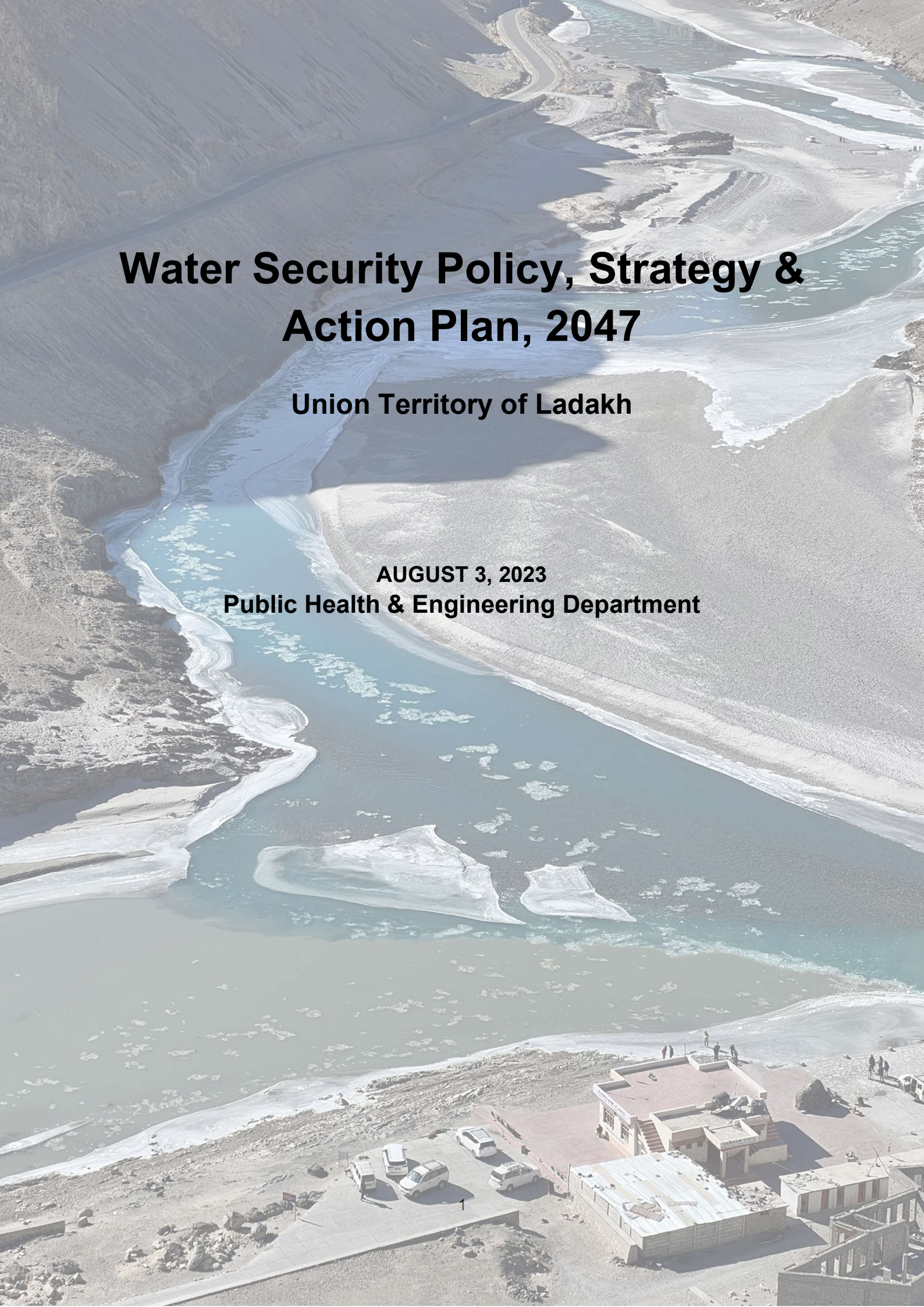

Water Security Policy, Strategy & Action Plan, 2047

Union Territory of Ladakh

AUGUST 3, 2023

Public Health & Engineering Department

Table of Contents

1 Introduction

1.1 Water scenario in Ladakh and key water related issues

Ladakh, situated in the Himalayan range, is an arid to semi-arid region with a severe moisture deficit throughout the year[1]. It is extremely sparsely populated with a population of 2.74 Lakh[2]. Ladakh relies mostly on glacial, and permafrost melt water[3]. However, owing to anthropogenic factors such as rapid urbanization, high growth in tourists and migrating population including traders and laborers, there is persistent water management issues[4]. In the past decade, Ladakh has experienced a shift from glacial melt to relying significantly on groundwater (90% of water supply)[5]. Springs have dried up, snowfall has decreased, and there is a 38% water shortage. The cities lack piped sewerage system also as more than 75% of the households are dependent upon on- site sanitation facilities[5]. Even in Leh and Kargil urban areas, implementation of piped water system are still in the nascent stage. This has resulted in reliance on public stand posts, bore wells, and on-site sanitation[5]. High contamination of inadequate wastewater treatment and solid waste management lead to pollution of groundwater and surface water, along with significant are major concerns in Ladakh[5].

Traditionally, the people of Ladakh have been following an organized water management system that have been developed over thousands of years. They primarily rely on mud canals and dams to distribute and store water. These systems have been successful in Ladakh for generations, but it has been proven to be insufficient in dealing with changes in demography, lifestyles and most importantly the adverse effects of climate changes.

There are currently only 1269 Households with FHTC (Functional Household Tap Water Connection) in Leh City, out of 15,973 Households, and 168 Households with FHTC in Kargil City, out of 17,992 Households[5]. Based on the data collected, Leh has a daily water demand of 8.65 MLD, considering its approximate population of 45,671[2]. However, the current water supply is only 5.15 MLD, leaving a deficit of 3.55 MLD[6]. To meet the remaining water requirement, tankers and private borewells are utilized. Future projections indicate that the water demand in Leh will increase to 18.26 MLD by 2055. For Kargil, the water demand is 11.55 for a population of 16,338[2]. Future projections indicate that the water demand in Kargil will increase to 20.95 MLD by 2055.

Challenges in water sector in Ladakh[5,7,8,9]:

- Being in the highest altitude and harsh region, climate change/global warming affecting supply of drinking water in the UT
- Growing imbalance between demand and supply of water
- Low consciousness leading to wasteful and inefficient use
- Inadequate access to potable water for drinking
- Exploitation of ground water leading to depleting resources
- Polluting water resources thereby deteriorating the quality
- Inadequate institutional capacity for efficient water management
- Limited inter-agency coordination
- Inadequate maintenance of water resource infrastructure
- Losses in distribution network due to extreme weather condition
- Encroachment and diversion of water bodies and drainage channels
- Discrepancy in accurate data base on water resources management

1.2 Need for a comprehensive water policy for Ladakh

The following factors explain the need for a water policy;

- Ladakh is an arid to semi-arid region with limited water resources, and most of the water sources are seasonal such as glacial, and permafrost melt water. With visible effects of climate change, in the form of decrease in snowfall, thinning glaciers, retreating glacial lakes and streams[3] and the added

disadvantage of harsh climatic conditions increases the need of management of traditional water sources.

- Some parts of the UT have become water stressed. Rapid growth in demand for water due to rapid urbanization, high tourist growth and migrating population including traders and laborers[4] pose serious challenges to water security.
- Growth in economic activity inevitably leads to an increase in water demands for a variety of purposes, including domestic, commercial, industrial, irrigation, hydropower generation, and recreation.
- Due to limited water resources, the UT became increasingly dependent on groundwater, resulting in exploitation of groundwater resources[7], raising concerns about the need for scientific management, conservation, and regulation of the ground water resources.
- Inadequate maintenance of existing irrigation infrastructure has resulted in wastage and under-utilization of available sources. There is a widening gap between irrigation potential created and utilized.
- As a result of climate change, Ladakh is experiencing more flash floods and cloudbursts, which are causing more damage, as they carry loose soil and cause mudslides. Given the mountain-specific challenges of the UT, proper planning is required to manage such extreme natural hazards and return to normalcy.
- Improvements in existing strategies, innovation of new techniques resting on a strong science and technology base are needed to eliminate the losses in distribution network, water pollution, inefficiency in water utilization and mismanagement of water resources.

All of these factors emphasize the need for a most effective water resource and supply management on a long-term basis. Further, there is also a need for public awareness on the importance of water conservation and quality maintenance in the UT. To address these issues, Ladakh needs an effective water security policy that can provide strategies and action plans.

1.3 Existing legal and regulatory Framework

1.3.1 State Water Resources Regulatory Authority (SWRRA)

The Administration of the Ladakh UT adopted the Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010 (Act No. XXI of 2010) enacted by Jammu and Kashmir. This Act is an endeavour to consolidate the law relating to use of water, measurement, construction, control, and management of works with respect to water storage, conservation and protection, irrigation, water supply, flood control and prevention, improvement in the flow of water, protection, and improvement in the physical integrity of water courses, lakes and springs, and safety and surveillance of dams[10] etc.

As per section 145 of the Jammu and Kashmir Water Resources (Regulation & Management) Act, 2010, the broad mandate of the SWRRA has been spelt out, but it shall essentially be responsible for regulating water resources, ensuring judicious, equitable and sustainable management, allocation, and utilization of these resources, fixing the rates for use of water, and all matters connected therewith or incidental thereto[10].

As per notification no. S.O. 53 dated 18.04.2022 issued by the Administration of Union Territory of Ladakh, wherein the Administrative Secretary, PHE / I&FC Department, Ladakh has been directed to exercise the powers and discharge the functions of the 'State Water Resources Regulatory Authority' under proviso to sub-section (1) of Section 139 of the Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010 till the Authority is established.

1.3.2 Other Central Agencies

Central Ground Water Authority (CGWA)- Groundwater abstraction guidelines have been developed by Central Ground Water Authority, **Ministry of Jal Shakti (MoJS**) to regulate groundwater extraction and conserve the country's scarce groundwater resources to have sustainable management of water resources. These guidelines provide guidance on how to issue 'No Objection Certificates' for ground water extraction to industries, infrastructure projects, and mining projects, among other things[11].

Currently, as per vide letter dated 03.08.2022, CGWA requested the Administrative Secretary, PHE / I&FC Department, Ladakh to take the necessary steps while framing rules to ensure that the provisions of ground water regulation and management implemented by the SWRRA are in consonance with CGWA Guidelines notified on 24.09.2020.

Central Ground Water Board (CGWB)- CGWB is responsible for providing scientific inputs for management, exploration, monitoring, assessment, augmentation, and regulation of ground water resources of the country[12]. The Central Ground Water Board, North Western Himalayan Region, Jammu prepared the Ladakh Ground Water Resource Estimation Report - 2022. This report provides a comprehensive understanding of the groundwater situation in UT Ladakh. It also provides detailed information on the total annual replenishable groundwater resources, their current status, and future development potential in accordance with the guidelines of the Government of India's Ground Water Resource Estimation Committee (GEC, 2015). It is an invaluable resource for administrators, planners, and agencies involved in the regulation of groundwater resource development[7].

CGWB also took up National Aquifer Management Programme (NAQUIM), to characterize the quantity, quality, and movement of groundwater in the aquifers. There are four major components of this activity viz: (i) Data collection /compilation (ii) Data gap analysis (iii) Data generation and (iv) Preparation of aquifer maps and management plan.

Central Water Commission (CWC)[13] **-** The Commission is entrusted with the general responsibilities of initiating, coordinating and furthering in consultation of the State Governments concerned, schemes for control, conservation and utilization of water resources throughout the country, for purpose of Flood Control, Irrigation, Navigation, Drinking Water Supply and Water Power Development. It also undertakes the investigations, construction, and execution of any such schemes as required.

1.3.3 Ladakh Vision 2047[5]

Ladakh's Vision 2047 incorporates sustainable development goals and an ambition to make Ladakh Self-Sustainable, SMART, Integrated and Carbon Neutral. It is based on 3C approach i.e., Community (Citizen Centric Development), Connectivity (intended to attain 100% Accessibility and Mobility) and Clusters Development (Decentralized Regional Development).

Ladakh Vision 2047 envisions ensuring 24x7 quality water supply and tap water connectivity to every household through the following key strategies in water supply and wastewater management.

1. Large scale harvesting and storing of winter water which can be used during peak demand in summers State Level accredited water testing laboratories for water quality testing.
2. Functional Household Tap Connections for water supply for every household under Jal Jeevan Mission. Technological interventions to provide piped water supply at sub-zero temperature during winter season.
3. Decentralised Faecal Sludge and Septage Management for wastewater treatment (1 FSTP for a cluster of 20,000 Population).

1.3.4 Indus Water Treaty[14]

Indus Water Treaty is a water-distribution treaty between India and Pakistan, arranged and negotiated by the World Bank. The Treaty fixes and delimits the rights and obligations of India and Pakistan in relation to each other concerning the use of waters of the Indus System of Rivers. The Indus basin comprised three Eastern Rivers (Sutlej, Beas, and Ravi) and three Western Rivers (Indus, Jhelum, and Chenab).

India is permitted to use the water of Western rivers for domestic use, non-consumptive use, agricultural use, and generation of hydro-electric power. In addition to that, India is also permitted to construct storage of water on Western Rivers up to 3.6-million-acre feet (MAF) for various purposes.

India can use the western river waters for irrigation up to 701,000 acres. Ladakh is entitled for utilizing Indus River water for irrigation purposes up to 1.5 Lac acres (excluding storage required for Hydel power generation), 0.25 MAF general storage capacity, and 0.15 MAF power storage capacity through surface irrigation projects. Presently, only 56,175 acres (30%) of irrigation facilities have been developed.

The permissible area under IWT is reflecting in the below table:

Table 1: Permissible area under Indus Water Treaty in Ladakh

Component	Existing	Permissible under IWT
Irrigation potential/ command area	56175 Acres (30%)	1,50,000 Acres
Already stabilized	30%	
Storage potential utilization target		0.40 MAF (Power 0.15 MAF+ General 0.25 MAF)

1.3.5 National Water Policy[15]

National Water Policy (NWP) was formulated to govern the planning and development of water resources and their optimum utilization across the states and UTs. The first NWP was adopted in September,1987. It was subsequently reviewed and updated in 2002 and later in 2012. The National Water Policy, 2012 proposed a framework for a plan of action with a unified national perspective. To achieve the objective of the Policy, several recommendations were made for conservation, development, and improved management of water resources of the country. Implementation of these recommendations involves coordinated and continuing efforts on the part of the concerned Ministries / Departments of Central and State governments, and the local Governments.

Table 2: Summary of key points on national water policies

Sector Description	National Water Policy (1987)	National Water Policy (2002)	National Water Policy (2012)
Perspective for Water Resources Planning	National perspectives	National perspectives	Integrated perspective considering local, regional, State, and national context
Information System	Standardized national information system	Standardized national information system	All water related data, should be integrated with well-defined procedures and formats to ensure online updation and transfer of data to facilitate development of database for informed decision making in the management of water

Sector Description	National Water Policy (1987)	National Water Policy (2002)	National Water Policy (2012)
Water Resources Planning	Hydrological unit such as a drainage basin as a whole, or a sub-basin	Hydrological unit such as a drainage basin as a whole, or a sub-basin	Integrated Water Resources Management taking river basin / sub-basin as a unit, should be the main principle for planning, development, and management of water resources
Project Planning	Water resource development projects should as far as possible be planned and developed as multipurpose projects	Water resource development projects should as far as possible be planned and developed as multipurpose projects	All water resources projects should be planned to the extent feasible as multi-purpose projects with provision of storage to derive maximum benefit from available topology and water resources
Ground-water development	Exploitation of ground water resources should be so regulated as not to exceed the recharging possibilities, as also to ensure social equity	Exploitation of ground water resources should be so regulated as not to exceed the recharging possibilities, as also to ensure social equity	Declining ground water levels in over-exploited areas need to be arrested by introducing improved technologies of water use, incentivizing efficient water use and encouraging community-based management of aquifers
Access to safe drinking Water	Adequate drinking water facilities should be provided to the entire population both in urban and in rural areas by 1991	Adequate safe drinking water facilities should be provided to the entire population both in urban and in rural areas	Minimum quantity of potable water for essential health and hygiene to all its citizens, available within easy reach of the household, must be ensured
Water Use Efficiency	The efficiency of utilization in all the diverse uses of water should be improved and an awareness of water as a scarce resource should be fostered	Efficiency of utilization in all the diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered	The “project” and the “basin” water use efficiencies need to be improved through continuous water balance and water accounting studies. An institutional arrangement for promotion, regulation, and evolving mechanisms for efficient use of water at basin/sub-basin level will be established for this purpose at the national level

1.3.6 Key National Investment Programmes in Water Sector

The Constitution of India has made provision for the Central and state governments to perform a crucial role in the planning and management of water resources and financing water supply in the country. Water is a State/Union Territory (UT) subject as per the Constitution of India, and the responsibility of water supply has been given to the local bodies as per the 74th Constitutional Amendment Act. (CAA). However, owing to various issues and limited implementation of the decentralization of power to the Urban Local Bodies (ULBs), various models of water governance exist across the states. At present, states and UTs generally plan, design, and execute water supply schemes (and often operate them) through the ULBs or State Departments/parastatal organizations (Public Health Engineering Department in Ladakh) or state-owned Corporations, state-owned Special Purpose Vehicles (SPVs), state owned parastatals (State Urban Development Agency, Municipal Engineering Directorate, and development authorities), State Water Boards, etc. The urban local bodies have to play a central role in governance of water supply and the formulation of water supply policy, while the Union/State/UT governments' roles will remain limited to developing policies, guidelines, design standards and service level benchmarks, oversees the interstate distribution of water resources through rivers and canals and capital investment for creating water supply infrastructure.

i. **National Water Mission (NWM)**[16]**:** National Water Mission ensures integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states. The Mission considers the provisions of the National Water Policy and develop a framework to optimize water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing. It seeks to ensure that a considerable share of the water needs of urban areas are met through recycling of wastewater.

ii. **Jal Shakti Abhiyan (JSA)**[17]**: Ministry of Jal Shakti** launched Jal Shakti Abhiyan - I (JSA-I) in 2019 in water stressed districts in all the states in the country to promote water conservation and water resource management. A second phase was launched in 2021 and third in 2022 as Jal Shakti Abhiyan: Catch the Rain" (JSA: CTR) was taken up to cover all the blocks of all districts (rural and urban areas) across the country. The campaign's targeted interventions are (1) water conservation and rainwater harvesting; (2) enumerating, geotagging, and inventorying all water bodies; and (3) developing scientific plans for water conservation based on it. (3) Establishment of Jal Shakti Kendras in all districts; (4) intensive afforestation; and (5) public awareness. Additional activities/sub-interventions have been incorporated into this campaign under the intervention 'water conservation & rainwater harvesting,' which include spring shed management, water catchment area protection, and the creation/renovation of 'Amrit Sarovars'.

   Ministry of Housing and Urban Affairs (MoHUA) is the implementing agency for the Jal Shakti Abhiyan through States/UTs/ Urban Local Bodies (ULBs) to make water conservation measures a mass movement. It has been designed to achieve greater public participation in the efforts being undertaken by the ULBs in this regard.

iii. **Jal Jeevan Mission (JJM)**: As an immediate response to India's escalating water crisis, the government has launched the mission to provide piped water supply to every rural household by 2024[18]. The programme also includes mandatory source sustainability measures such as recharge and reuse through grey water management, water conservation, and rainwater harvesting. Till date, the mission has provided tap water to over 75.75% of households, 83% of Anganwadis, and 91% of rural schools in Ladakh[19].

iv. **Accelerated Irrigation Benefits Programme (AIBP)**[20]**:** Central Government launched the program in the year 1996-97 to provide central assistance to major/medium irrigation projects in the country, with the objective to accelerate implementation of such projects which were beyond resource capability of the States or were in advanced stage of completion.

v. **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)**[21]**:** The primary goal of PMKSY is to bring together investments in irrigation at the ground level, increase the cultivated area with reliable water supply, and enhance water use efficiency to minimize wastage. It aims to promote the adoption of precision irrigation and water-saving technologies to achieve more crop yield with less water usage. Additionally, the program seeks to improve aquifer recharge and promote sustainable water conservation practices, including the potential reuse of treated municipal wastewater for peri-urban agriculture. Lastly, it aims to attract increased private investment in precision irrigation systems.

vi. **Integrated Wastelands Development Project (IWDP)**[22]**:** The project focuses on the development of non-forest wastelands in a holistic manner. It aims to develop entire micro watersheds rather than fragmented patches. The main objective of the project is to integrate wastelands development, based on village/micro watershed plans that consider land capability, site conditions, and local needs.

Key features of the project include promoting rural employment and encouraging people's participation at all stages of the wasteland development process. The program ensures equitable and sustainable sharing of benefits and returns from the projects. The primary thrust remains on wastelands development, and it operates under the National Wastelands Development Board.

1.3.7 The Sustainable Development Goals (SDGs)[23]

Sustainable Development Goal (SDG) 6 focuses on ensuring availability and sustainable management of water and sanitation for all. This goal recognizes the critical role of water and sanitation in eradicating poverty, promoting economic growth, safeguarding public health, and protecting the environment. The targets of SDG 6 are:

- By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
- By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.
- By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.
- By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.
- By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.
- By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.
- By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies.
- Support and strengthen the participation of local communities in improving water and sanitation management.

2 Ladakh Water Policy

2.1 Scope of water policy, strategy, and action plan

This policy will be applicable and binding upon all the urban local bodies (including census towns, notified areas), rural local bodies (including revenue villages and hamlets), development authorities, other UT and Central Government Departments, establishments, line agencies and public offices. The key users of this policy include the Government departments of Union Territory of Ladakh, Urban Local Bodies, Gram Panchayats, LAHDC, and Stakeholders and Agencies in the Water Management sector (Household, institutional, commercial, industrial, Agriculture, Irrigation). Table 2 shows the categories that are being focused on to ensure sustainable water sources.

Table 3: Focus areas of Ladakh Water Security Policy

Source Augmentation	Water Resilience	Water Efficiency	Integrated Water Resource Management	Water Governance
Artificial groundwater recharge	Water storage systems	Water saving technologies	Integrated water resource plans	Regulations and standards
Snow harvesting	Water recycling and reuse	Water conservation practices	Water resource monitoring systems	Institutional frameworks
River basin management	Flood management	Leak detection and repair	Stakeholder participation	Water User Associations
	Climate resilient infrastructure		Partnerships and collaboration	Transparent decision-making process
	Water quality and treatment			

2.2 Vision for water management in Ladakh

The 'Ladakh Water Vision-2047' document aims to provide sustainable and equitable access to safe drinking water and irrigation for all residents through data-driven policy interventions and a time-bound action plan with adequate financing, while reducing consumption through innovative agricultural practices. The vision prioritizes ecological balance, carbon neutrality and water conservation by protecting and conserving water sources through scientific planning and sustainable practices while adapting to the impacts of climate change. It will be achieved through SMART Water Governance, promoting a circular economy, active Jan-bhagidari in planning and implementation, ensuring accountability, transparency, regular monitoring, evaluation, and course correction.

2.3 Objectives of the water policy

The objectives of the policy are:

i) Ensure availability of potable water in adequate quantity to all water utilizing sectors covering livestock, agriculture, horticulture, power generation, industries etc.

ii) Provide universal piped water supply coverage in the UT with household water tap connection.

iii) Improve water management and reduction of loss.

iv) Promote traditional water resources such as zings, stupas and artificial glaciers involving local technology.

v) Ensure protection and conservation of catchments all water sources to prevent degradation of the quantity and quality of water sources

vi) Ensure development and improvement of ground water resources and prevent its over-exploitation and contamination.

vii) Achieve carbon neutrality vision of the Prime Minister of India.

viii) Enhance resilience to disasters and the impacts of climate change.

ix) Strengthen the generate financial resources for development of water resources.

x) Fix and modify water prices for various uses such that the price conveys scarcity value of water, encourages users to save water and generate adequate revenue to cover the expenditure to supply water and maintain and expand the required infrastructure. Develop an effective institutional mechanism and create capacity in the UT to implement water policy.

2.4 Strategies for achieving water security through the water policy

The following strategies have been set out for achieving water security through the water policy:

i) Proper accounting, budgeting, and allocation of water usage to various sectors as per the priority fixed by the government/administration.

ii) Introduce the concept of Integrated Water Resource Management (IWRM) i.e., coordinated management of water, land, and related resources, through community involvement, combined with Government support in a holistic manner, promoting conjunctive use of surface and ground water.

iii) Set up Ladakh water Informatics Centre with the goal of optimising the use of water data and adding value to existing data through standardisation, increased interoperability, improved data validation and integration of latest technologies and GIS framework.

iv) Set up Knowledge and Resource Centres (KRC) at the UT and district levels to facilitate localized databases on water availability, quality, and relevant information so that local decision-makers can use usable knowledge to support informed policy implementation and to connect with community-based institutions.

v) Ensure drought and flood management on scientific basis; implement flood plain zoning and establish flood forecasting system.

vi) Develop watershed management plans and implement measures to protect source waters and maintain ecosystem health.

vii) Promote integration of renewable energy and developing action plans for reducing carbon footprint to achieve carbon neutrality vision.

viii) Encourage public and private sector participation in planning and development of water resources projects particularly power projects, which may help in generating financial resources.

3 Policy Framework

3.1 Water allocation, prioritization, and rights

3.1.1 Fair and transparent system for water allocation that considers the needs of various sectors, including domestic, commercial, agriculture, industry, municipalities, and the environment.

As a policy instrument, water allocation across different use groups, such as domestic, commercial, agricultural, industrial, ecosystem, and other uses, is an effective way of managing the sustainability of water resources to increase resilience, economic prosperity, and quality of life for current and future generations alike. Having a well-structured allocation policy can boost the economy of the state.

The following objectives should guide the allocation of water to sectors in Ladakh:

i) Meeting basic human needs.
ii) Sustaining a clean and hygienic aquatic ecosystem.
iii) Achieving economic development of the UT in sustainable manner.
iv) Enhancing the water use efficiency.
v) Maximizing the value of water.

It is not necessary for sectoral allocations to be uniform throughout the UT. Depending on the area, requirements may vary from project to project. Project-specific sectoral allocations of available water resources are made by the competent authority in accordance with the existing laws.

3.1.2 Ensuring a balance between competing water uses and prioritize sustainable water practices.

The first priority and charge on water shall be to meet the basic safe water requirements of the citizen of the UT, which include water for drinking, cooking, washing, bathing, sanitation, and other domestic uses such as d domestic livestock water use.

Following the first priority, the importance of other water user sectors in allocation would be prioritised as follows:

Priority 1: Drinking and Domestic use
The UT would ensure access to a minimum quantity of potable water for essential domestic use and make it available within easy reach of each household.

Priority 2: Livestock use
Need of water for livestock would be assessed in a systematic manner. Suitable allocation and arrangement for supply of water to livestock would be made so that water is easily accessible to them.

Priority 3: Agriculture use
Ladakh has limited opportunity for agriculture since water is scarce and climate is harsh. Hence, it is necessary to efficiently use water for agriculture purpose.

Priority 4: Hydro Power Generation
Next priority would be given to hydro power/thermal power generation. Allocation as per demand would be made after allocating water for above priorities.

Priority 5: Ecological and environmental use and recreation
Water usage for ecological/environmental and recreational purpose will be prioritised as per demand. However, this is subject to modification if warranted by special considerations in any area/region.

Priority 6: Industrial use
The last priority will be given to the industrial sector.
However, this is subject to modification if warranted by special considerations in any area/region.

Sustainable water practices in the top priorities sectors are as following:

Drinking water

i. The UT will ensure the provision of potable drinking water to every citizen, both in the urban and rural areas. In rural areas having small communities, any available drinking water will be integrated with appropriate management of traditional water sources. Such water supplies should be decentralized, with adequately resourced community participation and ownership, and with technical support and assistance from PHED.
ii. Adherence to CPHEEO manual and IS 10500 (2012): Drinking water for maintain the quality and quantity of water supply in urban and rural areas.
iii. As the floating population of the region is higher, the tourist inflow and migrant population should also be considered while determining the demand and supply of water in region.
iv. Due consideration should be given to distribution of water through winter friendly pipelines suited for the harsh climate.

Domestic/Commercial

i. PHED would ensure supply of potable water to all citizens in adequate quantity. Norms for per capita use would be laid down as per the national standards for urban and rural areas with suitable modifications.
ii. Uniform volumetric tariff to be practiced.
iii. Promote the use of Digital Monitoring System (e.g., SCADA) to monitor tank levels, chemical levels, ultraviolet (UV) intensity, and environmental conditions, as well as pumps, valves, and filters.
iv. Contamination of domestic/ commercial water supply lines would be avoided by strict monitoring and adopting appropriate technologies.
v. Network of water quality testing laboratories would be established at the district level to ensure the water quality and regular monitoring based on the parameters laid down by Government of India.
vi. Public awareness about the standards of water quality and the likely impact on health of people due to possible contamination shall be conducted.
vii. For urban water management, household sewerage interconnection with the main grid could be proposed so that the sewage is discharged directly into the storm water drains and the water bodies are not contaminated. To ensure effective functioning of the STPs, all households should be connected to the sewer lines.

Agriculture

i. Farmers would be encouraged to adopt pressure / micro irrigation systems i.e., drip /sprinkler irrigation. All future irrigation projects shall be designed to adopt pressure irrigation technique.
ii. Government would provide subsidies to farmers to adopt pressure irrigation system.
iii. Farmers would be educated to adopt less water consuming crops instead of water intensive crops. Necessary trainings to farmers would be arranged by Irrigation and Flood Control (I&FC) department.
iv. All existing irrigation systems which are either not functioning well or are in defunct state, would be examined and restored/rehabilitated/rejuvenated by following prudent engineering norms.
v. Water supplied to farmers will be measured and irrigation charges (covering cost of supplying water and maintenance of infrastructure) would be recovered.

3.1.3 Recognize and respect Indigenous water rights and meaningful consultation and partnership

The order of water use set out above may be modified in a particular project at the discretion of the competent authority, with reference to area specific considerations such as prevalent land use pattern, activities and means of livelihood, cultural and spiritual values of water to indigenous citizens etc.

Indigenous peoples have relied on water for their livelihoods, cultural practices, and spiritual beliefs for generations. In Ladakh, irrigation technology was adopted from neighboring regions, allowing farmers to cultivate skillfully in barren, elevated semi-desert conditions. This technology is believed to have been introduced as early as the tenth century. The challenging terrain, with streams running away from cultivable

land or deeply incised, requires significant traditional expertise. The water for irrigation comes from melted snow water from various rivulets, known as "kangs-chhu" (ice water), which converge to form a stream flowing through a valley, touching multiple villages connected by a main channel called "ma-yur" (mother channel)[24]. From the "ma-yur," water is further diverted into "yu-ra" (small canals) to irrigate the fields[24]. This water distribution system is intricate and complex. To manage this complex distribution system, a chhur-pon, or Lord of the Water, supervises the supply of water to individual families for irrigation. The chhur-pon is a village official in charge of water distribution for irrigation and is perhaps the most important functionary in this regard[24]. Therefore, it is essential to acknowledge their inherent rights to water and involve then in decision-making processes regarding its management and allocation.

Meaningful consultation and partnership not only facilitate a more inclusive and equitable approach to water governance but also ensure that indigenous perspectives, knowledge, and traditional practices are considered in designing and implementing water-related projects. It is through these collaborative efforts that a more sustainable and inclusive water management system can be achieved, benefiting both indigenous communities and society as a whole.

3.2 Equitable access to water

3.2.1 Integrating provisions for ensuring equitable access to water, for safeguarding the marginalized communities, women, and vulnerable groups

Efforts would be made to analyse the specific water access issues confronting marginalised communities, women, and vulnerable groups in a particular region and determine their specific challenges and barriers to clean water access. This will serve as the basis for developing targeted interventions for the above-mentioned groups. Such regions will be given special consideration when finalising the allocation for water for various sectors.

3.2.2 Inclusion of traditional water management practices and indigenous knowledge in line with the social and cultural dimensions of water management in the UT

The UT will ensure that the social and cultural significance of water management in Ladakh is recognised and respected. Water management will design projects and schemes that will take into account of traditional water knowledge, beliefs, and practices. This will be accomplished by encouraging inclusive decision-making through the involvement of local communities, indigenous groups, and relevant stakeholders in the water management planning and implementation. Participatory workshops, public meetings, and community-driven initiatives methods will be adopted for the participation of the stakeholders.

3.2.3 Water Budgeting and Accounting

Water budgeting will manage and optimize water usage. A system would be developed for water budgeting at the village level which would be reviewed periodically. The approach to water budgeting would be through awareness creation about water resources and the need for water conservation, community participation for chalking out water management strategies, preparation of base map incorporating both quantity and quality of water bodies in the village, assessment of surface and ground water resources, including springs, assessment of demand for various sectoral uses, preparation of Operational Plan for water management and training of water volunteers.

A system will also be developed to benchmark the water uses for different purposes, i.e., water footprints, and water auditing would be developed to promote and incentivize efficient use of water. The ‘project’ and the ‘basin’ water use efficiencies need to be improved through continuous water balance and water accounting studies. An institutional arrangement for promotion, regulation, and evolving mechanisms for efficient use of water at basin/sub-basin level will be established for this purpose at the UT level. Audit of the working of systems shall be carried out periodically in accordance with the guidelines for water audit and water conservation and rectification measures initiated where necessary.

3.2.4 24x7 Water Supply

The administration will ensure that a 24-hour water supply scheme is implemented in urban areas to ensure safe drinking water. This will be an efficient water management practice that ensures access to clean water for basic needs while promoting equity and reducing resource distribution disparities. It allows service providers to invest in network extensions to serve the economically weaker section, which, in addition to raising their living standards, will help in achieving of the Sustainable Development Goals 6 for water supply.

3.3 Sustainable agricultural practices

3.3.1 Promotion of innovation in agriculture, horticulture and other farming sectors and promoting sustainable practices

70% of the population in Ladakh directly or indirectly depend on agriculture for livelihood[8]. Despite the vast geographical area, only 0.37% area is sown under agriculture[5]. Production of many crops such as off-season crops/vegetables remain limited due to improper harvesting of water. Domestic food production is unable to meet the demand of the increasing population in the region. Ladakh gets approximately 73% of its food grains from outside the region. The vegetable import dependency is approximately 67%, while that of fruit is approximately 85%[8]. The main crops grown in the region in past were barley, wheat, other grains and non-food crops, which mainly consist of fodder crops, especially alfalfa[25]. Cereals are grown for twin purpose of food and fodder. Fodder is the backbone of agriculture and animal husbandry industry in Ladakh. Cultivated fodder occupies 22.4% (2290hac) of the total cropped area[26]. Therefore, there is a scope to increase area under agriculture and horticulture in the region if water use efficiency could be improved.

a. Agriculture

Aims & Objectives:

- To bring the barren/waste land under cultivation of Agro-silvi-pastoral, Horticulture and Agriculture crops through micro irrigation.
- More crop per drop to enhance the adoption of precision irrigation and other water saving technology.
- To improve the measures to reduce wastage of water and increase availability both in duration and extent.
- To save water and increase water use efficiency.
- Bring undulated area under cultivation.
- Increase the income of farmers.
- Save labour and increase income of farmer
- Overall improvement of livelihood of farmers.

Last Five-Year Achievement

Since irrigation water become one of the major issues faced by the farmers of Ladakh, as glacier water is the only source of irrigation for whole Ladakh. Due to climate changes, the glacier water of the region is receded rapidly, and rate of snowfall is very less as compared to previous decade. So, to conserve water, the department has adopted different techniques such as:

1. Micro Irrigation system: Micro irrigation system is one of the best techniques to save/conserve water as compared to flood irrigation system. It reduces irrigation water losses occurring through evaporation, conveyance, and distribution; therefore, high water use efficiency can be achieved[27]. The department of agriculture has introduced this technology across UT Ladakh by providing incentives for lying and installing micro irrigation system like Drip and Sprinkler with photovoltaic borewell on farmers field and till date 1590 canals of land has been bought under this technology.

2. Mulching Technology: As Ladakh being a cold arid and harsh climatic region, it is hard to grow many summer crops like cucurbits, capsicum and brinjal etc., under open condition. However, with the introduction of

mulching technology farmers can cultivate different types of crops like sun-melon, watermelon, capsicum, brinjal etc which not only increase the income of farmers but also conserved water by retaining moisture in the field[28]. Till date the department has covered 7.5 hectares of land under this technology.

3. Ladakh Green House: Due to harsh climatic condition of UT Ladakh, it is not possible to cultivate any crops during winter season under open condition but with the introduction of protected cultivation technology like traditional green house and low trench technology the farmers can cultivate green vegetables during winter season to some extent i.e., from March to December. With the passage of time after formation of UT, the department has introduced the Ladakh Green House Project technology developed by DIHAR, Leh, under which the farmers can grow different kinds of vegetables throughout the season as the minimum temperature inside the greenhouse remains 5-7 degree centigrade when the outside temperature is -30 degree centigrade[29]. The technology brings revolution in the region would help in self-sufficiency in vegetable cultivation during winter season and farmers can fetch good income by selling their produce during peak winter. Further the department is planning to cover maximum numbers of Ladakh green house in UT so that Ladakh become self-sufficiency in green vegetables which restrict the import of vegetables from outside UT and till date 850 units of such greenhouse were constructed across UT of Ladakh.

Steps to be taken to improve water conservation in UT Ladakh:

Table 4: Action plan for incorporation in the Irrigation Plan

S. no	Programme component	Assistance	Area to be covered	Physical Target unit/No	Tentative unit cost (in lac)	Estimated cost (in lac)
1	Drip irrigation system (1.2m sp)		90	1800	0.080	144
2	Sprinkler Irrigation (3x3m spacing (1 unit =0.05ha)	100%	30	600	0.084	25.40
3	Distribution of unbreakable triple layered water storage tank (500ltrs capacity) (1unit=0.75ha)	75%	90	1200	0.10	60.00
4	UV treated Multi layered cross laminated black mulching film (1 unit=0.05ha)	75%	60.00	1200	0.24	144
5	Rain guns (demonstration purpose at departmental farms (1 unit=1hac)	100%	4.00	4.00	8.00	16.00
6	Multi Sensor Drone for surveillance of drought situation and remote sensing	100%		4.00	10.00	20.00
7	Photovoltaic Borewell	75%		400	3.00	1200
8	Distribution of drought resistant crop varieties (Rs5000/Canal)	100%	30.00	600	0.10	30.0
9	Incentives for promotion of cultivation of local drought resistant cultivars	75%	90.00	1800	0.06	54.00
10	Mobilization and capacity building: inter and intra UT & district level farmer training camps, kisan melas, goshties etc. (ATMA/MIDH guidelines)	100%		90	1.00	45.00
11	Technology dissemination component (projectors,	100%		16	150	12.00

S. no	Programme component	Assistance	Area to be covered	Physical Target unit/No	Tentative unit cost (in lac)	Estimated cost (in lac)
	computers, laptops etc) for promotion and dissemination of information on judicious irrigation methods, water conservation methods and sustainable agriculture etc.					

b. Horticulture

i. Rain/natural water conservation system by way of construction of water harvesting tanks/ check dams/ improving local ponds, etc.
ii. Awareness creation among farmers for use of Micro-irrigation in the fields by way of Drip Irrigation for efficient use of available water.
iii. Use of plastic mulching, especially covering the basins of trees to reduce water loss through evaporation and discourage weed growth.
iv. Terracing/ Basin/contour systems in the fields to be adopted/advocated to arrest run-off of irrigation water, thereby encouraging its absorption for climate better results.
v. Irrigation to the orchard areas during peak seasons especially in evening hours to reduce loss of water through evaporation due otherwise during daytime.
vi. Lifting of water from natural water bodies like rivers, its storage as per situations for subsequent irrigation purposes in orchard areas judiciously. Similarly, regulating the use of ground water efficiently by establishing borewells as per situations.
vii. Capacity building amongst farming community for judicious use of available water resources.
viii. Plantation of drought resistant and environment friendly fruit crops like Sea buckthorn need to be encouraged for better results/dividends to the farming communities.

3.4 Industrial water demand management

3.4.1 Efficient water uses in industries

The strategies envisaged for industrial water management are:

i. All industrial units will endeavour to reduce their water footprint over the time by optimizing the various industrial processes, modifying the equipment, recycling wastewater, and creating awareness amongst their workers to manage water efficiently. Accordingly, industries will be encouraged to recycle and reuse water and follow the policy of 'Zero effluent' in the final stage. The UT will ensure the installation of infrastructure for zero discharge in new as well as existing industrial estates. Initiatives and investments for wastewater treatment facilities will be encouraged in the UT of Ladakh by offering special incentives.

ii. All industries will be required to adopt latest water efficient technologies to reduce dependence on ground water resources.

iii. The UT will ensure that all water-intensive industries that extract ground water shall install water metres and engage in ground water recharge activities. Furthermore, UT will ensure the construction of observation well(s) (piezometer)(s) within the premises, as well as the installation of an appropriate water level monitoring mechanism for industries drawing/proposing to draw more than 10 m3/day of ground water. The project proponent will be in charge of monitoring the water level.

iv. Industries which are likely to cause ground water pollution e.g., Tanning, Slaughterhouses, Dye, Chemical/ Petrochemical, Coal washeries, other hazardous units etc. (as per CPCB list) will undertake necessary well head protection measures to ensure prevention of ground water pollution.

v. The UT will ensure that all industries and mining activities in Ladakh adhere to the guidelines published by the Central Ground Water Authority, Ministry of Jal Shakti, GoI, in notification S.O. 3289(E) dated September 24, 2020, to regulate and control groundwater extraction in India.

vi. A rolling programme of water auditing will be undertaken for all industries, large and small, to compile a register of industrial water usage. This audit will include the quantified water usage, the potential for water recycling and conservation, and actual and potential pollution associated with each site.

vii. Water bailed out from mines must be treated before releasing it into the natural streams. LPCB authorities will monitor the quality of the discharges from the mines. The water so bailed out from the mines will be used for irrigation purposes to the nearby areas.

3.5 Sustainability and adaptation

3.5.1 Integrated Water Resources Management (IWRM)

A River Basin Authority/ Centre may be established to promote IWRM at basin level for planning and development of water resources with focus on convergence among various resources and programs. The set-up will provide the modelling (e.g., basin water budgeting and water allocation for various water sectors) capability to support IWRM planning and developing various climate change adaptation strategies for current and future scenarios. Drought management could be one of the activities. This set-up will have monitoring systems covering the river basins (including glacial catchments) and numerical model capability including (but not limited to) rainfall-runoff, rivers, and structures. Flood forecasting and Early Warning measures could also be undertaken.

Following institutional arrangements are suggested for the management of water in irrigation sector for implementing IWRM:

- Formation of Water Users Association (WUA) with all beneficiary farmers.
- Institutional restructuring of government department for implementation of IWRM.
- The entire I&FC department shall be restructured to suit IWRM requirement.
- The role of I&FC department would be to plan and implement new irrigation and flood protection projects.
- Introduce irrigation charges by UT and provide the responsibility to WUAs for the recovery.
- O&M of projects will not be the responsibility of the department, hence staff deployed for O&M will be adjusted elsewhere.
- Government officers would continue to provide technical support to WUAs and monitor continuously whether all WUAs are functioning well, and problems are solved immediately. Necessary funds will be transferred to them on a timely manner.
- Ground water department would be made part and parcel of PHED.
- Water zoning: Economic development and activities including agricultural, industrial, and urban development should be planned with due regard to the constraints imposed by the configuration of water availability. There should be water zoning of the UT and the economic activities should be guided and regulated in accordance with such zoning.

i. **Formation of Water Users Association (WUA) with all beneficiary farmers**
   - One WUA will be formed for one irrigation system covering an area of about 1000 ha.
   - More than one WUA if the area is more than 100 ha with an apex body (Project Committee).
   - The WUA will have one president/chairperson and 4-5 ward members. Each ward member will represent ¼ or 1/5 area of the total CCA.

- All the office bearers of the association will be elected by direct election method and all the farmers of the project will be voters (owners only).

ii. Duties and functions of WUAs

- Actual irrigation done by individual farmer crop wise will be recorded by WUAs.
- To regulate distribution of canal water among the farmers by rotation system would be enacted, WUAs would be empowered to impose penalties to defaulters.
- For the purpose of O&M, government will provide certain financial grant to WUAs.
- Irrigation charges as fixed by government will be collected by WUAs and deposited into Govt. treasury; they will also be authorized to raise additional funds as per requirement.
- WUAs will maintain all sorts of accounts for all receipts and expenditure incurred by them.
- Adequate trainings to WUA office bearers and their assistants will be provided by the department for their capacity building.

3.5.2 Promotion of traditional water management wisdom and technologies

In Ladakh, where rainfall is low and access to water resources is limited, traditional water management technologies play a crucial role in ensuring water availability. Local communities and local bodies would be incentivized to increase water storage capacity, which inter-alia would include revival of traditional water harvesting structures and water bodies. The traditional water management practices in Ladakh are as follows:

i. Percolation tank[30]: It is one of the methods used locally in Ladakh to recharge the groundwater. In this method, localities store water in the shallow structures built to capture rainwater/ runoff water and allow it to percolate or seep into the ground, replenishing the groundwater reservoirs. These tanks are strategically located to maximize water absorption and minimize runoff.

ii. Local pond/Zings[31]: It is an old tradition of Ladakh to store the water locally known as ‘Zing’. It is a pond created artificially by human efforts in order to store runoff water to increase percolation or to store water during winter and non-agriculture season to make its effective use during agriculture season. This storage of water also helps to maintain moisture in the soil thus resulting in a good yield of crops and trees as well.

3.5.3 Winter water conservation measures

In Ladakh, most of the water sources are seasonal such as glacial, and permafrost melt water. With visible effects of climate change, in the form of decrease in snowfall, thinning glaciers, retreating glacial lakes and streams and the added disadvantage of harsh climatic conditions, there is a need to increases management of snow water, glacier conservation and suitable intervention to ensure sustainable water availability. Several efforts have been made at the local level in this regard such as artificial glaciers, ice stupas, and snow check dams. The detail of each type is as follows; The following are some local level snow harvesting and glacier conservation measures in Ladakh:

i. Artificial glaciers or snow harvesting: Artificial glaciers or snow water harvesting is a technique used in Ladakh for the preservation of snow and delaying melting so that snow melt water is available for a longer duration in a year. Selection of sites for snow harvesting depends on isolation of an area, wind direction, wind velocity and relative humidity. There are types of modern ice reservoirs have been developed[32].

Firstly, the basin structures store ice similarly to how traditional zings store water. While zings are generally built around the same level as fields, basins for ice storage are located at altitudes higher than the cultivated fields so that water can freeze. The advantage of ice basins over zings, and the advantage of ice reservoirs over water reservoirs, is that evaporation is minimized and so more water is retained. A second type of ice reservoir involves building a sequence of loose rock walls into a river. This slows down water velocity enough so that the water freezes in layers. This type of structure, called a “cascade”. A third type of artificial glacier diverts stream water to freeze in small, shaded side valleys.

This strategy also relies on reducing the velocity of river water and increased accumulation in layers of ice[33].

ii. **Glacier grafting[34]:** The art of 'glacier grafting' has been practiced for centuries in the mountains of Hindu Kush and Karakoram ranges as a way of storing water in the winter for slow release during the spring growing season.

iii. **Ice Stupas[35]:** A form of glacier grafting technique that creates artificial glaciers, used for storing early-winter water in the form of conical shaped ice heaps formed from well-constructed pipes fed by water from streams pressured by gravity. During early summer, when water is scarce, the Ice Stupa melts to increase water supply for crops. Artificial ice reservoirs are only implementable in "cold, arid environment", where temperature is extremely low during the wintertime because of the high altitude, the position, and the very arid situation. Ladakh's climate meets this description and therefore, such systems can be explored in Ladakh.

iv. **Permafrost preservation[36]:** Permafrost is an unconsolidated sediment or bedrock that remains frozen for at least two consecutive years. Occurring in Arctic and high mountain areas, permafrost accounts for about a quarter of the Northern Hemisphere land mass. In the Hindu Kush Himalaya, it is estimated to be about 1 million km2 which is more than 10 times the area under glaciers. Permafrost is an important component of land in areas above 4,900 m and could serve as a significant water source. Permafrost has important roles in feeding local springs and maintaining vegetation, however, with increased warming, can cause natural disasters.

iii. **Snow check dams[37]:** Check dams are used to check the surface runoff coming out from snowbound catchments and the snow flow during melting. Some snow check dams in dry stone masonry are raised which helps in raising the ground water table due to percolation and can also be used for irrigation purposes through flow channels and can make the wasteland usable.

However, there is a lack of systematic and scientific data collection and analysis on the effectiveness of these traditional methods. To address this challenge, Ladakh administration will prepare a data-driven strategy and master plan for snow/ice harvesting as well as glacier conservation.

3.5.4 Springshed management

i. Springshed management programs will be implemented in h convergence with various central and state government schemes, with an objective to conserve the natural springs in Ladakh.

ii. Research will be undertaken to identify and map springs in the region. This will be done through community surveys, field visits, consultation with urban local bodies/Gram Panchayats and experts. Detailed inventory will be prepared including the type, discharge, water quality, and recharge area.

iii. Hydrogeological surveys will be conducted in collaboration with experts to gain a comprehensive understanding of the hydrogeological characteristics of the region, including information on aquifer types, recharge zones, water table depth, and groundwater flow patterns.

iv. Based on the studies, protection of the recharge areas of springs will be ensured by implementing measures to prevent soil erosion, deforestation, and pollution in the areas.

v. Afforestation and land management practices shall be encouraged to promote natural infiltration and recharge.

vi. Community participation shall be promoted in the springshed management by raising the awareness about the importance of the springs, their recharge areas, and the need of their conservation. Participation of the local communities in the decision-making processes, monitoring, and maintenance of spring resources will be encouraged.

vii. Community led regular monitoring of the status of the springs, recharge areas, and groundwater levels will be done. The works caried out under springshed management program will be geo-tagged for monitoring the progress of work. Performance evaluation of water conservation works done earlier will be subject to a periodic review by a third party, comprising of representatives from institutions and NGOs working in the water sector. Outcome of such evaluation shall be used for planning, designing and implementation of future schemes.

3.5.5 Adaptation to climate change in water management

i. Climate change will increase the variability of water resources affecting human health and livelihoods. Therefore, special impetus would be given towards mitigation at micro level by enhancing the capabilities of community to adopt climate resilient technological options.

ii. Analysing the vulnerabilities of the water management system to climate change impacts would be done. This includes identifying risks such as changing precipitation patterns, altered runoff, water level rise, or increased frequency of extreme events. To start with, UT will examine the available climate projections and identify potential changes in temperature, rainfall patterns, and extreme weather events.

iii. As Ladakh heavily relies on glacial meltwater, glacial retreat and changes in meltwater patterns becomes significant challenge. Implementing monitoring systems to track glacier mass balance and establishing early warning systems will help anticipate changes in water availability and plan accordingly.

iv. With increasing uncertainty in precipitation patterns due to climate change, capturing and storing water becomes crucial. UT will increase the water storage in its various forms, namely, soil moisture, ponds, ground water, small and large reservoirs, and their combination. Local communities and local bodies would be incentivized to increase water storage capacity, which inter-alia would include revival of traditional water harvesting structures and water bodies.

v. The adaptation strategies could also be included for better demand management, particularly, through adoption of compatible agricultural strategies and cropping patterns and improved water application methods, such as land levelling and/or drip /sprinkler irrigation as they enhance the water use efficiency, as also, the capability for dealing with increased variability because of climate change. Similarly, industrial processes would be made more water efficient.

vi. Planning and management of water resources structures, such as, dams, flood embankments, tidal embankments, etc., would incorporate coping strategies for possible climate changes. The acceptability criteria in regard to new water resources projects need to be re-worked in view of the likely climate changes.

vii. UT will develop and implement policies and regulations that promote climate-resilient infrastructure and practices. This will include building codes, zoning regulations, and land-use planning that takes into consideration the vulnerability of the region to climate change.

viii. Stakeholder participation in land-soil-water management with scientific inputs from local research and academic institutions for evolving different agricultural strategies, reducing soil erosion, and improving soil fertility would be promoted. The specific problems of hilly areas like sudden run off, weak water holding capacity of soil, erosion and sediment transport and recharging of hill slope aquifers would be adequately addressed.

3.5.6 Achieving carbon neutrality

i. Integration of renewable energy in water-related infrastructure

- Integration of renewable energy into water related infrastructure is a crucial step to reduce carbon emissions and achieving sustainability. By harnessing the potential of solar and wind energy, and some environmentally viable use of the Indus, Zanskar, and Shyok rivers for power generation, the region's economy could be revolutionised, and a large amount of energy could be supplied to various parts of northern India.

- At present, power supply does not meet unrestricted demand and consequently curtailment measures need will be applied. There are many regions in Ladakh that are still largely isolated from the rest of the region, especially during the winter months[38]. Supplying power to such areas is a formidable challenge, and it is virtually impossible to do so using transmission lines from a centralised grid, which is neither technically feasible nor an economically viable option in a mountainous region, therefore decentralised solar and other renewable energy options will be the appropriate step to be taken in the area.

- **The total renewable energy potential in Ladakh**

Table 5: Potential of renewable energy in Ladakh

Renewable energy source	Potential	Remarks
Solar	25,500 MW	NIWE's assessment based on land availability, high quality radiation for more than 300+ days in a year.
Wind	5,000 MW	5,000 at 80 m hub height (with 500- 850 kW turbine); more than 80 m high turbines not possible because of logistics issues.
Small Hydro	400 MW	MNRE
NIWE = National Institute of Wind Energy, MNRE = Ministry of New and Renewable Energy		

ii. Actions plans for reducing carbon footprint

- For optimum efficiency and utilization of hydro-potential, constructing hydro-electric projects would be ensured, with a view to ensure generation of maximum power, revenue, and local employment.

- Small /mini/micro hydro projects coupled with irrigation systems will be promoted wherever economically viable.

- Solar-powered pumps can be used to extract groundwater or surface water for irrigation, drinking water supply and other water-related activities, reducing dependence on fossil fuel-powered pumps.

- UT will incentivize the use of solar power plants instead of DG sets in existing water supply schemes.

- Solar water heaters will be promoted, particularly for domestic use or in commercial facilities such as hotels and public buildings, reducing the use of conventional water heating methods.

- Private sector participation in planning and development of water resources projects particularly power projects, would be encouraged.

3.5.7 Environmental conservation and ecological protection

viii. Research will be undertaken periodically to understand impacts of climate change on water and environmentally sensitive areas. Findings of these studies will be used in decision making and disseminating to the community for appropriate IWRM planning.

ix. Independent environment impact studies will be taken up for all new irrigation and water resources projects.

x. Wetlands, ponds, and lakes will be conserved and managed to maintain ecologic continuity. Development of additional wetlands, and ponds will also be considered.

xi. Rivers, water bodies, aquifers and wetlands will be recognized as ecological systems and must be protected from over exploitation, depletion, pollution or contamination and degradation. Rivers will be protected from any form of construction on their flood plains and from sand mining.

xii. A prohibition would be imposed on the encroachment and diversion of water bodies (such as rivers, lakes, tanks, ponds, wetlands, lakes, etc.) and drainage channels (irrigated and urban drainage).

xiii. Measures aimed at maximizing retention and minimizing loss of water by watershed management through soil conservation, catchment area treatment, preservation of forests and wetlands, increasing the forest cover, construction of check dams and other ground water recharge measures would be taken up.

xiv. A comprehensive research program to assess impact of climate change on glaciers (including glacier related data collection) and water resources as well as identify suitable adaptation measures can be proposed for current and future water resources planning.

xv. "Water Resources Conservation Fund" shall be created with the participation of corporate sector, industries and local bodies. The proceeds collected from this fund will be used to sustainably conserve natural freshwater resources, protect water bodies, and overall ecosystem.

3.6 Data Driven Management System

3.6.1 Establishment of Knowledge and Resource Centre (KRC)

KRCs will be established and will be responsible for:

i. Facilitate disaggregated localized database on water availability, quality, and relevant information that would support local level decision making in a sharable form as usable knowledge.
ii. Provide knowledge to community for developing water plans with the involvement of local experts.
iii. Act as bridging institution with community-based institutions to support informed implementation of policy.
iv. Conduct research in the area of water and climate change, impact of changing cropping patterns and water resource planning imperatives and documenting best practices on community actions at various levels.
v. Provide incentives to support behaviour change in favour of sustainable water use and management at various levels.

3.6.2 Establishment of Ladakh Water Informatics Centre (LWIC)

Ladakh Water Informatics Centre (LWIC) will be established with the goal of optimising the use of water data and adding value to existing data through standardisation, increased interoperability, improved data validation and integration of latest technologies and GIS framework. The establishment of LWIC will help in:

- Strategic decision making
- Modelling activities and development of analytical tools
- Development of decision support systems and other knowledge products related to water
- Overall water resources management and planning in the respective states.

All water related data, covering rainfall, snowfall, geo-morphological, climatic, geological, surface water, ground water, water quality, ecological, water extraction and use, irrigated area, glaciers etc. would be integrated with defined procedures and formats to ensure online updating and transfer of data to facilitate development of a strong database for informed decision-making regarding water management. Basin/ Sub-basin wise availability

of water in the rivers/ nallahs will be prepared in a scientific manner to have a credible database which can be used in planning and development of water resources.

The issue here is not just access to information, which should have transparency but also availability of information in a manner and that is useful to primary stakeholders.

3.7 Water quality monitoring and management

i. Measures for monitoring and managing water quality

A review of basic water quality or analytical public health facilities will be undertaken at district level in collaboration with urban local bodies. A rolling program to improve the water analysis capability at district level will be initiated.

UT will include advance technologies, such as remote sensing and data analysis to aid in monitoring water quality on a larger scale. UT will ensure that accurate data is regularly collected and reported to identify areas that require immediate action.

A program of improved domestic water quality will be undertaken to prioritize health risks involving implementation of filtration, chlorination etc.

UT will establish standards for water quality, implement pollution control measures, and carry out regular inspections to ensure compliance with these standards.

Sewage effluent will not be allowed to discharge into streams or rivers without treatment. A regular monitoring system would be ensured by Ladakh Pollution Control Committee.

ii. Addressing pollution control and remediation

A public awareness program will be organised to educate the general public about importance of clean water and impacts of pollution. Water use practices that promote sustainability, and an eco-friendly lifestyle will be encouraged.

Rehabilitation and restoration of degraded ecosystem, such as wetlands, rivers, and lakes, would help improve water quality naturally.

A program to design and construct Sewage Treatment Plants in the UT would be implemented. Allocation of adequate funds would be ensured.

Punitive actions will be taken against those who are responsible for pollution. The polluter pays principle shall be followed in accordance with applicable laws and regulations. Strong regulations to prevent water pollution will be implemented.

For the effective control over water pollution in all sectors, and also to monitor maximum recycling & reuse of water, a coordinated efforts are necessary from all the water stakeholders together. For this, a high-power Apex body need to be formed, under the leadership of Environmental Ministry of the UT and with members from all the water users line departments.

3.8 Water related disaster management

Ladakh being a cold mountain desert and a multi-hazard-prone, makes it extremely vulnerable to natural disasters such as earthquake, cloudburst, floods, landslides, avalanches, windstorm, cold wave, snowstorm, drought, Locust menace beside man induced disasters such as war, chemical hazards, road accident, fire, conflict[39], etc. The urban areas fall in the seismic Zone-IV (of Damage Risk Zone) as strike-slip fault runs along Zanskar and Ladakh ranges.

Heavy rains caused by a cloudburst in August 2010 devastated Leh[40], causing mudslides and flooding that resulted in the loss of land, lives, homes, public infrastructure, and business hubs, etc. The Ladakh region experienced floods in 2006, 2013, 2014, 2015, 2017 due to rains or landslides that blocked the rivers and caused the water to rise when the blockages moved[41]. Previously, the majority of precipitation was snow that slowly melted, forming streams or seeping into the ground. However, as a result of global warming, more rain is falling, causing more damage, especially since it carries loose soil and causes mudslides[38].

Considering the mountain-specific challenges of the UT, proper planning is required to manage such extreme hazards in order to minimise risk and return to normalcy at earliest possible. Policy proposes the following activities to mitigate disaster-related challenges and improve the development of infrastructure facilities:

i. Draught and flood protection and forecasting measures

- Drought prone areas would be made less vulnerable to drought associated problems through soil moisture conservation measures, water harvesting practices, minimization of evaporation losses, development of ground water potential including recharging and transfer of surface water from surplus areas, where feasible, and appropriate. Pastures, forestry, or other modes of development with relatively less water demand would be encouraged. In planning water resource development projects, the needs of drought prone areas would be given priority.

- Relief works undertaken for providing employment to drought-stricken populations would preferably be utilized for drought proofing.

- Most vulnerable flood prone areas would be identified and a phased program for taking up flood protection works for these areas would be prepared and implemented on priority.

- Extensive network for flood forecasting would be established for providing timely warning to the people likely to be affected.

- Timely evacuation and shifting to safe areas for people from flood affected areas would be ensured.

- As the cloudbursts and Glacier Lake Outburst Floods (GLOFs) have led to catastrophic floods in Ladakh in the recent past, it is crucial to incorporate their management strategies as part of the Action Plan.

- It is understood that there are marginal hydro-meteorological, hydrological, and groundwater observation stations in the region. It is suggested that a network of stations may be installed at the earliest for observing different phenomenon in the region for detailed hydrological evaluation, planning, and design. Another important task is to assess the sustainable water availability from surface and groundwater resources and assessment of water demands for different purposes.

ii. Strategies for managing water related disasters

- UT will conduct the mapping of flood-prone areas, and restrict the construction in these zones, and promote the use of flood-resistant building materials and construction techniques.

- Responsible land use planning and development in floodplain areas would be encouraged to reduce flood damages. Master Plan for flood prone areas would be prepared, with a view to control floods and provide protection.

- Water informatics centre will be established, and it will periodically update the inventory of glacial lakes to this end. Further, there is need for radar based real-time forecasting systems for such events and emergency plans for their management.

iii. Early warning systems and emergency response plans

- Developing and maintaining robust flood forecasting and early warning system will help Ladakh predict and monitor flood events. This includes the installation of gauges and sensors to measures water levels, rainfall, and river flows. Timely and accurate information about impeding floods will allow authorities to issue warnings and evacuate residents if necessary.

- As part of the storm water drainage project for Leh, an automated early warning system will be established in strategic locations in the city.

- UT will develop comprehensive emergency response plans for flood related incidents. This includes coordination amongst relevant agencies, establishing evacuation routes, setting up emergency shelters, and ensuring efficient communication system. Regular drills and exercises can help prepare communities and response teams for flood emergencies.

3.9 Governance structure

3.9.1 Decentralisation of water management

Decentralization of water management and governance strengthening local institutional models must be persisted with. Participatory village level water security planning process using scientific methods of study and participatory methods for involving community leaders, women, and youth, and building capacity should be integrated into the policy framework. This would ensure a bottom-up approach to water sector planning involving communities not just in management but planning and taking ownership of their village water resources.

The following organogram depicts institutional arrangements.

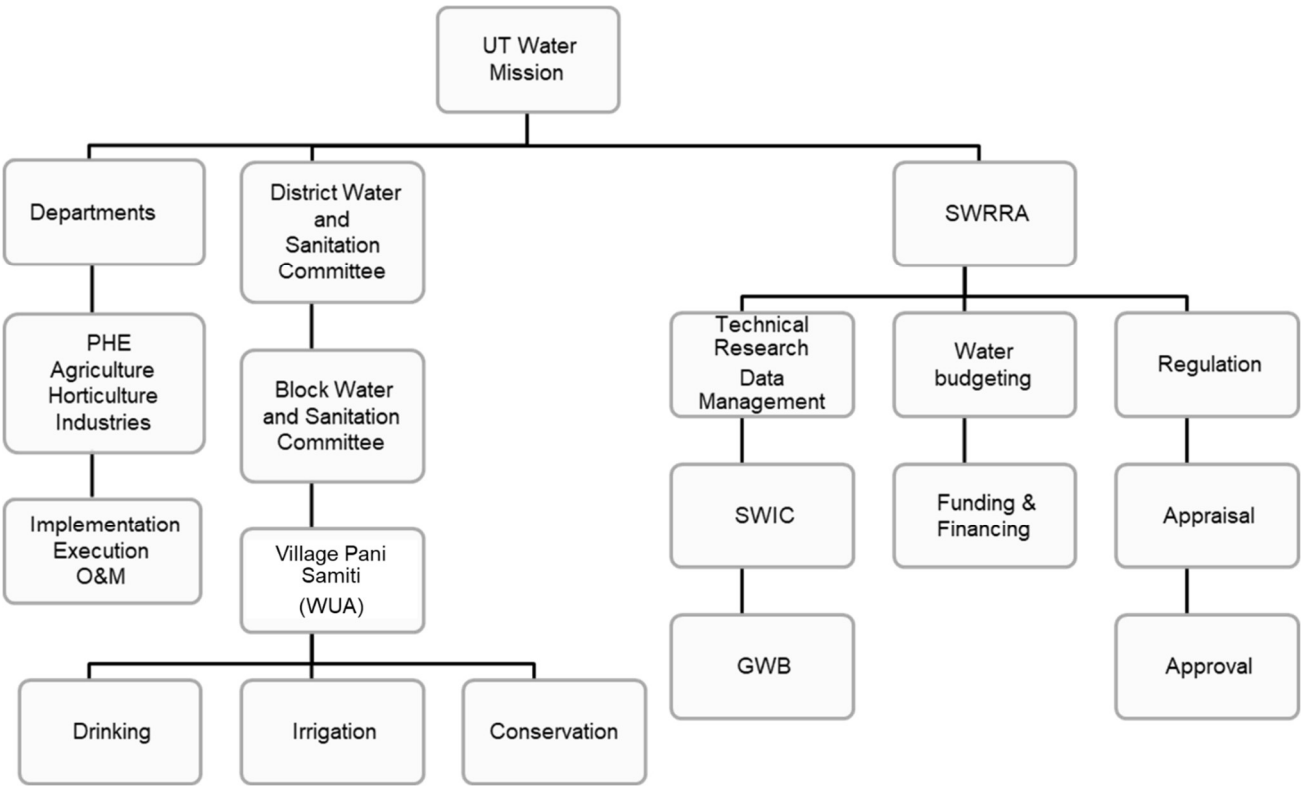

Figure 1: Organogram depicting institutional arrangements

3.9.2 Empowering Panchayati Raj Institutions (PRIs)

i. The PRIs to be Legally empowered to help regulate ground water use to prevent its over-exploitation and manage surface and ground water resources

ii. Institutional mechanisms will be strengthened to ensure channelizing of funds to the village level institutions instead of various functionaries and agencies of the government
iii. Village water and sanitation committee of the GP will be given the responsibility for planning, implementation, operation, maintenance, and management of village drinking water security.
iv. Pani samiti as a community organization can be a part of the Panchayat structure.
v. Local leadership should be created through training and creation of local youth cadres such as Jal doots, Gram Sevaks.

3.9.3 Strengthening the role of Gram Sabhas

i. Decision making through constitutional arrangements such as Gram Sabhas must be made mandatory.
ii. Encourage the involvement of local communities in the planning, implementation, management, and maintenance.
iii. Incorporate traditional practices, local materials and are manageable and maintainable by local communities.
iv. Local youth cadres such as Jal doots, Gram Sevaks will be encouraged to participate in the overall programme.
v. Ensure and strengthen the role of women in the entire spectrum of water management and governance.

3.9.4 Promoting community participation and Janbhagidari

The Ground Water Management Bills and National Water Policy address the governance of ground water under the public trust doctrine. The concept of public trust doctrine ensures that resources meant for public use cannot be converted into private ownership. Government being the trustee has the responsibility to protect and preserve this natural resource for and on behalf of the beneficiaries, that is, the people. It may be noted that the fundamental right to water has been evolved by the Supreme Court and various High Courts of the country as part of 'Right to Life' under Article 21 of the Constitution. Courts have delivered verdicts on concerns such as access to drinking water and on the right to safe drinking water as a fundamental right. In this policy the same principles will be upheld. There's a need to emphasize the imperative to end discrimination in access to water on grounds of caste, class, gender, location, and community, as emphasized in the draft.

3.10 Research, Awareness and Capacity Building

3.10.1 Research and development

i. Continuing research and advancement in technology will be promoted to address the issues in the water sector in a scientific manner. Adequate funding will be provided for R&D activities and also for updating the existing technology, design, planning and management practices. R&D advisory panel of internal/external experts will be established for steering and monitoring research activities and validating the same before role out.

3.10.2 Awareness and capacity building

i. At the local level, UT will conduct water conservation and sustainability awareness programs. Education in community-based water management, water-use efficiency measures, improved conservation methods, public health, and an improved sanitation system will be provided.

ii. An essential part of water resources development would involve implementing a comprehensive plan for standardized training. This plan would include various aspects such as training in information systems, sector-specific planning, project planning and development, project management, operation of projects and their physical structures and systems, and management of water distribution systems. This training would be provided to all personnel involved in these activities, including farmers.

iii. UT administration will conduct training programmes for the officials at UT, Deputy Commissioners, and local body level (PRIs/MCs.) through reputed training institutions.

iv. Collaboration with State educational institutes will be done to meet the changing need of the skilled manpower in the water sector.

v. Capacity building of existing research institutes functional in water sector will be done with necessary collaborations with national / international institutes.

vi. Community-based capacity-building programmes will be carried out, including training for pani samiti (WUAs) and other community-based stakeholders in the water sector on structural formulation, rights, and responsibilities.

vii. Technical capacity building will focus on improving human and instrumental data collection, website development, GIS application, computer modelling, new and improved ground water recharge techniques, water resource assessment and modification, and increasing irrigation efficiency.

viii. Innovative ideas and programmes in water resources sector must be encouraged, recognized, and awarded. (e.g., best performing WUA, best performing city in terms of recycling of its sewage, city having least NRW etc).

3.11 Financing

3.11.1 Water tariff mechanisms

i. The Ladakh State Water Resources Regulatory Authority would be in charge of ensuring equitable access to water and fair pricing for drinking and other uses, including sanitation, commercial, agricultural, recreation and industrial. This authority would conduct a detailed analysis of data, review of legal provisions, and consult with stakeholders. The pricing of water shall encourage its efficient use and reward conservation.

ii. According to the J&K Water Resources Management Act of 2010, water charges would be determined on a volumetric basis to ensure equity, efficiency, and economics.

iii. Annual O&M cost to be recovered from the beneficiaries. This shall match by a rigorous program of improvement in the efficiency of operation and maintenance. For industrial use, full cost of providing water would be recovered.

iv. Ladakh State Water Resources Regulatory Authority will ensure properly planned tariff system which will encourage the recycling and reuse of water after wastewater treatment.

v. A Water Users Association (WUA) would be constituted and given statutory authority to collect and retain portions of water charges, manage the volumetric quantum of water allotted to them, and maintain the distribution system in their jurisdiction. WUAs would also be given the freedom to fix rates subject to floor rates determined by the Ladakh State Water Resources Regulatory Authority.

3.11.2 Exploring Public Private Partnership (PPP) for water infrastructure development

i. The private sector would be encouraged to participate in the planning, development, and management of water infrastructure projects in order to introduce new ideas, new technology, innovative financing, management expertise, higher quality and cost-effective water services, and accountability to water users. Whenever possible, private sector participation in the development and operation of pumped storage schemes, large lift irrigation schemes, water treatment plants, water distribution systems, and wastewater treatment plants should be encouraged. External funding at a reasonable rate of interest will also be encouraged in the development and management of water resources.

ii. Research studies from across the world suggest that if a PPP arrangement is well-structured with an increased level of farmer participation and willingness to pay, it is possible to recover the capital as well as operation and maintenance (O&M) costs.

iii. The UT administration / local bodies may associate private sector in public private partnership (PPP) mode with penalties for failure, under regulatory control on prices charged and service standards with full accountability to democratically elected local bodies on a performance-based management contract.

iv. Once private sector participation in the delivery of services in the water sector becomes well entrenched in the State, a regulatory authority may need to be established to regulate use of water and pricing of services.

v. Models of public private partnerships can be explored in Ladakh are as follows:

- **Build-Operate-Transfer (BOT):** Under this model, a private entity is responsible for designing, constructing, and operating a water infrastructure project (such as a water treatment plant or distribution network) for a specified period. The private entity recovers its investment and operational costs by charging user fees during the contract period. After the contract period, the infrastructure is transferred back to the public sector.

  These projects do not usually involve the challenges of the private sector managing an existing public workforce or an interface with household customers, but they bring the benefits of private investment, expertise and technology and sustainable operations. They are often new build or substantially new build in nature and so also do not carry the risks of existing assets.

- **Design-Build-Operate (DBO):** This model involves the private entity undertaking the design, construction, and operation of the water infrastructure project. The private entity is responsible for financing the project as well. The revenue is generated through user fees or a long-term agreement with the government.

- **Performance-Based Contracts (PBCs)**: These contracts focus on results, with payments conditional on the achievement of outputs. In this type of contract, a private entity is contracted to deliver specified performance targets, such as reducing water losses, improving service quality, or meeting water supply and sanitation targets. The private entity is remunerated based on achieving these predefined performance targets.

- **Small scale private operators:** small scale private sectors are becoming more commonplace in developing countries, with many donor-sponsored water or sanitation PPP projects for rural and peri-urban areas having been successfully implemented and scaled up, with new local operators emerging.

3.11.3 5-Year action plan with funding priorities

The five-year action is developed based on the overall aim of Water Vision 2047 and strategies drafted in this policy which shall be the next steps in the water resource and infrastructure development process.

Following actions will be taken in next five years:

i. **Implementation of Ladakh Water Security Policy:** The UT administration would ensure that Departments and other institutions at various levels under the water sector will be appropriately strengthened and even created, wherever necessary, to enable them to carry out their mandated responsibilities with respect to the implementation of Water Policy. Various targets mandated by SDGs are to be achieved in time bound manner. The respective Line Department shall prepare action plans to achieve these targets as well as for implementation of the strategies envisaged in the policy. These

action plans shall be finalized and approved by State Water Resource Regulatory Authority. PHED shall regularly monitor its implementation.

Following action plans can be prepared:

- **Water Balance Plans (WBPs)** comprising of details of water sources including water bodies, water treatment and distribution infrastructure, area-wise water coverage, status of Non-revenue Water (NRW) and sewerage network including STPs etc. to be prepared.
- **Water Action Plans (WAPs)** comprising of projects in the priority sectors of water supply; sewerage/ septage management; rejuvenation of water bodies including green spaces and parks to be prepared.
- **Aquifer Management Plan** being prepared focusing on maintaining positive groundwater balance in urban aquifer systems. Leh and Kargil will strategize groundwater recharge augmentation by developing a roadmap for improving rainwater harvesting. Districts will develop an annual groundwater balance report to ascertain the current and future availability of groundwater.

ii. **Jal Jeevan Mission in rural areas:** - In rural areas, 75.75% of Functional Household Tap Connections have been installed, with the remaining portion expected to be finished by the end of the year 2023.

iii. **24x7 water supply projects for urban areas:** - A Detailed Project Report (DPR) is currently being prepared to establish an implementing agency for a 24x7 water supply system in Leh and Kargil cities. The system's proposed capacity is 18.26 MLD for Leh by 2055 and for 18.1 for Kargil by 2053. The DPR is in its final stage of development. In Leh, the Water Treatment Plant (WTP) will be constructed close to the Indus Stage-I pumping station. The project aims to provide 24x7 water supply to 100% of households, as well as effective control over the quantum of water supplied vs delivered and the reduction of non-revenue water.

iv. **Irrigation master plan:** An irrigation master plan is being prepared to improve the scenario of irrigation water use efficiency, increase the efficiency of existing defunct irrigation projects, and achieve the full irrigation potential of 1.5 Lac Acres as per the Indus Water Treaty. It is proposed that the funds for the project cost of all irrigation projects to be raised through the Government of India's Accelerated Irrigation Benefit Programme (AIBP).

v. **Solar water lift irrigation Pumps:** The UT- Administration have been provided solar water lift irrigation pumps of various capacities in drought prone arears of UT-Ladakh under budget. Till date 72 pumps have been installed, covering an area of approximately 1000 acres. During the current financial year, 2023-24, 100 more pumps will be installed, with a 500-pump target for the next five years. Furthermore, under Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyaan (PM KUSUM), the Ministry of Renewable Energy (MNRE) GoI has sanctioned 1000 irrigation pumps for each district, with installation expected to be completed by 2030.

vi. **Water Conservation Master Plan and Glacier Conservation Master Plan:** The UT Administration has taken up the matter with the Department of Water Resources & Drinking water, Ministry of Jal Shakti for their technical support in preparing water / snow harvesting and glacier conservation programme in Ladakh.

vii. **Integrated Watershed Management:** Preparation of integrated watershed development and management plan will be undertaken by the UT for each watershed which will form the part of sub-basin /basin water plans of the region and must be implemented through community participation. Initial research will be carried out in a scientific manner.

viii. **Springshed management**: Springshed management program will be implemented with convergence of various central and state government schemes, with an objective of conservation of the natural

springs. Research will be undertaken to identify and map springs in the region. Detailed inventory will be prepared including the type, discharge, water quality, and recharge area. Hydrogeological surveys will be conducted in collaboration with experts to gain a comprehensive understanding of the hydrogeological characteristics of the region, including information on aquifer types, recharge zones, water table depth, and groundwater flow patterns. Based on the studies, protection of the recharge areas of springs will be ensured by implementing measures to prevent soil erosion, deforestation, and pollution in the areas. The UT level Nodal Officer appointed for coordinating with agencies of Government of India in implementation of the springshed management in UT.

ix. **Ladakh Water Informatics Centre (LWIC):** LWIC is proposed to be set up with the goal of optimising the use of water data and adding value to existing data through standardisation, increased interoperability, improved data validation and integration of latest technologies and GIS framework.

x. **Flood zone mapping and flood master plan:** Tentative flood plain zone map (based on Digital Elevation Model levels) for flood area affected by Leh and Saboo nallah in Leh district along with recommendations for flood protection works have been prepared. Flood zone mapping for the Diskit area, which was severely impacted by the 2010 floods, is in progress.

xi. **Institution mechanism:** The UT has adopted a decentralized water management and strengthening of local institution model approach. A participatory village level water security planning process involving community leaders, women, and youth, as well as capacity building, has been proposed to be incorporated into the policy framework. This would ensure a bottom-up approach to water sector planning, with communities not only involved in management but also in planning and taking ownership of their village's water resources.

3.11.4 Water Infrastructure Development

i. UT will ensure safe drinking water, manage wastewater and stormwater, and update infrastructure on a regular basis by replacing antiquated technology, improve resilience to extreme weather events including floods and heavy snowfall, and integrate climate resilience into infrastructure planning and design.

ii. A periodic review of the maintenance and efficacy of all water infrastructure such as check dams, canals, flood protection works, springshed protection works, irrigation off-takes will be undertaken. A programme of improvement in infrastructure maintenance will be designed and implemented. Appropriate annual budgetary provisions should be made for this purpose.

iii. Norms for the maintenance of water supply and irrigation schemes, particularly for the replacement of pipelines and machinery, should be developed. Automation and the use of solar energy pumps shall be encouraged to reduce the maintenance costs of lift systems.

iv. Reliable and appropriate data and information essential for effective management of water resources. A modern integrated monitoring networks for hydro-meteorological, water resources and water use data with information management system, shall be established on real time basis. This will sustain and support planning, project formulation and implementation, operations and decision making.

v. The SWRRA shall conduct the benchmarking exercise in all UT projects in a phased manner, so that all projects are covered. Every year, the UT will publish an annual benchmarking report of water resources projects, along with analysis and recommendations for improvement.

3.12 Review of the policy

The Ladakh Water Security Policy being a dynamic document would be periodically reviewed as and when needed, to overcome the future water sector development and management challenges.

References

[1] Yangchan, J. Raghuvanshi, M. Kumar, A, and Arya, C.K. (2019) Climate Change-Induced Impact on Water Resource of Ladakh Cold Arid Region. Int.J.Curr.Microbiol.App.Sci.8(05): 1996-2009. Doi: https://doi.org/10.20546/ijcmas.2019.805.232.

[2] Census of India. (2011) Registrar General and Census Commissioner of India.

[3] Dormer, W. (2020) How ice stupas prevent water shortages in Ladakh. *The borgen project*

[4] Daphne, G. Sven, N. Akhtar, A. and Jenny, K. 2015. Planning Under Uncertainty: Climate Change, Water Scarcity and Health Issues in Leh Town, Ladakh, India

[5] Union Territory of Ladakh. (2020). Status of Drinking Water and Sanitation in Ladakh

[6] Public Health Engineering Department, Leh, Ladakh

[7] Central Ground Water Board (2023) Groundwater Resources of Union Territory of Ladakh. North Western Himalayan Region, Jammu

[8] Ladakh: Unleashing potential (2021). *Assocham*

[9] Bremen Overseas Research and Development Association, Ladakh Ecological Development Group. (2019). Water in Livable Leh: Report on Water Supply and Usage in the Highest Town of India

[10] The Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010

[11] Gazette of India, vide Notification number S.O. 3289 (E) 24th September 2020, Guidelines to regulate and control ground water extraction in India, Ministry of Jal Shakti, Department of water resources, river development and ganga rejuvenation, Central Ground Water Authority

[12] Central Ground Water Board, Ministry of Jal Shakti, Department of Water Resources, RD &GR Government of India. (n.d.). Retrieved from https://cgwb.gov.in/index.html

[13] Central Water Commission, Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, GoI. (2023, February 8). Retrieved from https://cwc.gov.in/welcome-central-water-commission

[14] The Indus Waters Treaty. 1960. Came into force on 12 January 1961, upon the exchange of the instruments of ratification at New Delhi, with retroactive effect from 1 April 1960, in accordance with article XII (2).

[15] National Water Policy. (2012). Ministry of Water Resources, Government of India.

[16] About Mission. National Water Mission, Ministry of Jal Shakti, Department of Water Resources, RD & GR, Government of India. (2023, July 7). Retrieved from https://nwm.gov.in/about-mission

[17] Jal Shakti Abhiyan. (n.d.). Retrieved from https://jsactr.mowr.gov.in/

[18] About. Jal Jeevan Mission, Department of Drinking Water and Sanitation, Ministry of Jal Shakti. Retrieved from https://jaljeevanmission.gov.in/about_jjm

[19] Jal Jeevan Mission progress report, 2023

[20] AIBP Monitoring System - PMKSY. (n.d.). Retrieved from https://pmksy-mowr.nic.in/aibp-mis/

[21] Pradhan Mantri Krishi Sinchayee Yojana. (2019, June 12). Retrieved from https://pmksy.gov.in/AboutPMKSY.aspx

[22] Integrated Wasteland Development Programme. Department of Land Resources. Ministry of Rural Development. Govt. of India. (2018, February 2). Retrieved from https://dolr.gov.in/en/integrated-wasteland-developmentprogramme#:~:text=Integrated%20Wastelands%20Development%20Project%20(IWDP)%20Scheme&text=This%20scheme%20is%20under%20implementation,taken%20up%20under%20this%20Scheme.

[23] Goal 6: Clean Water and Sanitation – Green Governance Initiative. (n.d.). Retrieved from https://ggiindia.in/goal-6-clean-water-and-sanitation/

[24] Angchok, D., Singh, P. (2006). Traditional irrigation and water distribution system in Ladakh. Retrieved from https://www.academia.edu/66833739/Traditional_irrigation_and_water_distribution_system_in_Ladakh

[25] Singh, H. (1978). Ladakh: Problems of Regional Development in the Context of Growth Point Strategy. Unpublished PhD thesis, Centre for Study of Regional Development, Jawaharlal Nehru University, New Delhi.

[26] Agriculture Department, Ladakh

[27] Saxena, A. Raghuvanshi, M., Suna T. (2021, April 4). Traditional water management of subsistence agriculture system in cold arid ladakh: A review. *Ijser*

[28] Tundup, P. Wani, M. Dawa, S., Hussain, S. and Laskit, J. (2017). Water Harvesting and Conservation under Cold Desert Condition of Ladakh (J&K): Constraints and Strategies. Int.J.Curr.Microbiol.App.Sci. 6(2): 1796-1800. doi: http://dx.doi.org/10.20546/ijcmas.2017.602.201

[29] Wangchuk, R. N. (2021, November 20). This Innovative Ladakhi Greenhouse Is Letting Farmers Grow Tomatoes in Freezing Winter. Retrieved from https://www.thebetterindia.com/266439/this-innovative-ladakhi-greenhouse-is-letting-farmers-grow-tomatoes-in-freezing-winter/

[30] Chosdol, K. (2018, June 16) Water. *Reachladakh.* https://www.reachladakh.com/news/opinion/expert-talk/water

[31] Sharma, J. & Mir, A. (2000). Dynamics of cold arid agriculture. Kalyani publisher, New Delhi, India.

[32] Nusser et al., 2019

[33] Norphel, C. (2009). Artificial Glacier: A High-Altitude Cold Desert Water Conservation Technique. Leh Nutrition Project, Leh, Ladakh

[34] Stapleton, P., Patacsil, C. (2016, December 2). Grafting glaciers and building ice stupas. International Water Management Institute (IWMI). https://www.iwmi.cgiar.org/2016/12/grafting-glaciers-and-building-ice-stupas/

[35] Leh Nutrition Project & Elrha. (2022, December). Artificial Glaciers (AGs) – Past, Present and Future: A Report

[36] Wani et al., (2020). Single-year thermal regime and inferred permafrost occurrence in the upper Ganglass catchment of the cold-arid Himalaya, Ladakh, India

[37] Brief on Jal Shakti Abhiyan – Source of Sustainability of Drinking Water. (2023). Jal Shakti Abhiyan, Ministry of Jal Shakti, GoI

[38] Siddiqui, M., Chohan, S., Upadhyay S. (n.d) Lighting Up Ladakh: Realizing the importance of off-grid energy solutions in the context of unique geographical reality. *Heinrich Boll Foundation*

[39] Sharma, S., Rawal, R., Pande, R., Phunsog, C., Raina, P., Sultan, M. (2020). Disasters and Ladakh: Action Points for Management and Mitigation. G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand

[40] In Pictures: The ruins of Ladakh. (2014, August 6). Retrieved from https://www.aljazeera.com/gallery/2014/8/6/in-pictures-the-ruins-of-ladakh

[41] Ladakh Floods: A Timeline of Disaster. (n.d.). Retrieved from https://thewire.in/environment/ladakh-floods-timeline-disaster