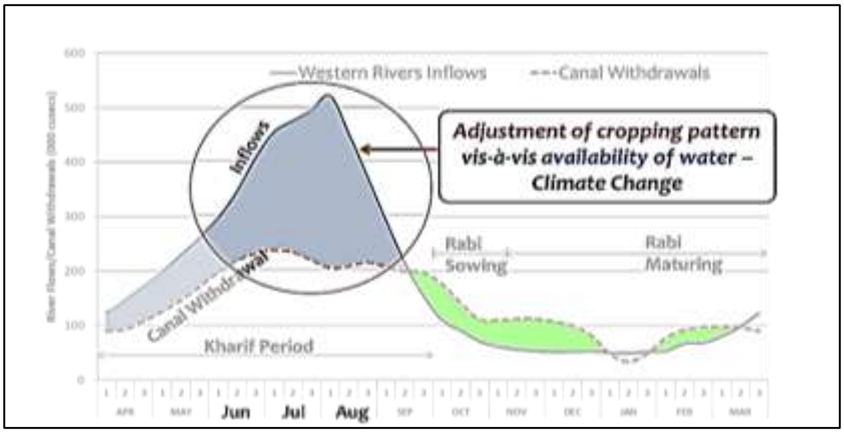
Surplus high delta crops like sugarcane should be replaced with low delta crops with more value (such as vegetables, pulses) while considering the impact on already established sugar industries and agro-ecological zoning by Provincial Agriculture Departments under overall coordination of the Federal Ministry of National Food Security & Research.

Figure - 5: Suggested Replacement of Surplus Sugar cane Crop



Moreover, study may also be conducted for adjusting cropping pattern vis-à-vis availability of water due to climate change.

Figure – 6: Suggested Adjustment of Cropping Pattern



Living with Salinity – Agriculture Sector

We need to find localized solutions for "**living with salinity**" while benefiting from best practices and experiences (especially of the Middle East and Australia). Pakistan Agriculture Research Council (PARC) in collaboration with Pakistan Council of Research in Water Resource (PCRWR) may be assigned a project for the development of **salt-tolerant** and **high-yield low water low-water-consumption** crop varieties.

Modernizing Irrigation Water Distribution System

After deliberate and successful pilot projects of pipelining minor canals in Punjab and Sindh, pipelining should be prioritized for salinity-affected zones of the provinces. In the medium to long term, expand the project to key distributaries, while exploring canal-surface leases for private solar installations to curb evaporation and generate energy. Upon completion of pipelining to farms, volumetric meters should be installed at each outlet, replacing fixed fees with usage-based tariffs, while offering farmers initial incentivized rates (below current levels) to encourage adoption.

Figure - 7: Suggested Plan – Modernization of Irrigation Water Distribution System

Indigenization of Water-Efficient Technologies/ Equipment

The private sector may be encouraged to manufacture **water-efficient technologies/ equipment** (like drip irrigation, sprinklers, and tunnel farming) and **desalination plants** through tax relief and subsidized loans, thereby reducing the equipment cost, besides the availability of maintenance support.

Implementation of National Water Policy – 2018

To expedite the implementation of the National Water Policy – 2018, the meeting of the National Water Council may be increased from once a year to thrice a year. Permanent staff for the Secretariats of the National Water Council and the Steering Committee may be detailed[31].

Water Management Information System

IRSA may be assigned with the mandate to establish Pakistan's Water Management Information System, responsible for **acquisition of data on water resources** from all stakeholders including Pakistan Meteorological Department, SUPARCO, Provincial Irrigation Departments and Land Information and Management System (LIMS) for collation, management and dissemination to facilitate decision-making for an integrated water resources management of Pakistan.

Amendment in Water Apportionment Accord – 1991

Water Apportionment Accord may be amended to include:-

- Representation and suitable water share for AJK & GB.
- Consensus-based installation and management of the telemetry system by IRSA.
- Empowering IRSA for the acquisition of data required for the Water Management Information System from all stakeholders.

Prioritization of Dams

Though the development of storage and hydropower is intertwined, WAPDA may prepare a harmonized plan with due priority to dams having storage capacity like:-

- Akhori - 6.0 MAF/ 600 MW
- Kalabagh - 6.0 MAF/ 3600 MW (subject to national consensus)
- Shyok - 5.5 MAF/ 640 MW
- Skardu - 3.0 MAF/ 1200 MW

Minimum Inflows Required in River Ravi & Sutlej

PCRWR, in collaboration with the World Bank, may carry out a comprehensive study on the impact of significantly reduced inflows in Ravi and Sutlej on the environment, biodiversity, and ecological balance. Based on the study, the minimum environmental flow in the Ravi and Sutlej rivers may be diverted from western rivers.

Water Sharing Agreement with Afghanistan

Pakistan may endeavor for a comprehensive bilateral agreement with Afghanistan, outlining equitable water distribution of the Kabul River.

National Projects Having an Impact on Water Management

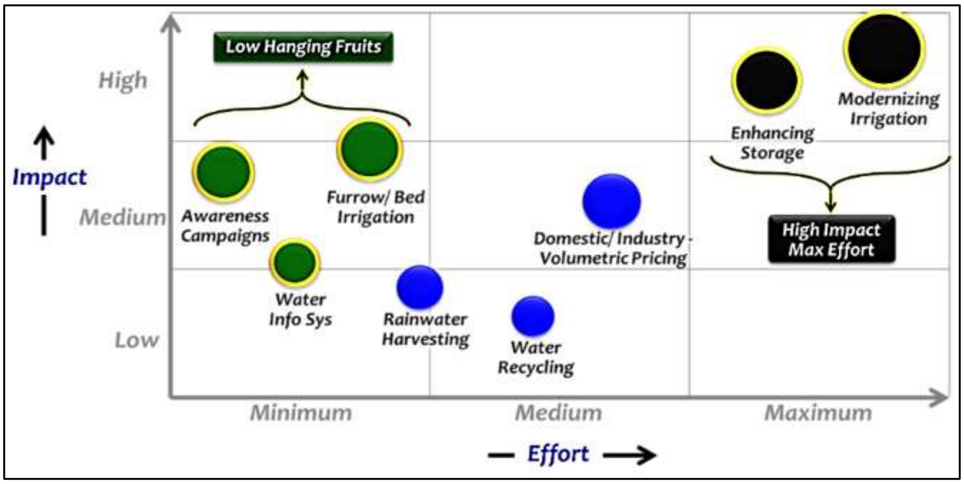
Following projects of national importance, having a significant impact on water conservation, should be given priority for implementation:-

- **Population Control** through educating the masses.
- **Urbanization regulation** emphasizing vertical construction.
- Implementing **Agro-Ecological Zoning** as part of Cluster Development Based Agriculture Transformation (CDBAT)-2025.
- **Promoting Cooperative Farming** as part of Green Revolution 2.0.

Effort vs Impact Matrix

An attempt has been made to estimate the efforts and impact of suggested measures. Modernizing Irrigation systems and storage capacity emerge as high-impact measures requiring maximum effort, while furrow & bed irrigation, awareness campaign, and water information management system are low-hanging fruits.

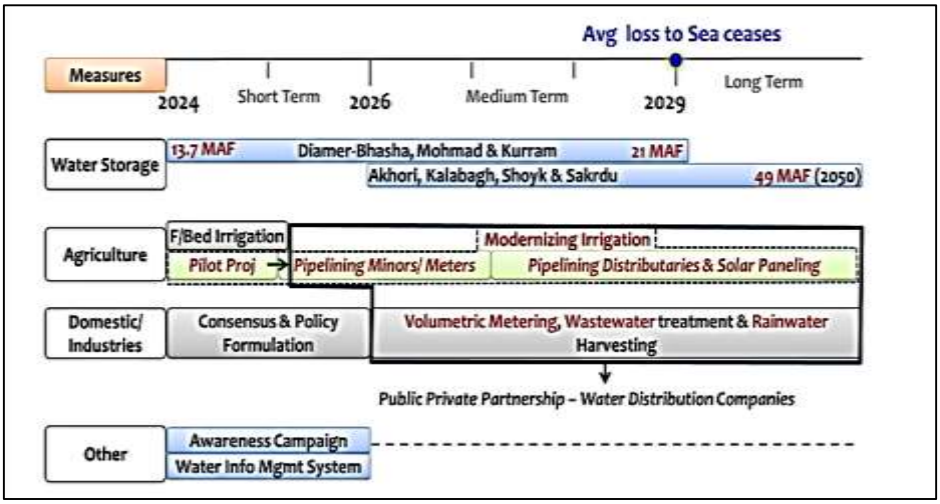
Figure - 8: Effort vs Impact Matrix – Suggested Measures



Implementation Plan

Completion of ongoing dams by 2032 will increase storage capacity to 24.5 MAF where our losses to sea are expected to cease. Implementation on Bed/ Furrow irrigation may commence immediately. While pilot project on irrigation modernization, augmented by awareness campaigns and information management system should start immediately. On success of pilot project, pipelining, metering and solar paneling of canal may commence. After developing consensus and policy framework, volumetric metering of domestic and industrial sector should start by 2026. The option of public and private partnership for water distribution may be explored during this phase. On implementation of measures, a minimum of 17% conservation of available water is expected.

Figure - 9: Implementation Matrix – Suggested Measures



Conclusion

Our availability of water is declining due to decades of neglect towards value and management of water. Comprehensive water management strategy based on enhancing storage, pipelining irrigation system, instituting volumetric pricing mechanism and awareness campaign will ensure water security for Pakistan.

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[31] Present arrangement is ad hoc; wherein Ministry of Water Resources and Federal Flood Commission are acting as secretariates of National Water Council and Steering Committee respectively, with dual tasking of officers/ staff already committed in primary tasks.