PCRWR

Ministry of Water Resources
Government of Pakistan
وزارتِ آبی وسائل حکومتِ پاکستان

National Water Conservation Strategy for Pakistan (2023-27)

(A Guiding Document)

February 2023

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Pakistan Council of Research in Water Resources

February 2023

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Abbreviations and Acronyms

ACEEE	American Council for an Energy-Efficient Economy
AHKNCRD	Akhtar Hameed Khan National Centre for Rural Development
ASB	Anjuman Samaji Behbood
BCM	Billion Cubic Meters
BCWD	Balochistan Communication and Works Department
CCRD	Centre for Climate Research and. Development
CoC	Chamber of Commerce
CPP	Changa Pani Project
DSM	Demand Side Management
E & T Dept.	Excise and Taxation Department
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
FBR	Federal Board of Revenue
FFC	Federal Flood Commission
GIS	Geographic Information System
IFPRI	International Food Policy Research Institute
IoT	Internet of Things
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
MAF	million-Acre Foot
MGD	million Gallons per Day
Mha	Million hectares
MNFS&R	Ministry of National Food Security & Research
MoC	Ministry of Communication
MoCC	Ministry of Climate Change
MoE	Ministry of Education
MoRA	Ministry of Religious Affairs
MoFEPT	Ministry of Federal Education and Professional Training
MoHW	Ministry of Housing & Works
MoIB	Ministry of Information and Broadcasting
MoIP	Ministry of Industries & Production

MoWR	Ministry of Water Resources
NRSP	National Rural Support Program
NUST	National University of Science and Technology
NWCS	National Water Conservation Strategy
NWP	National Water Policy
PARC	Pakistan Agricultural Research Council
PCRWR	Pakistan Council of Research in Water Resources
PEC	Pakistan Engineering Council
PEMRA	Pakistan Electronic Media Regulatory Authority
PHA	Provincial Housing Authority
PHA-KP	Provincial Housing Authorities of Khyber Pakhtunkhawa
PHED	Public Health Engineering Department
PMD	Pakistan Meteorological Department
PWC	Provincial Water Commission
RWH	Rainwater harvesting
SCHA	Sindh Cooperative Housing Authority
TMA	Tehsil Municipal Administration
UD&PHED	Urban Development & Public Health Engineering Department
UNESCO	United Nations Educational, Scientific and Cultural Organization
WASA	Water and Sanitation Agency
WWF	World Wide Fund for Nature
ZLD	Zero Liquid Discharge

Executive Summary

Pakistan is a semi-arid country that relies heavily on the Indus River and its tributaries for water, which altogether contribute over 175 billion cubic meter per annum. The Indus Basin has the largest contiguous irrigation system in the world. About 18 Mha of crop land is irrigated by the Indus Basin Irrigation System. Despite having one of the largest irrigation systems and the fourth largest groundwater aquifer in the world, the per capita water availability declined below the scarcity threshold of 1,000 m^3/capita in 2010. This places, Pakistan in the category of water-scarce countries. In Pakistan, surface water particularly as a subnational hydro-political issue, has always been the main focus. However, issues such as groundwater overdraft, salinity and waterlogging, climate change and ecosystem deterioration are expected to have more deleterious effects on the overall water use. With these challenges, water scarcity is going to increase further due to growing demand, mainly coming from rising population with an annual growth rate of 2.8%, rapid urbanization and exacerbated by the impact of climate change.

The Pakistan Council of Research in Water Resources (PCRWR) had forewarned in 2016 that with the current growth rates in population and declining water resources, the country would cross the threshold for absolute water-scarcity (annual per capita water availability of 500 m^3) by 2025. Though scientific evidence has proved that water resource development and governance have influenced water security, however, poor and outdated management practices have exacerbated the water crisis. This mismanagement results in low water productivity in all sectors including agriculture, domestic and industrial. Consequently, with low water efficiency, the country's status has gradually changed from a water surplus to a water-scarce country.

The National Water Policy (NWP) approved in 2018 emphasizes on water management through conservation and provides guidelines for effective planning to manage existing water resources. Pakistan's critical water situation demands an appropriate water conservation strategy that may help in optimizing water usage; reducing wastage of this precious resource and satisfy all users and demands equitably. The NWP states "Efficiency and conservation will be promoted at all levels". Accordingly, water conservation needs to be a central part of all process of planning, development and management of water resources.

The Ministry of Water Resources recognizes the competing demands for water from various sectors including but not limited to; drinking water and sanitation, agriculture, irrigation, manufacturing and industry, environment and ecosystems, and hydropower. Based upon these national needs and in line with the recommendations of the National Water Policy, the Ministry of Water Resources has developed this National Water Conservation Strategy (NWCS) for federal and provincial government institutions, international development agencies, research institutes, academia, private sector, and civil society organizations. This strategy takes into account challenges faced by agriculture, domestic and industrial sectors and suggests some necessary conservation measures to create a balance between demand and supply.

This strategy is a result of intensive consultative and participatory process involving stakeholders ranging from Federal and Provincial Governments line departments, civil society, academia and the development sector. The aim of formulating this NWCS is to develop a mechanism for supporting the National Water Policy (2018) in achieving sustainable water resources management through water conservation strategies, activities and technologies. Overall objective of the strategy is to ensure conservation of water, minimizing wastage and securing its equitable distribution both across and within provinces.

The strategy has four main dimensions focusing on three major sectors (Agriculture, Domestic and Industrial). Related to these, the key target dimensions include: low population growth; improve water productivity and efficiency; effective public-private partnership and enhance public awareness. The proposed strategic actions in this document aim to strike a balance between supply and demand in a cost-efficient manner. For each sector, key strategic objectives are formulated and listed below:

The Agriculture Sector

Strategic Objective 1: Improve water productivity in agriculture by introducing pricing policy and water efficient technologies.

Strategic Objective 2: Optimize groundwater abstraction and balance with recharge.

Strategic Objective 3: Develop non-conventional water sources for agriculture (secondary treated sewage water, drainage effluent, rainwater, saline effluent, seawater) and undertake watershed management.

Strategy Objective 4: Promote the use of information technology for water resources management.

The Domestic and Commercial Sector

Strategic Objective 1: Meter and price water in residential and commercial sectors.

Strategic Objective 2: Regulate groundwater abstraction for residential and commercial sectors.

Strategic Objective 3: Conduct water audits of water supply service providers, private housing societies and commercial settings on annual basis.

Strategic Objective 4: Introduce and promote water-saving technologies.

Strategic Objective 5: Formulate and enforce Zero Liquid Discharge (ZLD) Policy for residential & commercial settings.

Strategic Objective 6: Launch mass awareness programs for water conservation to reduce wastewater generation.

The Industrial Sector

Strategic Objective 1: Form ulate and enforce Zero Liquid Discharge (ZLD) Policy for industries.

Strategic Objective 2: Meter and price water for industries.

Strategic Objective 3: Conduct water audits on annual basis.

Strategic Objective 4: Launch awareness program for water conservation in industry.

The implementation framework for this strategy will require public and private partnerships with lead and supportive roles assigned to different agencies/institutions to ensure a coordinated implementation of the strategy with all the relevant departments/agencies and other relevant actors.

1. Background

Pakistan is a semi-arid country that relies heavily on the Indus River and its tributaries (Kabul, Jhelum, Chenab, Ravi and Sutlej) for its water resource. These rivers of the Indus Basin contribute to over 175 BCM per annum of water resource[1]. The Indus Basin is home to the largest contiguous irrigation system in the world. Approximately 17 Mha of cropland is irrigated by the Indus Basin Irrigation System[2]. Despite this significant water resource, one of the largest irrigation systems in the world; and the fourth largest groundwater aquifer in the world, Pakistan's per capita water availability had declined below the scarcity threshold of 1000 m^3/capita in 2010, categorizing Pakistan as a water-scarce country[3].

In Pakistan, surface water particularly as subnational hydro-political issue has always been the main focus. However, some issues such as groundwater overdraft, salinity and waterlogging and ecosystem deterioration are expected to have more serious effects on the overall water use. Groundwater contributes over 60% to total supplies at the farm gate, the over-exploitation in certain areas has led to depletion of this valuable resource[4]. In few areas, the excessive use has resulted in the intrusion of saline (brackish) groundwater into the fresh groundwater aquifers, thereby rendering it unusable.

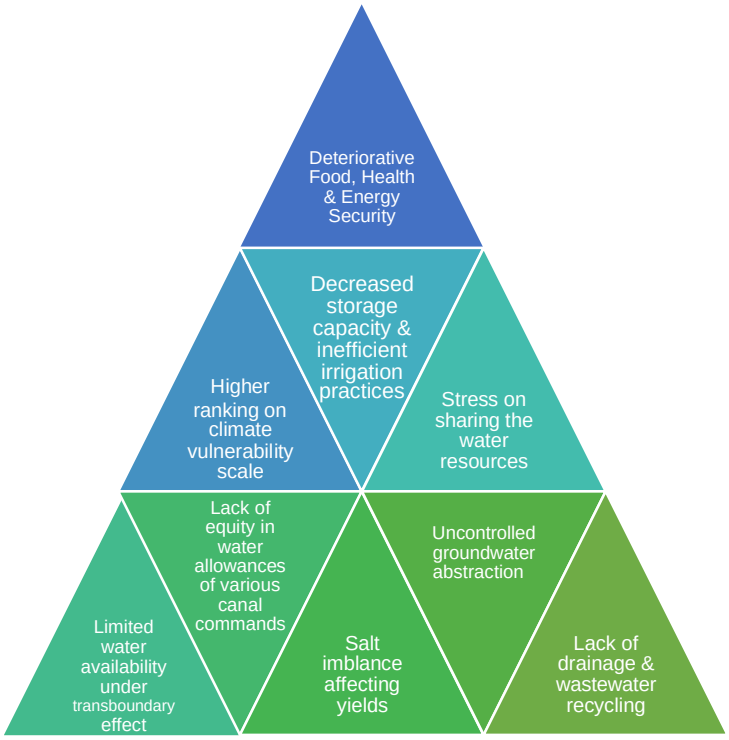


Figure 1: Some specific issues affecting the water sector of Pakistan

[1] Food and Agriculture Organization of the United Nations, 2021. Water availability, use and challenges in Pakistan

[2] Habib, Z., Wahaj, R. 2021. Water availability, use and challenges in Pakistan – Water sector challenges in the Indus Basin and impact of climate change. Islamabad. FAO. https://doi.org/10.4060/cb0718en

[3] Naveed, I., Ashraf, M., Imran, M., Salam, H.A., Hasan, F.U. and Khan, A.D., 2020. Groundwater Investigations and Mapping in the Lower Indus Plain. *PCRWR: Islamabad, Pakistan pp 70.*

[4] Naveed, I., Ashraf, M., Imran, M., Salam, H.A., Hasan, F.U. and Khan, A.D., 2020. Groundwater Investigations and Mapping in the Lower Indus Plain. *PCRWR: Islamabad, Pakistan pp 70.*

With challenges depicted in Figure 1, water scarcity is aggravated by an increasing demand, primarily from an increasing population which continues to grow at the annual rate of 2.8%. Other factors include rapid urbanization, and the adverse impacts of climate change.

Pakistan Council of Research in Water Resources (PCRWR) had forewarned in 2016 that with current trends of population increase and declining water resources, that by 2025 the country would breach the absolute water-scarcity threshold (annual per capita water availability below 500 cubic meters)[5]. The extensive work of PCRWR on surface and groundwater resources has revealed that Pakistan's water sector challenges are multi-dimensional and inextricably linked to water resources development, governance and management. All three categories of interrelated challenges discussed in the subsequent section limit the availability and access to freshwater.

2. Inter-related Challenges of Water Resources

Since 1947, Pakistan, has constructed 3 large dams, 17 barrages, and numerous head works and canals on the Indus River to irrigate its barren lands. The two major reservoirs, Tarbela and Mangla are challenged by silt accumulation which has resulted in the loss of 32% and 20% of their storage capacities, respectively [6] . To address the growing population, industry and electricity demands, the construction of mega dams such as Diamer-Bhasha Dam and Mohmand Dam as well as a number of small dams have been prioritized. However, the country needs to reduce its dependency on a single basin and also harness the potential of floods, hill torrents and runoff.

Pakistan's water governance issues are older than its existence, linked to its old colonial infrastructure. These governance challenges are compounded by; salinity, silt deposits, seepage losses, environmental degradation of the river ecosystem, lack of water pricing system, lack of groundwater regulatory framework and inability to enforce crop zoning. Effective water governance is a key to achieve water security, fairly allocating water resources and avoiding disputes at various scales. The scientific literature has shown that water resource development and governance influence water security, however the mismanagement of water has worsened the water crisis. For instance, in agriculture sector, the supply of water is linked to the canal command area and farmers are required to use water even when it is not required. Thus, the output produced against a unit of water remains extremely

[5] Ashraf, M. 2022. Water Conservation and Management in Pakistan. Hilal Magazine pp 6 (https://hilal.gov.pk/eng-article/detail/NjM0MQ)

[6] Sattar, E., Robison, J. and McCool, D., 2017. Evolution of Water Institutions in the Indus River Basin: Reflections from the Law on the Colorado River. *U. Mich. JL Reform*, *51*, p.715.

low i.e., low productivity of water (defined as the crop product per unit of water applied). Similarly, inequity and the lack of any service delivery obligation in domestic water supply system is also the result of ineffective water management. This ineffective management results in the wastage of water in all sectors including agriculture, domestic and industrial. Consequently, with low water efficiency in these sectors, the country's status has changed from a water surplus to a water scarce country.

3. Conservation for Effective Water Management

The objectives of the National Water Policy (2018) are focused on a set of principles that aim to promote the greater national interest and welfare of the people of Pakistan. In addition, the National Water Policy (NWP) has also identified strategic priorities of critical importance to the water, energy and food security of Pakistan (Figure 2).

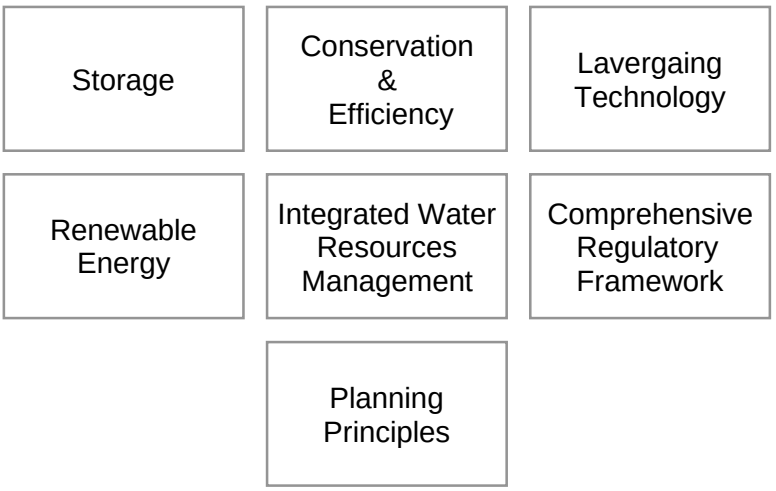


Figure 2: Strategic priorities set by the National Water Policy

This set of principles is to guide federal and provincial governments in the process of planning, development and management of water resources and includes the promotion of efficiency and conservation at all levels. The NWP emphasizes water management through conservation in all the sectors and has given guidelines for effective planning to manage existing water resources. The Policy also emphasizes on improving the availability, reliability and quality of fresh water resources to meet critical municipal, agricultural, energy, security and environmental needs. Section 7 of NWP (Conservation of Water) focuses on water conservation and provides policy directives regarding development and implementation of water conservation plans to ensure water and food security for the growing population. Within these broad parameters of water security, the provincial governments in accordance with the NWP directives have formulated their own policies and legislation although, plans for water conservation are still to be formulated.

Pakistan's critical water situation demands appropriate water management strategies, which can reduce water usage, wastage or loss to satisfy all users and demand on an equitable basis. Water conservation needs to be intrinsic to all planning, development and management of water resources.

Pakistan Vision (2025) sets out a vision wherein the country will have adequate water available through conservation, development and good governance. Following both the governing instruments (NWP 2018 & Vision 2025), conservation strategies for agricultural, domestic and industrial sectors are extremely important for sustainable and efficient use of water. Therefore, the motivation for developing a water conservation strategy is to provide strategic guidance to stakeholders on mechanisms needed to best facilitate water conservation measures in the light of future population growth, changing climate, disaster risks and socio-economic values associated with water.

The NWP provides the policy directions for water management challenges in the three key areas of agriculture, domestic and industries. A brief review of main policy directions with the context of water conservation in three sectors is provided herein.

Agriculture sector: The NWP stresses on planning - the preparation of strategies and action plans to ensure food security through water conservation and improved irrigation methods and practices. These include adequate water pricing (Abiana) for irrigation, minimizing flood irrigation, proper operation, and maintenance of irrigation infrastructure, a crash program for lining the water courses to overcome water losses, rationalized water allocation for different canal command areas, profitable use of flood water for irrigation, adoption of water conservation techniques/technologies at the farm level, adoption of technology for sustainable use of drainage water in agriculture, regulating groundwater extraction and consumption, developing water resources in rainfed agriculture areas and growing resistant crop varieties. All these interventions should improve water productivity by pursuing the concept of "*More Crop Per Drop*".

Domestic sector: The NWP emphasizes on improving urban water management by increasing system efficiency and reducing non-revenue water through adequate investments to address drinking water demand, aquifer recharge, enhancing water productivity through infrastructure development and adoption of improved technologies in a sustainable manner, sewage disposal and recycling.

Industrial sector: Along with agriculture, industry is the backbone of country's economy. The NWP also accentuates on management of industrial water demand through formulating a mechanism for

groundwater abstraction licensing and water pricing for industrial use as well as recycling of industrial effluents.

For above three sectors, NWP also directs the development and enforcement of regulations to ensure efficient and sustainable utilization of groundwater and wastewater management. In this regard, policy speaks about waste water reuse, regulating groundwater withdrawals for curbing over-abstraction and promoting aquifer recharge, behaviour change to reduce wastage of water by raising public awareness through media campaigns and incorporating water conservation contents in the formal education curriculum.

The NWP also highlights the conservation and efficiency for Demand Side Management (DSM) of water resources rather than relying exclusively on supply side solutions. In the same context, NWP (Section 3.7 *Planning principles*, clause 3.7.3) states that "*Efficiency and conservation will be promoted at all levels*". Towards achieving this goal of the NWP, this National Water Conservation Strategy (NWCS) is developed which is aligned with the national policies such as National Water Policy (2018), National Drinking Water Policy (2009), National Food Security Policy (2018), National Environmental Policy (2005), National Sanitation policy (2006), National Climate Change Policy (2012), and Provincial Water Policies/Acts.

This National Water Conservation Strategy also closely aligns with UN Sustainable Development Goals 2015 agreed by countries as Agenda 2030 for sustainable development such as; Goal 6 (clean water and sanitation), Goal 10 (reducing inequalities), Goal 11 (sustainable cities and communities), Goal 12 (responsible production and consumption), Goal 13 (climate action), Goal 14 (life below water), Goal 15 (life on land), Goal 16 (peace, justice, strong institutions) and Goal 17 (partnerships). This indicates worth of water conservation and its impact on multiple dimensions of sustainable development.

4. NWCS Development Approach (From Roadmap to Success)

All water sector stakeholders in Pakistan have concerns about the water future of the country. Therefore, there is a need to come up with clear approach of strategy framing process by involving all of them. Following a consultative process to seek opinions/feedback/concerns of all stakeholders (List at Annexure-I), these will be incorporated into this document as it is developed (Figure 3).

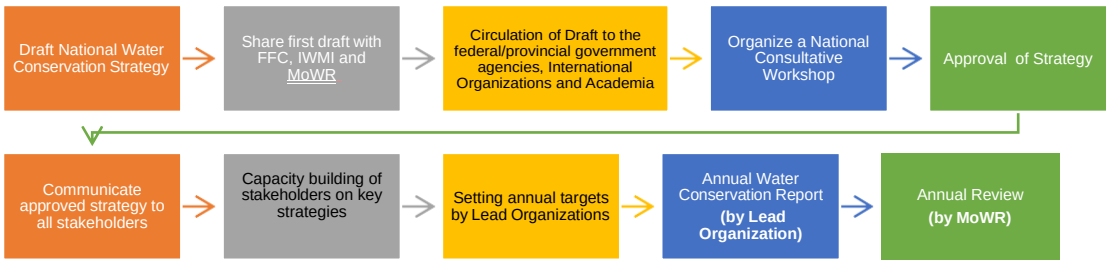


Figure 3: Process adopted from framing national strategies to implementation

Setting high-level targets for the water conservation following the approved document of the national water conservation strategy should be the responsibility of the provincial stakeholders. The MoWR can firm up these targets in consultation with the provincial governments and review these periodically for inclusion in the future plans e.g., Five Year Plans etc.

5. Aim and Objectives of NWCS

The aim of formulating NWCS is to support the delivery on the NWP for sustainable water resources management through policy guidelines, water conservation strategies, activities and technologies. The overall objectives are:

a. Ensuring conservation of water, minimizing wastage and securing equitable distribution both across and within provinces.
b. Supporting service providers to develop best management practices for water conservation in agriculture, domestic and industrial sectors minimizing financial dependence on federal and provincial governments.
c. Providing actionable information around water conservation in all the three sectors ensuring water security under changing climate.

Setting these ambitious objectives during the ongoing water crisis in the country, will invariably raise questions about the capacity and priorities of provincial stakeholders to develop their own plans to achieve the above listed objectives.

A summary of few of the questions and possible solutions are given below:

What are the key priorities of the provinces to get more value from water?

Provinces in Pakistan have their own regulatory system, policy framework, specific management requirements, institutional challenges and capacity and budgetary challenges viz-a-viz the administration of its water resources. To achieve the above listed objectives in this diverse situation, key water conservation strategies are developed for the three sectors listing main activities, responsibility and timeline. Following this guiding document, provinces will develop their own water conservation strategies across all sectors as guidance for all water-associated agencies.

In Pakistan's federal structure, although water as a resource is a national responsibility yet irrigation and agriculture, rural and urban water supply, environment and other water-related subsectors are delegated provincial matters. Therefore, provinces need to prioritize

their water management initiatives to get more value of water. In all their ongoing or planned programs in accordance with the national or provincial water policies, the value of water to agriculture, domestic, industry, business and energy must be assessed though an economic input-output perspective that quantifies returns or benefits, such as product value per unit of water or product value-added as well as employment created. For economic and financial monetary valuation, volumetric estimation is a basic unit i.e., price per cubic meter, multiplied by the volume of water used, and must include all internal costs such as the cost to treat and dispose of wastewater.

What are the innovative technologies that are being adopted by provinces and to what extent?

Pakistan's ongoing water crisis demands the provinces to value water to the extent that each liter is used and reused, making use and reuse of water to become part of the infrastructure rather than a use just once resource. To obtain such a high value from water and more crop per drop of water, provinces would require to launch an intensive drive to switch over from traditional practices to innovative technologies and interventions. Some potential practices are listed in Table 1:

Table 1: Innovative Technologies & Interventions for Improving Water Efficiency

Monitoring	Storage and Recharge	Conservation	Treatment & Recycling
1. Telemetric monitoring of water distribution in all sectors 2. Use of Internet of Things (IoT) for Irrigation scheduling and advisories 3. Early flood warning systems 4. Remote sensing and GIS technologies for preparation of an inventory of water resources 5. Effective and real-time monitoring of irrigation water delivery (examples velocity radar sensors, depth sensors etc.) 6. Real-time water quality monitoring for drinking water supplies	1. Artificial recharge wherever technically and economically feasible 2. Check dams, inverted wells and delay action dams 3. Rainwater harvesting (RWH) technologies 4. RWH ponds and mini dams construction in rain-fed areas 5. Sustainable extraction and skimming of fresh groundwater layers overlying saline water	1. On-farm water conservation techniques/technologies 2. Growing drought tolerant crop varieties 3. Micro catchments 4. Utilizing the potential of Hill Torrents and flash floods 5. Cost-effective technologies for improving *Sailaba* spate irrigation systems 6. Sustainable and natural urban landscape management to manage urban flooding 7. Promoting saving water-saving technologies and leak proof fixtures for buildings 8. Laser land levelling	1. De-salinization of seawater 2. Re-use and recycling of municipal and industrial wastewater effluent after appropriate treatment at the source 3. Drainage water storage and secondary treatment for agriculture, horticulture and forestry
Solar Energy, Zero Liquid Discharge, Education, Awareness & Behavior Change			

What are the outcomes of those interventions and the potential for upscaling?

The above sustainable and climate smart water management technologies and interventions (Table 1), if promoted and adopted through participation of community and private partnerships across the provinces is expected to produce more crop per drop of water and improved systems efficiency in the three sectors. The best cases of such approached across the globe lend evidence that these interventions have the

potential to improve water productivity and efficiency. Provincial governments need to think and plan their comprehensive water use program reframing the whole discourse on water for agriculture, domestic and industrial sectors.

What are the future priorities for the Provincial governments?

Provinces need to develop and implement water conservation plans choosing geographically feasible interventions/ technologies to complement the management of water supply with management of water demand and to ultimately achieve the common goal of water conservation in all the three sectors. This strategy should also serve as guiding document for the international development agencies for designing official development assistance accordingly. The opportunities offered by specific strategies to increase and sustain the quantity and quality of the provincial freshwater resources are given. These strategies to be prioritized by the provinces.

Though there are many initiatives to be taken for water resources management and conservation as outlined in the NWP and/or Provincial Water Policies, however, this document for national water conservation includes key strategies of high priority areas which would have greater impacts on society, economy and the sector itself.

6. Strategic Framework: Key Dimensions and Priority Areas of Action

The strategic framework of the NWCS is designed to achieve ecological and social equity, sustainability and economic efficiency. To achieve these, the development of the conservation strategy framework considers four key dimensions (Figure 4) identified from a range of required actions as proposed in this document. These dimensions as shown in Figure 4 take into account all segments of society to frame the national strategy that strikes a balance between supply and demand in a cost-effective manner.

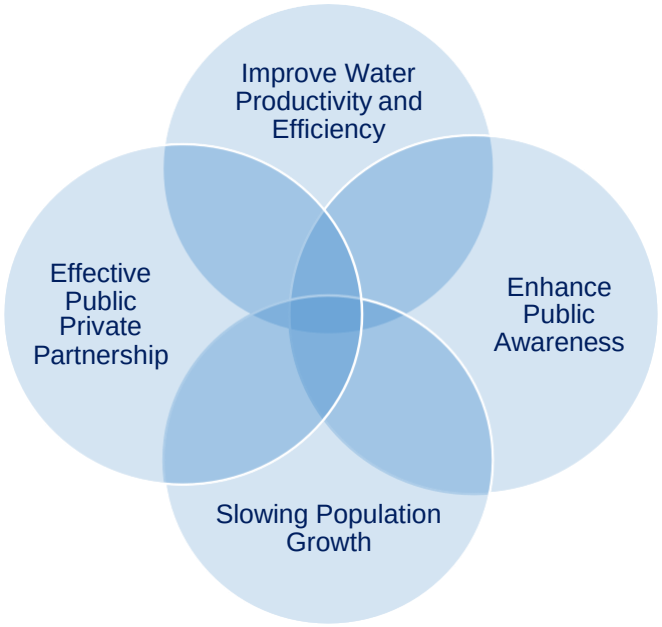


Figure 4: Key dimensions considered to frame national strategies for water conservation

A number of countries of the world have put into practice remarkable water conservation strategies and have overcome the challenges of water scarcity and poor water efficiency. At a small scale, Pakistan also has its success stories, however a complete paradigm shift and mindset change is required to obtain more value from water. Therefore, the effective implementation of the strategies as articulated in this document will require inter-departmental coordination and ensuring allocation of responsibilities to respective departments for improved water productivity and efficiency.

6.1 Water and Population

The challenge of addressing water shortages in Pakistan is exacerbated by the country's ongoing population pressure and urbanization. Between 1972 and 2020, Pakistan's population increased by 2.6 times, moving it in rank from the 9th to the 5th most populous country globally. Pakistan's population is projected to increase by over one-half (53%), reaching 338 million by 2050. The share of the population living in cities is also projected to increase from 37.2% in 2020 to 52.2% in 2050[7]. If water efficiency remains the same, the water withdrawal to water resources ratio may exceed 100 percent in the coming decades. Population growth usually see an increased demand for water in all sectors of the economy such as agricultural, domestic and industrial.

North China Plain Water Conservation Project (2008)

China launched the North China Plain Water Conservation Project (2008) to improve the agricultural practices on more than 250,000 farms. The main improvements of the project included:

a. More efficient drainage
b. Irrigation sprinklers and wells
c. Farming practices like soil and environmental monitoring
d. Ground levelling support
e. Institutionalized water and soil conservation practices.

This program resulted in:

i. Increased agricultural productivity (60-80%);

ii. Reduced groundwater depletion and in some places eliminated the problem;

iii. Agricultural contribution to overall GDP improved to 8%.

[7] Maqbool, N., 2022. *Water Crisis in Pakistan: Manifestation, Causes and the Way Forward* (No. 2022: 60). Pakistan Institute of Development Economics.

The connection between a growing population that needs a higher demand for drinking water and water for agriculture requires urgent and effective planning to conserve and protect water resources or find alternative methods to find new sources of water. Pakistan can expect a future of absolute water scarcity by 2025 which calls for new strategies to balance water scarcity and human demand. In the long term, slowing population growth in the country and creating effective policies and programs for improved water management are critical to the country's sustainable development.

The provinces need to examine their population challenges and review possible measures on slowing population growth to achieve socially equitable and sustainable development. Without integrating the measures of slowing down population growth, water conservation strategies may at best remain ineffective and marginal. The Ministry of Population Welfare may need to provide the provinces with a framework to manage population growth and improving people's lives and livelihoods. This would provide time for better water conservation and management strategies to be developed and would allow freshwater resources to be used more efficiently.

The other three priorities such as improving water productivity and efficiency, effective public private partnership and enhanced mass awareness are incorporated in strategic actions for agriculture, domestic and industrial sectors as discussed below.

6.2 Water Conservation Strategy in the Agriculture Sector

Water productivity in agriculture remains a crucial strategic priority because this sector consumes almost 95% of freshwater resources. The more crop per drop paradigm will lead to improved food security and optimal economic use of water. The following priority actions are proposed in accordance with the NWP to achieve water conservation in the agriculture sector (Figure 5).

Figure 5: Water conservation strategies in agriculture sectors

Strategic Objective-1: Improve water productivity in agriculture by introducing pricing policy and water efficient technologies

This strategy promotes the concept of water productivity for sustainable agriculture and food security by acquiring increased agriculture output per unit of water consumed. The overall efficiency of irrigation system will be improved by minimizing distribution, conveyance and application losses as water traverses from its source to the field. To achieve this, following set of actions are proposed:

- Develop and notify the crop zones based on land and water resource availability.
- Notify water efficient technologies as part of production technologies of Agriculture Extension departments.
- Ensure the availability of water-efficient technologies at the village level through Agricultural Services Providers.
- Make farmer training compulsory as part of the sale of technologies by the private sector.
- Provide incentives to motivate the farming community to steer the adoption of water-efficient /technologies.
- Promote the private sector/industries for the fabrication of water-efficient technologies indigenously in every province.
- Introduce water pricing in agriculture on a volumetric basis.
- Increase the existing rate of *Abiana* forcing farmers to adopt efficient irrigation technologies after undertaking a comprehensive research study taking into account all social, technical, and political and sustainability aspects (Suggested pricing model for agriculture given in subsequent section).

- Promotion of conventional well accepted irrigation methods such as raised beds, ridges and zero tillage technology in Rice grown areas of the country.
- Promote and adopt drought and salt tolerant crops/plants in the drought prone areas and areas with higher salinity.
- Introduce solarization of tube wells with restricted flood irrigation where required.
- Provide fruit plants to farmers at subsidized rates for orchards development in water scarce areas of the country such as Balochistan.
- Launch capacity building and training programs specifically of women folk on tunnel farming, kitchen gardening and nurseries in water scarce, drought and salinity affected areas such as Sindh and Balochistan.
- Introduce artificial rainwater technologies in water scarce areas.

Suggested Model of Water pricing in the agriculture sector

The existing water pricing system in agriculture sector is not realistic due to many socio-political barriers in Pakistan. The irrigation system is not self-sufficient because the water price charged from the farmers is independent of the volume of water used by the crops. Mostly flat rates have been introduced by the provinces which have no relation to the operation and maintenance charges of the irrigation infrastructure. Crop-based rates have also been imposed in some provinces, however these are also independent of the actual water used by the crop.

A report of the Planning Commission (2012) on Canal Water Pricing has also stated that the irrigation system in Pakistan is not self-sustainable and the provincial government has to spend a hefty amount on the operation and maintenance of this irrigation infrastructure. Since farmers are charged on seasonal basis, this only recovers 20% of the operation and maintenance expenses and imposing the load of Rs.686 million per annum on the local governments[8].

In a well-structured irrigation system, consumers pay the cost of efficient operations, maintenance and replacement costs of the irrigation assets. Considering this, there is an urgent need to study and review the existing system and introduce a pricing model, which can bring the irrigation infrastructure into sustainable form. For appropriate water pricing in the agriculture sector, a comprehensive research study is required to be undertaken by the Provincial Irrigation Departments and research organizations to assess water demand, supply and success of existing cost-profit model as well as need of rationalized tariffs. This study will help to suggest a realistic pricing model. However, following model (Figure 6) may be followed to make the agriculture sector self-sustainable. The suggested model as below may be further refined in the light of outcomes of research study.

[8] Planning Commission, (2012). Canal water pricing for Irrigation in Pakistan assessment, Issues, and Options. Government of Pakistan, Islamabad.

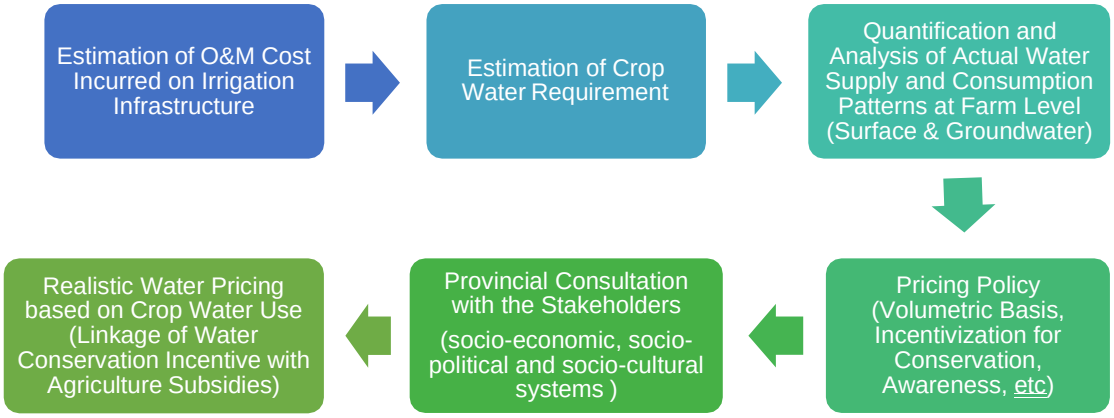


Figure 6: Suggested model for water pricing in agriculture sector

Lead Role: Provincial Agriculture & Irrigation departments.

Supporting Role: Ministry of National Food Security & Research (MNFS&R), International development organizations (IFPRI, FAO, etc.), National Water Council and Rice Research Institute, Kala Shah Kaku.

Research Partners: University of Agriculture Faisalabad, Arid Agriculture University Rawalpindi, University of Agriculture Peshawar, Balochistan University of Information Technology, Engineering and Management Sciences, Mehran University of Engineering and Technology, Jamshoro, University of Punjab Lahore, University of Azad Jammu and Kashmir and Karakoram International University.

Time line: Two years following approval of Strategy.

Strategic Objective-2: Optimize groundwater abstraction and balance with recharge

This strategic objective strives to address the depleting groundwater table applying artificial recharge techniques while ensuring sustainable management of groundwater through following actions:

- Develop an inventory of tube wells for the estimation of groundwater abstraction to determine the existing use pattern.
- Install automatic data loggers at key locations to enhance groundwater monitoring.

Overcoming the water crisis in Cape Town, South Africa

Cape Town, South Africa's "Day Zero" drought was caused by an exceptional 3 years rainfall deficit. The city emerged from this crisis through an effective urban water management system through:

a) Increased rainwater harvesting dams in the outskirt of Cape Town.
b) Reduction in free water supply limit from 220 liters per day/ per capita to 50 liters per capita per day in 2017.
c) Reduction in free water supply limit to 87 liters per capita per day in 2019.
d) Rationalized water pricing system to increase public ownership for water and sanitation services.
e) Outsourcing of water and sanitation services to the private sector.

- Estimate annual groundwater budgets by determining available resource base and consumption.
- Analyze qualitative variations and identify hotspots and bright spots for groundwater availability and quality.
- Introduce metering of groundwater supplies through protected zoning based on services delivery concept.
- Build capacity of groundwater professionals on the latest technological advancements.
- Demarcate natural recharging zones and declare as protected areas against any further encroachment by housing societies.
- Develop sites for managed aquifer recharge in urban as well as rural areas to utilize flood water through people-government partnership.
- Notify the irrigation zones based on surface and groundwater availability, water-table depths, and soil lithology. In such areas urbanization and industrialization should be restricted
- Develop and implement Water Emergency Policy for areas with intensive groundwater table depletion and water scarcity such as Balochistan.
- Rehabilitate and revitalize historical water resources such as Karezes, springs, waterfalls where possible.
- Identify the issues of land subsidence under influence of depleting groundwater table due to over abstraction.
- Capacity building of farmers for groundwater table monitoring using real-time device and to undertake required measures to replenish groundwater table.
- Initiate public education program regarding groundwater abstraction, use, recharge and water conservation in general.
- Make evidence-based groundwater data available for future planning and management.

Lead Role: Provincial Water Commissions[9]

Supporting Role: Irrigation Departments, Agricultural Department, Ministry of Water Resources (MoWR), PCRWR, international development organizations (IWMI, Water Aid, WWF etc.).

Research Partners: PCRWR, Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore, and; U.S Pakistan Center for Advanced Studies in Water, Mehran University of Engineering and Technology, Jamshoro, Balochistan University of Information Technology, Engineering and Management Sciences, University of Agriculture Peshawar, University of Azad Jammu and Kashmir, and Karakoram International University.

Time line: One year following approval of Strategy to kick start and adopted as a long-term policy.

[9] Provinces/Territories where Provincial Commission is yet to be established, Provincial Irrigation Departments is suggested to have the Lead Role

Strategic Objective-3: Develop non-conventional water sources for agriculture and undertake watershed management

Non-conventional water resources (i.e., secondary treated sewage water, drainage effluent, rainwater, saline effluent, seawater) will be either generated as a product of specialized treatment such as recycling and/or appropriate soil–water–crop management strategies when used for irrigation. For this strategy, the following actions are proposed:

- Conduct profiling of non-conventional water resources and develop these sources for irrigation and livestock farming.
- Design crop system appropriate for different kinds of non-conventional water sources and share it with farming communities.
- Coordinate with district wastewater management companies for the treatment and sale of wastewater to the agriculture sector.
- Design and implement district watershed management plan to reduce irrigation demand, retain soil moisture, and minimize soil loss and ultimately maintain agricultural productivity.
- Notify watershed management as an integral component of hydropower development project for sustainability of ecosystem.
- Promote inter-provincial transboundary watershed management and water conservation to minimize damage to cropland due to flow of floodwater from one province to another.
- Develop and enforce uniform policy for utilization of hill torrents water by the local farmers.
- Recover the encroached area surrounding the drainage system for the revival of drainage system.
- Integrate the land use plan with the water conservation plan to be developed by each provincial Government.
- Conduct community awareness and capacity building regarding potential uses of such resources.

Lead Role: Provincial Agriculture, Irrigation, and Environment departments, Agency for Barani Area Development.

Supporting Role: Wastewater treatment companies, MNFS&R, UN Organizations and International development organizations (IWMI, IFPRI etc.).

Wastewater Recycling to overcome Water Scarcity

Israel, a country that is 70% desert faced a unique challenge in finding sustainable water sources. However, by treating and reusing around 90% of its wastewater, Israel has converted its deserts into green.

Treated wastewater is used primarily for agriculture, which receives 546 million cubic meters (about 144 billion gallons) of freshwater to supplement the 473 million cubic meters (about 125 billion gallons) of treated wastewater provided each year.

Storage of treated wastewater is made in more than 200 open or underground reservoirs especially in Metropolitan Tel Aviv. These reservoirs act as storage units and/or equalization and treatment units.

Source: Jerusalem Institute for Policy Research, Ben Gurion University of the Negev & Sapir Academic College, 2019. Israeli Water System. R2Pi_Case-Study-Report_Israel-Water_FINAL-2.pdf (milkeninnovationcenter.org)

Research Partner: PCRWR, Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore, and; U.S Pakistan Center for Advanced Studies in Water, Mehran University of Engineering and Technology, Jamshoro, Balochistan University of Information Technology, Engineering and Management Sciences, University of Agriculture Peshawar, University of Azad Jammu and Kashmir, and Karakoram International University.

Time line: Two years following approval of Strategy.

Strategic Objective-4: Promote the use of information technology for water resources management

The IT sector has potentially the largest untapped opportunity in the agriculture sector for data generation, real-time monitoring and decision making to bring about significant changes in agricultural water use by focusing on some of the following key priority areas:

- Scale-out Irrigation Advisory Services for Irrigation Scheduling.
- Application of IT for transforming advisory messages into local languages.
- Install soil moisture sensors, automatic weather stations and earth observation techniques for canal water indenting
- Establish automatic flow monitoring network at canal level (head, middle, and tail).

Lead Role: Provincial Irrigation and Agriculture departments.

Supportive Role: Pakistan Meteorological Department (PMD) and MoWR.

Research Partners: PCRWR, Centre for Water Informatics & Technology, Lahore University of Management Sciences.

Time line: Two years following approval of Strategy.

6.3 Water Conservation Strategy in the Domestic Sector

The provincial and local governments have traditionally focused on increasing access to freshwater by locating, developing, and managing new sources despite the high costs often involved. With increasing water scarcity, Pakistan also needs to turn to other conservation options for the domestic sector as shown in Figure 7.

Figure 7: Water conservation strategies in domestic sectors

These strategic objectives strive to address the domestic sector issues by introducing conservation activities detailed below:

Strategic Objective-1: Meter and price water in residential and commercial sectors

This strategic priority aims to provide water utilities, municipalities and citizens with an ICT enabled platform to design, develop and implement better water management policies using metering and pricing mechanisms. The following actions are proposed in the strategy to achieve this priority:

- Build partnership with private partners for service delivery both in urban and rural areas.
- Design and conduct a pilot study on water metering to analyze demand, supply and cost of delivery in selected urban/rural areas that will inform future investments.
- Quantify price model, set a rationalized water pricing policy and its implementation framework for residential and commercial set ups.
- Install smart water meters, implementing volumetric water pricing mechanism, formulating service delivery and cost recovery models.
- Develop schedules to check calibration/ operation, maintenance of water meters and financial audits of water supplier.

Suggested Pricing Model for Domestic/Commercial Sector: Domestic water is usually priced under block-rate schedules established to ensure the efficient use of the resource, as well as to achieve equity, environmental conservation, cost recovery and public participation. The water supply service providers have kept tariffs below cost recovery levels, forcing a deficit and reliance on provincial government grants and loans. They can scarcely recover its overhead and maintenance costs.

Water pricing can be considered a policy tool to address some of the challenges and dimensions of the larger nexus of water security in all three sectors (agriculture, domestic and industrial). A pricing model that fits with the socio-economic, socio-political and socio-cultural systems will be required to be formulated. Therefore, water supply service providers would require smart planning of water pricing design, structure, and enforcement. This cannot be achieved in isolation and would require data collection, extensive consultations, partnership with private partners and the community.

The contribution of water pricing toward the sustainable management of water resources requires large investments and financial commitments to manage direct and indirect pressures affecting the quantity and quality of water resources. It is therefore suggested that the provincial water supply service providers in collaboration with research partners should conduct a comprehensive study to understand water availability, demand, supply, existing pricing systems, shortfall in water supply, socio-economic, socio-political, socio-technical issues, prevailing systems both in urban/ rural areas and climate change impacts in order to develop a workable pricing policy for domestic/commercial and industrial sectors. It is therefore, suggested that service providers must achieve water pricing goals by adopting step-wise approach (for instance the Figure 8).

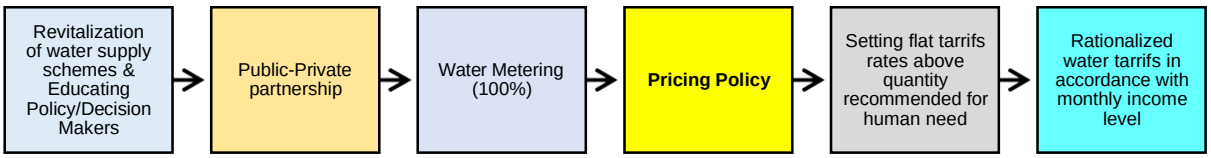


Figure 8: Suggested model for water pricing in domestic/commercial sector

Lead Role: Public Health Engineering Department (PHED).

Supporting Role: Water and Sanitation Agencies (WASAs), Private partners, Water Users Associations.

Research Partners: PCRWR, Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore, and; U.S Pakistan Center for Advanced Studies in Water, Mehran University of Engineering and Technology, Jamshoro, Balochistan University of Information Technology, Engineering and Management Sciences, University of Agriculture Peshawar, University of Azad Jammu and Kashmir, and Karakoram International University.

Time line: Three years following approval of Strategy.

Strategic Objective-2: Control groundwater abstraction for residential and commercial sectors

The priority set of actions to achieve this strategy is listed as below:

- Establish and functionalize Water Authorities in the provinces.
- Monitor groundwater extraction and identify hot spots.

- Develop groundwater management plans, regulatory framework and annual targets.
- Enforce groundwater regulatory framework in all provinces.
- Develop and implement mechanism to charge fee on abstraction licenses for commercial/ residential setups.

Lead Role: Provincial Water Commissions (PWC) [10]

Supporting Role: PHED, & WASAs

Research Partners: PCRWR, Balochistan University of Information Technology, Engineering and Management Sciences, Mehran University of Engineering and Technology, Jamshoro, University of Punjab, Lahore, and: University of Engineering and Technology, Lahore.

Time Line: Three years following the approval of Strategy.

Strategic Objective-3: Conduct water audits of water supply service providers, private housing societies, and commercial settings

Water audit is a periodic assessment to determine water supplied into the distribution system as well as water lost and/or used within the distribution system. This priority will be achieved by developing water audit SOPs for water supply service providers, private housing societies, and commercial settings (offices, hospitals, hotels, universities, mall/shopping centers etc.). The SOPs should include an inventory of water use in an area (sources of water), measurement of water quantity from each source using flow meters, determining metered and unmetered water consumption, estimation of non-revenue water, water losses and cost of consumption and losses, water efficiency quantification etc. This strategic priority will be achieved by following the actions listed below:

- Conduct water audits on annual basis
- Develop leak detection/repair mechanism and schedules (on annual basis)
- Take post audit measures to reduce non-revenue water (NRW) and associated cost (on annual basis).
- Post audit assessment (on annual basis).

Lead Role: Provincial Water Commissions (PWC)[11].

Supporting Role: MoWR, PHED, WASAs, and Water Users Associations.

Research Partner: PCRWR, Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore, and; U.S Pakistan Center for Advanced Studies in Water, Mehran University of Engineering and Technology, Jamshoro, Balochistan University of Information Technology, Engineering and Management Sciences, University of Agriculture Peshawar, University of Azad Jammu and Kashmir, and Karakoram International University.

Time line: Three years following approval of Strategy.

10 Provinces/Territories where Provincial Commission is yet to be established, PHED is suggested to have the Lead Role.

11 Provinces/Territories where Provincial Commission is yet to be established, PHED is suggested to have the Lead Role.

Strategic Objective-4: Introduce and promote water saving and rainwater harvesting technologies

Implementing water-efficient measures makes it possible to substantially save on water, energy and costs. This will be achieved by introducing and promoting water saving technologies adopting following priority actions:

- Initiate joint study to assess water and cost savings using water efficient technologies/fixtures in Pakistan.
- Develop and regulatory drivers for water efficient fixtures, retrofits and replacements in commercial and residential buildings.
- Launch water efficiency labelling scheme after water audit for commercial settings, private housing societies etc.
- Introduce incentives such as tax breaks for utilities, subsidies/ lower tariffs for water reuse.
- Promote private companies to produce household/commercial water-saving technologies locally through subsidies.
- Promote and enforce mandatory rooftop rainwater harvesting for meeting domestic water requirements (washing, horticulture, etc.)
- Launch public awareness campaign on using water-saving technologies, fixtures and retrofits.
- Introduce ablution water reuse system in the mosques/religious places.
- Notify mandatory car wash recycling for the car wash service stations.

"Zero liquid discharge strategy implemented at Salvador Bahia Airport, Brazil"

a) For this purpose, a wastewater treatment plant was installed and commissioned in 2018, recycling and saving 2 million m^3 of water over a decade, equivalent to 800 Olympic-size swimming pools.

b) This plant ensures that 100% of effluent can be treated on site, making the airport one of the few anywhere to already meet the zero liquid discharge target.

c) Treated wastewater is reused for toilets, maintaining green spaces, firefighting, on-site construction works and in cooling towers.

d) This airport was honored for the Green Airport Recognition by the VINCI Airports network for its wastewater treatment processes.

Source: The International Civil Aviation Organization, 2020. Water Management at Airports. https://www.icao.int/environmental-protection/Documents/Water%20management%20at%20airports.pdf

Lead Role: Public Health Engineering Department (PHED).

Supporting Role: PWC, WASAs, PCRWR, Chamber of Commerce (CoC), Federal Board of Revenue (FBR), Pakistan Engineering Council (PEC), Excise and Taxation Departments (E&T Deptt.), Local NGOs, Private partners, Water Users Associations.

Research Partners: PCRWR, Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore, and; U.S Pakistan Center for Advanced Studies in Water, Mehran University of Engineering and Technology, Jamshoro, Balochistan University of Information Technology, Engineering and Management Sciences, University of Agriculture, Peshawar, University of Azad Jammu and Kashmir, and; Karakoram International University.

Time line: Two years following approval of Strategy.

Strategic Objective-5: Formulate and enforce Zero Liquid Discharge (ZLD) Policy for residential & commercial settings

Zero liquid discharge is an efficient wastewater management system that ensures no discharge of wastewater into the environment. This strategic priority would help to achieve:

- Develop Zero Liquid Discharge Policy & framework for residential and commercial settings (housing societies, offices, hospitals, hotels, universities, malls/shopping centers, airports, railway and bus stations etc.).
- Introduce amendments in federal and provincial building regulations to restrict all commercial settings and private housing societies to include rainwater harvesting systems, on-site wastewater treatment (modified septic tanks).
- Enforce new building regulations in the provinces to convert all buildings into water efficient buildings.
- Develop national and provincial wastewater management action plans including annual targets for bringing abandoned centralized/decentralized wastewater systems into operational mode.
- Develop sustainable facilities for decentralized treatment of municipal wastewater to be used for urban agriculture, landscaping, horticulture or aquaculture.

Lead Role: Ministry of Housing and Works (MoHW).

Supporting role: WASAs, PCRWR, Provincial Housing Authorities of Khyber Pakhtunkhawa, (PHA-KP), Urban Development & Public Health Engineering Department (UD&PHED-Punjab), Sindh Cooperative Housing Authority (SCHA), Balochistan Communication and Works Department (BCWD), Housing & Works Departments of GB & AJK, Wastewater treatment companies, and relevant Private partners.

Research Partners: PCRWR, Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore, National University of Science and Technology (NUST) Islamabad.

Time line: Two years following approval of Strategy.

Strategic Objective-5: Launch Mass Awareness Programs for Domestic & Commercial Water Conservation

Public water conservation campaigns raise awareness at all levels of society about the importance of saving water to cope with its scarcity and ensure sustainability. The aim of such campaigns is to change citizen attitudes and behavior to improve water

use efficiency. This is done through education and awareness campaigns on the socio-economic and environmental benefits of water conservation and different conservation methods.

Provincial Governments will require to launch their Water Conservation Awareness Programs with defined goals, targets, strategies and actions to change the behavior of farmers, champions of industry and the general public to conserve their water and to sustainably manage the resource for future generations. This program may include the variety of water conservation activities as shown in Table 2.

Table 2: Raising Water Conservation Awareness through Public Outreach Campaigns (2023-2027)

No.	Activity	Key Responsible Organizations	Mode of Communication	Supporting Organizations	Frequency
Collaboration between Ministry of Water Resources (MoWR) and Ministry of Federal Education and Professional Training (MoFEPT)					
1	Preparation of awareness material (such as; flyers, brochures, on water conservation strategies/methods with pictorial display, slogans and messages)	MoWR & MoFEPT	Dissemination of flyers and brochures' in schools, hospitals, dispensaries, Madrasas, workplaces etc.	Ministry of Information and Broadcasting	Quarterly
2	Public awareness campaign in universities, colleges and schools (40 institutions 10 from each province)	MoFEPT	• Dissemination of information through flyers, brochures, demonstrations, lectures. • Arranging poster and debate competitions. • Contents permanently included in School Curriculum. • Establishing School WASH clubs & WASH committees • Celebration of School Water Week annually.	Provincial Education Departments/ MoWR	Quarterly
Collaboration between Ministry of Water Resources and Ministry of Religious Affairs (MoRA)					
3	To train imams (religious leaders) mosque staff/madrassa students so that they can serve as water ambassadors teaching water conservation to communities.	MoRA	Delivering the training to imams (religious leaders) mosque staff/madrassa students on importance and techniques of water conservation	MoWR/Local Government	Annually
4	Water conservation as a mandatory part of Friday prayers in the mosques	Ministry of Religious Affairs and Interfaith Harmony	Delivering lecture on importance of water conservation in Islam.	Community based Organizations	Monthly basis
5	Display of Posters, Banners, Bill boards with key messages etc.	Provincial Government/ MoWR	Display on roads, intersections, parks, offices, bridges, mosques, bus and railway stations, etc.	CDA, District Development Authorities/ International organizations	Biannually
6	Stakeholders Dialogues (12 No.)	PCRWR/Provincial irrigation departments	Workshops	Provincial departments/ International organizations	Annually

No.	Activity	Key Responsible Organizations	Mode of Communication	Supporting Organizations	Frequency
7	Community awareness sessions(36 No.)	Provincial /Local governments PCRWR	Delivering the lectures, dissemination of information through flyers brochures and practice demonstrations	local NGOs	Quarterly
Collaboration between MoWR & Ministry of Information and Broadcasting (MoIB)					
8	Public Service Announcements on water conservation and its techniques	MoIB	Through newspapers, radio, television, local cable channels, magazines, and web sites on the National Days like Pakistan day, Independence Day, Defense day etc.	MoWR	Quarterly
9	Allocation of time for public messages/awareness dialogue on electronic media	MoIB	Weekly allocation of time on public and private electronic media on water conservation dialogues, awareness messages	MoWR	Routine
10	Social media campaign Paid Advertisement,	MoIB	You tube messages, textual and graphics messages on twitter and official pages	MoWR	3 months
11	Voice messages during the calls	Mobile network association/ MoWR	Mobile calls, SMS messages	Mobile network,	6 months
Collaboration between MoWR & Ministry of Industries and Production (MoIP)					
12	Mandatory campaigns by the bottled water companies as requirement of licensing process	MoIP	Water conservation awareness campaign in institutes, workplaces in communities	Bottled water companies	Annually
Collaboration between MoWR & Ministry of Communication (MoC)					
13	Water Conservation Campaign through messages displayed on Transports/tickets	MoC	Display messages through transport mean such as Road/Railways/ Air transport (Messages/Slogans on tickets and on vehicles)	MoWR	Annually
14	Economic incentives	Provincial irrigation and PHED/WASA	Free installation of water meters	Provincial departments/ International organizations	Annually
15	Water Conservation Day Celebration	MoWR	Multiple activities such as Stakeholder dialogue, debate, poster, project competitions etc.	Provincial departments/ International organizations	Annually
16	Pakistan Water Week	MoWR	International Conference, National workshop and Youth engagement activities	IWMI, UNICEF/iNGOs	Annually

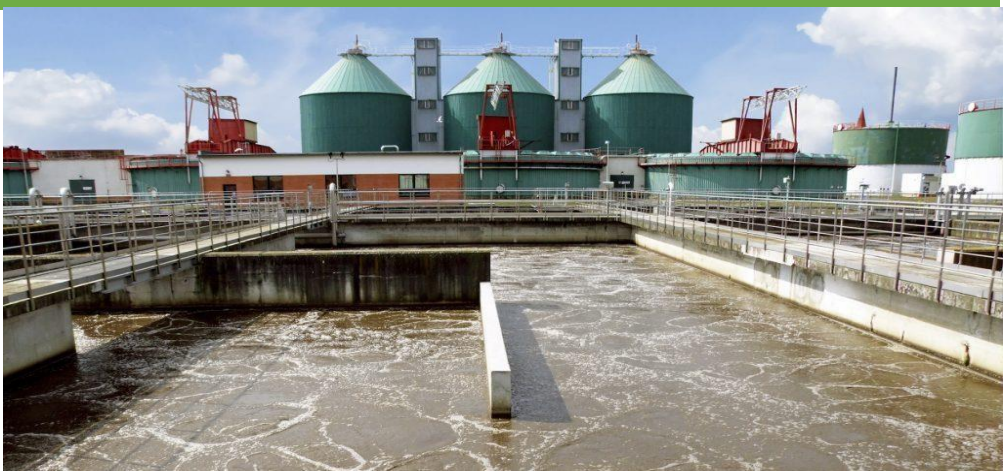
Lead Role: Ministry of Water Resources (MoWR).

Supporting Role: PWC, Water sector Service providers, Bottled water companies, Ministry of Education, Provincial Education Departments, Ministry of Religious Affairs and Interfaith Harmony, Ministry of Communication, Akhtar Hameed Khan National Centre for Rural Development (AHKNCRD), Provincial Local Government & Community Development Departments, National Rural Support Program (NRSP).

Time line: Four years following approval of Strategy.

Other than the direct and indirect communication means, economic incentives can also be employed for example, free installation of water meters. Raising water conservation awareness is important as the combined impact of even small improvements in individual households use can amount to significant savings at a municipality or regional level.

6.4 Water Conservation Strategies in the Industrial Sector



Conserving water throughout industrial facilities requires thinking on a larger scale than simply updating individual pieces of equipment. For the industrial sector, saving water means saving costs for electric power, gas, chemicals, and wastewater disposal. Efficient water use can also have major environmental, public health, and economic benefits by helping to improve water quality, maintain aquatic ecosystems, and protect drinking water resources. To achieve these the following water conservation priorities are set for industrial sector:

"Successful Zero Liquid Discharge in Egyptian Industry"

Egypt instituted new environmental regulations prohibiting wastewater discharge in 2004. The Egyptian Ethylene and Derivatives Co. (ETHYDCO), a largest polyethylene production facility in Egypt built Egypt's first ZLD water treatment facility to recycle wastewater, allowing it to be continuously used in the production line.

Objective was to maximize the lifecycle of incoming water from River Nile and preserve freshwater resources. With this intervention ETHYDCO plant optimized its fresh water consumption through conservation and recycling, reducing it by nearly 70% i.e., from 2600 to 700 cubic meters per hour. Consequently, ETHYDCO became the pioneer in ZLD and a global model for industries with no liquid waste released into the environment.

Source: Amrish Rathi, 2017. Zero to One-Hundred: Egypt plant installs first zero liquid discharge system. https://www.wwdmag.com/wastewater-treatment/article/10936289/zero-to-one-hundred

Strategic Objective-1: Formulate and enforce Zero Liquid Discharge (ZLD) Policy for industries

Zero liquid discharge (ZLD) is a strategic wastewater management system that ensures that there will be no discharge of industrial wastewater into the environment. It is achieved by treating wastewater through recycling and then recovery and reuse for industrial purpose adopting following actions:

- Design and conduct a study to assess demand and supply of wet/dry industries and cost of water delivery & consumption.
- Develop ZLD Policy for industries.
- Enforce ZLD Policy restricting all industries to establish rainwater harvesting, effluents recycling, groundwater recharge & drip irrigation systems in their premises.
- Replace water saving appliances, fixtures and retrofits in the premises of industry.
- Notify wet and dry industries, which can work without/least water consumption.

Lead Role: Ministry of Industries & Production (MoIP).

Supporting Role: PHED, CoC, WASAs, EPAs, PCRWR.

Research Partners: PCRWR, Balochistan University of Information Technology, Engineering and Management Sciences, and; University of Punjab, Lahore, Pakistan Council of Scientific and Industrial Research, Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore, and; U.S Pakistan Center for Advanced Studies in Water, Mehran University of Engineering and Technology, Jamshoro, University of Engineering and Technology, Peshawar, University of Azad Jammu and Kashmir, and Karakoram International University.

Time line: Two years following approval of Strategy.

Strategic Objective-2: Meter and price water for industries

This strategic priority aims to provide water supply agencies with an ICT enabled platform to design, develop and implement better industrial water management policies using metering and pricing mechanisms. The following actions are proposed in the strategy to achieve this priority:

- Build partnerships with private partners for service delivery.
- Design and conduct a pilot study on water metering to analyze demand, supply and cost of delivery in selected industries.
- Quantify price model and setting a rationalized water pricing policy and its implementation framework for industries.
- Install smart water meters, implementing volumetric water pricing mechanism, formulating service delivery and cost recovery models.
- Develop schedules to check calibration/operation, maintenance of water meters and financial audits of water supplier
- Develop and enforce mechanism to charge fee on abstraction licenses for industries.

Suggested Pricing Model for Industrial sector: Pricing is an efficient and effective method for managing the demand for industrial water. The target of reduction in water consumption by industries cannot be met without having industrial water pricing policy and its enforcement. The wet industries especially food and beverages industries consume more water and also produce wastewater which is disposed without any considerable treatment. The rationalized water prices for volumetric use of water in wet and dry industries will result in revenue generation, which can ultimately be used to improve water supply and treatment infrastructure. In this connection the suggested model for industrial water pricing is given as Figure 9 and to refine this further based on ground realities a comprehensive well designed research study will be conducted.

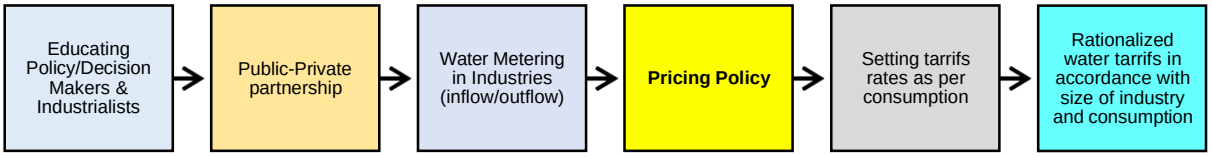


Figure 9: Suggested model for water pricing in industrial sector

Recognizing the true cost of water by the industries will help to understand the importance of water risk and the benefits of investing in sustainable strategies such as water reuse and wastewater resource recovery. However, complete rehabilitation of main and distribution pipe network is very important for uninterrupted and good quality water supply to all the sectors.

Lead Role: PHED.

Supporting Role: PWC, MoWR, PCRWR, MoIP, CoC, WASAs, EPAs.

Research Partners: PCRWR, Centre for Climate Research and Development (CCRD), COMSATS Islamabad, Balochistan University of Information Technology, Engineering and Management Sciences, and; Mehran University of Engineering and Technology, Jamshoro, University of Punjab, Lahore, University of Engineering and Technology, Lahore, University of Engineering and Technology, Peshawar, University of Azad Jammu, and Kashmir and Karakoram International University.

Time line: Two years following approval of Strategy.

Strategic Objective-3: Conduct Industrial Water System Audit (initially on annual basis)

Water audit is a qualitative and quantitative analysis of water consumption to identify means of reducing, reusing and recycling of water in an industrial context. To establish the process of water audits for industry, following set of actions are suggested:

- Develop SOPs for water audit of industries. The SOPs would include inventory of water use in industry (sources of water production), measure quantity from each source and consumption at cooling towers, boilers or closed loop systems using flow meters, determine metered and unmetered water consumption and leakages, estimation of water efficiency based on incoming and outgoing water quantity etc.
- Conduct water audit as per developed SOPs (initially on annual basis).

- Develop leak detection/repair mechanism and schedules (on annual basis).
- Take post audit measures to reduce non-revenue water (NRW) and associated cost.
- Post audit assessment of measures taken by industry to meet audit objections.

Lead Role: PWC.

Supporting Role: PCRWR, MoWR, CoC, WASAs, EPAs, MoIP.

Research Partners: PCRWR, Centre for Climate Research and. Development (CCRD), COMSATS Islamabad, Balochistan University of Information Technology, Engineering and Management Sciences, and; Mehran University of Engineering and Technology, Jamshoro, University of Engineering and Technology, Lahore, University of Engineering and Technology, Peshawar, University of Azad Jammu and Kashmir, and; Karakoram International University.

Time line: Two years following approval of Strategy.

Strategic Objective-4: Launch awareness program for water conservation in Industries

- Develop the water conservation awareness module for industries.
- Build understanding among employees and co-workers about the importance of water conservation.
- Every industry to contribute compulsorily in water conservation awareness program for the general public.

Lead Role: MoIP.

Supporting Role: MoWR, PCRWR, CoC, WASAs, EPAs, PEMRA, PHED.

Time line: Two years following approval of Strategy.

"Successful Public Awareness Campaign in Jordan"

A public awareness campaign on water conservation was found overwhelmingly successful in highlighting the significance of preserving water resources in Jordan. This was achieved by the close working of the project team of the Jordanian Ministry of Water and Irrigation with the Ministry of Awqaf Islamic Affairs using below approaches:

- Developed information and teaching materials on water conservation and hence trained imams (religious leaders) and waithat (female preachers) so that they can serve as water ambassadors teaching water conservation to communities.
- Inclusion of religion-based teaching materials in syllabi of schools and universities to raise awareness on water scarcity.
- More than 2,5000 religious leaders are trained until now. In the beginning, about 60% of respondents believed that they can do what they want with the water they receive, this mind-set has reduced to 29%. According to the same survey, water saving behavior increased by more than 15% among Syrian refugees in Jorden.

Source: GIZ, 2021. Religious leaders support water conservation. https://www.giz.de/en/worldwide/31932.h

7. Incentivizing the Water Conservation Strategies: Subsidy and Grants Program

A water conservation subsidy and grant program can provide incentives for farmers to shift out of flood irrigation and bring more land into production by adopting water-saving irrigation technologies. This program may increase crop yields, raise profitability of farming, and increase the shadow price of water. Although a conservation subsidy policy will incur a financial cost to the taxpayer, it may be politically and economically attractive for both irrigators and environmental stakeholders. Likewise, a Water Conservation Grant Program may be initiated to provide commercial, industrial and multi-family residential property owners with incentives to install fixture retrofits and other water efficiency technologies, such as on-site water reuse systems.

8. Public-Private Partnership

The capacity of certain service providers such as WASAs and PHEDs is not enough to align their roles with the requirements of service delivery and sustainability principles. As governments seek to upgrade infrastructure and address the challenges of climate change, the need for private-sector involvement in the water sector has grown globally. Therefore, partnership with the private sector especially for domestic sector would be helpful for any successful implementation of domestic water conservation strategies by the provincial governments. Cost recovery is linked with improved service delivery and to achieve this successfully, reforms in the existing structure of service providers and public-private partnership would be required (Figure 10).

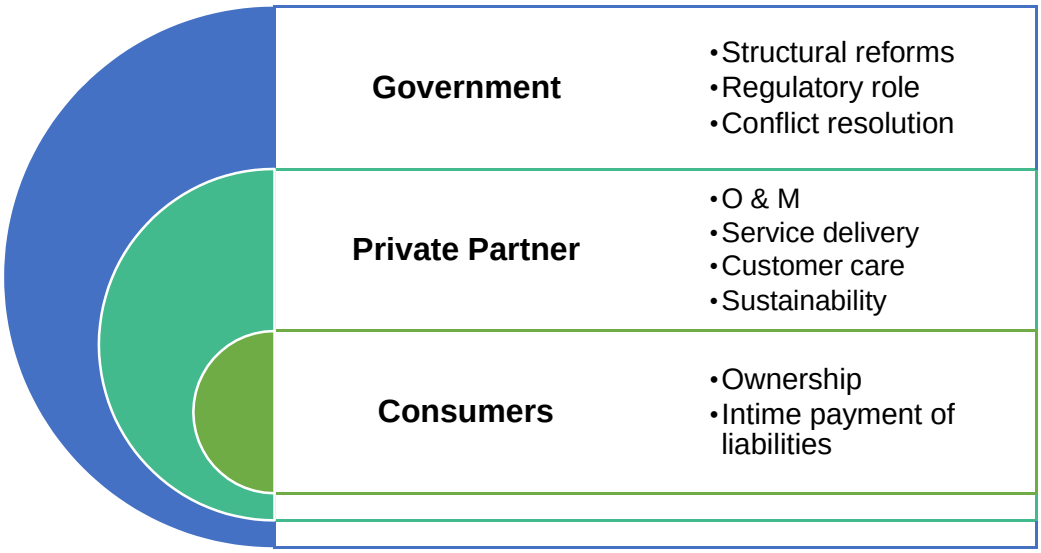


Figure 10: Role of partners in improving service delivery in Pakistan

The best example of sharing the responsibilities with private sector is the city of Dakar, the capital of Senegal, which faced a host of challenges including; extraordinary levels of urbanization, lagging services and infrastructure, wastewater treatment and

sanitation issues. In recent years, the city has been working in partnership with development banks and other organizations to improve urban sanitation and wastewater management, raising livability standards and health outcomes for urban and peri-urban populations.

In 1995, the Government of Senegal recognized that to move forward in the water sector, structural reforms were needed. They contracted out the management of the potable water sector and created three new entities. These companies are working towards local and global agendas, such as the Sustainable Development Goal 6, to ensure water and sanitation for all. Dakar, due to water sector restructuring, policy reforms, and emphasis on decentralization has moved fast to strengthen water governance, quality, and availability. Delegations from Africa, Asia and Latin America have visited Senegal on fact-finding missions to help improve services in their own cities and replicate the same models.

9. Funding, Monitoring and Review of the NWCS

This strategy has been devised for a period of 5 years. While the strategy should remain a living document with the possibility to make amendments, it is essential to let the strategy work in the field and to revisit it after two years, or earlier only after any critical change is required. For every activity defined in the strategy, the responsible organization will develop its own annual plan and targets to implement the activity within due time frame. It is assumed that a considerable part of the strategy will be financed by the Annual Development Plans and/or Public Sector Development Plans and lead roles as identified for each strategy will ensure the required finances are mobilized. However, another part will require financing from development partners including international donors interested in water conservation. It is suggested that provinces should be provided the finances in their annual budget for water conservation activities outlined in this strategy, whereas provincial departments will develop their annual plan to implement the assigned activities within due time frame. Individual sectoral departments will perform respective duties indicated in the strategy and monitored within their rules of business and governing mechanism. They will also monitor implementation of IWRM plans and act as partners of the districts in this regard.

10. Gender and Water Conservation

Women are most often the collectors, users, and managers of water in the household and the farmers of irrigated and rain-fed crops. Women have consequently accumulated considerable knowledge about this resource, from its quality and reliability to acceptable storage methods. The advantages of engaging women in water conservation would be highly fruitful. Therefore, women's participation will be ensured in all the activities defined for water conservation in agriculture, domestic/commercial and Industrial sectors. To include local ownership for implementation of water conservation activities, all users and stakeholders will be involved including—and perhaps first and foremost—women.

11. Coordination and Data Sharing Mechanism

Coordination efforts led by government are considered strategically important in achieving an appropriate enabling environment of water related programmes. In this regard, a three-prong coordination approach is suggested such as:

i. The Research Development and Policy Implementation Cell of the Ministry of Water Resources will develop a National Water Conservation Portal for data storage, reporting, sharing and dissemination to facilitate the lead and supporting organizations to implement the activities defined in this strategy document.

ii. Ministry of Water Resources will designate a National Water Conservation Coordinator, whereas every province will have its own Provincial Water Conservation Coordinator. The national coordinator will conduct a quarterly review of implementation of conservation strategies in consultation with provincial coordinators (Figure 11).

iii. The Federal Ministry of Water Resources will conduct an annual review of the complete plan and targets as defined in this strategy document (Figure 11).

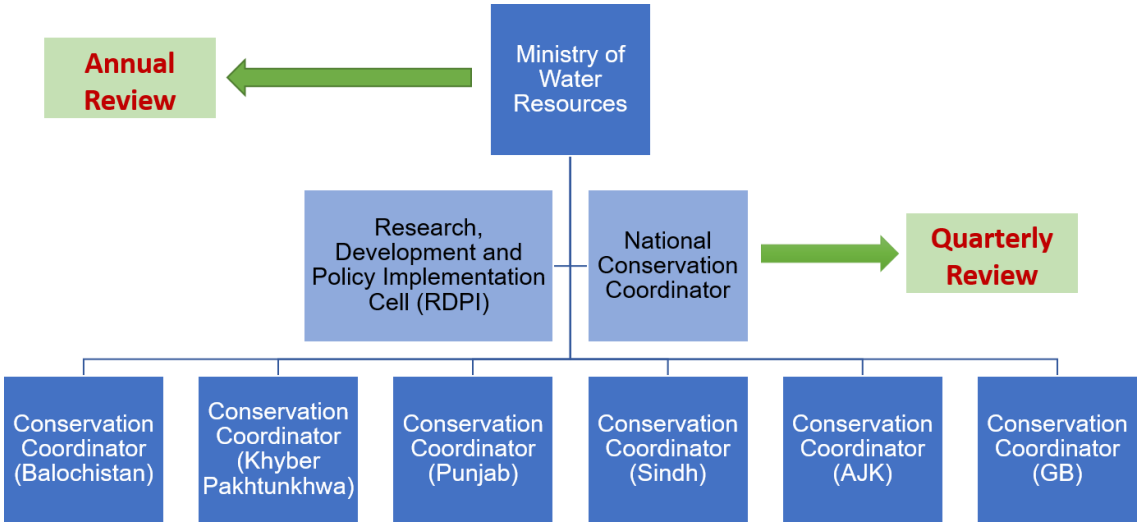


Figure 11: Mechanism for coordination, review of targets

12. Examples of Best Management Practices

Key activities as listed in this NWCS may seem daunting at first but are doable. In the current situation of water scarcity, we do not have option other than starting from somewhere, and taking difficult decisions for a sustainable water future. To these ends, the federal and provincial governments and stakeholders would need to undertake concerted efforts breaking social, financial and policy barriers. Without firm commitments to implement these strategies, sustainable water resources management specifically under the changing climate would not be possible. As reflected previously, different countries of the world like China, UK, Saudi Arabia, Brazil, South Africa, Egypt, Jordan etc. have made this possible by developing and implementing their effective water conservation strategies, policies, technologies, and

forecasting models to better manage their water resources in all sectors. The implementation of such strategies in various developed and developing countries has reduced water consumption. Pakistan has also demonstrated some best management practices depicted below as Figure 12. However, it is the time for a paradigm shift and mindset changes to ensure a sustainable water future in all areas of the country.

Improved irrigation water efficiency by successfully growing rice on beds consuming 50% less water compared to conventional methods[12].

PCRWR successfully demonstrated higher yield and water use efficiency cultivating banana on beds consuming 10 times less irrigation water than conventional practice.

Use of recycled wastewater for the watering of plants/ grass/ land escape in the Gwadar city facing issue of water shortage.

The Changa Pani Project (CPP) is an established public-private partnership model of metered water supply in Bhalwal city, Punjab, Pakistan which supply continuous water to 2100 connections and recovers 87% of the total monthly expenditures[13].

[12] Soomro, Z.A., Ashraf, M., Haq, Zia ul., and K. Ejaz., 2019. Water Conservation through Bed Plantation in Rice-Wheat Cropping System of the Upper Indus Basin. Pakistan Council of Research in Water Resources (PCRWR), Islamabad, pp,44.

[13] Hifza, R, Badshah, S., M. Ashraf, M. Ahmed, and S. Rehman. 2020. Comparative Assessment of Changa Pani and Traditional Water Supply Schemes (Bhalwal, District Sargodha, Punjab). Pakistan Council of Research in Water Resources (PCRWR), Islamabad, pp 44.

A network of 110 rainwater harvesting ponds in the Cholistan desert serve as a life line for enormous herds of livestock and the local community. Following PCRWR, Cholistan Development Authority has also constructed a similar number of ponds in the area.

Installation of 100 recharge wells in Islamabad to harvest rainwater and recharge the depleting aquifers.

Figure 12: Best Management Practices developed by the PCRWR in Pakistan

Annexure-I

Stakeholders who provided Feedback/Comments on the Draft National Water Conservation Strategy

Balochistan

- Agriculture Water Management / Trickle Irrigation, Department of Agriculture Balochistan, Quetta.
- Balochistan University of Information Technology Engineering Management Sciences (BUITMS), Quetta.
- Chamber of Agriculture of Balochistan, Quetta Office.
- International Water Management Institute, Quetta.
- Irrigation Department, 100 Dams in Balochistan, Quetta.
- Islamic Relief Balochistan, Quetta.
- Landell Mills Awarded “Revival of Balochistan Water Resources Programme (RBWRP)” Balochistan, Quetta.
- Pakistan Meteorological Department, Quetta.
- Pakistan Meteorological Department, Regional Office Quetta.
- Public Health Engineering Department (PHED), Quetta.
- QUESCO, WAPDA, Balochistan, Quetta.
- Tareeque Foundation, Balochistan, Quetta.
- WAPDA, Ministry of Water Resources, Quetta.
- Zameendar Action Committee, Quetta.

Sindh

- Agriculture Extension Wing, Karachi.
- Centre of Excellence in Marine Biology, University of Karachi.
- Community Health & Climate Change and health, Department of Community Health Sciences, Aga Khan University, Karachi.
- Environmental Protection Agency (EPA) Karachi.
- Geological Survey of Pakistan, Karachi.
- Green Water Environmental Labs & Services, Karachi.
- Mehran University of Engineering & Technology, Jamshoro.
- Nai Gaj Dam Project WAPDA Karachi.
- National Institute of Oceanography, Karachi.
- NED University of Engineering and Technology, Karachi.
- Nowshera Pipe Industries, Nowshera.

- On Farm Water Management Deptt. SIAPEP Project, Hyderabad.
- Pakistan Council of Scientific & Industrial Research (PCSIR) Karachi.
- Pakistan Meteorological Department, Karachi.
- PCSIR Laboratory Complex, Karachi.
- PMO-SBIP, Sindh Barrages Improvement Project, Sindh Barrages Irrigation Department, Karachi.
- Public Health Engineering Department, Karachi.
- Sindh Agriculture University, Tandojam.
- University of Karachi, Karachi.
- WASH-HANDS, Karachi.
- World Wildlife Fund (WWF-PAKISTAN), Karachi.

Khyber Pakhtunkhwa

- Agriculture Research Department, Government of Khyber Pakhtunkhwa, Peshawar.
- Center of Excellence in Geology, University of Peshawar.
- Construction Management of Civil Engineering, Peshawar.
- Department of Agriculture Extension, Khyber Pakhtunkhwa, Peshawar
- Directorate General Soil & Water Conservation Dept. Khyber Pakhtunkhwa, Peshawar.
- Economic Recovery & Development Activity, USAID Funded Project, Peshawar.
- Institute of Management Sciences, Peshawar.
- International Water Management Institute, Peshawar.
- Irrigation Department (North), Govt Khyber Pakhtunkhwa, Peshawar.
- Irrigation Department, Govt Khyber Pakhtunkhwa, Peshawar.
- Irrigation Department, Mardan.
- Khyber Pakhtunkhwa Irrigated Agriculture Improvement Project, Peshawar.
- On Farm Water Management, Govt. of Khyber Pakhtunkhwa, Peshawar.
- Peshawar Development Authority, Peshawar.
- PMU, Agri-Emergency Program, Agri. Dept. Peshawar, Govt. of Khyber Pakhtunkhwa, Peshawar.
- Public Health Engineering Dept. Govt. of Khyber Pakhtunkhwa, Peshawar.
- University of Engineering and Technology, Peshawar.

- University of Swat, Ala Abad, Char Bagh, Swat.
- Water and sanitation Services Peshawar, Peshawar.
- Water Management Department, Govt. of Khyber Pakhtunkhwa, Peshawar.
- Water Supply & Sanitation Co, Peshawar.

Punjab

- Agriculture Department, Government of the Punjab, Lahore.
- Ayoub Agriculture Research Institute (AARI), Faisalabad.
- Changa Pani, Bhalwal.
- Environment Protection Agency (EPA) Punjab, Lahore.
- International Water Management Institute (IWMI) Pakistan.
- Pakistan Standards & Quality Control Authority (PSQCA), Lahore.
- Parks & Horticulture Authority Lahore.
- Punjab Curriculum and Textbook Board, Lahore.
- Punjab Irrigation Department, Government of the Punjab, Lahore.
- Punjab Rural Support Program, Lahore.
- WAPDA-Punjab, Lahore.
- Water and Sanitation Authority, Lahore.
- WaterAid-Pakistan.
- WWF-Pakistan.

Azad Jammu & Kashmir

- Agriculture/ Irrigation Department, Government AJK, Muzaffarabad.
- Environmental Protection Agency, AJK, Muzaffarabad.
- Local Government, Rural Development Department, AJK, Muzaffarabad.
- Public Health Engineering Department, Government of AJK, Muzaffarabad.

Gilgit-Baltistan

- Gilgit-Baltistan Public Works Department, Gilgit.
- Irrigation Department, Government of Gilgit-Batistan, Gilgit.
- University of Baltistan, Skardu.

Ministry of Water Resources
Government of Pakistan
وزارت آبی وسائل حکومت پاکستان

National Water Conservation Strategy

Goal:
Support the enforcement of National Water Policy for sustainable water resources management through policy guideline, water conservation strategies, activities and technologies

a. Ensuring conservation of water, minimizing wastage and securing its equitable distribution.

b. Supporting service providers to develop best management practices for water conservation in minimizing financial dependence on federal and provincial governments.

c. Providing actionable information around water conservation in all three sectors ensuring water security under climate change effects.

Agriculture Sector

- More Crop Per drop
- Water-efficient technologies
- Aquifers recharge
- Non-Conventional Water sources for agriculture
- Modern IT tools for water resource management

Domestic Sector

- Improved Service Delivery & water efficiency
- Water metering & pricing
- Controlled groundwater abstraction
- Water audits of municipal and commercial settings
- Water saving technologies and fixtures
- Water education program
- Zero liquid discharge from large residential & commercial settings

Industrial Sector

- Zero Liquid Discharge
- Water metering & pricing
- Abstraction licenses
- Water audits
- Water awareness