Global Water Partnership South Asia
India Water Partnership

Report on

Enhancing Capacity to Address Climate Change in Integrated Water Resources Management (IWRM) in Uttarakhand State

December, 2021

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Acknowledgment

We convey our sincere thanks and place on record the valuable support we received from the National Institute of Hydrology (NIH), Roorkee & Indian National Committee for Intergovernmental Hydrological Programme (INC-IHP), UNESCO in organizing the State Level Sensitization Workshop on "Enhancing Capacity to Address Management (IWRM) in Uttarakhand" at NIH, Roorkee campus on 7th December, 2021 successfully.

We also convey our earnest regards to the Forest Department, Irrigation & Minor Irrigation Department, Uttarakhand Council of Science and Technology, Horticulture Mission of Uttarakhand, Department of Rural Development, Watershed Development Department, Agriculture Department, Public Health Engineering Department, Uttarakhand Pollution Control Board, Swajal Sansthan, Uttarakhand State Disaster Management Authority, Irrigation Research Institute for nominating the concerned officials who contributed their meaningful participation in the workshop.

We express our sincere thanks to Er. A B Pandya, Secretary General, International Commission on Irrigation and Drainage (ICID) and Dr Rajendra Dhobal, Director General, Uttarakhand Council of Science and Technology for gracing the workshop as the Chief Guests and addressing the audience with their dynamic and insightful speeches.

Our thanks also go to the eminent guest speakers namely; Mr.H K Varma, Executive Director, ICID; Dr V C Goyal, Scientist "G", NIH Roorkee & Member Secretary of INC IHP, UNESCO; Dr Lior Asaf, Water Attaché, Israel Embassy, New Delhi; Mr. Sunil Kumar, Director, Basin Planning-I, Central Water Commission, Ministry of Jal Shakti, Government of India; Mr. Dharm Singh Meena, IFS, Divisional Forest Officer, Narendra Nagar Forest Division; Dr Swapnamita Vaideswaran, Scientist, Wadia Institute of Himalayan Geology; Dr Soban Singh Rawat, Scientist "E", NIH, Roorkee; Dr Debashish Sen; Director of People's Science Institute, Dehradun; Dr Jyoti Patil, Scientist "D", NIH, Roorkee; Mr. Anshuman Shukla, CEO of Retrota Technology Pvt Ltd, Dehradun and Mr Kesar Singh, Editor, India Water Portal and our overseas colleagues, Mr Laurent Charles, IWRM and Knowledge Management Specialist, Global Water Partnership and Ms Gergana Majercakova, Senior Learning Specialist, Global Water Partnership for their lucid presentations/speeches.

We are also grateful to Mr. S P Subudhi, I.F.S, Member Secretary, Uttarakhand Pollution Control Board Government of Uttarakhand, Mr. Sushant Kumar Patnayak, I.F.S, Chief Conservator of Forest & Additional Chief Secretary, Forest Environment & Climate Change Directorate, Dehradun and Mr. Gauri Shanker, Director, Agriculture, Uttarakhand for nominating senior officials to participate in the workshop.

Dr. Veena Khanduri,
Executive Secretary-cum-Country Coordinator

Need for the Project

Climate change has strong influence on precipitation and melting response of glaciers/snow cover in the Himalayas. The Himalayan region is projected to exhibit an increase in the precipitation in the 2030s scenario, with some areas of Uttarakhand showing an increase of up to 50%. The number of rainy days in the Himalayan region in 2030s may increase by 5-10 days on an average. Further, the intensity of rainfall is likely to increase by 1-2 mm/day. Uttarakhand is most vulnerable to climate mediated risks. Mountainous regions are vulnerable to climate change and have shown "above average warming" in the 20th century. Studies conducted by Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India have shown an increase in annual temperature in the Himalayan region, a net increase in rainfall in the 2030s with respect to the simulated rainfall of the 1970s in the Himalayan region (Government of Uttarakhand, 2014). Impacts are expected to range from reduced genetic diversity of species to erratic rainfall leading to flash floods to glacial melt in the Himalayas leading to increased flooding that will affect water resources within the next few decades. Some of the reported climate-change-induced changes in the Uttarakhand Himalaya include receding glaciers and an upwardly moving snowline, depleting natural resources, erratic rainfall, irregular winter rains, advancing cropping seasons, fluctuations in the flowering behavior of plants, shifting of cultivation zones of crops, reduction in snow during winters, a rise in temperature, an increasing intensity and frequency of flash floods and drying up of perennial streams. Climate change will also affect the hydrological regime changing water flows, global and regional precipitation levels, evaporation, and snow cover. Rising temperatures can also cause rapid glacial melt consequently impacting freshwater supply and quality. The concerns over water resources in the State emerge at various levels such as:

- Significant variations in glacial melt volumes and the lack of information to estimate reliable quantum's of water availability.
- Lack of a water management policy that reflects on the intimate relationship of water resources and forests.
- Poor water supply systems in urban and rural areas with ever changing systems of water management.

Discharge of the water sources has shown a considerable depleting trend during the last decade, due to which rural drinking water supply schemes under maintenance charge of Uttarakhand Jal Sansthan have been badly affected.

Due to the technical nature of the topic of climate change and its varied understanding within different levels of the stakeholders, the need to raise awareness and build capacities to integrate climate change in planning for Integrated Water Resource Management (IWRM) is important and need of the hour. The project will sensitize and build capacities of officials of

water resources and other relevant departments and institutions to implement and mainstream adaptation actions into IWRM planning. The climate responsive approach to IWRM will help the State government to ensure efficient and effective planning for water use with a view to meet the needs of all the sectors.

Description of Project

Under the project it is planned to sensitize relevant officials, departments, and institutions to develop skills in water management, and concrete knowledge for managing water related risks and climate change impacts for Uttarakhand State. This requires sensitization and building capacities of various stakeholders involved in IWRM planning, which will help them to understand the impact of climate change on glaciers, snowmelt and runoff, simulate future water availability and help in taking appropriate decisions towards sustainable use of the available water resources for climate adapted development of watersheds in the mountain regions.

Objectives

The main objective of the project is two-fold. One is to understand the capacities of the officials of Water Resources Department, other line departments, local government and other relevant stakeholders with respect to IWRM in Uttarakhand State. Within this objective, it is also important to understand the emerging gaps in the capacity with respect to IWRM. The capacity is understood in terms of human resource, access to technology and the requisite skills to make use of the technology and knowledge. The other objective is to contribute to capacity building in the same respect through a multi-agency workshop with the core aim of bringing all stakeholders on a common platform to discuss IWRM, make a joint study of various case studies on work done in the Uttarakhand State and bring subject matter experts from in and around the World/different regions of the country to help in the capacity building of the stakeholders.

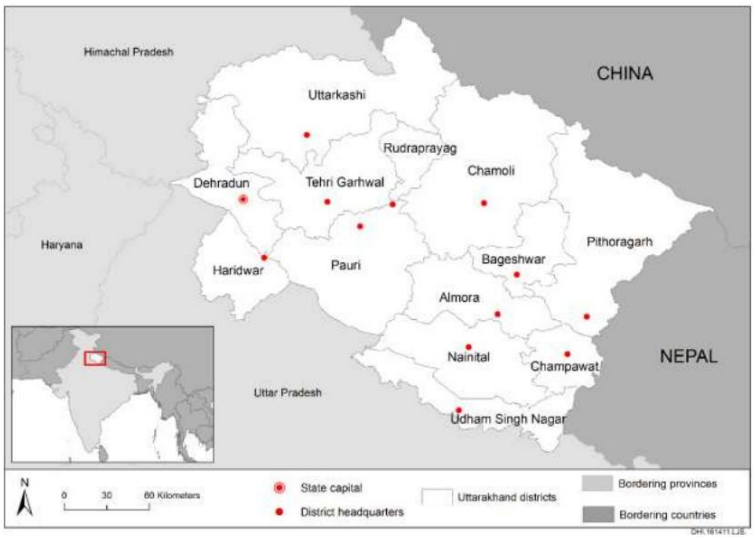
Methodology

The methodology for the project had three aspects. First one was to do the background research to know about the work done on IWRM in the State. Under this aspect, the water resources of Uttarakhand were comprehensively studied with particular focus on challenges and implementation of IWRM. The river basins of the State were studied along with their drainage systems. To get more insight about the project a Report prepared by India Water Partnership in 2016 on “To Review and Examine the existing Regulatory and Institutional Framework of Uttarakhand to operationalize the National Water Policy-2012” was also studied. The second aspect comprised of site visits to locations across Uttarakhand to gain a better understanding of the water resources situation of the State and also to corroborate what the secondary sources /reports were indicating about the situation on the ground. The third aspect comprised of personal interviews with key stakeholders in government nodal agencies such as

Forest Department, Irrigation & Minor Irrigation Department, Uttarakhand Council of Science and Technology, Rural Development Department amongst the others. Interviews were also conducted with various NGO's working in this sector across Uttarakhand. The purpose of these interviews was to understand the capacity of the key officials with respect to IWRM, and also to understand the gaps and shortcomings with respect to effective implementation of the same. These interviews along with site visits were used to generate case studies that showed how effective IWRM had created benefits in the water resources of the State. Based on the above research and interviews, a State Level Sensitization Workshop on "**Enhancing Capacity to Address Climate Change in Integrated Water Resources Management (IWRM) in Uttarakhand**" was organized by India Water Partnership (IWP) in collaboration with National Institute of Hydrology (NIH) & Indian National Committee for Intergovernmental Hydrological Programme INC-IHP) on 7th December, 2021 at NIH, Roorkee, Uttarakhand to build the capacity of key officials of the Nodal Departments of Uttarakhand State Government. The Workshop report is placed as ***Annex-I*.**

Water Scenario and Climate Change in Uttarakhand

Uttarakhand is the birthplace of the majestic Ganga River of India. The Ganga Basin is the cradle of one of the most ancient civilizations of the World. Needless is to emphasize the importance of this basin in the World, and the importance of safeguarding the cradle of this basin.



Map 1: Geographical setting and district boundaries of Uttarakhand

It is known that water bodies are the most sensitive to climate change and rising temperatures. Enough cannot be said about retreating glaciers, increasing discharge in the rivers, increase in precipitation and the intensity of precipitation in monsoon and non-monsoon season in turn increasing the frequencies of flash floods, also causing increase in frequencies of landslides. Uttarakhand with its Himalayan topography and sensitive ecosystem is at much greater risk from experiencing the disasters caused by the climate change. In the year 2021 with the evident risk of climate change, International focus has increased in understanding ground capacities of the communities to understand and mitigate the associated risks of climate change to their ecosystem.

Overview of State River and Drainage System

Map 2: Main River systems of Uttarakhand

The two major river basins of the State are the Ganga Basin and the Yamuna Basin. Within the Ganga basin in Uttarakhand, the area is sub-divided into Alaknanda and Bhagirathi basins ending at Devprayag. The Alaknanda basin includes the major Rivers Alaknanda and Mandakini.

The Mandakini River joins Alaknanda at Rudraprayag district and flows downward as River Alaknanda. This basin primarily lies in Chamoli, Rudraprayag, Tehri Garhwal and Pauri Garhwal districts. Small areas of Pithoragarh district and Bageshwar district also fall in the Alaknanda basin.

Uttarkashi, Tehri Garhwal and Pauri Garhwal districts constitute the Bhagirathi basin. On the eastern part lies the Sarda basin. The rivers Dhauliganga and the Kali (which is the continuation of Dhauliganga) ending at Pancheswar were partly considered for this study.

The Alaknanda and Bhagirathi Rivers meet at Devprayag town and move forward from this confluence with a new name "Ganga". The Dhauliganga and Kali rivers also lie in the Ganga basin, and feed the River Ganga. The Dhauliganga River is fed by two head waters, namely Dharamganga and Lasser with a glacier close to the Darma Pass as their source. The Dhauliganga joins Kali and serves as its important tributary. Kali flows through the India-Nepal border which after reaching the plains is called Sharda. The river flows southeast across the plain to join Ghagra River, a tributary of Ganga.

The table below gives an idea of the range of climate zones that Uttarakhand lies in. It also gives an idea of the precipitation pattern that Uttarakhand experiences as the State encompasses through glacier zones to Gangetic planes and the range of temperatures being very broad.

Climatic Zone	Altitude (m)	Average Temperature Range (^{0}c)		
		Annual	June	January
Tropical	300-900	18.9-21.1	27.2-29.4	11.1-13.3
Warm (Sub Tropical)	900-1800	13.9-18.9	21.1-27.2	6.1-11.1
Cool	1800-2400	10.3-13.9	17.2-21.1	2.8-6.1
Cold	2400-3000	4.5-10.3	12.3-17.2	1.7-2.8
Alpine	3000-4000	3.0-4.5	5.6-13.3	Below zero
Glacial	4000-4800 Above 4800	For 10 months, below zero and in July and August between 2.2-3.9		
Perpetually Frozen zone (Cold Desert, No vegetation)				

Table 1: Climatic zones in Uttarakhand

The Overall Problem

Challenges faced by more and more countries in their struggle for economic and social development are increasingly related to water security. Water shortages, quality deterioration and flood & drought impacts are among the problems which require greater attention and action. The overall problem can be summed in key points as follows:

1. Resources under Pressure:

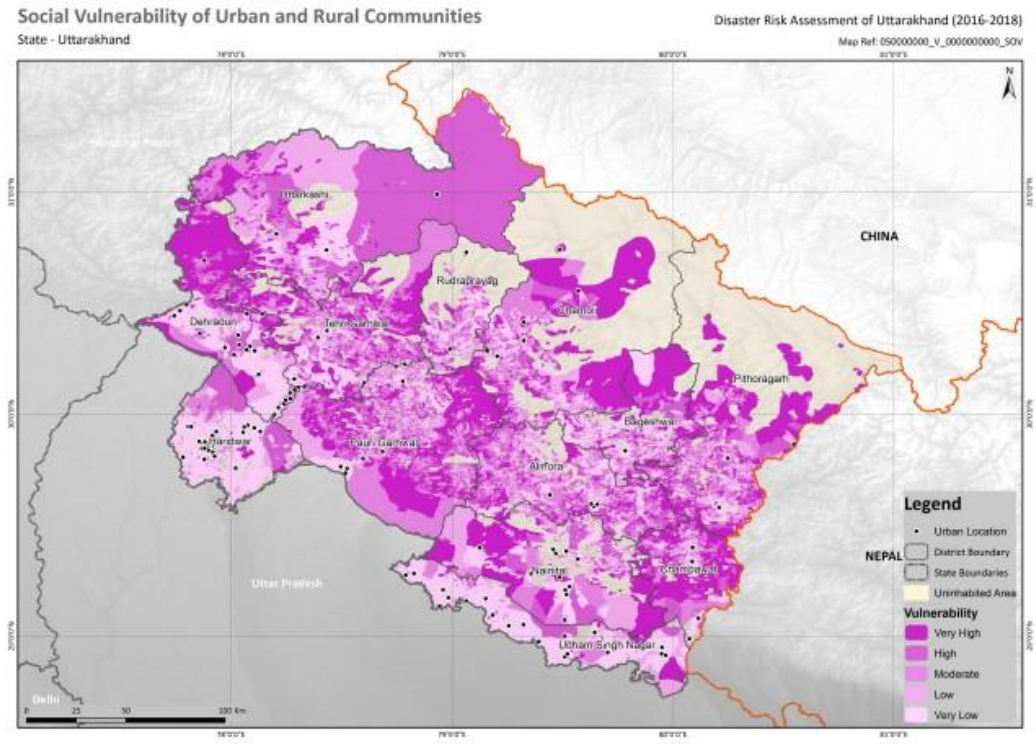
The World's fresh water resources are under increasing pressure. A combination of social inequity, economic marginalization and lack of poverty alleviation programs also force people living in poverty to overexploit soil and forest resources which often results in negative impacts on water resources.

The same trends witnessed in Uttarakhand are watershed areas of the State which are part of the bigger watershed of the Ganga river system. The small watersheds which once were water sufficient are now water scarce. Groundwater systems are overexploited in urban, agricultural and industrial areas, leading to depletion of groundwater aquifers. Spring sheds are not being fed with enough water and hence important springs feeding the larger and evergreen river systems are now seen as dry creating water stressed areas in Uttarakhand.

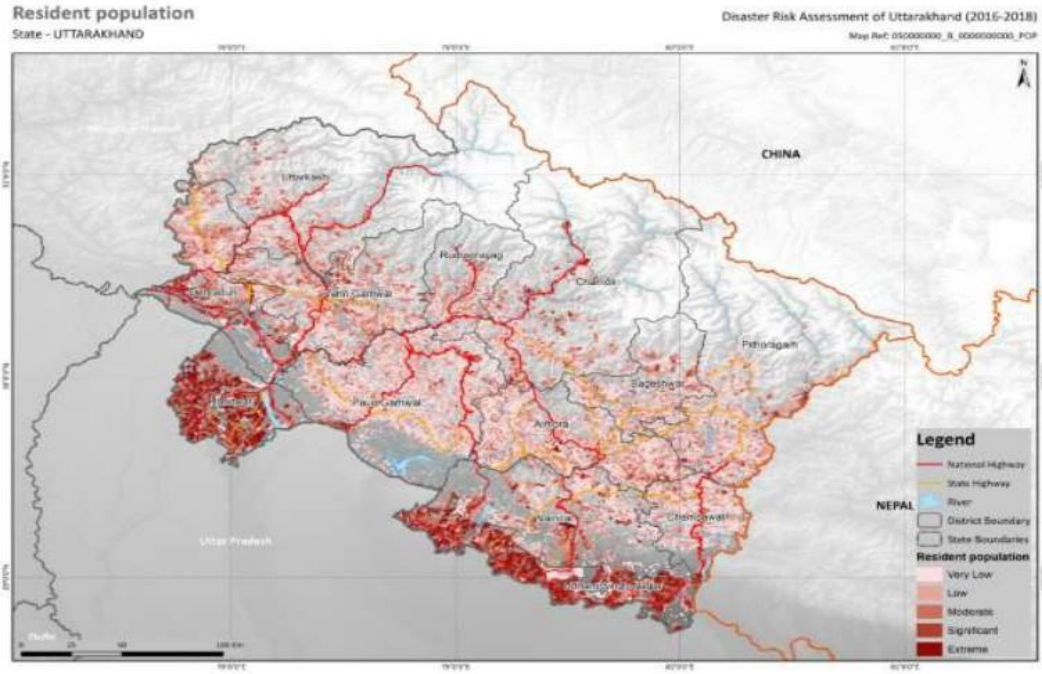
2. Population under water stress:

The World population has increased by factor of about three during the 20th century whereas water withdrawals have increased by a factor of about seven. This ratio is expected to grow to two thirds by the year 2025.

According to the Census of 2011, Uttarakhand has seen a total population growth of 18.8% in the decade from 2001 to 2011. In the previous decade, the State had seen a rise of almost 20% in its population. This rising trend has led to overexploitation of water resources to cater the demands of the rising population. The map below gives an indication of the social vulnerability of urban and rural population of Uttarakhand. The data of the map is derived from baseline ranking of urban and rural settlements indicating baseline community socio-economic vulnerability. The second map gives an idea of resident population density in Uttarakhand. This resident population is termed as vulnerable because they are not secured with basic requirements of life which are food, water, shelter and economic stability. Study of these two maps together gives us an idea of the extent of vulnerable communities in Uttarakhand which are also the indigenous communities translating the vulnerability to water insecurity.



Map 3: Map indicating socio-economic vulnerability



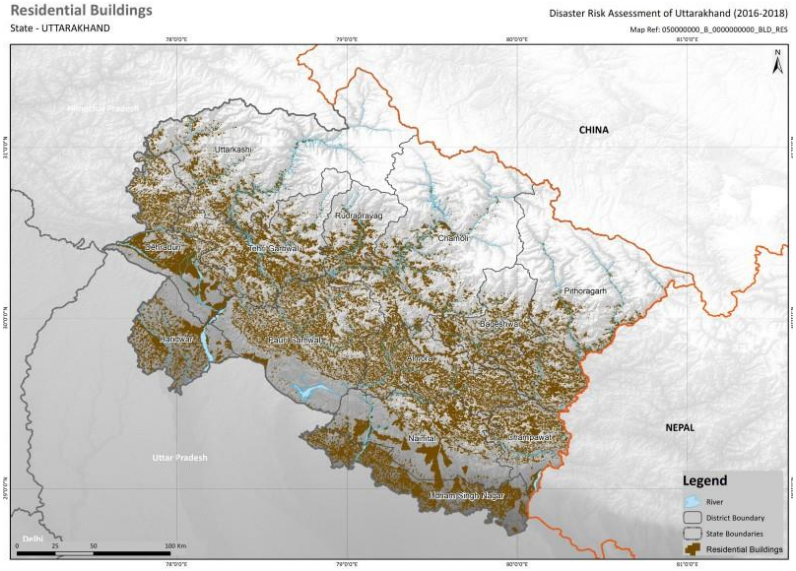
Map 4: Resident Population Density across Uttarakhand

3. Impact of the pollution in river systems:

Pollution of water is inherently connected with human activities. Deteriorating water quality caused by pollution influences water usability downstream, threatens human health and the functioning of aquatic and vulnerable ecosystems so reducing effective availability and increasing competition for water of adequate quality. These effects are also seen in the vulnerable areas in Himalayan region.

Uttarakhand has seen an increase in the number of polluted stretches of the rivers. Being a part of the extensive Ganga River system, which eventually feeds a large part of the country, this situation is alarming. According to the Central Pollution Control Board (CPCB) Report, 2018 added four more stretches from 2015-2018 to the category of polluted rivers making the total official number of polluted rivers in the State to nine. This revelation means that the civic and industrial waste is not being handled adequately at the source and is disposed in the river system. This also shows the inefficiency of the State administration to ensure management of the wastewater from civic and industrial bodies.

The map below gives a schematic representation of the concentration of residents in Uttarakhand. This also gives an idea of the increase of sprawl into the earlier forest areas of Uttarakhand. As these forest areas were home to many vulnerable springs and streams which feed the Ganga River system. The increase in the residential areas vis a vis industrial areas catering to the residential population gives an idea of the pressure that is exerted on the natural water resources in the State.



Map 5: Digitized map of residential buildings in Uttarakhand

4. Water Governance Crisis:

The above problems are aggravated by shortcomings in the management of water. Sectoral approaches to water resources management have dominated and are still prevailing. This leads to the fragmented and uncoordinated development and management of the water resources in the State. Water management is usually left to top – down institution, the legitimacy and effectiveness of this approach is mostly seen to be failing.

Water governance in India has seen a major crisis as many administrative bodies are linked to water governance dissolving the accountability of these bodies. Similarly, Uttarakhand has seen a water governance crisis with the increase in industrialization and with the changing times. But there is an unclear understanding of accountability of the safeguarding of water systems. Since water systems include a complex variety of systems from spring shed, groundwater percolation, groundwater aquifers, smaller water streams leading to major river systems. These water systems go through different jurisdictions of administrative bodies for example forest areas – coming under Forest Department, Micro-Irrigation Department, Irrigation Department, Rural Development Department, Peyjal Nigam catering to water supply, State Pollution Control Board catering to waste management and many more. This is the problem where all of the departments and bodies associated in some way or the other in water management draft their own policy and development plans thus increasing confusion in the system. These departments over the years started working in silos and increasing miscommunication over the projects within each other.

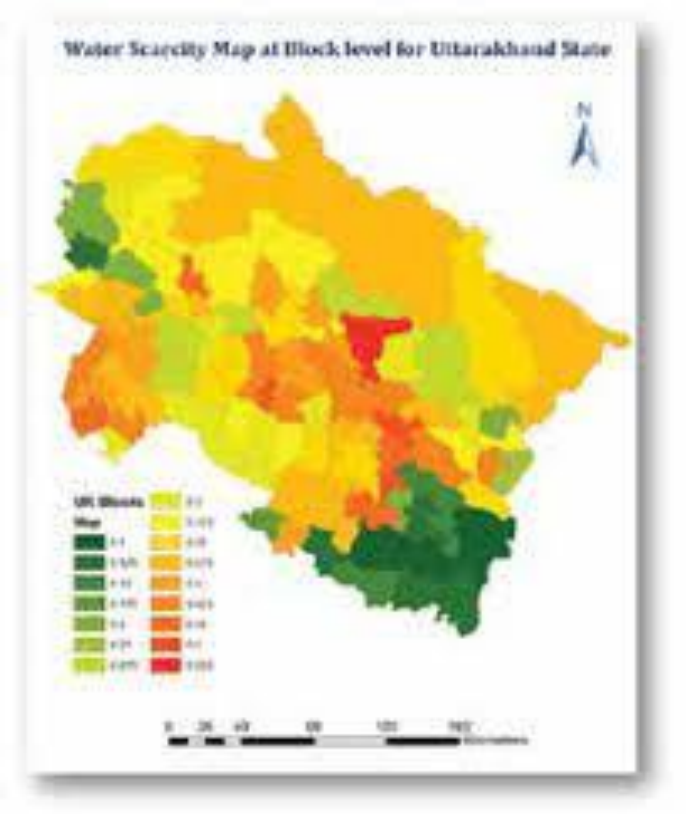
The Main Challenges

This century is witnessing unprecedented growth with an extraordinary level of challenges in water resources management. The main challenges are summarized as below:

1. Securing Water for People

It is observed that one fifth of the World's population is without access to safe drinking water and half of the World's population is without access to safe sanitation which also requires water. In the coming era water supply and sanitation for urban and rural areas represents one of the most serious challenges.

Uttarakhand is seeing a similar problem. The map published by GB Pant National Institute of Himalayan Environment and Sustainable Development shows the water scarcity map of Uttarakhand. This map clearly indicates that most of the areas in Uttarakhand are experiencing water scarcity. This challenge is going to increase with time thus it is imperative that agencies should act in a collaborative way to reduce the water scarcity of Uttarakhand State.



Map 6: Water scarcity map of Uttarakhand published in 2019

2] Securing Water for Food Production

Water is a key requirement for food production across the globe. Water is also increasingly seen as the main constraint on food production. Water withdrawal for agriculture is already responsible for more than 70% of all water withdrawals. Even with an estimated need for additional 15 to 20 % of irrigation water over the next 25 years, serious conflicts are likely to arise between water for irrigated agriculture and water for other human needs and ecosystem uses.

3] Protecting vital ecosystems

Terrestrial ecosystems in the areas of the entire watershed are vital for rainwater infiltration, groundwater recharge and river flow regimes. The ecosystems depend on water flows, seasonality and water table fluctuations. These ecosystems have high water quality as a fundamental determinant. Land and water resources management need to ensure that vital ecosystems are maintained, and adverse effects on other natural resources are minimized.

4] Dealing with variability of water in time and space

Almost all the freshwater available for human use, originates in some or the other way from precipitation. Precipitation varies immensely over time and space. Most regions of the World especially tropical and subtropical regions are characterized by huge seasonal and annual variations in rainfall. These variations are accentuated with the climate change and related temperature changes in the atmosphere. The ability to managing this variability is seen to decrease greatly with the decrease in socio-economic stability of a region and communities therein.

5] Managing risks

Studying every stage of water flow in a watershed area will bring about the risks associated with managing the watershed areas for the betterment of the communities living in those areas. Variations in water flows, land mismanagement can have catastrophic effects in terms of large-scale loss of human life and damage to economic, social and environmental systems. Water pollution creates another set of risks affecting the health and stability of the entire ecosystems and human settlements therein. Economic and political instabilities also add to a set of risks. These risks need to be carefully understood and various risk -tradeoff options need to be considered to develop a robust IWRM plan.

6] Political Will and Awareness

Political will is vital to ensure necessary investments that are made towards the development and management of water resources. It is also important that this is on top of the political agenda. To achieve this, it is important to create public awareness and mobilize effective support for sustainable water management. Such awareness will put adequate pressure for action that may help create the required political will to act. However, there remains the challenge of a fragmented approach to water resources management, where governing bodies with conflicting interests may scuttle the potential to create maximum benefit. Additionally, policies are designed without considering the entire spectrum of water users or without consulting stakeholders across various sectors and institutions. Hence a coordinated and collaborative approach is essential for a successful IWRM, where complex coordination issues amongst various stakeholders must be carefully considered.

Water Resources Management

The development of infrastructure, allocation of the resources, incentives for its efficient use, its protection, as well as the financing of all these activities are among the activities that collectively constitute water resources management. But the society grapples with the challenges of managing large, complex and interconnected systems. This is exemplified by

current approaches to sustainable development: the attempt to manage our resources in a manner that ensures tomorrow's generations can draw the same benefit from them as we do or even better. The management of water resources is amongst the most challenging dimensions of sustainable development. It is the challenge that the approaches being implemented under the banner of "Integrated Water Resources Management" address, explicitly placing environmental sustainability as one of the three key objectives of water management along with social equality and economic efficiency.

IWRM as an Element of Sustainable Development

In the history of water management this is one of the emerging challenges as the number of users and uses of the water bodies has grown and the intensity of their water use, often measured in terms of the proportion of available water that is used, has increased. This is very evident in the Ganga basin right from its source to the Ganga delta, we see at every point, every tributary and distributary (estuary) of Ganga being exploited for its water.

Where single-purpose infrastructure is developed to serve, for instance, the farmers of a particular region, as in many parts of the Indian subcontinent, it is sufficient to establish an agricultural administration that could control irrigation water use along with other aspects of the schemes. But as more schemes are built, and other water uses and users emerge, it becomes increasingly difficult to enable continued use without coordination and engagement among different users. Even where the needs of individual users could be sustained, this is often at the cost of the natural environment – and of communities who depend on the environment for their livelihoods. As a result, we must pay greater attention to the 'soft' management and protection of the water resource. This has led to the emergence of the concept of IWRM, which in many cases reflect good practices**.**

The IWRM explicitly promotes use of the resource base in the ways that best support social equity, economic efficiency and environmental sustainability objectives. These objectives are:

Social Equity goal is 'to ensure equitable access to water, and to the benefits from water use, between women and men, rich people and poor, across different social and economic groups both within and across countries, which involves issues of entitlement, access and control.

Economic Efficiency – to make scarce water resources go as far as possible and to allocate water strategically to different economic sectors and uses.

Environmental Sustainability refers to protect the water resources base and related aquatic ecosystems, and more broadly to help address global environmental issues such as climate change mitigation and adaptation, sustainable energy and sustainable food security.

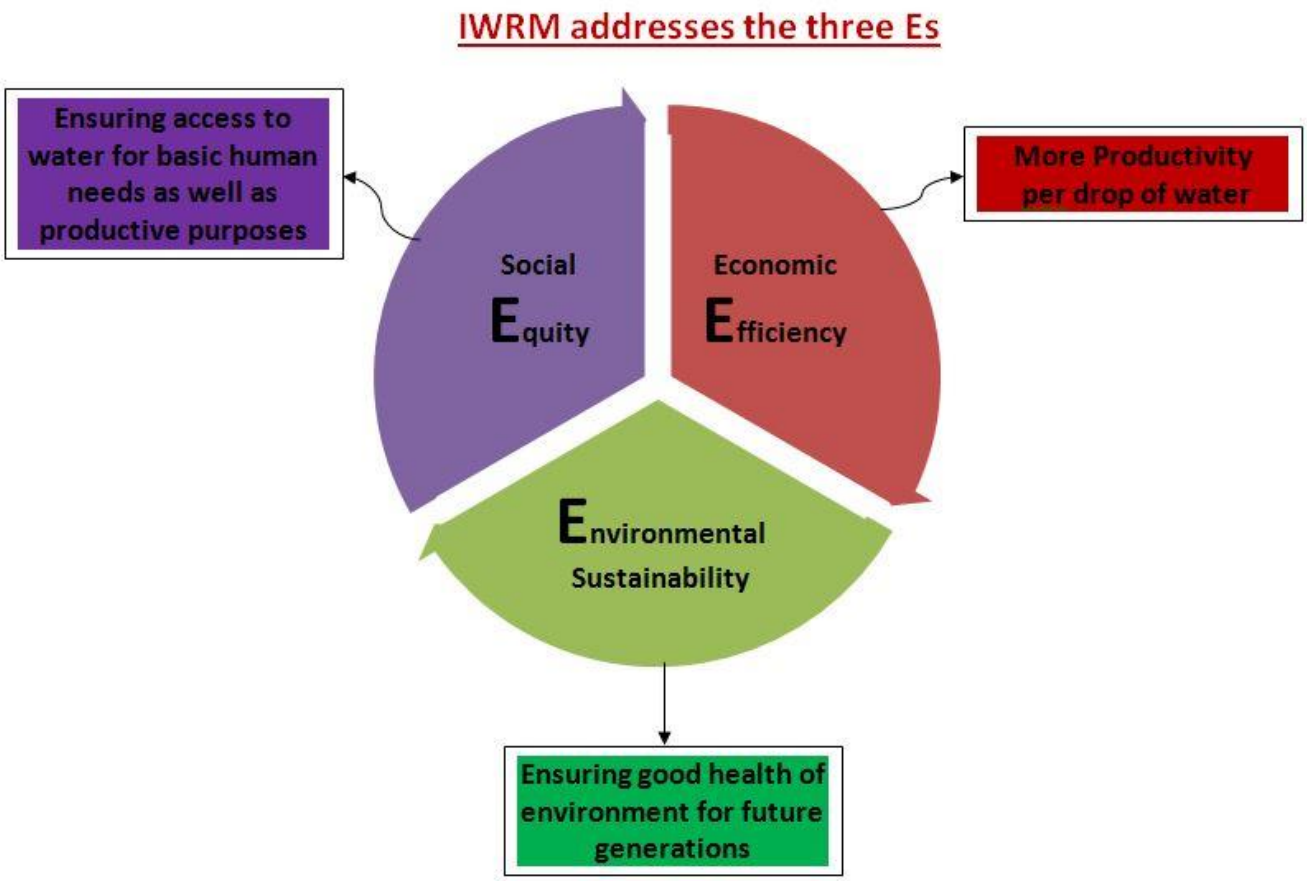


Figure 1: The three Es of IWRM

Blueprint and Key Features of IWRM

Experience has shown that effective strategies for better water resources management consistently include some common features. Good practices almost certainly involve, to one extent or another. Following are the elements:

1. **Sound investments in infrastructure** – to store, abstract, convey, control, conserve and protect surface and ground water.

2. **A strong enabling environment** – setting goals for water use, protection and conservation: improving the legislative framework; enhancing financing and incentive structures; and allocating financial resources to meet water needs.

3. **Clear, robust and comprehensive institutional roles** – laying out institutional reforms and functions, building institutional capacity, developing human resources, establishing transparent processes for decision making and for informed stakeholders participation.

4. **Effective use of available management and technical instruments** for such purposes as water resources assessment, water resource management planning, demand side management and social change, conflict resolution over water, allocation and water use limits, using value and prices for efficiency and equity, information management and exchange.

Figure 2: Blueprint of IWRM

IWRM and Climate Change related Risks

Climate change is one of the significant threats for the society. Water is the primary medium through which climate change influences the Earth's ecosystems and therefore people's livelihoods and well-being are at risks. Changes in hydrological cycle due to climate change can lead to diverse impacts and risks. Renewable surface water and groundwater resources in most dry subtropical regions are projected to reduce due to climate change. The fraction of global population that will be affected by water scarcity and riverine floods is projected to increase

with the level of global warming in current century. Agriculture is directly related to water and therefore, food security will be potentially affected by climate change, including food production, transportation, process, access, use and price stability. Climate change and the associated impacts on water are expected to increase the water-borne diseases in many regions and especially in the low-income developing countries. In urban areas, climate change is projected to increase risks for people, assets, economies and ecosystems, including risks from heat stress, storms and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, sea level rise and storm surges. Rural areas are expected to experience major impacts on water availability and supply, food security, infrastructure and agricultural incomes, including shifts in the production areas of food and non-food crops around the World. Beside climatic drivers, other non-climatic drivers such as current demographic trends, economic development and related land-use changes have direct impact on social and ecological systems and their processes. These drivers of change are closely linked to each other and pose complex management problems for land and water resources.

In order to deal with these complex problems, water management issues should generally consider multiple decision-making criteria and large numbers of possible alternatives, usually characterized by high uncertainty, complex interactions and conflicting interests of multiple stakeholders, but also of a multiplicity of compartments, such as river, land or coastal ecosystems or different economic sectors. Therefore, the traditional fragmented approach of management must be replaced by more holistic system review approaches. The IWRM is such an approach that has been widely accepted internationally as the way forward for efficient and equitable management of water and related resources.

Climate Change in the Indian Himalayas

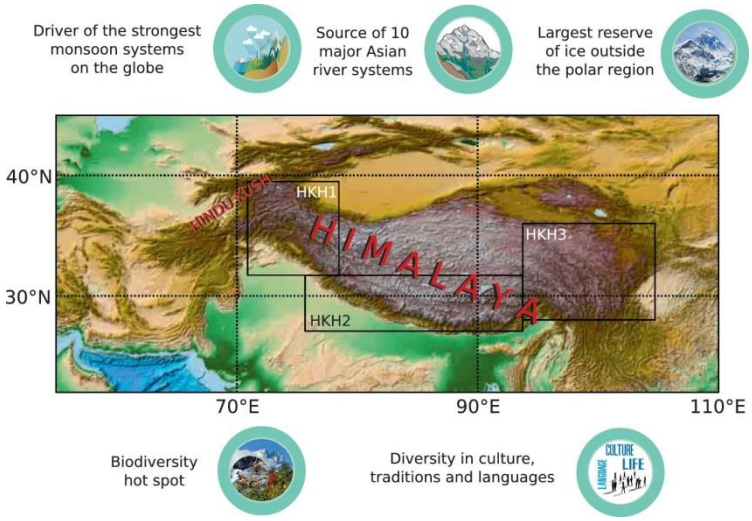


Figure 3: Importance of Himalayas

Some Key Predictions for Climate Change over the Himalayan Region

- The Himalayas and the Tibetan Plateau have experienced substantial global warming during the twentieth century. The warming trend has been particularly pronounced over the Hindu Kush Himalaya (HKH) which is the largest area of permanent ice cover outside the North and South Poles.
- The annual mean surface-air-temperature in the HKH increased at a rate of about 0.1 °C per decade during 1901–2014, with a faster rate of warming of about 0.2 °C per decade during 1951–2014, which is attributable to anthropogenic climate change (*High confidence*). Additionally, high elevations (> 4000 m) of the Tibetan Plateau have experienced stronger warming increase, as high as 0.5 °C per decade, which is commonly referred to as Elevation-Dependent Warming (EDW).
- Several areas in the HKH have exhibited declining trends in snowfall and retreating glaciers during the recent decades. Parts of the high-elevation Karakoram Himalayas have, in contrast, experienced increased wintertime precipitation in association with enhanced amplitude variations of synoptic western disturbances (*Medium confidence*).
- Future climate projections under various Coupled Model Inter-comparison Project (CMIP-5) scenarios suggest warming of the HKH region in the range of 2.6 to 4.6 °C by the end of the twenty-first century. While future projections indicate significant decrease of snowfall in several regions of the HKH, high-elevation locations (> 4000 m) in the Karakoram Himalayas are projected to experience an increase in annual precipitation during the twenty-first century.

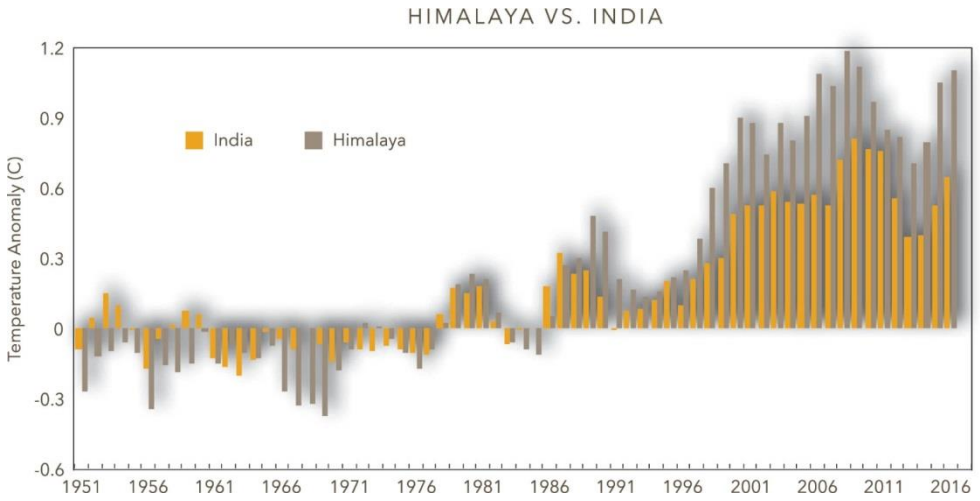


Figure 4: Annual mean temperature time series (5-year running mean) averaged over HKH (grey) and Indian land mass (yellow) from 1951 to 2018

These predictions directly mean higher temperatures, higher precipitation and higher water discharge in the rivers of the Himalayas viz.

- High temperatures increase the risk of extinction of ecology of the Himalayas;
- High precipitation increases the risk of flash floods and landslides in the Himalayas; and,
- High discharge of water due to glacier melt in Himalayas poses the risk of flash flooding in the Himalayas and surrounding areas.

Project Outputs

From the research, site visits, interviews with key officials, and the State level workshop, various tangible and intangible outputs emerged are as follows:

- The research, site visits and interviews brought to the fore the various crucial issues and challenges in implementing Integrated Water Resources Management (IWRM) regime in the Uttarakhand State. This also covered the good works taking place in the State with respect to IWRM, and pre-existing strengths in this regard, especially in the State apparatus and non-State institutions.

- At the one-day State level workshop, an exchange of information, knowledge and ideas took place between experts of the State Government agencies, academicians, quasi-government bodies, non-governmental organizations, media and independent groups working on the ground.

- Notably, case studies were shared in the workshop with regard to management of water resources in the State of Uttarakhand, where important works done by the participants and the NGOs were brought to the fore and presented for the benefit of all stakeholders.

- Best practices on the IWRM outlined by subject matter experts and practitioners were also shared for the benefit of the participants.

- Two case studies developed under the project are given as Appendix-III and IV.

Project Outcomes

- The information exchange helped identify gaps in dialogue between various stakeholders; gaps in policy implementation; and gaps in infrastructure/capacity of the key stakeholders.

- The presentation of case studies, initiated discussions amongst the participants and the experts added incremental value for the State Nodal Agencies and other stakeholders, on key challenges and success parameters for IWRM.

- The discussion around best practices by subject matter experts and practitioners threw light over the key lessons to be drawn from the implementation of best water management practices.

- Representatives of the Global Water Partnership introduced the upgraded and re-launched GWP IWRM online toolbox, detailing its various features and how the toolbox can add value for the practitioners of IWRM in Uttarakhand State. The tutorial helped to bring participants to speed-up their capabilities and how it can be useful to help to their efforts towards IWRM in Uttarakhand State.

Conclusions

- Deeper involvement of local level government administration and local community stakeholders is important to achieve IWRM in the State, as external agencies can play only limited role.

- While higher level stakeholders in government and outside have significant knowledge and skills with respect to IWRM, there are crucial gaps in both knowledge and skills at the local level government administrations and amongst local community stakeholders. This shortcoming is detrimental to the cause of IWRM as the role of the local stakeholders is crucial to success of an IWRM regime in the State.

- The infrastructure for watershed management and the institutional capabilities for the same have certain gaps and need to be enhanced.

- Short duration workshops are effective in furthering the cause of IWRM in the State as the workshop associated with this project proved to be convenient for participation and was able to help participants, the key stakeholders for taking forward IWRM in Uttarakhand.

Key Recommendations

- Uttarakhand State needs to pivot from an industrial development centric approach to an environmental, community centric development approach to ensure long term sustainable development in the State, with a particular focus on water resources.

- A formal approach is recommended for the capacity building of local line departments and local community stakeholders with respect to IWRM in Uttarakhand.

- A comprehensive State level Watershed Management IWRM online portal is required for effective implementation of IWRM in the State.

- An inclusive universally accessible stakeholders' repository is recommended for easy access, collaboration and better coordination between all the various stakeholders working towards IWRM directly or indirectly.

- Case studies should be elevated through eco-tourism/aqua-tourism so that the work is safeguarded for posterity with the aid of a revenue stream as greater awareness is achieved through such efforts, leading to encouragement of similar efforts in other locations in the State.

- Spring sheds need to be safeguarded urgently to prevent the decline of river systems in the State. The case study about the spring-shed rejuvenation presented a success story of the good works done by the State Forest Department in Tehri Garhwal District. This and the similar works done elsewhere in the State can be replicated in other districts of Uttarakhand.

The State-level sensitization workshop report is given below as **Annex-I**.

Annexure I


Global Water Partnership South Asia
India Water Partnership
State-Level Sensitization Workshop on
Enhancing Capacity to Address Climate Change in
Integrated Water Resources Management (IWRM)
in Uttarakhand
Organised by:
India Water Partnership (IWP)
In collaboration with
National Institute of Hydrology (NIH), Roorkee &
Indian National Committee for Intergovernmental Hydrological Programme (INC-IHP), UNESCO
on
7th December, 2021
11.00 AM to 05.00 PM (IST)
Venue: Society Room, National Institute of Hydrology, Roorkee

Summary

Photo 1: Outreach of the workshop

The State Level Sensitization Workshop on "**Enhancing Capacity to Address Climate Change in Integrated Water Resources Management (IWRM) in Uttarakhand**" was organized by India Water Partnership (IWP) in collaboration with National Institute of Hydrology (NIH) & Indian National Committee for Intergovernmental Hydrological Programme (INC-IHP) on 7th December, 2021 at NIH, Roorkee, Uttarakhand on the theme "**Integrated Water Resources Management (IWRM) in Uttarakhand**" for the key officials of the Water Resources Department, other Line Departments and stakeholders of Uttarakhand Government.

This workshop was organized as a part of the study which focuses on understanding the capabilities of the State Government officials of Uttarakhand with respect to concepts of IWRM, and whether the projects and planning of water resources in the State incorporate the idea of IWRM, reviewing the current practices of planning and implementation of water resources management in Uttarakhand State, and capacity building of State Government officials. For this, a series of interviews were conducted with the State Government officials along with site visits to projects which could have incorporated the concepts of IWRM in the State as indicated in the report. It was also one of the requirements to identify if the State Nodal Agencies can

integrate the strategies to mitigate and adapt to climate change in their water resources projects planning and implementation.

The main objective of the workshop was to bring together all the stakeholders on one platform, especially the State Government officials of Uttarakhand dealing with water resources projects planning and implementation. The International experts were also invited to this platform to guide the State Government officials on National and International policies and best practices.

The workshop was very successful as eminent experts in water & climate change and the bureaucrats of the State Government, and International experts initiated informed discussions on IWRM. The technical sessions provided a very good guiding path for the participants to understand in-depth how to incorporate the concepts of IWRM and community upliftment through IWRM. Deliberations and recommendations of the workshop are included in the report.

About the Workshop

Chief Guests and the Eminent Speakers

Er. A B Pandya, Secretary General, International Commission on Irrigation and Drainage (ICID) and Dr Rajendra Dhobal, Director General, Uttarakhand Council of Science and Technology (UCOST) were the Chief Guests at the workshop.

Other eminent guest speakers were Mr H K Varma, Executive Director, ICID; Dr Veena Khanduri, Executive Secretary-cum-Country Coordinator, IWP; Dr V C Goyal, Scientist “G”, NIH Roorkee & Member Secretary of INC IHP, UNESCO; Dr Lior Asaf, Water Attaché, Israel Embassy, New Delhi; Mr Dharm Singh Meena, IFS, Divisional Forest Officer, Narendra Nagar Forest Division; Dr Swapnamita Vaideswaran, Scientist, Wadia Institute of Himalayan Geology; Dr Soban Singh Rawat, Scientist “E”, NIH, Roorkee; Dr Jyoti Patil, Scientist “D”, NIH, Roorkee; Mr Anshuman Shukla, CEO of Retrota Technology Pvt Ltd, Dehradun and Mr Kesar Singh, Editor, ‘India Water Portal’ joined in-person. Experts who shared their presentation and views through online sessions were Mr Sunil Kumar, Director, Basin Planning-I, Central Water Commission, Ministry of Jal Shakti, Government of India; Dr Debashish Sen, Director of People’s Science Institute, Dehradun; Mr Laurent Charles, IWRM and Knowledge Management Specialist, Global Water Partnership and Ms Gergana Majercakova, Senior Learning Specialist, Global Water Partnership.

Workshop Sessions

The workshop was divided into 5 sessions viz; an Inaugural session and four technical sessions. The first technical session was on a perspective of IWRM from the National and International Perspectives – IWRM concepts, their applications, vision and inclusion in policies & planning. The second technical session was on understanding the geology of Uttarakhand, rejuvenating springs in Uttarakhand, case studies from Uttarakhand and a perspective from young entrepreneurs of Uttarakhand. The third session was for conducting group exercises[1]. The fourth takeaway session gave a perspective from NGOs who are working on the ground and giving a voice to the communities of Uttarakhand and their needs.

Participating State Nodal Departments and other Stakeholders

The participants of the workshop included officials from different Nodal Departments of Uttarakhand such as Forest Department of Uttarakhand, Irrigation & Minor Irrigation Department, Uttarakhand Council of Science and Technology, Horticulture Mission of Uttarakhand, Department of Rural Department, Watershed Development Department, Agriculture Department, Public Health Engineering Department, Pollution Control Board, Swajal Sansthan, Uttarakhand State Disaster Management Authority, Irrigation Research Institute, National Institute of Hydrology, India Water Portal etc. Many independent members and stakeholders of the Water Resources Management community also joined the workshop including consultants and academicians. In total 45 people joined the workshop in person and about 40 members joined the workshop virtually. The workshop had a good outreach. The organisers tried to connect with as many as stakeholder organisations working for Water Resources Management in the State of Uttarakhand**.**

The workshop allowed the participants including the speakers a platform to reflect and contribute ideas to the development of IWRM in Uttarakhand State. The deliberations were received right from the National IWRM plan and policy vision, Uttarakhand State Government vision for IWRM, best practices adopted and efforts made towards IWRM, basic technical knowledge required for better IWRM planning and implementation through the participation of Government and civil society.

[1] The third session could not be organized due to paucity of time.

Session-wise Proceedings

Inaugural Session

Welcome Address & Context Setting

Photo 2: Inaugural Session Dr. Rajendra Dobhal and Er. A B Pandya (3rd & 4th from left)

Dr Veena Khanduri, Executive Secretary-cum-Country Coordinator, India Water Partnership (IWP), extended a warm welcome to the Chief Guests, eminent speakers and the participants for taking out their time for attending this workshop. She started by setting the context for the workshop, outlining the objectives and desired outcomes expected. Dr Khanduri gave some background of the project how it was conceived and what was the thinking behind it. She delved into the importance of IWRM for Uttarakhand State and how capacity building was crucial to get optimal results for the region and Uttarakhand as a whole.

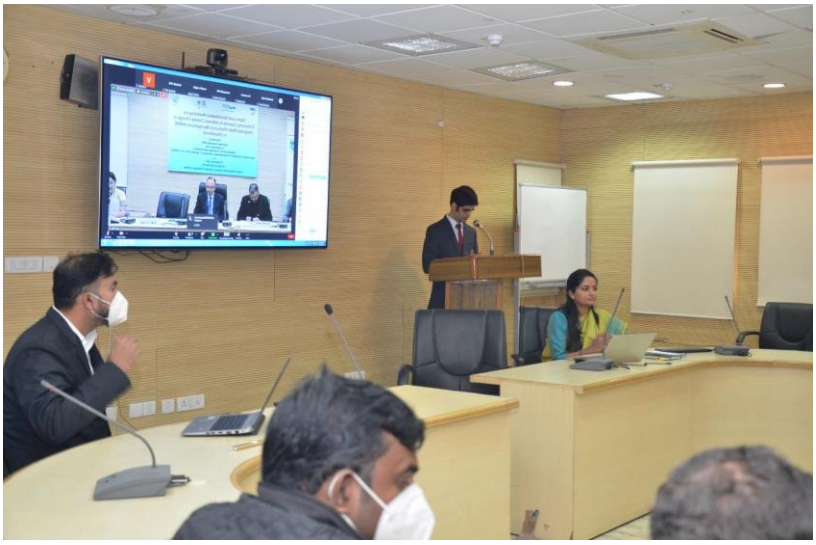


Photo 3: Online streaming of the workshop for better outreach

Dr Veena Khanduri also threw light on the IWP and its goal of promoting IWRM in India. She also spoke about IWP network organizations. She shared that recently IWP facilitated interaction between UNEP-DHI Partnership – Centre on Water and Environment (UN-DHI) and appointment of a Nodal Officer from India for submission of Country status on IWRM SDG 6.5.1. While interacting with key officials at various levels it was realized and indicated by the officials to build the capacities of State officials to prepare the IWRM plans.

She also emphasized that the nodal agencies in water infrastructure development & water management are the core stakeholders who deal with water resources planning. She said that the work of these agencies is very important for the future course of action of the entire State. Hence it is important to understand the capacities of officials of these agencies and facilitate them to enhance their capacity for better water resources planning and management.

She shared that very recently the GWP IWRM Toolbox has been upgraded with new innovations and re-launched in 2021. During this workshop we all will have the opportunity to know about the upgraded IWRM toolbox which will be useful for the professionals and practitioners for better water resources management in the World.

Dr Khanduri mentioned that Ms. Aditi Tallu (Environmental Consultant, IWP) had done some works with the Uttarakhand State Government officials and requested Aditi Tallu to present her findings and insights to kick off the workshop. She requested the participants to feel free to express themselves in Hindi or English and assured them that language should not be a barrier for interaction.

Aditi Tallu stated that before the project started, an Inception Report prepared by her laid out the broad objectives of the project. Ms. Tallu said that as part of the groundwork, extensive interviews were conducted with State Government department officials working on water resources development and management in Uttarakhand, such as: Forest Department, Irrigation Department, Minor Irrigation Department, Agriculture Department, Rural Development Department, Public Health Engineering Department, Pollution Control Board, Uttarakhand State Disaster Management Authority (USDMA) and Uttarakhand Council of Science and Technology (UCOST).

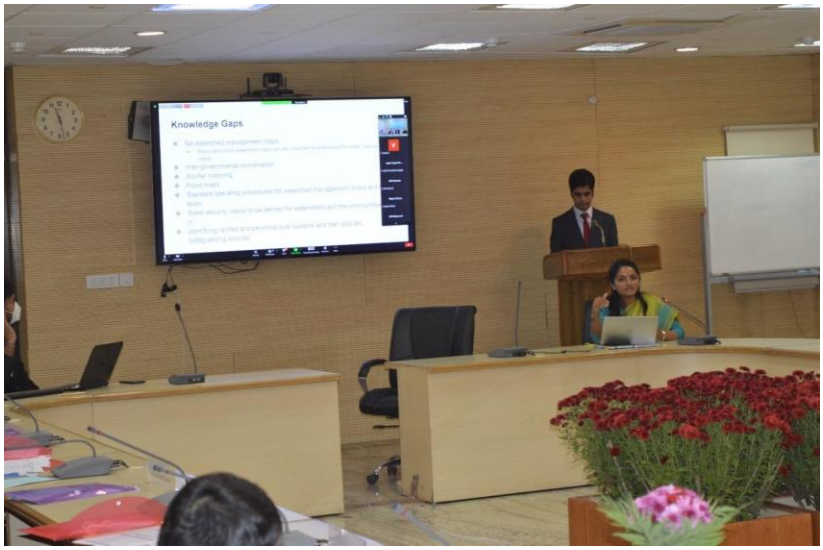


Photo 4: Ms. Aditi Tallu welcoming the participants and setting the context in Knowledge gaps in Uttarakhand

Aditi Tallu further told that interviews were also conducted with various NGO's and tourism enterprises which are dealing with IWRM challenges in the growing tourist hubs of the State. Apart from interviews, she mentioned that site visits were conducted to understand the terrain of Uttarakhand, especially in Haridwar and Dehradun districts and also to understand the works done in IWRM such as revival of local rivers, lakes, springs, etc. Aditi Tallu narrated that she observed some knowledge gaps around the concepts of IWRM and lack of interdepartmentally coordinated long term plans for the water resources management in Uttarakhand. She also shared some photos of the site visits conducted at various spots in Uttarakhand, detailing her observations along with photos for reference. She presented a list of identified knowledge gaps, with details on the feedback she got from various State Government officials. She also discussed how filling-up these knowledge gaps would yield greater benefit to the people of the State. She concluded by expressing that the deliberations during the workshop would help understand how to address these knowledge gaps with respect to IWRM in the Uttarakhand State.

Address by Chief Guest – Dr Rajendra Dhobal, Director General, Uttarakhand State Council of Science and Technology & Chairman, Rural Development and Migration Commission of Uttarakhand

Dr Rajendra Dobhal started his address by highlighting how sensitive Uttarakhand is to climate change apart from being a water abundant State. He stated that atmospheric water and surface water extraction was good, however the extraction of sub surface water was poor in the State. He went on to detail the water resources sources of Uttarakhand, along with their vulnerability data. He also spoke about the poor monitoring of glaciers which are a significant source of water, adding that glacial water was perhaps accumulating under the surface rather than flowing into the rivers. Glacial water sub surface percolation is the biggest knowledge gap, he opined. He also spoke about climate changes impacts on every sector and how SDGs were a good holistic way to address these issues.

Photo 5: Chief Guest - Dr Rajendra Dobhal addressing the inaugural session

He added that although the climate change has a direct impact on water but the pressure to supply water to all the households could make the Water Resources Department to first take adequate measures to supply water, forgetting about the climate change implications. He went on to detail about the quality of water, stating the ample research laboratories and research works, indicate that quality of both direct supplied water and treated water is very good in the State.

Dr Rajendra Dobhal also spoke about the panic around dying water streams suggesting that it was a direct and inevitable consequence of diverting the water to taps. He again highlighted the point about sub surface water as a lot of this water when given back to the streams ends up below the surface which was totally unknown to us due to lack of research and data on sub surface water.

He shared about the problem of data sharing and how officials were reluctant to share the data, due to copyright related concerns. He added that despite improvements in policy, the problem remained the same due to a working culture problem where stakeholders remain reluctant to freely share the data under their ownership.

Dr Dobhal concluded his address by stressing on the importance of an integrated approach wherein stakeholders' dependence on each other proved that an integrated, coordinated effort was required. Here, he mentioned the role of enabling agencies that had the data and the mapping of the data but stressed the need for working together with everyone to push better results for water resources management in Uttarakhand. Dr V C Goyal asked whether Dr Rajendra Dobhal could help bring about the integration amongst the various departments through sensitization and training activities to which Dr Dobhal replied that he is always ready for all such efforts.

Address by Mr H K Varma, Executive Director, International Commission on Irrigation and Drainage (ICID)

Mr H K Varma's presentation was on '**Emerging innovations in Water management tools'**. He started by summarizing the climate change issue with relation to water, stating the key problems and causes, and how the problem cannot be ignored anymore.

He supported his presentation with several graphs that revealed how water demand was swiftly outstripping supply and how per capita water availability was on the decline. Additionally, he predicted that the situation is going to become more acute due to the current trends of industrialization and population growth. Next, he went into the details of water demand, explaining through graphs and charts about the extensive freshwater use, the increase in water for agriculture, and the rate of water withdrawal. He showed through spatial representations, the condition of water scarcity across the World and stated how the frequency of floods and droughts would increase due to climate change.

Mr Varma explained the UN's definition of water security, and the various nuances within the definition with respect to water quality, quantity, pollution, disasters etc. He shared a framework for Water Security in Agriculture (WASAG), setup by FAO and its partners. Mr. Varma then brought up the issue of food security which he explained was a grave problem

across the World, and how to solve the problem by increasing food production, would in turn increase stress on freshwater supplies, land and other challenges. After setting the context of the World scenario, he explained the need for sustainable development, sustainable agriculture and a viable water management. He then went on to list sustainable strategies for resilient agriculture.

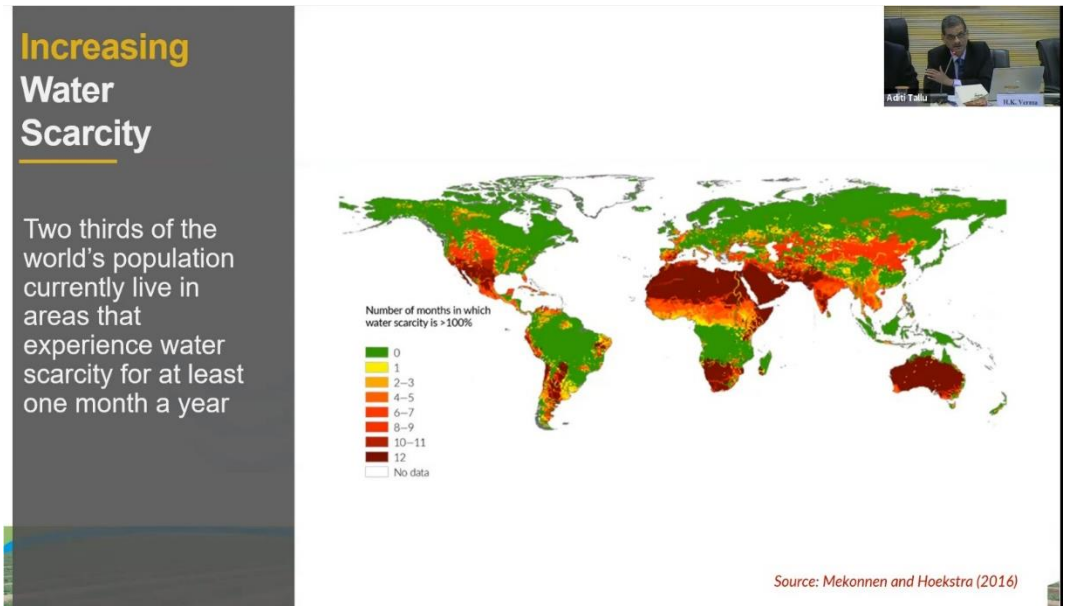


Figure 5: Water scarcity explained by Mr H K Varma

After detailing the strategies, Mr. Varma shared about the various current innovations and technologies in managing the water in agriculture. These included high technological data collection methods, advanced hydrological modelling, use of satellites for remote sensing, and various agronomical practices such as laser land levelling and use of "happy seeder" to name a few. He concluded by introducing ICID's Water Saving Awards that are presented to those who create water saving innovations in agriculture. At end of his presentation, Mr. Varma said that he is involved in an Asian Development Bank Project with the Karnataka Government which is dealing with IWRM that could serve as learning for other States of India.

Address by the Chief Guest – Er. A B Pandya, Secretary General, International Commission on Irrigation and Drainage & Former Chairman, Central Water Commission, Ministry of Jal Shakti, Government of India

Er A B Pandya started his speech by getting into a detailed examination of the meaning of Integrated Water Resources Management (IWRM). He went into definitions given by various organizations of repute and tried to explain them in simple and clear terms. He also went into

supplementary explanations of IWRM throwing light on all its aspects and detailed some practical considerations based upon unique ground realities before setting up an IWRM regime. Next, he explained the various ingredients of IWRM through a pictorial representation. He said that on the one side there were various factors that determine the availability of fresh water with outflows for coastal areas and biodiversity needs, and on the other side there were the multiple kinds of human water needs. Connecting the two was IWRM, he said.

Photo 6: Mr A B Pandya addressing the Inaugural Session

Er. Pandya then went on to list and explain the various requirements for setting up an IWRM regime. He specially noted Uttarakhand's disaster perspective and how this needs to be adequately addressed as a prerequisite for an IWRM regime. He stressed on the importance of trans-boundary inter-linkages in ensuring water security for all and consequently maintenance of social harmony, as an important requirement for setting up an IWRM plan for the State. He also explained the need to have a proper authorization for implementation of IWRM through statutory processes as water being a public good, made this even more necessary.

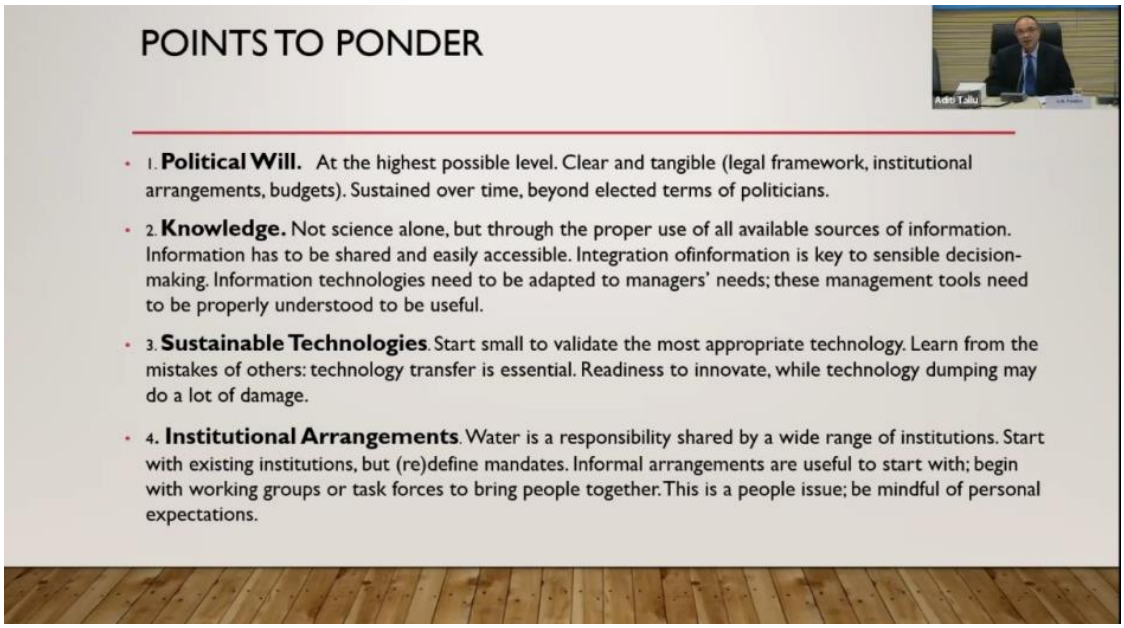
Er. Pandya thereafter spoke about resource mobilization as the next logical step. He added his perspective to the question about data, mentioning that all data collection has a particular purpose and hence it is not suitable for all purposes in its original form. He stressed on the need of the data seeker to be ready to process the raw data to make it suitable for a particular purpose, rather than expect the data to be in a ready to use form.

On demand side assessment, he added that further stress on the water usage in agriculture is a cause of concern. He mentioned how Uttarakhand State was going through development changes and changing urban – rural compositions, which had a significant impact on water demand. Another is the demand assessment of energy generation in the State how this ties into an economic model for the IWRM regime.

He detailed about the Uttarakhand scenario with respect to water resources, stressing on the diversity in terms of water availability across different parts of the State, and different times of a year. Mr. Pandya talked about the diverse topography and the land use pattern in the State. He highlighted the impact of water related disasters in Uttarakhand where extreme events in the recent past were of a scale that was recognized at the International level.

Mr. Pandya listed and explained IWRM strategies for Uttarakhand. He noted the difficulties of water type compartmentalization and how they lead to sub optimal solutions. He explained that such issues must be sorted out by setting suitable mechanisms at a higher level and collation of demands. He explained the IWRM implications of religious tourism in the State of Uttarakhand with its own unique challenges and considerations. He explained that IWRM has to be a dynamically changing exercise with respect to changes induced by climate change, and hence IWRM could not be a one-shot exercise.

He opined that political will is a necessary condition for IWRM but the case has to be made for the political will to emerge. For this, he said, that the adequate knowledge and institutional arrangements are crucial. He also stressed on the importance of building on existing expertise or capacity development at every level from the village to district. Mr. Pandya noted the importance of economic prosperity being tied into these initiatives given the tough living conditions in the mountain State Uttarakhand. He concluded his speech by stressing on developing IWRM at an early stage of development rather than a later stage of development, as the right timing would ensure much better results.



Vote of Thanks

To conclude the Inaugural Session, Dr Jyoti P Patil, Scientist "D", National Institute of Hydrology, Roorkee, delivered the Vote of Thanks.

Photo 8: Dr Jyoti P Patil giving the vote of thanks on behalf of the National Institute of Hydrology

Technical Session-I

Theme: India's Journey, Policies, National IWRM Plan (Virtual)

Speaker: Shri Sunil Kumar, Director, Basin Planning-I, Central Water Commission, Ministry of Jal Shakti, Government of India

Shri Sunil Kumar, Director, Basin Planning-I, Central Water Commission, Ministry of Jal Shakti, Government of India joined the workshop virtually. He flagged at the outset that India is utilizing about 18% of the precipitation it receives as per a recent estimates. He added that although this reveals a difficult situation, he is optimistic about the immense scope for improvement to serve the huge rising demand by augmenting the water supply.

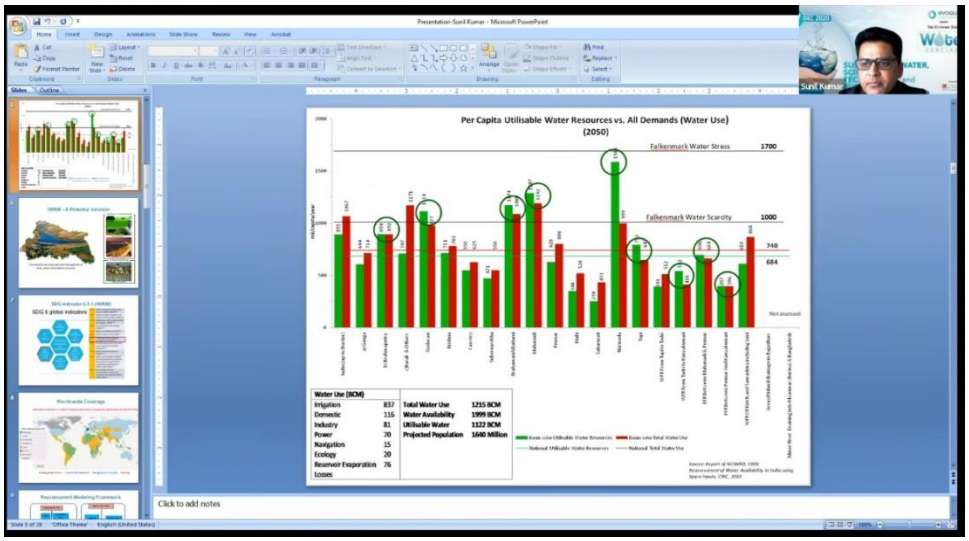


Figure-6: Current IWRM scenario and water deficits in different watersheds of India presented by Mr Sunil Kumar

Mr Sunil Kumar showed a scenario for 2050 showing per capita water supply and demand, basin wise. The graphs shows the per capita demand is higher than supply. He further flagged that around nine river basins of India would be able to meet demands of the population if the water resources are adequately developed, but the remaining river basins would not be able to serve demand even if the utilizable water resources are fully developed. He surmised that a lot of work in supply augmentation is needed to ensure that the future demand is met.

Mr. Sunil Kumar highlighted the usefulness of IWRM due to its consideration of the natural boundary of the river basins and concerns itself with not only water but also land and all other sources, taking care of socio-economic issues without compromising the vital ecosystem. He added that IWRM takes care of equitable development and distribution of benefits, both social and economic. He pointed out that amongst the eight targets of the SDG framework, one of them is water resources management. He explained the various facets of this target and how India fared in terms of the score factoring in various contributing assets. He went on to detail

the efforts of Central Water Commission, Ministry of Jal Shakti, Government of India in terms of scientific assessment of the water resources of the country in all twenty river basins, further divided into 150 sub basins. He stated that inter-river basin linkage would ensure that the demand of 2050 is met in all river basins.

Mr. Sunil Kumar explained how the integration of three Ministries under the Jal Shakti has helped develop a more integrated and coordinated approach to water resources management, adding a caveat that even further integration is required. He detailed the various schemes in alignment with SDG goals like Jal Jeevan Mission, National Water Mission, Jal Shakti Abhiyan, Swachh Bharat Mission and stated that these programs would be the various limbs of the water resources management in India. He stated the need for a legal framework for effective implementation for the IWRM and said that such a framework had been drafted and is waiting to be passed in the legislature. He also added that various financial models needed to be developed to diversify the source of the investment, which is currently majorly funded by Government only. He also detailed efforts of the Central Water Commission and tie ups with the various Indian Institute of Technologies (IITs) for IWRM work and stressed on the need of other stakeholders also to contribute to the development of IWRM, and not expect the Government alone to do 100% of the work, however the Government would have to lead the way, he said.

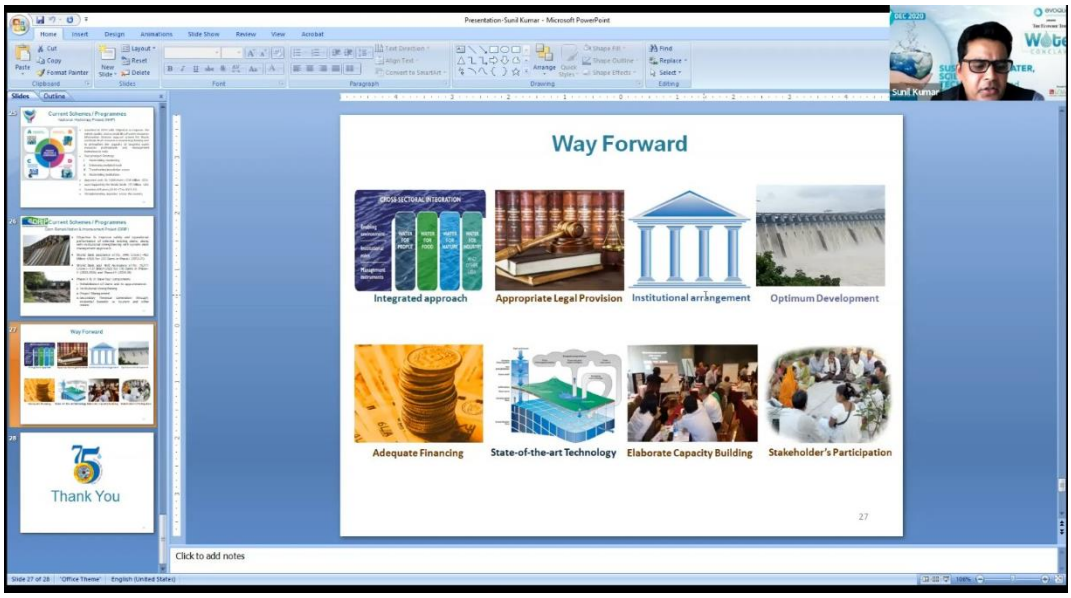


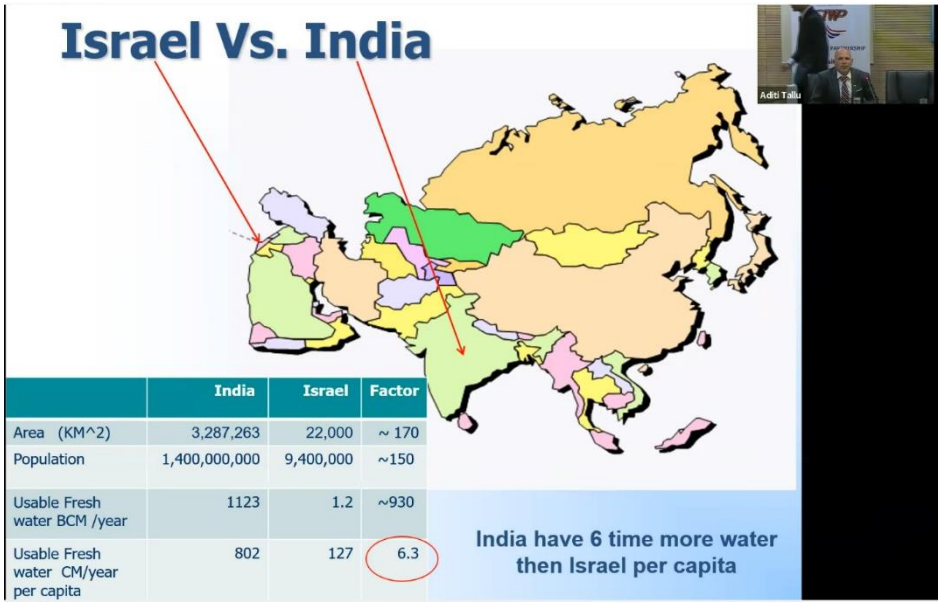
Figure-7: Mr Sunil Kumar presented the way forward for better IWRM management in India

Theme: International Perspectives of IWRM; Incorporating learnings from other Countries in Indian Scenarios

Speaker: Dr Lior Asaf, Water Attache, Israeli Embassy, New Delhi

Dr Asaf explained Israel's severe water shortage and how it was overcome. He also talked about India's water stress across regions and presented some key data points that revealed the scenario.

He made a brief comparison of the water resource scenario in India vs Israel. He pointed out that although Israel had one sixth of the per capita usable fresh water, it managed to export water, have abundant household water supply, and a flourishing export agriculture sector. He noted that Israel's usage of water management technology had led to higher efficiency in water usage and reduction in leakages, pointing out India's water leakage at 40% whereas Israel was at 5-7%.



	India	Israel	Factor
Area (KM^2)	3,287,263	22,000	~ 170
Population	1,400,000,000	9,400,000	~150
Usable Fresh water BCM /year	1123	1.2	~930
Usable Fresh water CM/year per capita	802	127	6.3

Figure-8: A comparison between water availability of India and Israel given by Dr Lior Asaf

He further described Israel's challenging landscape, majority of them dry with limited water, and stressed that innovations helped them emerge self-sufficient in water. Dr Asaf outlined the various measures taken by Israel to build their strength in water resources. These included policy/legal measures as well as technological innovations. He highlighted the importance of optimizing water efficiency and increasing awareness in the success of Israel in terms of water resources planning and management. The he talked about Israel's Water Authority Board that comprised of top authorities from all the important ministries, which helped in taking decisive steps for Israel's water planning.

Photo 9: Dr Lior Asaf discussing with the participants(3rd from left)

Dr Asaf listed the ways to increase water sources such as rain harvesting, seawater desalination, amongst others. He stressed that Israel was monitoring each and every water source in the country with full data recording. He pointed out that Israel's water resources breakdown was changing with a slow but steady decline in natural water resources, and hence an improvement in recycled and desalinated water was need. This, he said, was important to build resilience in the water sector. He highlighted how sustained awareness campaigns in Israel have reduced the per capita consumption of water and helped manage the water demand despite rising population. He talked about importance of drip irrigation, which is all pervasive in Israeli agriculture, is helping in conserving the water resource. He further elaborated on the various benefits of drip irrigation, beyond water saving.

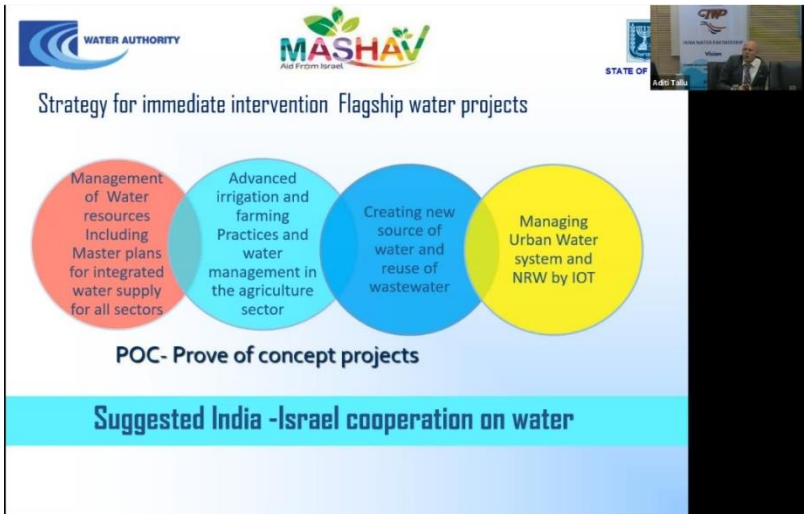


Figure-10: Strategy for India - Israel cooperation presented by Dr Lior Asaf

Dr Asaf also talked about suitability of the solutions for India. He stressed that every country has a unique situation, hence needs a well thought out solution that factors in that country's condition. He then stressed that technology imposition in isolation would not work. He explained the big potential in Uttarakhand for micro irrigation due to the low base in the State. He spoke about the Mashav's Indo-Israel Centres of Excellence for advancement of the innovations tailored to each region. Dr Asaf explained a strategy for immediate intervention through flagship water projects in India. He listed some works done by the above Centres and also doing in other parts of India. Dr Asaf added in conclusion that those could be a suitable reference point for finding solutions elsewhere in India, including the Uttarakhand.

Theme: Sharing Knowledge about IWRM Toolbox (Virtual)

Speakers: Mr. Laurent-Charles Tremblay-Lévesque, IWRM & Knowledge Management Specialist, Global Water Partnership (GWP), Stockholm, Sweden, and Ms. Gergana Majercakova, Senior Learning Specialist, Global Water Partnership (GWP), Stockholm, Sweden

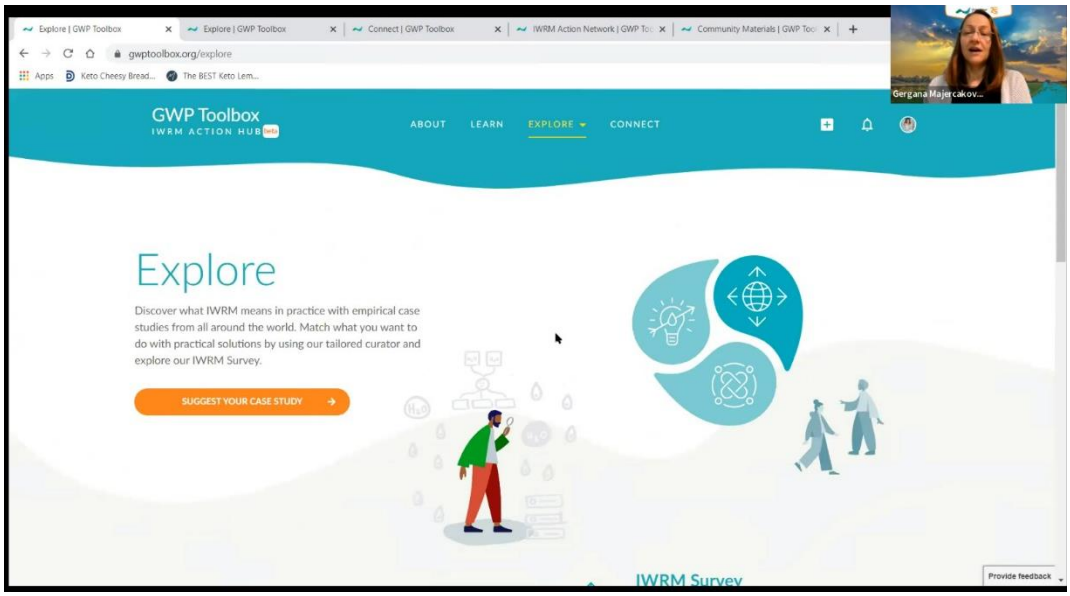


Figure-11: Ms Gergana introducing the GWP toolbox to the workshop participants.

Ms. Gergana Majercakova introduced the GWP IWRM toolbox that was upgraded and re-launched in 2021. She spoke about how the toolbox was a repository of tools, references and case studies that serve to connect the concepts, theory, and knowledge of IWRM. She informed that the toolbox had gone through a very recent revamping that focused on changing from a static online repository to a more dynamic responsive and interactive resource.

She stressed on enabling of the GWP toolbox for IWRM to become a platform for IWRM professionals to interact with each other. She went on to present the re-launched toolbox. She also spoke about the various considerations the GWP team went through before deciding on the upgrading the toolbox. She guided the viewers through the GWP website, giving brief descriptions of the overall features of the toolbox.

Mr. Laurent-Charles Tremblay-Lévesque introduced the IWRM tools. He explained that the tools were based on the four pillars of IWRM and explained each of the pillars in detail. He highlighted on the increasing significance of innovation in the pillar of finance where newer thinking had led to building of investment rationale in IWRM projects. He went through the list of tools and explained how they were segregated in the toolbox. He further went through a few tools in detail explaining the various components and how they help in the work of an IWRM professional.

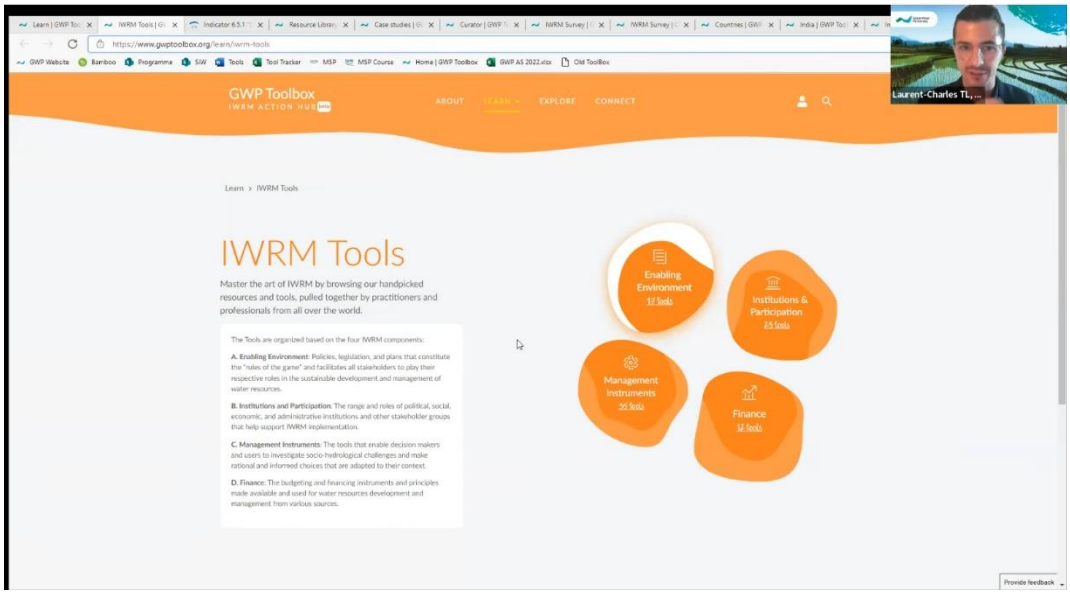


Figure-12: Mr Laurent further explaining the GWP toolbox to the participants of the workshop

Mr Laurent went through the section of related case studies that embody the practical application of the tools being studied. Besides the case studies, he also went through the related sources section that include technical publications, academic journals, and other related publications that could further illuminate the use of the tools. He then went through the comprehensive resource library on the toolbox that allows the users to search for resources of

specific interest related to IWRM. He went on to guide the viewers through an Indian case study, going through the various components of the case study briefly.

He then spoke about the IWRM curator feature that helps an IWRM user/researcher to find the tool most suitable for his/her needs. He then introduced the IWRM survey for users to be able to conduct the IWRM survey, which is the official diagnostic instrument of the SDG's, to assess the degree to which countries are implementing IWRM. This is a way to assess the key challenges a country is facing with IWRM, and the survey provides insights and solutions for the surveyed country. Mr. Laurent then guided the viewers through the operation of the survey tool. He then moved to the IWRM country feature that showed IWRM scores of each country and on selecting any country, the feature threw up various contents related to IWRM in that country.

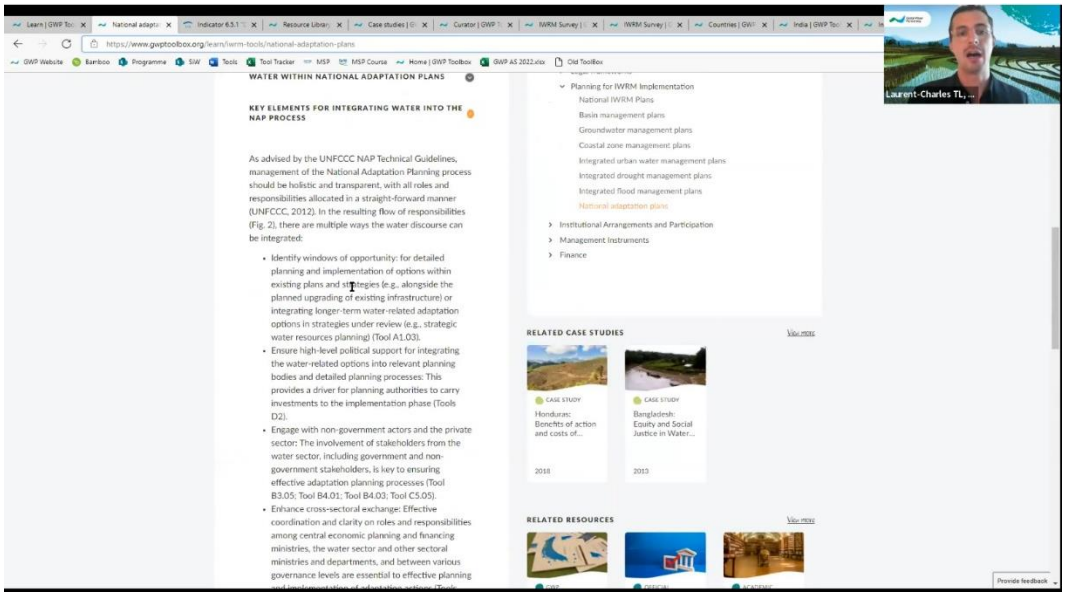


Figure-13: Mr Laurent further explaining the case studies section of the toolbox

Ms. Gergana explained about the connect feature of the IWRM toolbox. She went through the search feature that would help IWRM professionals to discover each other to connect further. She went on to guide viewers through the community space where professionals sharing a common IWRM interest could share ideas, insights, and various digital materials with each other. She showed how the materials would get collated historically on the page and some other features such as opportunities and discussions. She concluded by elaborating on the intention of the toolbox to help the international community strengthen IWRM all over the World and mentioned other planned activities by GWP to help in capacity building and training for the toolbox.

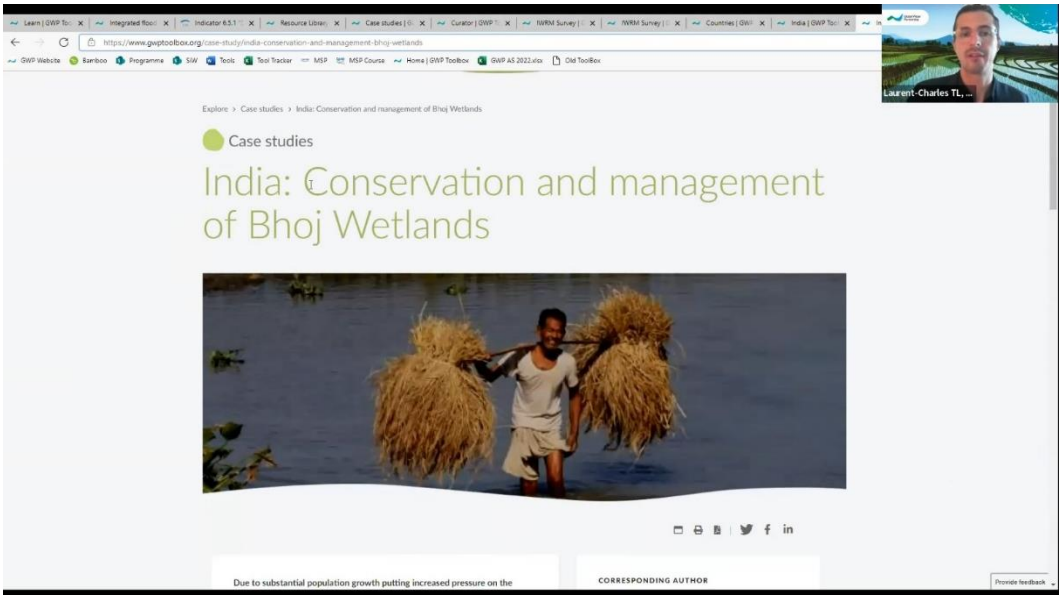


Figure-14: Mr Laurent explaining the Bhoj wetland case study in the GWP toolbox

Question and Answer Session:

Query: Mr. Dharm Singh Meena had a question for the speakers. He said that he had worked in Uttarakhand on a river rejuvenation project and had gathered a lot of data that could be useful for the community. He asked whether the IWRM toolbox had any provision to store the data so that it could be fruitfully accessed by the community in the future.

Mr. Laurent Charles answered that the toolbox consists of tools to help build useful data sets but do not act as a Data Management Centre. He detailed the way the tools could be utilized to build the data and keep it in a form that is useful for the community going forward.

With this, the pre-lunch session drew to a close, and the Chair of the session Er. A B Pandya shared his closing remarks. He thanked the speakers for their valuable inputs and expressed satisfaction about the different tools and innovations that were discussed to take the IWRM forward.

Technical Session- II

Theme: Rejuvenating Heval River, Tehri Garhwal District, Uttarakhand

Speaker: Mr. Dharam Singh Meena, IFS, Divisional Forest Officer, Narendra Nagar Division, Uttarakhand

Photo 10: Mr Dharm Singh Meena addressing the technical session

Mr. Dharam Singh Meena, I.F.S introduced one of his Department's initiatives led by him in Tehri Garhwal district of Uttarakhand on revival of Heval River. The Heval River, one of the many tributaries of the Ganges, originates as Khuret Gaad from the forests, near Surkanda Devi and Nagdevta temple in Tehri Garhwal district. It is a perennial river in the Chamba block that is used for both drinking water and irrigation.

He shared the efforts of his Department on the rejuvenation of Heval River. He spoke briefly on the different kinds of rivers in Uttarakhand, glacial and rainfed rivers. He stated that around one lakh people are dependent on the Heval River for different uses. He showed the map of the Tehri Garhwal district highlighting the Heval River from its origin and its merger with Ganga River, and other characteristics of the river system. Of the twenty-five thousand hectares catchment area of the Heval River, he stated that his Department took up the work in sixteen thousand hectares in the first phase. He spoke about the public anger due to drying of the river earlier. Because they were highly dependent on it for their sustenance as agriculture got severely impacted due to drying of the river. He went through the assessment of the causes behind the decline of the water discharge in the river. He mentioned about reducing deep

forest cover and unplanned cutting of roads as the major causes for the poor health of the river system. Mr Meena listed out the various preparatory activities he undertook like consultations with various State nodal agencies, NGO's and the community. Based on this, he decided that a project can be undertaken considering all the land uses which should be sustainable, and community driven for long term success. He mentioned about the challenge of poor quality of water that was studied.

Mr Meena explained his ten-pronged approach to the project, detailing the various steps of the methodology that he followed. As part of this, he laid out how critical springs which were the source for the water, were identified for rejuvenation that would in turn flow into the river system. To ensure sustainable solutions, it was decided that no cement or steel structures would be used, with an emphasis on measures that mitigate erosion and increase the ground water levels. He spoke about the involvement of local youth through employment, driving interest of the community. Selfie points were developed for opportunities for eco-tourism, as well as riverfront development at the point of merger with Ganga River to create a biodiversity hub as an asset under the project. He went through the various components of the action plan including stream-shed management, afforestation, and riverbed management, to mention a few. He laid stress on the convergence activities which brought in various other Departments – Agriculture, Irrigation, etc. and the various relevant Central Government schemes that could be tied into the project for more dynamism and synergy, that lent a collective strength to the project.

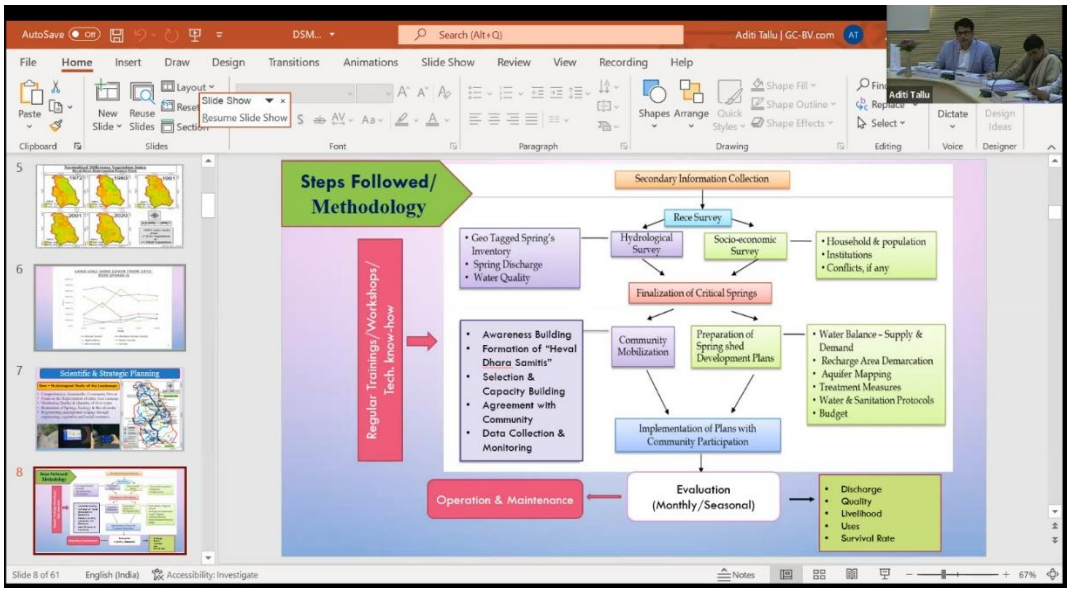


Figure-14: Mr Meena explaining the steps he followed to plan and implement the rejuvenation of Heval river

Mr. Meena listed the various villages and regions that benefitted from the Heval river systems and stressed on the importance of starting similar initiatives in other parts of the State where water scarcity prevails. He went on to show the various mappings undertaken for the project such as the digital elevation map, recharge zone mapping, stream network map, amongst the others. He went through the planning workflow of the project, highlighting how plans kept changing in the past due to some knowledge gaps which were slowly filled, hence leading to more consistent planning. He then went through the various components of the planning.

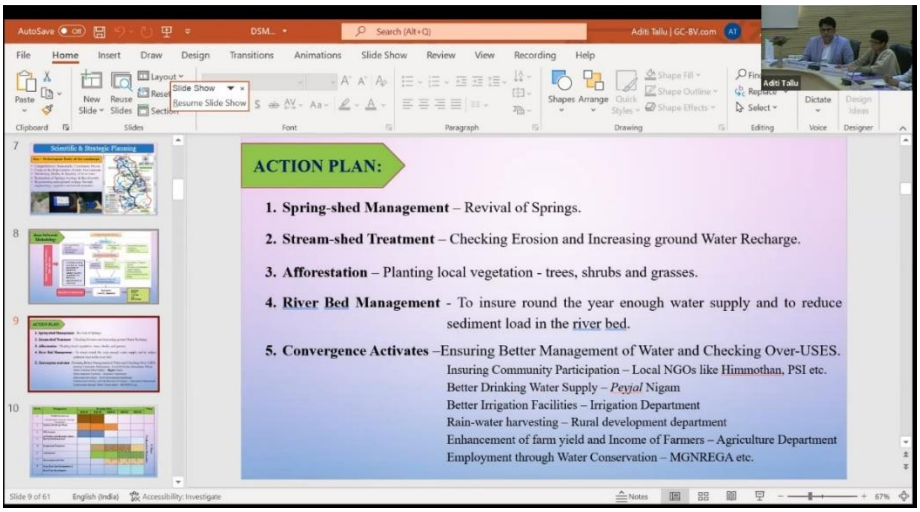


Figure-15: Mr Meena explaining the action plan he followed to make his project a success

Mr Meena explained the geo hydrological study undertaken in all the sixty-six (66) springs linked to the river and guided through a study of one of the springs in detail as an example. There was also a list of activities undertaken for each spring, wherein Mr Meena detailed the activities for a particular spring as an example.

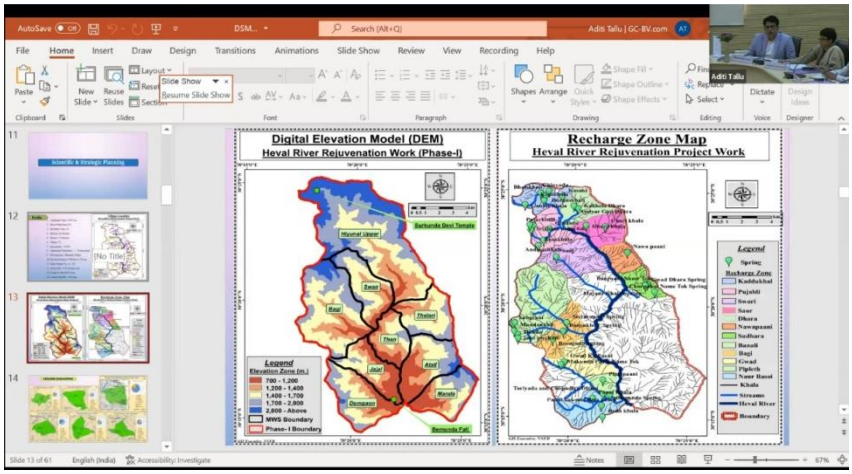


Figure-16: DEM models created by the Forestry department of Uttarakhand under Mr Meena's leadership

Thereafter Mr Meena shared the work done on stream shed management including geo hydrological study as well as various kinds of scientific mapping. He then explained the various activities conducted for the stream sheds such as erosion control works and soil moisture control measures, to name a few. He also stressed on the need of using natural plantation to add the processes so that the management is self-sustaining and going forward requiring minimal interventions.

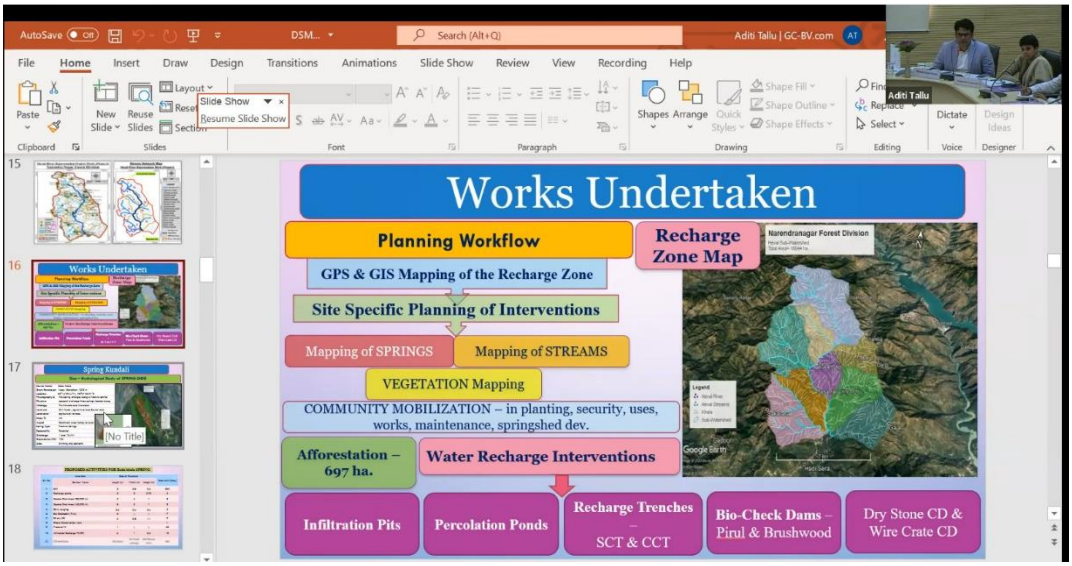


Figure-16: Mr Meena explaining in detail the works undertaken by his department under his leadership for Heval river rejuvenation

He showed some photographs of the works done such as check dams, trenches, recharge ponds etc. and explained with a visual reference. There were also some other photographs showing the various solutions to a diverse set of water related problems. He explained that all the interventions were GIS mapped whether it was the trenches or the afforestation to ensure data accessibility for future reference. He stressed on the importance of community partnership.

In conclusion, Mr. Meena listed the major outcomes of the entire project and the various kinds of media coverage that the entire project received.

Photo 11: Dr Lior Asaf and Mr Dharm Singh Meena discussing during the technical session

Commendation: Dr Asaf commended on the works done by Mr Meena under his leadership and mentioned that similar work had been undertaken in Israel. Dr Asaf added that it was important to make intersections that reduce the drainage runoff in the stream rather than to make a huge straight flow canal that drains quickly, which would keep the groundwater recharge healthy and strong and add to the health of the river system. Mr Meena agreed with the point and discussed some of his own experiences and challenges faced in his attempt to work on those lines.

Theme: How to Understand Local Geology, Incorporating Himalayan Geology into Planning

Speaker: Dr Swapnamita Vaideswaran, Scientist D, Associate Professor, Wadia Institute of Himalayan Geology, Dehradun

Photo 12: Dr Swapnamita addressing the Technical Session

Dr Swapnamita stressed that mountain people are very cautious about springs and surface runoff therefore it is important to study the ecology and geology of the springs to predict their future survival. She highlighted that sometimes streams dry up due to natural phenomenon emanating from the lithology. She gave an example of how limestone is a great substance for groundwater recharge due to sub surface tunnels, but the limestone tunnels tend to collapse causing change in the groundwater recharge. She added another example of how Devdar trees help water retention whereas pine trees cannot. She surmised that the streams drying up are linked to topology, lithology etc. and anthropological activities, as opposed to a singular reason. She agreed that climate change is influencing the drying up of the streams due to extreme precipitation events, that did not allow ground water retention and actually causing more surface runoff.

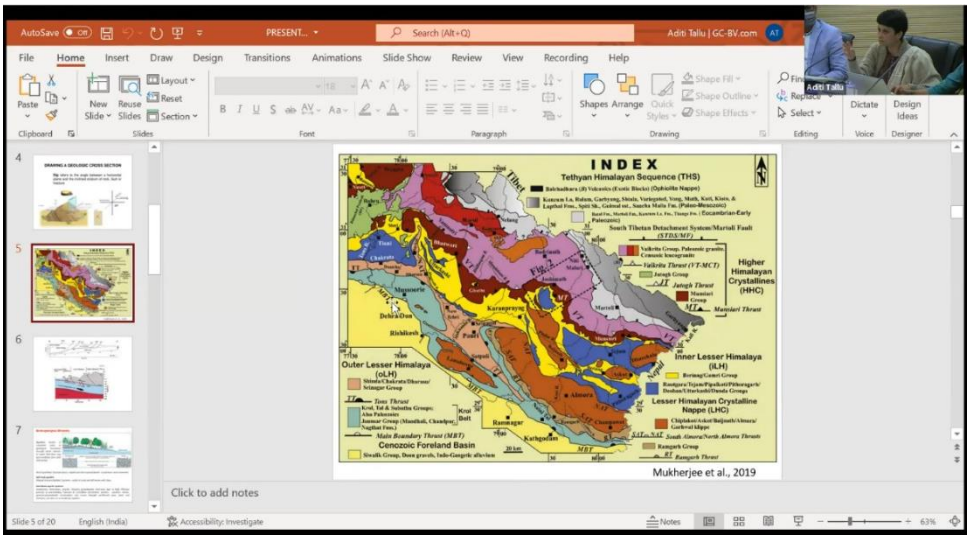


Figure-17: Dr Swapnamita explaining the specific details of geology of Uttarakhand

Dr Swapnamita gave a detailed explanation of the geological nature of the Himalayan region, mentioning the history of being a seabed before folding into the Himalayas due to tectonic pushes. She explained the implications of this event on the nature of Himalayan surfaces and how they react to water flow. She explained with the example of Dehradun valley or basin, how the geological nature of the basin determined the kinds of aquifers it could contain. She added that the nature of aquifers depended on the geological conditions in all such areas. She explained the three types of materials where aquifers may exist, and how this impacts the groundwater recharge. Dr Swapnamita mentioned how the unplanned digging of bore wells by private property owners may exhaust the aquifers.

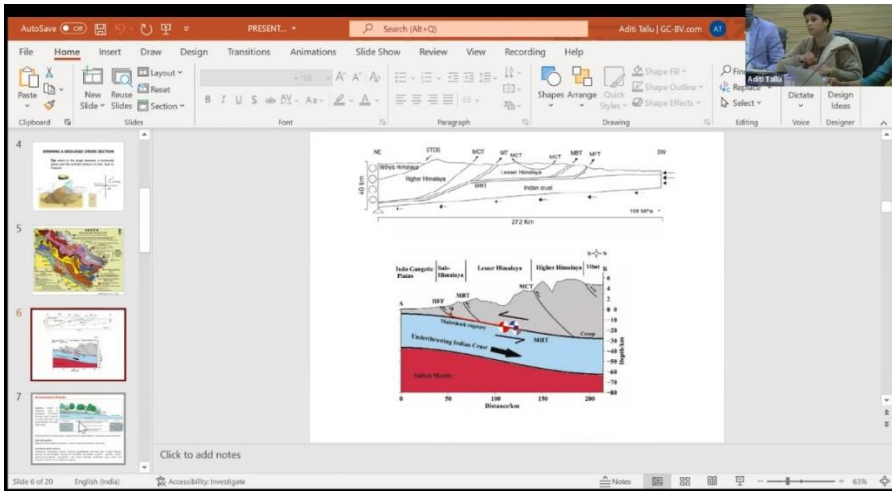


Figure-18: Dr Swapnamita explaining the geology of the Himalayan region pertaining to Uttarakhand to the participants

She listed various kinds of geological profiles in Uttarakhand of which she highlighted limestone and dolomites to be the best for water reservoir capabilities. She highlighted that somewhat complex nature of clay with respect to water holding capabilities by explaining how clay retained water but due to being impervious did not let it go of the water, hence proving to be non-useful for human extraction. She explained through pictorial reference how sinkholes are formed and explained the implications of the sinkholes on groundwater recharge. She explained how meadows are crucial for water recharge zone and how human activities like farming, construction etc. were certain to destroy its ability as a recharge zone. She also emphasized on the need to identify the recharge zones using scientific methods to study the impact on springs.

Photo 13: Interactions during the technical session

Q & A-1: After she concluded her talk, Dr Asaf asked Dr Swapnamita whether the studies and research she was referring to is publicly available to which she replied that all research data is publicly available**.**

Q & A-2: Another participant asked Dr Swapnamita about the reason for why water levels had drastically decreased in certain aquifer wells to which she replied that due to decrease in water recharge, there may have not been sufficient hydraulic pressure for the water to raise in the wells hence leading to drastic decrease in water level.

Theme: Case Studies and Inclusion of Communities in IWRM

Speaker: Dr. Debashish Sen, Director, People's Science Institute (PSI), Dehradun

Dr. Debashish Sen presentation title was **"**Participatory Integrated Water Resources Management (IWRM) in Himalayan landscape: PSI's Experiences**".**

Dr. Sen started by detailing PSI's work over the past two decades in the Himalayan region. He mentioned about his understanding on IWRM as a concept, stressing upon the systems approach factoring in all related sectors such as agriculture, land, human resources etc. He also stressed on the economic and social welfare of the communities and the importance of implementing IWRM in an equitable and sustainable manner. He briefly stated the various facets related to IWRM, mentioning that he would elaborate on the community participation aspect.

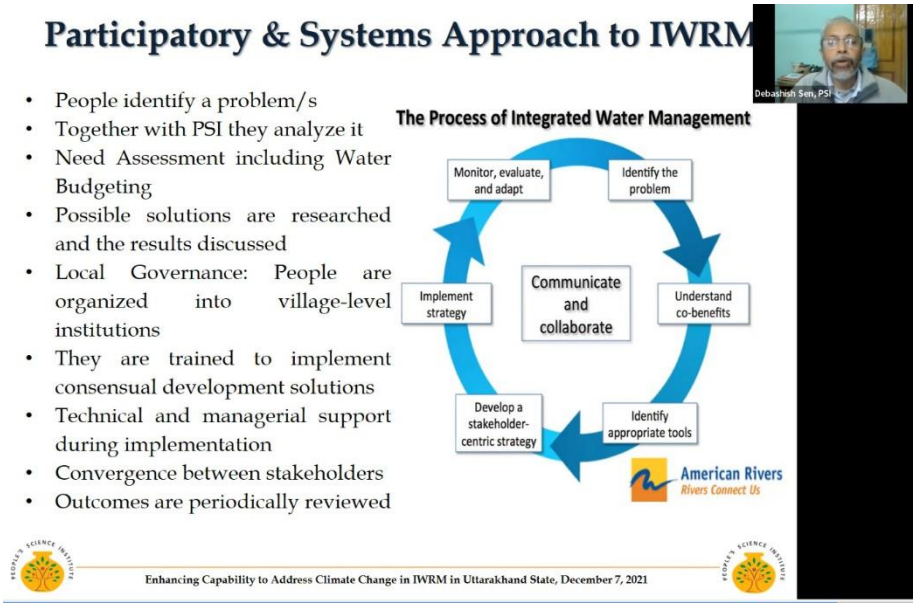


Figure-19: Dr Debashish Sen explaining the participatory approach adopted by PSI

Dr Sen gave an outline of PSI's participatory and system's approach to IWRM. He stated that the community approaches the PSI with a problem, post which PSI conducts a participatory needs assessment including the water budgeting and assess the available water. Once the gap estimation is done, interventions are thought of. He stressed on the community mobilization aspect through street plays, songs etc. He mentioned that PSI also places importance in building capacity at the local level, so as to make the community self-sufficient. Once the watershed plan is in place, convergence is sought with various Govt. Departments**.** He also stated that a system is established for the participatory monitoring of the works before start.

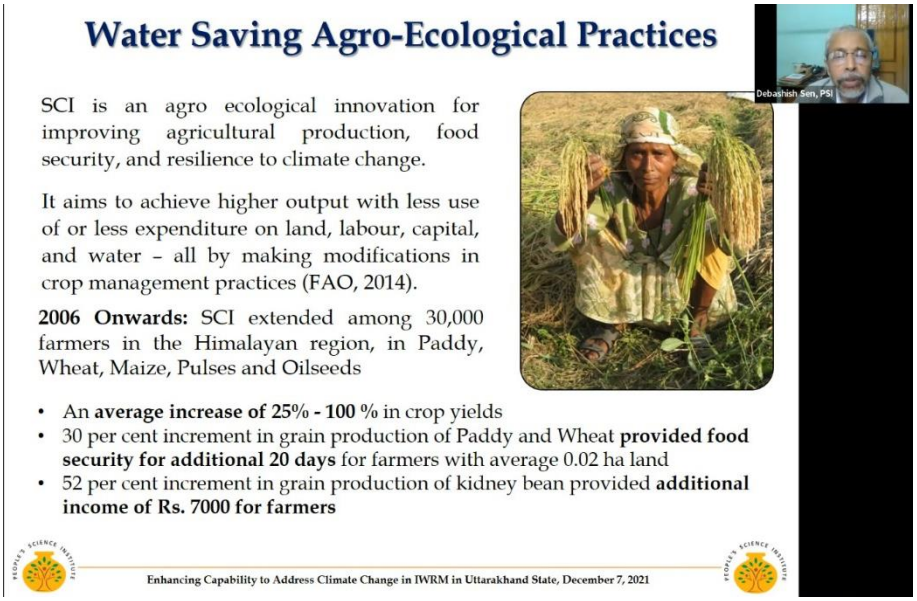


Figure-20: One of the case studies presented by Dr Sen and the principle behind the project

Dr Sen shared some of the PSI's works in IWRM starting from year 1997 in Uttarakhand and Himachal Pradesh. He spoke of water saving agro-ecological practices that achieve higher crop outputs with lesser inputs, hence releasing some of the stress on water demand. He highlighted how these practices had a huge impact on the food security of the farmers who adopted them, also making them more climate resilient. He also spoke about the successful implementation of drinking water projects that have provided safe drinking water to households through a community participatory framework.

Query: Dr V S Goyal asked Dr Sen how IWRM could be implemented on the ground in Uttarakhand given your extensive experience on the ground. Dr Sen replied that watersheds and micro watersheds need to be the basis of the approach, along with springs as a next level to understand the horizontal and vertical linkages between surface and ground water. Secondly, Dr Sen stated that the communities needed to be involved in the water budgeting

based on their domestic and farm water demand. Thirdly, he said the package of practices need to be decided based on the slope, soil depth, soil texture and the unique needs of the people. Fourthly convergence with different departments to tap the funds that are waiting to be put into good use.

Dr Goyal had a counter question on the last point of convergence regarding how it is to be done. Dr Sen replied that it is certainly possible as PSI is managing to converge with six Govt. Departments in Himachal Pradesh. He elaborated that each village has a Water Security Plan which is shared with different State line departments to contribute funds for the proposed works as per the Plan. Dr Sen suggested that Uttarakhand Govt. should also try a pilot a project in a couple of villages on similar lines and he expressed confidence that convergence is possible based on PSI's success in Himachal Pradesh. Dr Sen further stated that Forest Department and Rural Development Department are the main one's that could drive the work.

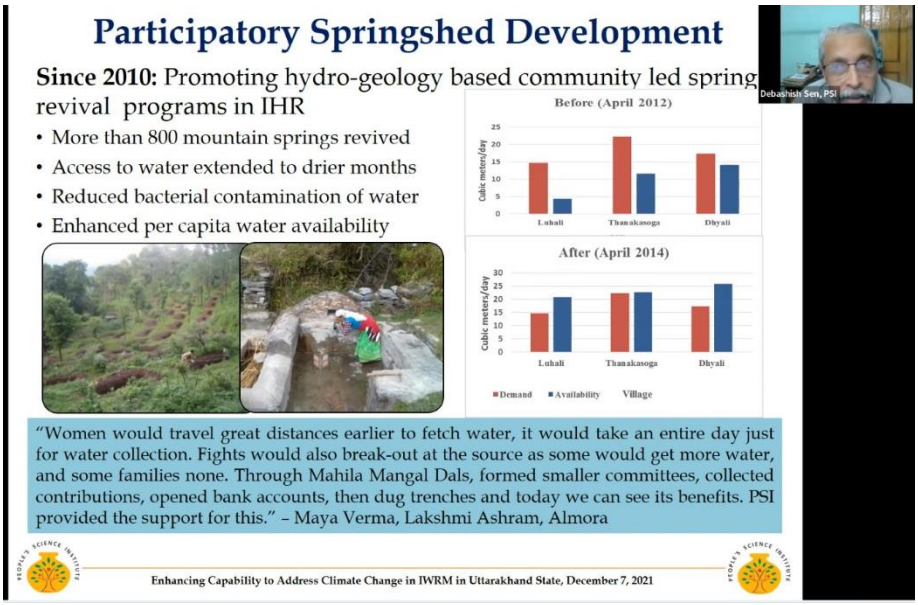


Figure-21: Participatory springshed development approach adopted by PSI.

Dr Sen concluded by showing another PSI work undertaken in Haridwar District in the Terai region of Uttarakhand where certain sustainable agricultural practices led to higher outputs with lesser water inputs leading to water savings in the area. Again, a participatory framework was used, and a lot of benefit was created by PSI's interventions apart from its efforts for increasing the ground water level.

Theme: Understanding Springs and their Importance in River Systems and Safeguarding them

Speaker: Dr Shobhan Singh Rawat, Scientist E, National Institute of Hydrology, Roorkee

Dr Shobhan Singh Rawat started by expressing his happiness to talk about IWRM with respect to Uttarakhand being his native State. Dr Rawat spoke about having developed an information system for vulnerability analysis and spring rejuvenation, called ISHVAR - Information System of Himalayan Springs for Vulnerability Assessment and Rejuvenation.

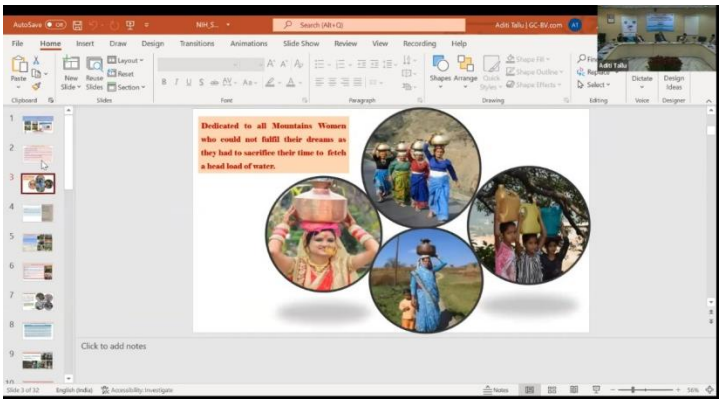


Figure-22: Dr Singh dedicated his presentation to the local women of Uttarakhand

He mentioned how five years back springs were not studied comprehensively. He explained that the recent increase in study of springs was due to Government of India in forming a Working Group on the study of Himalayan springs which became the catalyst for extensive work by many institutions. He spoke about having developed a six-step methodology for the holistic development of springs in the Indian Himalayan region. Dr Rawat showed some photos of women carrying water dedicated his presentation to the women of the mountains that could not fulfill their dreams as they sacrificed a lot of time to fetch a head load of water. He added a local Hindi saying about the same.

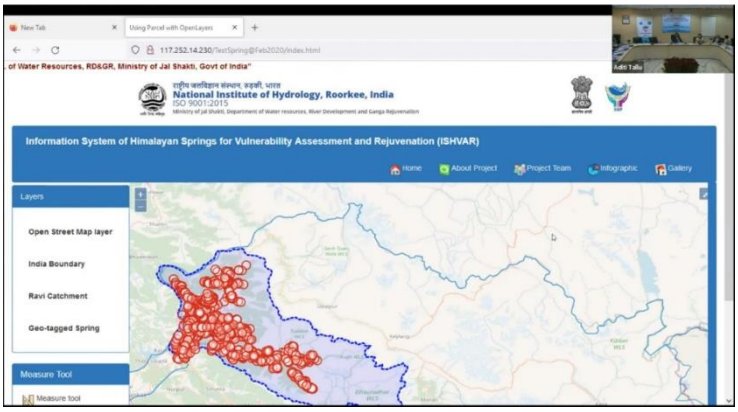


Figure-23: Dr Singh explaining the ISHVAR portal that is created under his leadership to map the spring shed areas.

Dr Rawat continued by showing the portal for ISHVAR where a comprehensive mapping of about thousand springs in the Ravi River basin with thirty-five characteristics, were shown as an example. He guided the viewers through the various features of the portal such as infographic tools to find out details about the various springs mapped. He went through the various galleries of photographs on the portal regarding the field investigations and supplementary research work.

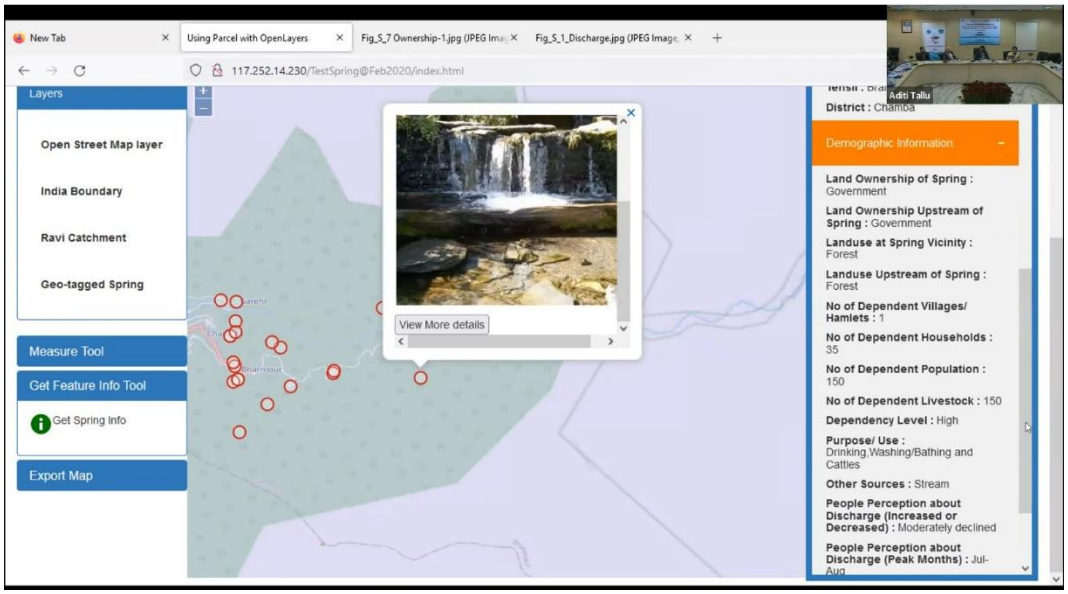


Figure-24: Dr Singh further explaining the ISHVAR protal and how it works.

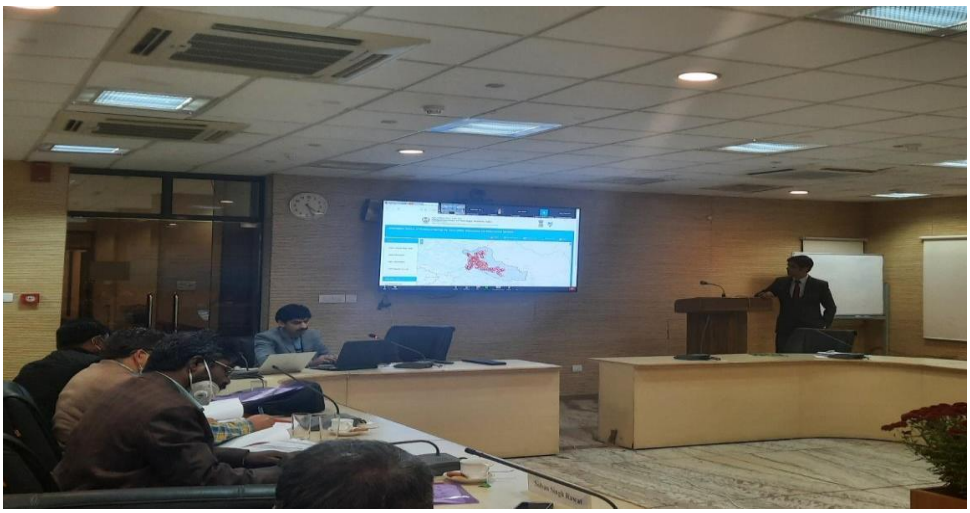


Photo 14: Dr Singh taking queries on ISHVAR portal

The spring photos were also available by simply clicking on the dot on the map representing springs, along with various associated information with details such as the geology, latitude, longitude, altitude, Gram Panchayat, land ownership, demographic information etc. He explained the importance of these bits of information for undertaking IWRM work related to springs, by giving examples of his own work experience. He stated his plans with respect to mapping of springs in the entire State of Himachal Pradesh and concluded by stressing on the importance of measuring all these resources to be able to manage them.

Theme: An Entrepreneur's Vision for Water Resources Development in Uttarakhand

Speaker: Mr Anshuman Shukla, Chief Executive Officer, Retrota Technology (P) Limited, Dehradun

Mr Anshuman Shukla Introduced his work on Multi-hazard Risk Assessment of Uttarakhand. He mentioned about his experiences by interacting with people of Uttarakhand and the problems they faced due to disasters.

He observed that after 2013 floods tragedy, infrastructure construction such as roads and buildings were undertaken in a very fast paced manner in Uttarakhand. He further observed that while the Government was building infrastructure corridors, the local Real Estate Developers and Entrepreneurs were building a lot of private commercial entities to capitalize on the development which was creating stress on the natural resources. He detailed the various externalities of the infrastructure plans posed a risk to the communities and the biodiversity due to higher vulnerability.

He suggested that integrated plans should be chalked out at the Gram Panchayat level with the help of scientific information regarding natural resources and disaster vulnerability as a guideline for development in the region. He concluded that such a strategy would help to promote development in a sustainable way with lesser carbon footprint.

Photo 15: Mr Anshuman Shukla discussing his experiences as a young entrepreneur working in the water sector in Uttarakhand

Technical Session -IV: Way Forward and Concluding Remarks

Theme: Stakeholders' Perspective and Solution-based Experience from the ground on IWRM

Speaker: Mr. Kesar Singh, Editor, India Water Portal Hindi

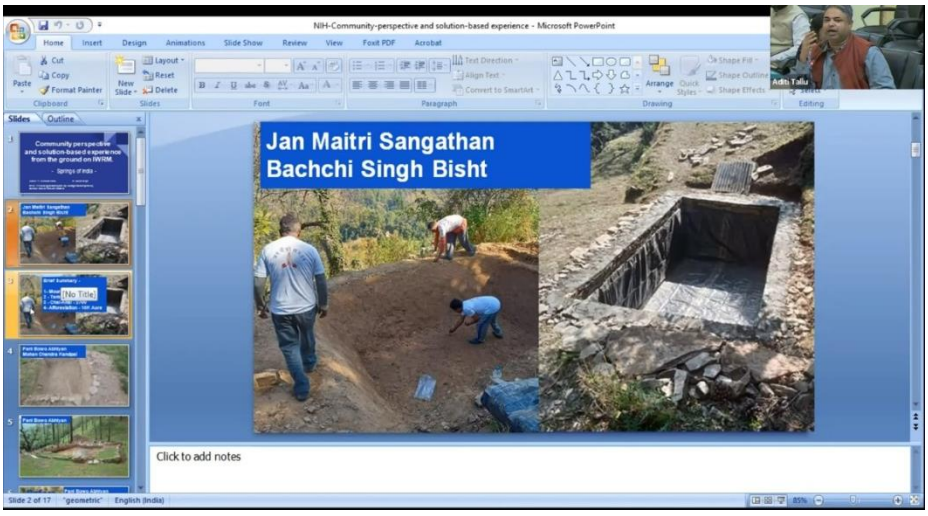


Figure-25: Mr Kesar Singh explaining his work on the ground with the communities of Uttarakhand

Mr Kesar Singh stated that the scientific aspects had been covered by the earlier speakers. He wished to focus on the work done by the community in different parts of Uttarakhand. He focused on those small-scale NGO's and common citizens with very limited budgets despite that they managed to carryout significant works.

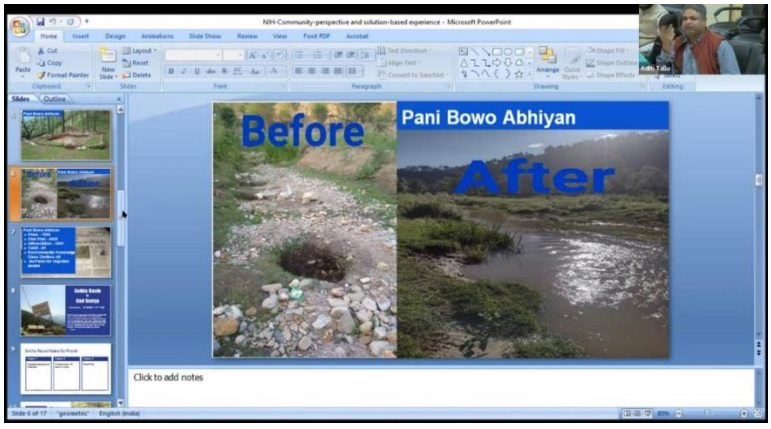


Figure-26: Mr Kesar Singh showing the impact of the work he has done with the communities of Uttarakhand

He started by showing photographs of the noteworthy works done by certain citizens in afforestation, mountain tanks, amongst others. Mr. Kesar Singh said that these were the projects initiated by individuals or small to medium organizations. He also showed photographs of some areas which were before the works were done and after the works were completed, where the changes were clearly visible. He listed out the works done by such citizens besides planting trees and building toilets, including conducting environmental knowledge classes for children to increase awareness of water resources management and environment sustainability. He further said that some works were also done specifically for the pandemic affected migrants who had to leave their livelihoods and return to the villages after the pandemic, by providing them with cattle as a means for sustaining their livelihoods.

He further added more examples of afforestation works done along the rivers for their rejuvenation leading to greening of many villages.

He mentioned that he knew more than a hundred people who had planted more than one lakh to one & a half lakh trees each, as afforestation activities in their respective areas. With that he concluded that he wished to highlight the power that general citizens and the community/people possess to bring about transformation in the Himalayan region of Uttarakhand, with sheer commitment and selfless work.

Photo 16: Mr Kesar Singh interacting with the participants of the workshop

Query: Dr V C Goyal asked Mr Kesar Singh about his view on IWRM as a concept and how it could be implemented in the State of Uttarakhand.

Answer: Mr Kesar Singh replied that within the ambit of the work that he is doing i.e., documenting the environmental work of common citizens. He has seen that the work is done as per their own understanding. He added that understanding of IWRM may be a knowledge gap amongst these people, however a lot of knowledge is being passed on to fill this gap.

He stressed that these community volunteers/citizens or Samaritans have limitations in terms of finance, therefore they could not work at the scale of a Government machinery or big organizations. Mr Kesar Singh surmised that if the Government machinery, be it the State Government or the Village Councils start working along with these community members, huge change can be brought about as the Government institutions would fill the knowledge gap and make available manpower and funds. He concluded by adding that the Village Councils had already started working with proper planning and the only need was to plug in the community environment workers to multiply the benefits to the community and the ecosystem.

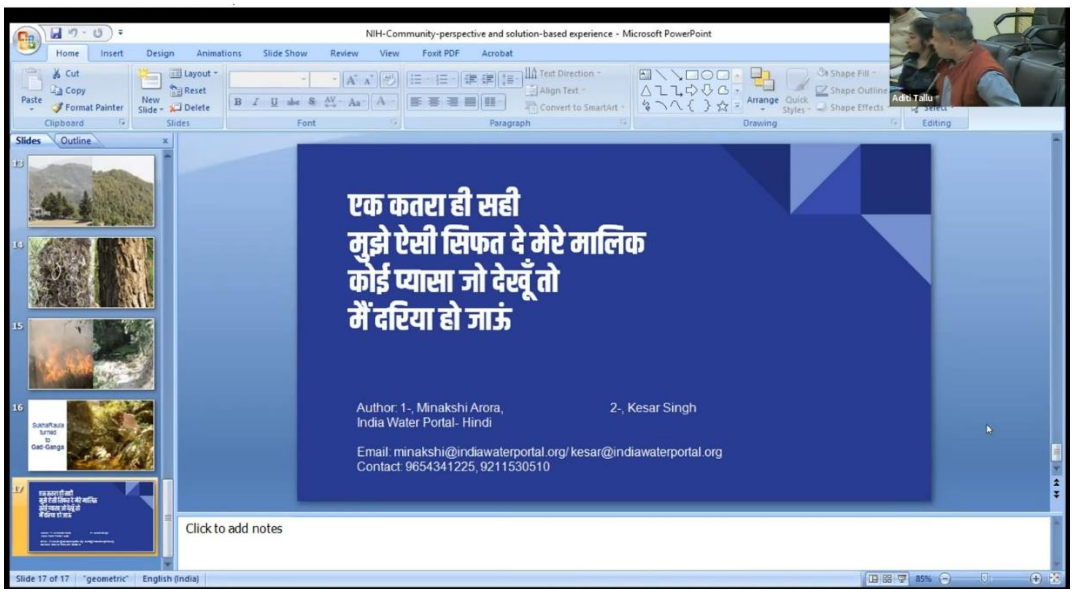


Figure-27: To conclude Mr Kesar Singh presented a beautiful couplet

Summing up of Workshop

Summing up, Dr Veena Khanduri, Executive Secretary-cum-Country Coordinator, IWP observed that capacity building at the local level was the huge gap that needed to be filled to ensure that holistic work is done in the State. She commented on the limitations of an outside agency coming into and implement a holistic IWRM regime without the deep involvement of local government administration and local community stakeholders. She added that the earlier presentations revealed that a lot of works have been done but it needed some crucial knowledge gaps to be filled at the local level to achieve the IWRM at the desired level.

Photo 17: Dr Veena Khanduri summing up the workshop and presenting the way forward

The Chair of the session, Dr V C Goyal concluded by expressing satisfaction on the discussions and presentations in the workshop. He mentioned various National and International perspectives that were offered by Mr Sunil Kumar and Dr Asaf respectively. He also mentioned various on ground perspectives from the people with his field experience. He concluded that the approach needed to be formalized with greater capacity building for the local line departments of the Government of Uttarakhand and the local community, to achieve greater success to achieve the objectives of IWRM.

Dr V C Goyal thanked the IWP and GWP for organizing this workshop for capacity building of the officials Water Resources Department of Uttarakhand State and other line departments for holistic management of water resources in the State in line with IWRM.

Photo 18: Dr V C Goyal summing up the workshop and presenting the way forward

At end of the workshop, Ms Aditi Tallu, Consultant, IWP delivered a Vote of Thanks to the Chief Guests, eminent speakers and the participants.

Appendix-I

State-level Sensitization Workshop on
"Enhancing Capability to Address Climate Change in Integrated Water Resources Management (IWRM) in Uttarakhand State"

7th December 2021 (In-person as well virtual)

Workshop Background

India Water Partnership (IWP) is a non-profit organization with the goal of promoting Integrated Water Resources Management (IWRM) in India. The IWP serves as an independent voice on water management issues and is working on various disciplines of water and allied sectors across India.

IWP is undertaking the assignment "Enhancing Capability to Address Climate Change in Integrated Water Resources Management (IWRM) in Uttarakhand State". The assignment will sensitize and build capacities of officials of water resources and other relevant departments and institutions of Government of Uttarakhand to implement and mainstream adaptation actions into Integrated Water Resource Management (IWRM). The climate responsive approach to IWRM will help the State Government to ensure efficient and effective planning for water use with a view to meet the needs of all the sectors considering the recent challenges.

Towards end of the assignment, a one-day workshop is being organized by IWP in collaboration with Indian National Committee for Intergovernmental Hydrological Programme (INC-IHP), UNESCO and National Institute of Hydrology (NIH), Roorkee at NIH, Roorkee campus on 7th December 2021 to seek inputs and sensitize the State government officials on the theme of "Integrated Water Resources Management in Uttarakhand".

Appendix-I : Workshop Agenda

INAUGURAL SESSION		
Time	**Speaker**	**Theme**
11.00-11.10 AM	Dr Veena Khanduri Executive Secretary-cum-Country Coordinator, India Water Partnership, GWP-India	Welcome Address & Context Setting.
11.10-11.20 AM	Shri Mukesh Mohan Engineer- in- Chief Department of Irrigation, Government of Uttarakhand	Presentation/Talk on Current highlights and work in the state related to IWRM
11.20-11.30 AM	Shri A K Dinkar Secretary, Central Board of Irrigation and Power & Former Engineer-in-Chief, Department of Irrigation, Government of Uttarakhand	Presentation/Talk on Journey of Uttarakhand related to IWRM
11.30-11.40 AM	Dr Rajendra Dobhal Director General, Uttarakhand State Council of Science and Technology & Chairman, Rural Development and Migration Commission of Uttarakhand	Address by Chief Guest
11.40-11.50 AM	Shri A B Pandya Secretary General, International Commission on Irrigation and Drainage & Former Chairman, Central Water Commission, Ministry of Jal Shakti, Government of India.	Address by Chief Guest
11.50-12.00 PM	Dr Jyoti P Patil Scientist "D" National Institute of Hydrology, Roorkee	Vote of Thanks
Close of Inaugural Session (Tea/Coffee Break 12.00 PM to 12.05 PM) (IWRM Video 1 in the background)		

TECHNICAL SESSION-I: **IWRM – National and International Perspectives** **Chair – Shri Mukesh Mohan, Engineer-in-Chief, Irrigation Department, Government of Uttarakhand**		
Time	**Speaker**	**Theme**
12.05- 12.20 PM	Dr V C Goyal Scientist "G", National Institute of Hydrology, Roorkee & Member Secretary, INC-IHP, UNESCO	IWRM Concepts; their applications; vision; inclusion in policies and planning.

Time	Speaker	Theme
12.20-12.35 PM	Shri Sunil Kumar Director, Basin Planning-I Central Water Commission, Ministry of Jal Shakti, Government of India.	India's Journey, Policies, National IWRM Plan.
12.35-12.50 PM	Dr Lior Asaf Water Attache, Israeli Embassy, New Delhi	International perspectives of IWRM; Incorporating learning from other countries in Indian scenarios.
12.50 - 01.15 PM	Laurent-Charles Tremblay-Lévesque IWRM & Knowledge Management Specialist, Global Water Partnership (GWP), Stockholm, Sweden & Ms. Gergana Majercakova Senior Learning Specialist Global Water Partnership (GWP), Stockholm, Sweden	Sharing Knowledge about IWRM Toolbox. (Virtual Session)
01.15 – 01.25 PM	Interaction/Question & Answers. Closing remarks by the Chair.	
Close of Technical Session – I (Lunch Break 01.25 PM to 02.00 PM)		
TECHNICAL SESSION-II: **TECHNICAL UNDERSTANDINGS – CASE STUDIES** **Chair – Dr Veena Khanduri, Executive Secretary-cum-Country Coordinator, India Water Partnership, GWP-India**		
Time	**Speaker**	**Theme**
02.00 – 02.15 PM	Dr Swapnamita Vaideswaran Scientist D, Associate Professor Wadia Institute of Himalayan Geology, Dehradun	How to understand local Geology, incorporating Himalayan Geology into planning
02.15 – 02.30 PM	Dr Shobhan Singh Scientist E, National Institute of Hydrology, Roorkee	Understanding Springs and their importance in the river systems – safeguarding them.
02.30 – 02.45 PM	Mr Dharm Singh Meena (IFS) Divisional Forest Officer, Narendra Nagar Division	Rejuvenating Heval River
02.45 - 03.00 PM	Dr Debashish Sen Director, People's Science Institute, Dehradun	Case studies and including communities in IWRM
03.00 - 03.15 PM	Mr. Anshuman Shukla Chief Executive Officer, Retrota Technology (P) Limited, Dehradun	An Entrepreneur's vision for Water Resources Development in Uttarakhand
03.15 – 03.25 PM	**Interaction/Question & Answers. Closing remarks by the Chair.**	
Close of Technical Session – II (Tea/Coffee Break 03.25 PM to 03.35 PM) **IWRM Video 2 (Heval River rejuvenation video) in the background**		

TECHNICAL SESSION-III: GROUP EXERCISE Chair – Dr V C Goyal, Scientist "G" National Institute of Hydrology, Roorkee & Member Secretary, INC-IHP, UNESCO Support Team: Dr Jyoti P Patil, Scientist "D", NIH & Ms. Aditi Tallu, Consultant, IWP	
Time	**Details**
03.35 – 04.15 PM	- Participants will be divided into groups of 6 persons each. - There will be three scenarios given to the participant (one after the other). - 5 minutes will be provided for each scenario - Participants would be asked to develop comprehensive solutions for the three scenarios - 15 minutes for presentation (In total) (2 mins for each presentation)
04.15 – 04.25 PM	Summing up of the Group Exercise by the Chair.

TECHNICAL SESSION-IV: WAY FORWARD & CONCLUDING REMARKS		
Time	**Speaker**	**Theme**
04.25 - 04.40 PM	Shri Kesar Singh Editor, India Water Portal Hindi & Mrs. Minakshi Arora (Advocate) Founder and Managing Trustee for TREE & Manager, India Water Portal, Hindi	Stakeholders' perspective and solution-based experience from the ground on IWRM.
04.40 – 04.45 PM	Summing up of the Workshop by Dr VC Goyal, Scientist "G", NIH and Dr Veena Khanduri, Executive Secretary-cum-Country Coordinator, IWP	
04.45 – 04.50 PM	Vote of Thanks by Ms. Aditi Tallu Kaul, Consultant, IWP	
Close of Workshop **Tea / Coffee and snacks (Networking with guests and participants – 04.50 PM to 05.00 PM**		

Appendix -II

List of Participants
(In-person)

S. No.	Name	Designation	Organisation
1	Kesar Singh	Editor	India water portal
2	Shivendra	Video production	India water portal
3	Amarjeet Sah	Assistant Engineer	IRI, Roorkee
4	Jhalesh Kumar	JRF	NIH, Roorkee
5	Dr. Sandeep Kumar Malyan	SPO	NIH, Roorkee
6	Dr. Shweta Yadav	RA	NIH, Roorkee
7	Omkar Singh	Scientist F	NIH, Roorkee
8	Dr. Senthil Kumar	Scientist F	NIH, Roorkee
9	Digambar Singh	Scientist C	NIH, Roorkee
10	Nageswara Rao Allaka	RA	NIH, Roorkee
11	V C Goyal	Head, RMOD	NIH, Roorkee
12	A B Pandya	Secretary General	ICID
13	Dr. Lior Asaf	Water Attache	Israel Embassy
14	H K Varma	Executive Directir	ICID
15	R Dobhal	Director General	UCOST
16	Dr Prashant Singh	DC	UCOST
17	Minakshi Arora	Chairperson	TREE
18	Ram Kumar	P.S.	NIH, Roorkee
19	Dr. Swapnamita Vaideswaran	Scientist	NIHG, Dehradun
20	Dr. S S Rawal	Scientist E	NIH, Roorkee
21	Ankit Singh Rana	Draftman	Forest Department
22	Dr. Akash	Project Coordinator	Forest Department
23	Dr. Amrendra Bhushan	Research Scientist	NIH, Roorkee
24	Anshuman Shukla	CEO	Retrota Technology Private Limited
25	S K Saha	S.E.	IRI, Roorkee
26	Sushil Kumar	RO	IRI, Roorkee
27	Ashok Giri	Assistant Director	Agriculture Department
28	Dharm Singh Meena	DFO	Forest Department
29	Dr. Jyoti Patil	Scientist D	NIH, Roorkee

S. No.	Name	Designation	Organisation
30	Dr. Veena Khanduri	Executive Secretary-cum-Country coordinator	India Water Partnership
31	Sunil Kumar	Director, Basin Planning- I	Central Water Commission
32	Dr. Debashish Sen	Director	PSI, Dehradun
33	Laurent Charles Tremblay-Levesque	IWRM & Knowledge Management Specialist	Global Water Partnership
34	Gergana Majercakova	Senior Learning Specialist	Global Water Partnership
35	Varun Goyal	RP (S)	NIH, Roorkee
36	Shubham Agarwal	MT (F)	India Water Partnership
37	Mangla Rai	Project Coordinator	IWP
38	Aditi Tallu Kaul	Consultant	India Water Partnership
39	Rishank Kaul	Writer (Science Communication)	Freelance
40	Naresh Kumar	Assistant	India Water Partnership

Appendix- III
Case Study-I

A Case Study on the Forest Officer's Efforts to Rejuvenate the Heval River, Tehri Garhwal, Uttarakhand through River-landscape based Approach

Summary

50 Kms long Heval River, one of the many tributaries of the Ganges, originates as Khuret Gaad from the forests, near Surkanda Devi and Nagdevta temple in Tehri Garhwal district, Uttarakhand. It is a perennial river in the Chamba block that is used for both drinking water and irrigation. The river is fed by springs and streams along its length and merges with the Ganges at Shivpuri.

Anthropogenic activities like mining, release of industrial waste, smelting of ore, incineration of fossil fuel, particularly coal, rising demand of water for the increasing population and unplanned deforestation had forced the Heval river springs and streams to dry up. These factors also resulted into perennial streams of the River reducing it to the seasonal tributaries. This led to a change in cropping pattern falling from four crops to two. The lean discharge of the river reduced to less than half from 2012 to 2018.

This is the case study of an Indian Forest Officer, Mr. Dharm Singh Meena, I.F.S, Divisional Forest Officer, Narendra Nagar Division, Tehri Garhwal to revive the Heval River having at least one lakh people across 167 villages dependent on it.

The Heval River Rejuvenation project using river-landscape based approach started by Mr. Dharm Singh Meena in 2018 was completed in 2021. The project not only rejuvenated the river but also revived springs, streams and the riverbed. Employment opportunities were also created for the local people. After its realization, the local people hailed Mr. Meena as 'Bhagirathi Ji'' for bringing the river landscape back to its original form. In this case study, we will go through the thinking of Mr. Dharm Singh Meena behind, for success of the project and how it was executed.

Scientific and Strategic Planning

Geo-Hydrological Scientific Study of the Landscape

To remedy the situation, it was decided that the focus would be on rejuvenating the entire river landscape. Regular monitoring of quality and quantity of river water was initiated as a first step towards rejuvenation process. The aim was to restore springs, ecology and biodiversity of the entire river landscape and gradually reduce water's velocity and then store the water naturally along with checking soil erosion. It was also felt that community participation would help in accelerating the pace of rehabilitation. Indian Institute of Technology (IIT) Roorkee, National Institute of Hydrology (NIH), Roorkee, CAR-Indian Institute of Soil and Water Conservation (IISWC) Dehradun and Scientists of Himmothan and People's Science Institute (PSI) and the local NGOs were also roped in for the scientific studies.

Action Plans

The following Action Plans were prepared for rejuvenation:

1) Spring shed management: Revival of springs that feed the river system.
2) Stream shed treatment: Erosion checking and increasing the groundwater recharge.
3) Afforestation: Planting of local vegetation – trees, shrubs and grasses.
4) River bed management: Ensuring round the year water supply and reducing sediment load in the river bed.
5) Convergence activities: Ensuring better management of water and checking over uses.

Various departments were roped in for different kinds of contributory activities:

1) Ensuring community participation – local NGOs like Himmothan, PSI etc.
2) Better drinking water supply – Uttarakhand Peyjal Nigam
3) Better irrigation facilities – Irrigation Department, Uttarakhand
4) Rainwater harvesting – Rural Development Department, Uttarakhand
5) Enhancement of farm yield and income of farmers – Agriculture Department, Uttarakhand
6) Employment through water conservation – MGNREGA etc.

Methodology

The forest team was adequately trained by NIH Roorkee and Himmothan NGO. A preliminary survey was undertaken for collection of baseline data. A socio-economic survey of the individual households was conducted who depend on the river system. A bio-physical survey was carried out to adequately understand the technical details around the springs, mountain aquifers and streams. The catchment area was surveyed and the vegetation in the area was mapped. The periodical discharge of the springs and streams was measured. Treatment measures were undertaken for the recharge area. GIS technology was used for recharge zone mapping.

The water recharge interventions included construction of Infiltration pits, Percolation ponds, Recharge trenches, Bio-check dams, pine-needle check dams and dry stone CD along with erosion control measures as part of the stream-shed treatment. All these interventions were geo tagged for recording and monitoring purposes. Over the years, these engineering structures will be replaced by vegetative measures, as part of the comprehensive eco-friendly initiative.

Outcomes

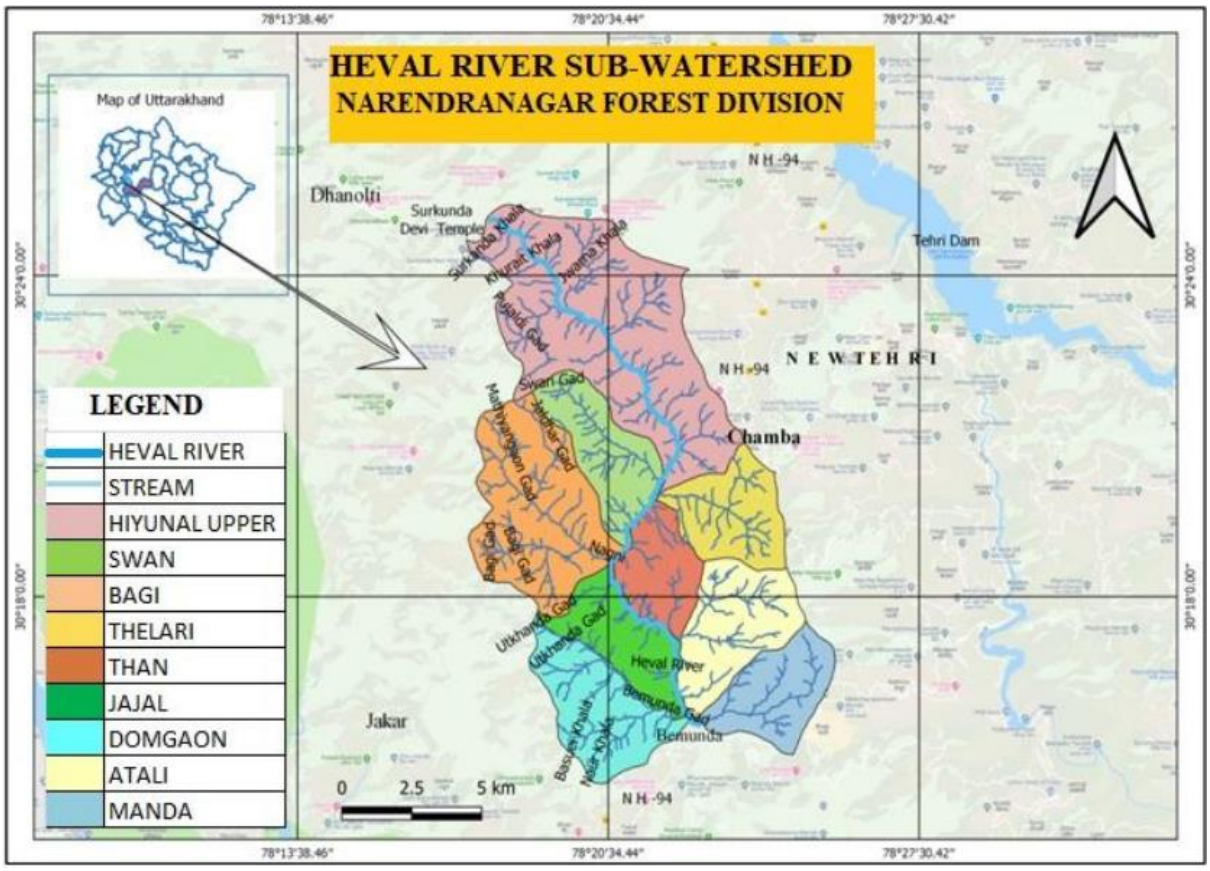
The project outcomes are as under:

- Creation of additional recharge by constructing 39529 water harnessing structures contributing to 865.86 Lakh litres of ground water augmentation.
- GIS mapping ensured transparency – timeline tracking of works and sites.
- Community participation ensured sustainability of the rejuvenated river system.
- Increase in discharge level noticed in 23 springs which are part of the Heval river system.
- Afforestation in 697 hectares – planting of 9,88,400 local water loving trees, grasses & shrubs.
- In all 66 springs were rejuvenated benefiting more than 1.00 lakh people living in 23 villages.
- Available regular funds (around 2.32 Crores) under Compensatory Afforestation Fund Management and Planning Authority (CAMPA) were utilized and there was convergence with MGNREGA scheme also.
- Creation of 96085 man-days of additional employment across 34 Village Panchayats giving the region an economic fillip.
- Increase in quality and quantity of water in springs have helped farmers increase the agriculture production by 30 per cent.

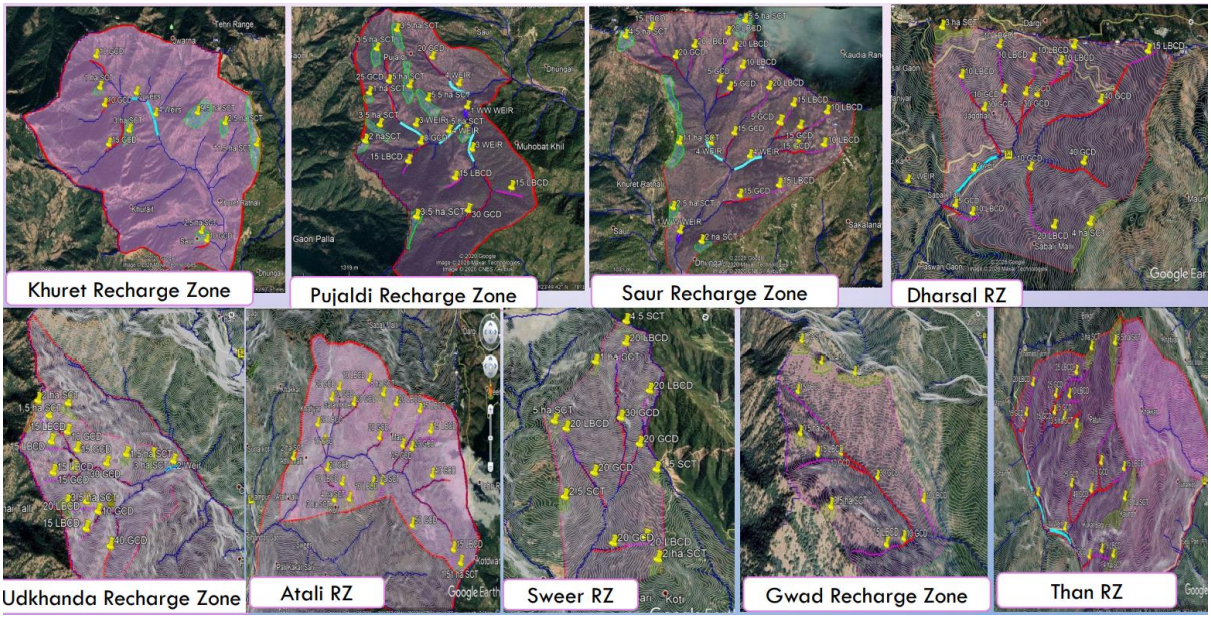
Monitoring and Evaluation

- All the works and activities continued to be uploaded on web portal (completed/up-coming).
- Regular checking was conducted on the river water quality, quantity and discharge level in the lean and peak periods. Link www.Heval-rejuvenation.ayushi.co.in

Relevant Images



The above map shows the various sub-watersheds taken up for the project with each sub-watershed represented through colour coding. Additionally, the main river and its various streams are shown in the map.



The above map shows the various recharge zones which were worked upon for this project.

The above pictures show the various infiltration trenches and infiltration recharge ponds that were used to improve the water recharge in each sub-watershed. Apart from this, Bio-check dams were constructed. Also, Dry Stone CD and Wire Crate CD were made available.

Community participation was the basis of the collaborative approach of the project, for which various community engagement events were conducted to ensure maximum participation and contribution from the community stakeholders.

A Case Study of Assan River Rejuvenation by HESCO with the Community Participation

Summary

The Assan river rejuvenation project was taken up by HESCO based in Shuklapur, Dehradun. Led by Dr Anil Joshi, HESCO undertook short zone watershed management efforts around the Assan river. These interventions were aimed at increasing the water recharge of the surrounding areas around the Assan River. With these interventions, the water recharge of the area increased over the years, thereby expanding the green cover area. Eventually, the river discharge started rising and river flow also increased. The area of Shuklapur in Dehradun was facing water scarcity before this project was undertaken. The Shuklapur Assan river rejuvenation project has not only helped in increasing the natural forest area of Shuklapur but also provided water security to residents of Shuklapur.

Severity of the Problem

Dry Zone Water Crisis

The Assan river was drying up like the other rivers of Dehradun. The residents of Shuklapur were experiencing extreme water shortage. The drying of the river also resulted in change in cropping pattern. The area was experiencing high evapotranspiration due to reduction in green cover. In 2010, HESCO decided to build their offices in Shuklapur area and adopted the river Assan in an attempt to develop its watershed area to restore the river.

Image 1: Assan river in 2010 - source HESCO website

Scientific and Strategic Planning

Geo-Hydrological Scientific Study of the Landscape

To remedy the situation, it was decided that the focus would be on rejuvenating the Assan river strip around Shuklapur area. Rainwater harvesting interventions such as gully plugging, small check dams, recharge holes and recharge pits were planned under the project. The watershed recharge zone around the river Assan was demarcated with the help of the Forest Department, Dehradun. The aim was to restore springs, ecology and biodiversity of the entire river landscape. Community partnership was a big part for project success. Local Forest Department (Dehradun) was roped in to demarcate the slopes and stream gully plugging was done as an intervention to build the water recharge. Community in Shuklapur area was invited to bring their knowledge for river rejuvenation. Community youth was asked to help digging the recharge holes and recharge pits. They also helped in constructing the gully plugs and check dams in the watershed areas of the streams that feed the Assan river.

Image 2: Reviving streams in the watershed of Assan river system.

Action Plans

1. Stream shed management: revive the smaller streams that feed the river system.
2. Stream shed treatment: Check erosion and increase groundwater recharge.
3. Afforestation: Planting local vegetation – trees, shrubs and grasses. Bamboo, litchi, mango and guava trees were planted around the stream shed areas.
4. River bed management: insure round the year water supply and reduce sediment load in the river bed.
5. Convergence activities: Community outreach to undertake water conservation measures and take ownership of the project.

Image 3: Information board of the project built by the forest department.

Various departments were roped in for different kinds of contributory activities:

1. Gaining access in the forest area, understanding the watersheds and geological understanding of the area to ascertain places for best recharge efficiency – Forest Department, Dehradun.

2. Employment through water conservation measures under MGNREGA – digging recharge pits, recharge holes, gully plugs, smaller check dams, etc.

Image 4: Assan river rejuvenation.

Methodology

The HESCO team and the forest team gained their training by learning from past experiences of community knowledge of the river and accessing research materials on watershed development techniques. HESCO approached the Forest Department of Dehradun with their plan of adopting the Assan river and working to revive it. Dr Anil Joshi of HESCO, through his herculean efforts brought together the local administration, Forest Department and the community leaders to create an ideal environment for inter-departmental cooperation. The catchment area was surveyed with the help of the forest officials and vegetation in the area was identified. The slope areas from where the water rushes downstream were also identified. Gullies were identified and Gully plugging measures were undertaken.

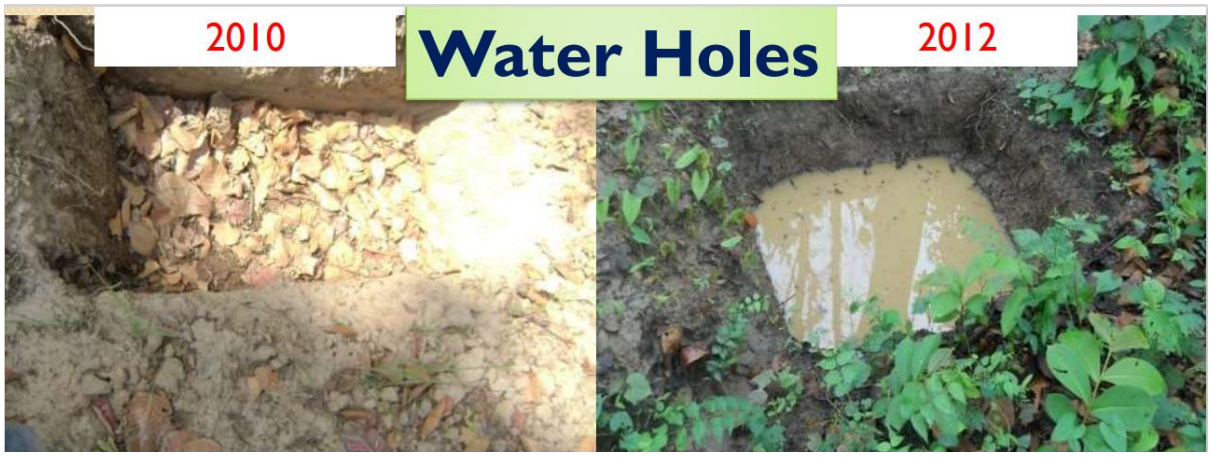


Image 5: Water holes dug in 2010 and its result in 2012

Image 6: Gully plugging undertaken in 2010 and its effect in 2018

The periodic discharge of the springs and streams was measured. Treatment measures were planned for the recharge area. The water recharge interventions included Recharge pits, Recharge holes, Percolation ponds, Recharge trenches, Gully plugs, Bio-check dams, planting indigenous plants around the area. All these interventions were physically tagged for recording and monitoring purposes.

Project Outcomes

1) Creation of additional recharge water harnessing structures contributing to substantial ground water augmentation.

Image 7: Groundwater augmentation through recharge pits

2) Community participation for ensuring sustainability of the rejuvenated river system.

Photo 1: Dr Anil Joshi in consultation with the local community.

3) Increase in discharge level noticed in the surrounding springs and river Assan.

Image 8: Increase in stream discharge.

4) Afforestation – Planted local water loving trees, grasses & shrubs such as bamboo, litchie, guava, mango, etc.

Image 9: Afforestation and increase in green cover.

Monitoring and Evaluation

1) All the works and activities were uploaded on HESCO web portal.

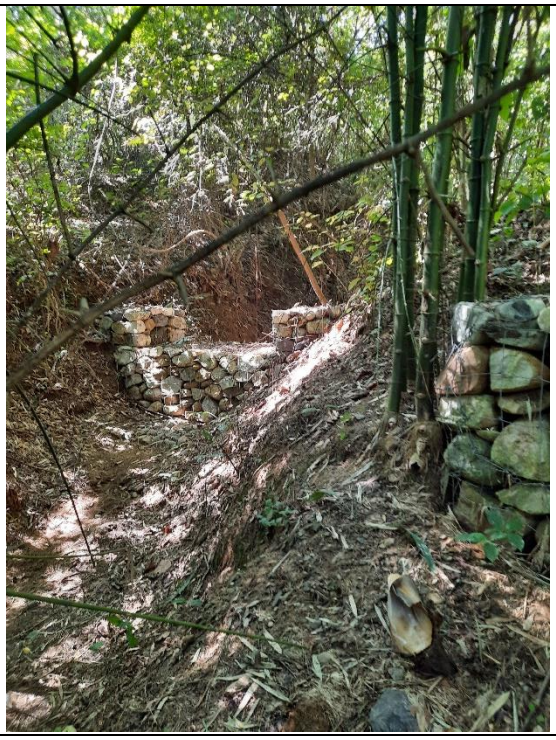
2) Regular maintenance of the recharge interventions was undertaken. Cleaning the interventions, regular desilting, recharge monitoring, etc. were carried-out.

Image 8: Maintained bio check dams.

Image 11: Water recharge achieved through continuous efforts since 2012 .(Left is the view of Before Project and right is the image of After Project)

Relevant Images

Photos of recharge structures taken during the site visit	
	
	
	



Photos of green cover and recharged watershed taken during the site visit.

India Water Partnership (IWP)

India Water Partnership (IWP) is an Indian non-profit organization with the goal of propagating, promoting and supporting Integrated Water Resources Management (IWRM) in India. It was registered in 2001 under Haryana Societies Registration Act 1860 and re-registered as per new Haryana Registration and Regulation of Societies Act 2012. The IWP has also been accredited by the Global Water Partnership (GWP) with its headquarters at Stockholm, Sweden as Country Water Partnership of GWP and hence, also known as GWP-India.

IWP serves as an independent voice on water management issues outside the government's ambit and has been pursuing activities that influence policy and enhance stakeholders' participation through critical and unbiased analysis of issues, stimulating public awareness and understanding and promoting dialogue and exchange of information between the individuals, agencies and government departments within the country.

IWP has more than 120 network partners comprising of Institutions, Research Organizations, NGOs/ Community-based Organizations, Corporate bodies, etc. working in multiple water-related issue across India. It holds periodic meetings and conferences within the country for discussions on the aforementioned aspects in water sector, ensures effective participation of the country in various international events facilitated by GWP and other international institutions and encourages cooperation and collaboration among allied disciplines and institutions within the country to propagate integrated water resources development.

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