CEDAR
CENTRE FOR ECOLOGY DEVELOPMENT AND RESEARCH

IDRC | CRDI

Canada

# CLIMATE ADAPTIVE WATER MANAGEMENT PRACTICES & STRATEGIES

CEDAR
CENTRE FOR ECOLOGY DEVELOPMENT AND RESEARCH

IDRC | CRDI

Canada

# CLIMATE ADAPTIVE WATER MANAGEMENT PRACTICES & STRATEGIES

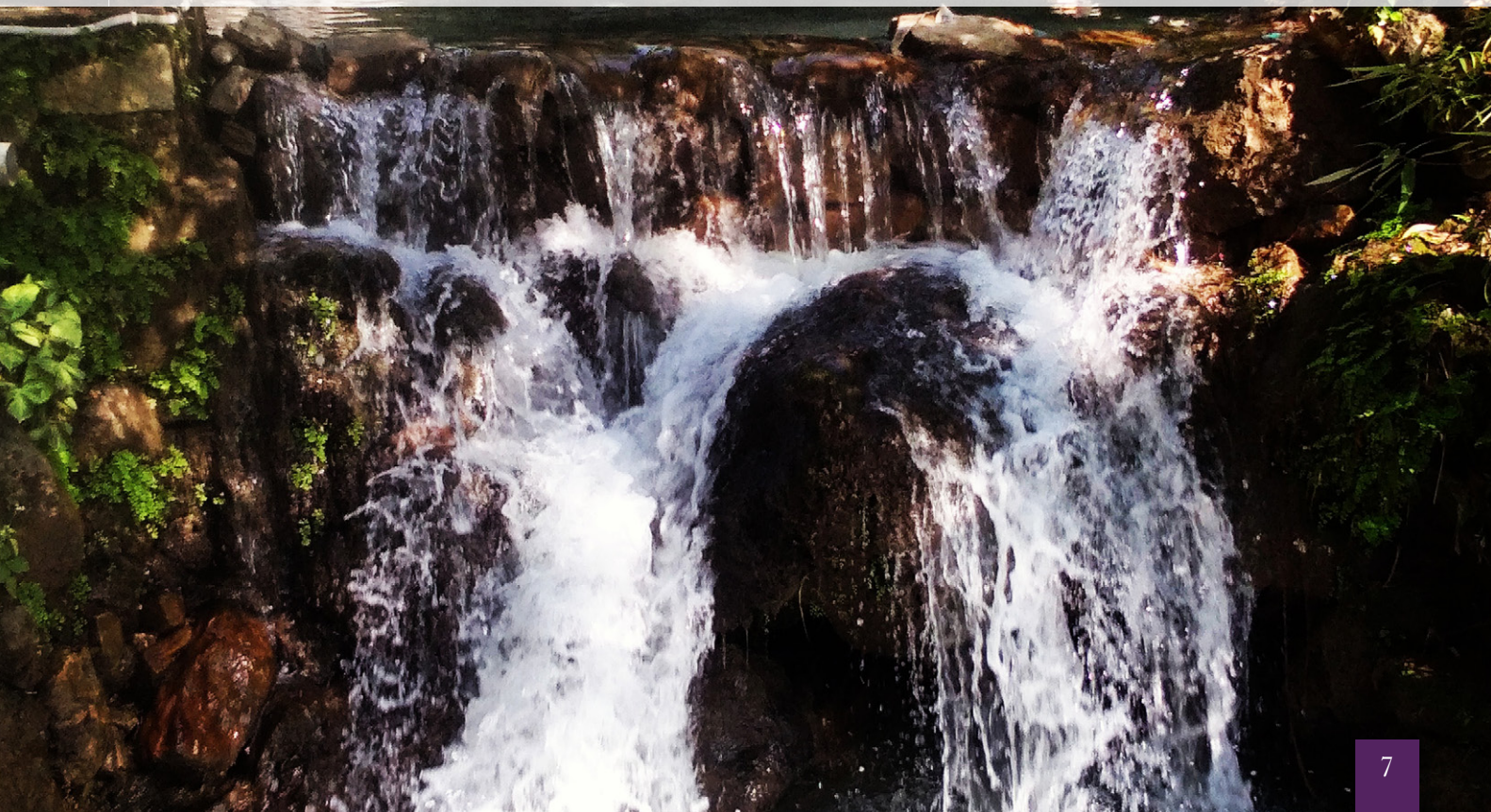
# TABLE OF CONTENT

# About **CEDAR**

CEDAR is a not-for-profit organisation founded in 2006 by a group of academics and development practitioners with the aim of bridging the gap between applied research and field-based interventions. CEDAR carries out research, liaises with stakeholders and facilitates the implementation of sustainable solutions to improve the management of natural resources. The registered office of CEDAR is in Delhi while the main research office is in Dehradun, Uttarakhand. CEDAR is recognised as a Scientific and Industrial Research Organisation (SIRO) by the Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India. CEDAR brings together a group of experienced professionals with young researchers and offers a fresh approach to applied research and development.

# Project **INTRODUCTION**

Climate Adaptive and Water Management Practices for Cities in South Asia (CAMPS) The project was carried out in two countries India and Nepal in which four cities were selected for the study (Haldwani & Mussoorie in India and Dharan & Dhulikhel in Nepal). The project was funded by International Development Research Centre (IDRC), Canada. CEDAR being the Indian collaborating partner conducted research activities under the project for the two selected cities i.e Mussoorie and Haldwani. The project was intended to address the water insecurity in the Mussoorie and Haldwani cities, Uttarakhand, largely aimed to develop climate adaptive and equitable water management practices and strategies (CAEWMPS). Main focus was given to institutional building or transformation, informed by a diagnostic analysis of social, political and biophysical dimensions of the urban water systems. Using an interdisciplinary and participatory approach, a variety of city-specific CAEWMPS were developed and tested. Likely elements of CAEWMPS include: improving management of critical water zones and their catchments, informed city-scale water management planning, effective knowledge partnerships, and institutional frameworks and tools for enhancing water security under a changing climate.



# About **CAMPS**

CAMPS are climate adaptive and gender sensitive nature based approaches that reduce water vulnerability due to changingclimate conditions in a given area. CAMPS are developed via testing various city specific strategies, which include elements like improving management of critical water zones and their catchment, informed city scale water management planning, effective knowledge partnerships, intuitional frameworks and tools for cities and towns in mountainous areas and foothills of Himalayas.

# Why **CAMPS**

Cities in South Asia face extreme water insecurity due to changing climate and rapid urbanization. Critical urban water zones that supply essential water are under threat as rainfall patterns become more erratic and cities are slow to develop adaptation strategies. Although cities in north India receive significant annual rainfall, they struggle to find institutional solutions to store rainwater in critical water zones such as reservoirs, off-season flow in the running rivers, and the ground water system. Many cities have a poor record in ensuring equitable water access. Thus, we investigate water insecurity in two cities of Uttarakhand State, and develop Climate Adaptive and Equitable Water Management Practices and Strategies (CAEWMPS) for cities facing water shortages.

# Objectives

CAMPS are climate adaptive and gender sensitive nature based approaches that reduce water vulnerability due to climate conditions in a given area. CAMPS are developed via testing various city specific strategies, which include elements like improving management of critical water zones and their catchment, informed city scale water management planning, effective knowledge partnerships, intuitional frameworks and tools for cities and towns in mountainous areas and foothills of Himalayas.

1) Analyze existing water management systems to identify adaptation issues and opportunities in relation to
   (a) existing and predicted impact of climate change on water cycles,
   (b) city-level planning and governance context,
   (c) socio-economic trends of urbanization in the region, and day-to-day water use practices;

2) Explore, experiment and develop Climate Adaptive and Equitable Water Management Practices and Strategies (CAEWMPS) focusing on priority critical water zones of the four cities;

3) Investigate city-scale planning and institutional change pathways for mainstreaming CAEWMPS, with particular reference to economic incentives, knowledge partnerships, and social enterprise innovations;

4) Analyze policy and regulatory barriers to CAEWMPS in the context of Nepal and the two States in India, and demonstrate actionable policy improvement pathways for upscaling CAEWMPS

5) Develop and disseminate scientific outputs in aspects of
   a) governance of critical urban water zones,
   b) reframing institutions for urban water system adaptation,
   c) effective planning pathways for urban water adaptation,
   d) gender sensitive urban water management,
   e) policy directions for effective urban water systems adaptation,
   f) economic analysis of climate adaptive water management options,

# Site **SELECTION**

## *Study Sites*

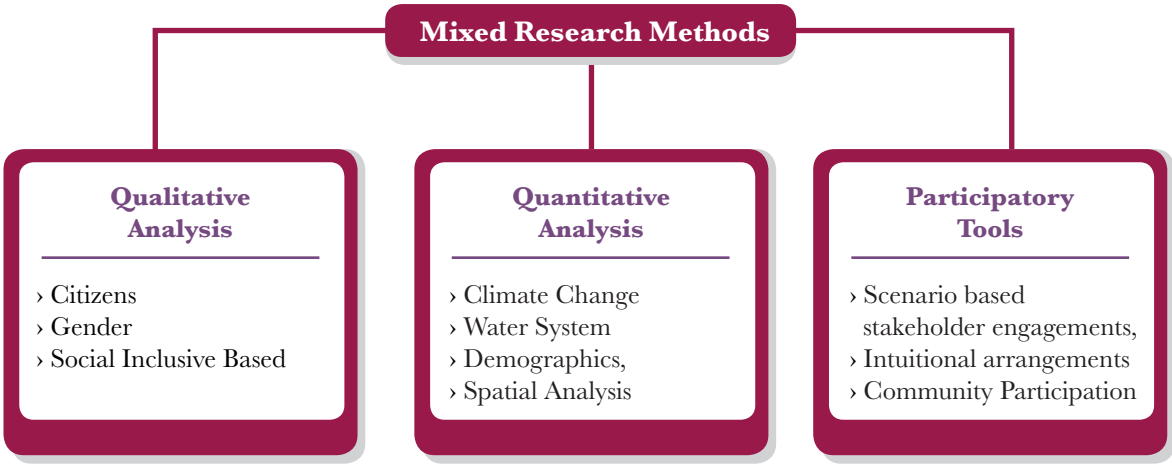
Under the CAEWMPS project two cities were selected for study Haldwani and Mussoorie. The two cities demonstrate diverse urban contexts which underlie water insecurity: high rate of urban expansion, diversity of urban water systems and diverse water insecurity situations such as ground water depletion in Haldwani (fall in Bhabar region), in Mussoorie High tourist influx especially during tourist season create high water demand during summer months and institutional challenges in water management.

## *Selection Methodology*

For having an in-depth understanding of urban water adaptations, problems and solutions.

Research method of inter disciplinary approach combining

• Urban Geography • Urban Planning • Governance • Science Policy Interface



## *Mussoorie*

## *Haldwani*


6
5
4
3
2
1

# HALDWANI

Also Known as "Gateway to Kumaun'"

Established in 1834 AD

**Population:** 156,078 (2011, census)

**Major Water Source:** Gaula River, tubewells & Sheetlahat spring

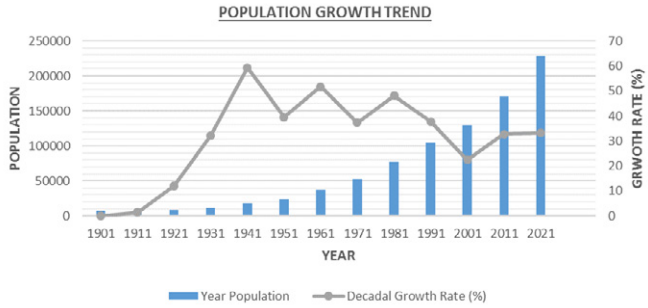
**Supply:** 26.67 MLD (Million Liters/Day)

**Demand:** 34.5 MLD [The gap in demand and supply is 7.83%]

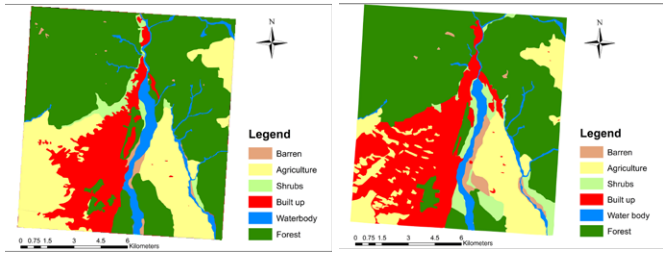
Haldwani historically been a trading post and a hub between the hilly regions of Kumaon. Located in the plains of Nainital City, surrounded by Shivalik hills, the town is situated along the banks of River Gaula and falls in the Bhabar region. The settlement comprises both of main Haldwani city and its mildly hilly area Kathgodam, together the Haldwani urban system falls under one administrative unit.

## *Demographics and Urbanisation*

The population of Haldwani has grown significantly over the past decades, the growth can be seen significant in the last three decades, 1991, 2001 & 2011 following a growth rate of around 30.19% (Fig. 1). Based on the trends, a projected population of 2,28,239 can be foreseen in 2021 from existing 1,71,351 as of 2011.




Considering the growth of population, high urbanization rate can also be seen for Haldwani. The current census data shows, almost 86.06% of population engaged in tertiary sector. Fig. 2 shows a comparative land use analysis for Haldwani City as per ISRO's Bhuvan imagery for 2005-06 & 2011-12. Significant land use change can be seen for the city from an agrarian rural (yellow & dark red) to urban settlement (orange red). The urban built-up has significantly increased from 8.57% to 57.03%, as most of the agricultural and fallow land has been converted to urban.

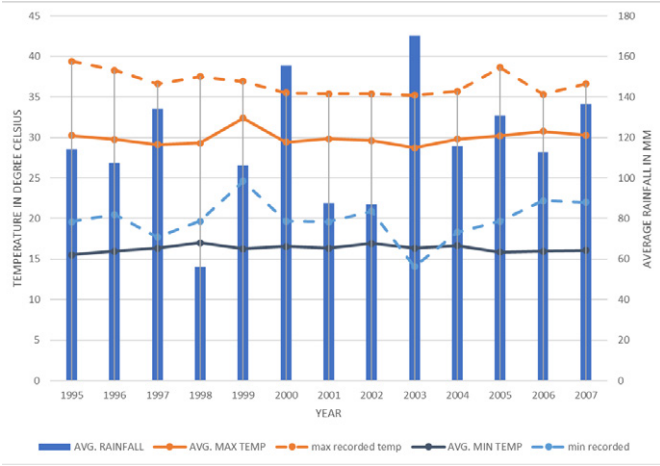



*Haldwani land use change. 2005 - 2006 (Left), 2011 - 2012 (Right)*

# Climate

The climate is distinctive based on the topography of the city, Kathgodam area in the municipal boundary receives better rainfall as compared to Haldwani. While there is not much temperature differences, precipitation trend differs with high variability, the same are discussed in detail as below.

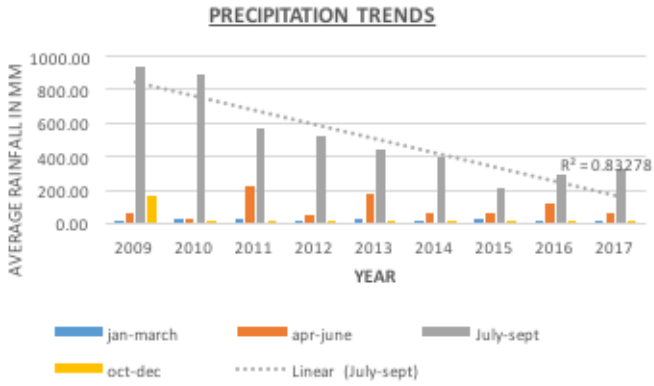
# Temperature




*Source: author's analysis based on IMD, Pantnagar Data*

Temperature data for the period 1995-2007 shows an increasing trend in minimum temperatures while a decreasing trend in maximum temperatures.

# Precipitation




*Source: Author's analysis based on worldweatheronline data*

A drastic decreasing trend in rainfall pattern is observed for the period. Similarly, considering average rainfall in each quarter of the year namely – Jan-Mar, Apr-June, July-Sep, Oct-Dec, a decrease and seasonal shift in rainfall pattern is observed, from peak season of July-Sep to Apr-June.

# Urban Water Resource and Management

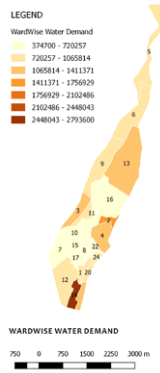
Haldwani is fed by three water systems, namely – River Gaula, Ground Water and Sheetlahaat Springs. Being located in bhabar region (the gently-sloping coarse alluvial zone below the Shivalik Hills in outermost foothills of Himalaya where streams disappear into permeable sediments), the underground water level is deep in this region. However, almost 50% of water is derived from underground, 45% from river Gaula and 5% from Sheetlahaat Springs. With addition of all the water resources, almost 26.67 MLD of water is available for the city and its agglomeration or peri-urban areas.

# Water Management

Uttarakhand Jal Sansthan and Jal Nigam, are the two institutions responsible for water management in the city. While Jal Nigam is mostly responsible for planning and execution of projects, Jal Sansthan is responsible for operation and maintenance.

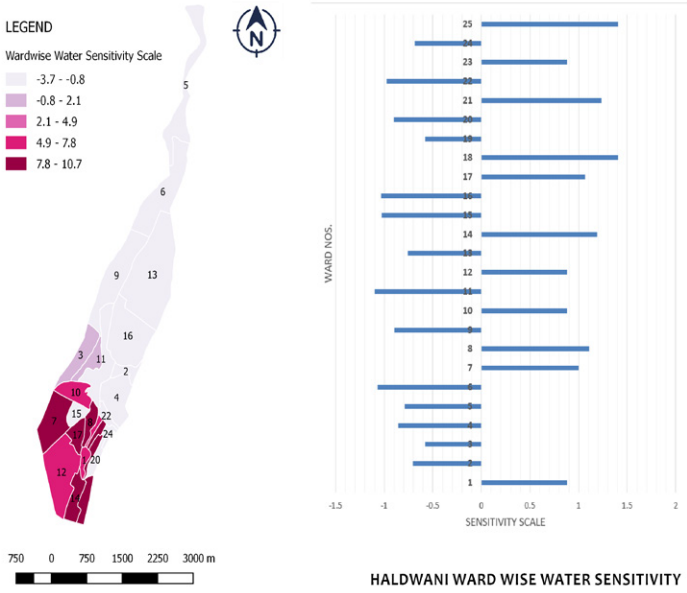
Water requirement for the city is drawn from three water sources namely Gaula River, Sheetlahat Spring and Underground water in quantities 15.83 MLD, 2.0 MLD and 17.28 MLD (Million Litres per Day) respectively with net availability of 26.67 MLD of potable water against overall water demand of 36.49 MLD for the city.

*This map shows the water demand of each ward in Million Liters Per Day (MLD). The range of water demand, 374700-2793600, has been split into 7 categories. The categories correspond to a colour gradient, light yellow to dark red. The lightest yellow corresponds to the lowest water demand of 374700-720257. For example, Ward 10. The darkest red indication wards with the highest demand of 2448043-2793600. For example, Ward 14.*




# Demographic and Water Sensitivities

The general spatial pattern shows an overall sensitivity concentrated in the south periphery of the city, particularly the south-east. The exception is Ward 13. The Wards with the highest sensitivity include Wards 14, 21, 20 and 18 (in descending order). These wards require the most immediate improvement in water management given that climate change and urbanisation are likely to exacerbate the situation. Ward 14 shows the highest overall sensitivity by far, as shown in the graph, which indicates ward 14 is the largest concern in terms of water insecurity.




*The water sensitivity range, -1.0992-1.4055, has been split into five categories. These categories correspond to a colour gradient from pale grey to dark pink. The light grey indicates wards with the lowest water sensitivity between -1.0992- -0.5983. This category includes most the wards. The darkest pink corresponds to wards with a water sensitivity between 0.9045-1.4055. For example, Ward 14.*

# Issues and Challenges

Insufficient Storage Capacity & Water Reservoirs.



Lack of a metering system. The intermittent supply system incentivizes the consumer to keep the taps open throughout the potential supply period - thus increasing peak demand and wastage of water. Low storage capacity of the treatment plant.



The pipelines are about 50-60 years old and are severely damaged. This causes sewage contamination in drinking water.

Wastage of million liters of water in a day through damaged pipelines. Low level of awareness among citizens.



Lack of interconnected institutional arrangement.



Inequitable water distribution among all socio - economic classes.

(Unallocated) water supply pipelines/ OHSRs/ water reservoirs in new urban growth areas.

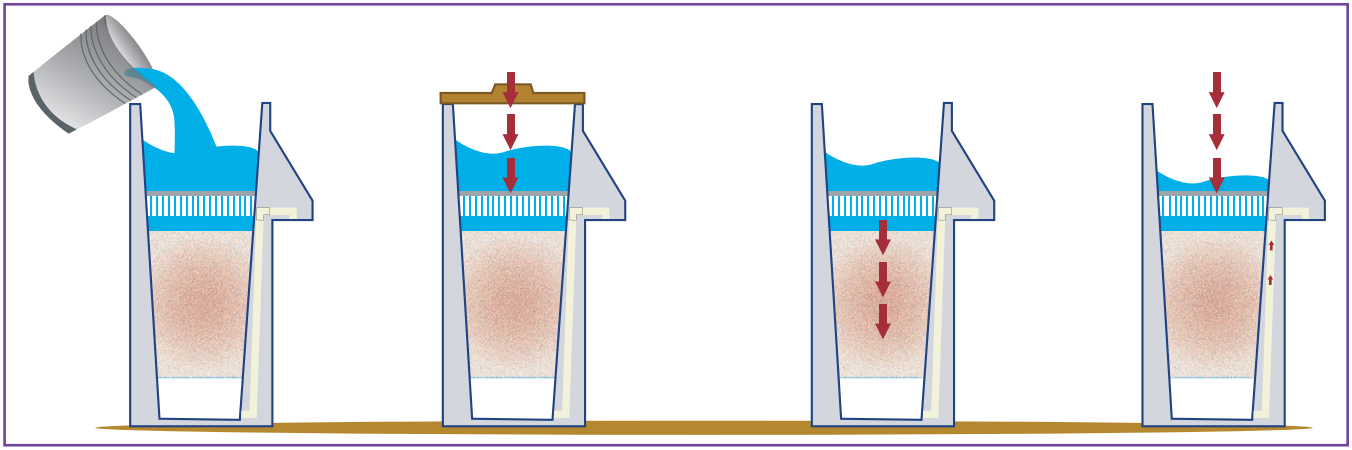
# Implementation of Pilots

To supplement water quantity and improve quality, a slum area on Haldwani called Dholak Basti was selected for pilot. As per site survey the residents of this settlement had limited access to potable water and had reported high water borne diseases in the past. In order to meet both the requirements, bio-sand filters were installed with 500 litres capacity each at two site locations in the area. Bio-sand filters are durable, economic, require low maintenance while removing pathogens and dirt. Here conventional water tanks were designed in-house as per standards of a bio-sand filter to suit to the population while incrementing their water supply with provision of clean drinking water. The pilot was undertaken with active participation from the community and installed with demonstration to the locals. This helped in building the capacity of the community for self for long term operation and maintenance of the system. Thus, translating research findings to action based research with community participation.


*Bio Sand Filter*


*Site 1*


*Site 2*



*Bio Sand Filter working process*

# MUSSOORIE

Also Known as 'Queen of Hills'

Established in 1823 AD

**Population:** 30,118 (2011)

**Major Water Source:** 23 Springs

**Supply:** 7.76 MLD (Million Liters/Day)

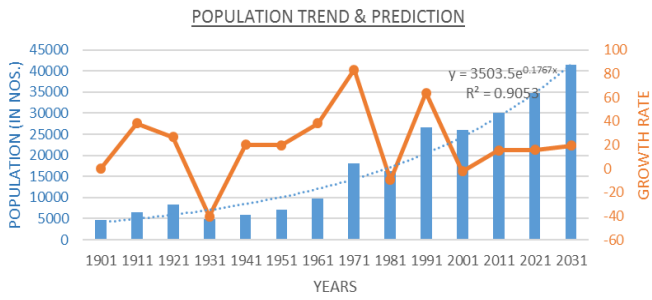
**Demand in Peak Tourist Season:** 14.40 MLD

Mussoorie is located in Dehradun District of Garhwal Himalayas, Uttarakhand. The main characteristic feature of this city is its popularity as hill station and high impact generated by tourism. Every year especially in summer months and periodic holidays the city receives around 60,000 tourist influx as compared to its native population of around 30,000 thus creating a high demand of infrastructure related services such as water supply, solid-liquid waste management, traffic and accommodation. This has led to the development of hospitality as chief business sector in the city, with high number of hotels being constructed to supply the needs of accommodation. The city is administered by Mussoorie Municipal Council (Nagar Palika Parishad).

## *Demographics and Urbanisation*

At present Mussoorie houses 30,118 residents (Census 2011) compared to 26,075 in 2001 (Census 2001), housing 6245 households in the city with average 5 members in the household. Mussoorie has a literacy rate of 90% which is higher than both National and State average. It has a total of 36% population engaged in either main (32.1%) or marginal works (3.4%).

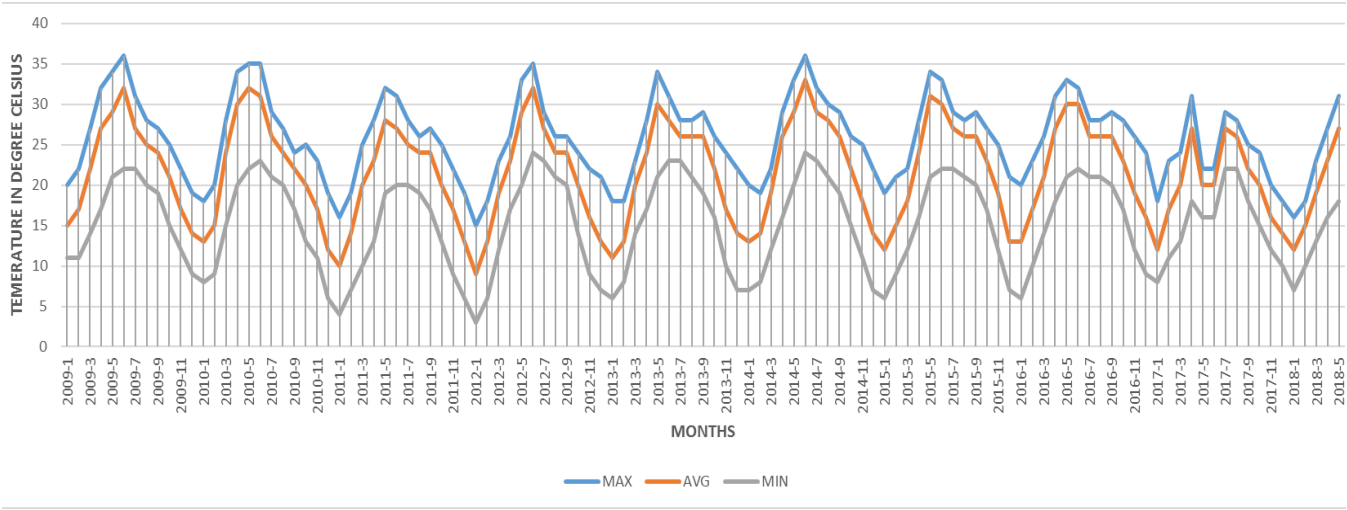
Slow and steady growth has been reported for Mussoorie, trend analysis undertaken for population from 1901 to 2011 shows exponential growth rate with probable increment to 34,839 in 2021 and 41,573 in 2031. This forecast was cross checked with census method of population prediction which came out to be 34,789 in 2021 and 40,300 in 2031. In this regard a population of around 35,000 can be expected to be permanently residing in the city by 2021 40,000 by 2031.



# Climate

In Mussoorie summers are warm and very wet, with July and August averaging approximately 660 mm or 25.98 inches of rain per month due to orographic lift of the extremely moist monsoonal air. The pre-monsoon seasons in April and May is warm to very warm and generally dry and clear, giving way to heavy rainfall from mid-June, while the post-monsoon season is also dry and clear but substantially cooler. In winter, rainfall is a little more frequent than in the pre-and post-monsoon seasons, and the general weather cool and partly cloudy. Mussoorie usually receives a few spells of snowfall in December, January and February, although the number of snowy days has come down in recent years due to a combination of local and global factors, such as deforestation, construction activity and global warming.

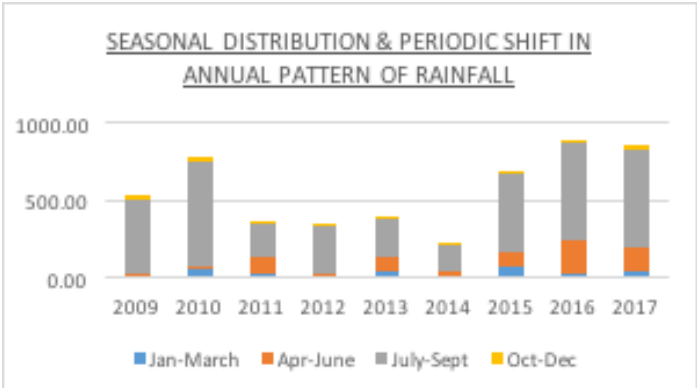
# Temperature




*Source: author's analysis based on worldweatheronline data*

Temperature data showed that there is shifting pattern observed in hot months of the year wherein high temperature recordings are observed for May (in 2011, 2013, 2015, 2016) and April (in 2017) which differ from general trend of June as the hottest month of the three.

# Precipitation

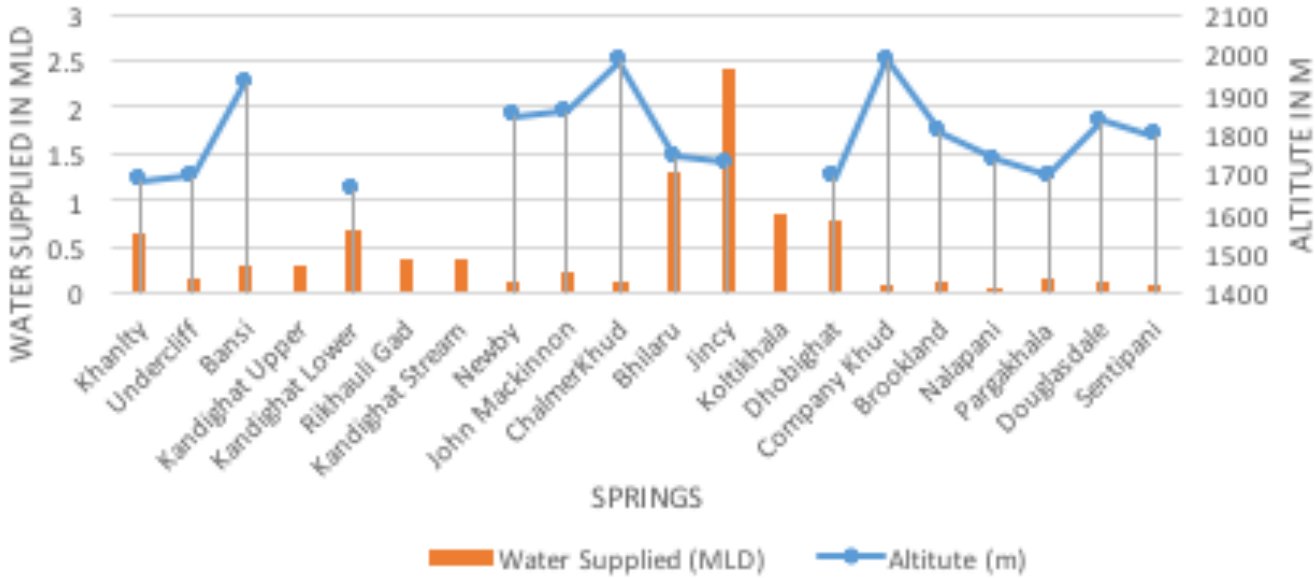



The Precipitation trends, considering average rainfall in each quarter of the year namely – Jan-Mar, Apr-June, July-Sep, Oct-Dec, a seasonal shift in rainfall pattern is observed, from peak season of July-Sep to Apr-June.

*Source: author's analysis based on world weather online data*

# Urban Water Resource and Management

There are as many as 23 springs and brooklets in Mussoorie region that are responsible for feeding the urban population with water, all of them being tapped by Jal Sansthan to meet water demand throughout the year. Their discharge varies with their location and elevations, out of which Jincy Bhilaru, Koltikhala, Khanalty and Kandighat have high water discharge rate as compared to other sources.

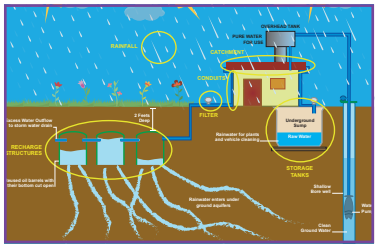


# Issues Identified in Mussoorie

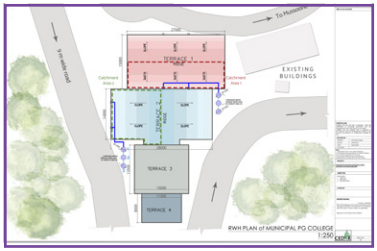
- Changing climate pattern is observed, there is a shift in hottest months and seasonal rainfall.
- There has been an overall decline in water discharge in almost all the springs.
- Rapid urbanization has increased the surface run-off of rainwater.
- Proper maintenance of data through a data base is not there.
- Supply gap in peak season: 6.73 MLD
- Supply gap in off-season: 0.03 MLD

# Implementation of Pilots

RWH Pilot in Mussoorie consisted of rain water harvesting tanks and in-house system design to tap rainwater from roofs, storage and further re-use, thus putting less pressure on existing system while supplementing the institution. Instead of constructing large rain water tanks, which was not feasible due to difficult terrain and availability of limited space in the hills, three conventional water storage tanks with 2000 litres capacity were proposed to equate with catchment area of 2000 square metre with a run-off coefficient of 0.8. Thus, increasing the rain water harvesting potential by three times the catchment. The pilot unlike huge RWH tanks which have high installation and maintenance cost was easy and economical in installation, provided better operation and maintenance in longer run. It was also calculated if the number of RWH systems as units were multiplied the rainwater harvesting capacity would eventually increase in same provision, since the design was easily replicable and required less area for installation as well. The RWH system was installed in one of the government institutions - Municipal Post-Graduate Degree College, Mussoorie, with participation from students who were required to monitor and maintain the system in longer run, thus, fostering long term awareness and behavioral change.



*Rain Water Harvesting*



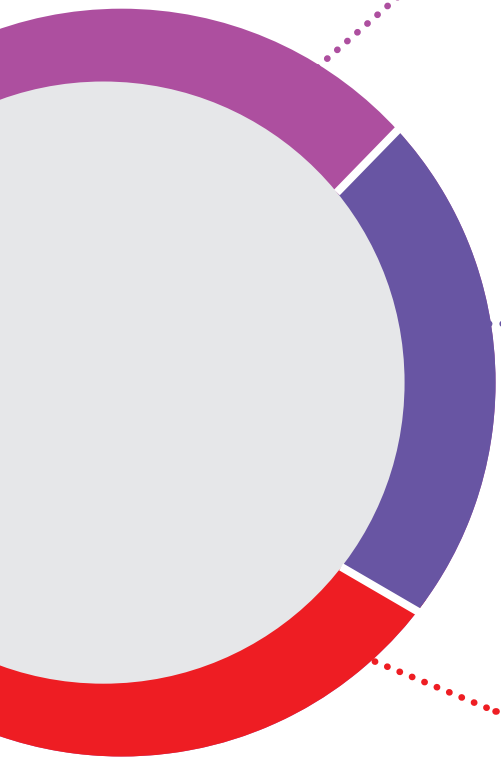
*Schematic of implemented site*


*Implementation of RWH at Municipal Degree College, Mussoorie*

# Project **OUTCOMES**

## *Key Elements*

- Knowledge exchange and empowerment
- User driven research (Water Forums)
- Special focus on women and population at the base of pyramid (BOP)
- Public private partnership



### *Field Interventions*

- Demarcation of WZ's
- Rain Water Harvesting
- Bio - Sand Filter

### *Knowledge Products*

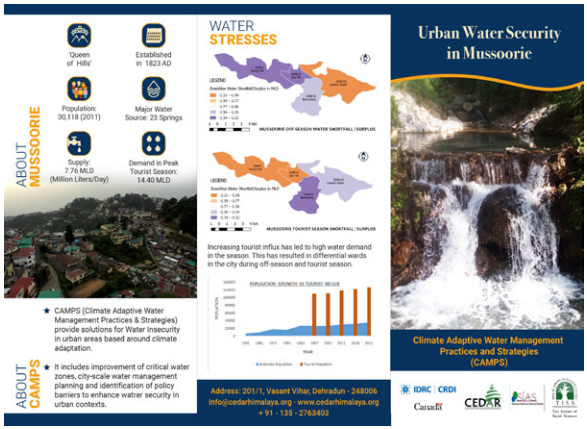
- Brochures
- Videos
- Policy Brief
- Publications
- Mobile Data Collector

### *Capacity Building*

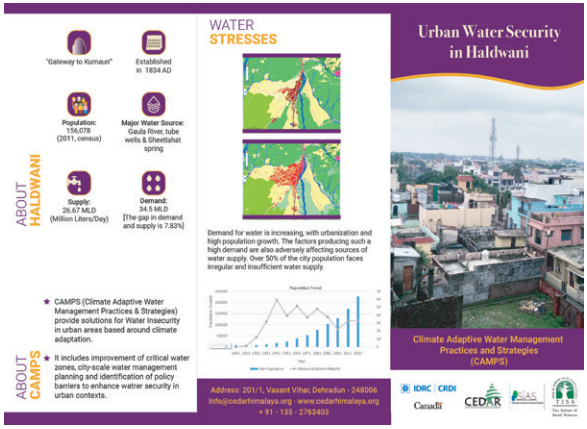
- Institutional
- Community
- Organisational

# Knowledge Products

## Brochures









## Videos

Scan QR Code to Watch Video

- **A City with Depleting Water Sources Haldwani (Uttarakhand), CEDAR**
  The video is based on the water challenges of Haldwani City, Uttarakhand. Video focuses on:
  - » How existing water sources in the city are depleting.
  - » How due to urbanization and rise in population leads to climate change and increase pressure on ground water.
  - » How residents are facing problems of water scarcity in summers.
  - » What are reasons and possible solutions to overcome this situation.

- **Bio-Sand Filter**
  It is important to make science affordable. Recently, CEDAR has successfully installed Bio-Sand Filter in Haldwani at ward no. 22, of Municipal Corporation. This simple looking object is easy to install and operate. This was designed as a low cost water purifier for people who lack access to clean drinking water.

- **Urban Water Insecurity, Mussoorie**
  The video is based on Urban Water Insecurity in Mussoorie, explaining how rapid increase in Population and Urbanization in the city is effecting its climatic conditions which leads to the depletion of existing water sources in the city and how its effecting the life of localities.

# *Policy Brief*

» Issues & Barriers » Future Vulnerabilities insights from research » Need of climate adaptive measures
» What are the measures » Recommended Practices as well as Strategies

**» NEED FOR POLICY**

Climate Change (CC) and Urbanisation in the Himalayas are genuinely challenging in relation to water security. Where climate change has a direct impact on the water resources in numerous ways, water security problems are escalated due to the rising demand of the population and urban growth. Uttarakhand, being a Himalayan state, has characteristics of both hills and Terai region. The Himalayas harbors various water sources such as springs, lakes, river, and groundwater. From government documents, reports, academic and grey literature, and shreds of evidence from the on-going CAMPs Project under IDRC, Canada, different impacts of climate change are highlighted. For Springs, the discharge rate has shown a negative trend over the years; in case of lake system, the reduced capacity of critical recharge zones, as well as the differential precipitation, has shown a decline in lake level; and in case of river system, altered flow of rivers are reported due to seasonality. All these declining water resources then turn the pressure of meeting water demands leads to the tapping of new water sources, mainly groundwater. Groundwater depletion in Uttarakhand's Terai region is also evident because of the unregulated abstraction. Additionally, irregular intense rainfall has also impacted the quality of water sources in many areas.

Provided the sensitivity of Uttarakhand with respect to CC, it becomes imperative to evolve climate adaptive practices and strategies. Adaptation and adaptive measures are required to reduce the vulnerability and for devising a technological, social, institutional and educational solutions respectively

**» BARRIERS**

Either CC impacts are mitigated, or adaptive strategies are formulated for reducing the vulnerability. There are four significant barriers which interfere with smooth and effective water governance in an urban set up as investigated in the CAMPs study.

***Policy Barrier –*** The state inability to draft a working Water Policy is one of the central barriers.

***Regulatory barriers -*** Under-representation of mountain water sources such as springs in Govt. Rules & regulations is a

prominent challenge. Lack of regulatory mechanisms such as water metering and pricing system are causes of inefficient water management. Alongside, unregulated development and land use management in the hills are aggravating the water crisis. The prescribed solutions like Rainwater Harvesting to adapt to water crisis are not being followed or implemented effectively.

***Institutional Barriers –*** The evident disparity in water distribution shows a lack of capacity and inadequate institutional reforms to address water shortages and climate change impacts on water resources. Five different institutions are working in isolation for managing a single resource, i.e., water.

***Geographical and Regional barriers –*** the presence of upstream and downstream conflicts and absence of economics tool to manage water resource.


### *RESEARCH FINDINGS & FUTURE VULNERABILITIES*

Taking representative cities of Mussoorie and Haldwani from hill and Terai regions respectively, CAMPS studied climate trends, urbanization and population, water supply and institutional setups. Inability to tackle the barriers shall further accelerate the climate change vulnerabilities. Under the arrays of results, inequitable distribution, quality of water, polluted/depleting sources of water, and cosmetic solutions on paper which are poorly implemented are found. Measures to address the complexity of water management is necessary. Under CAMPS, pilots were developed to benefit in climate change adaptation. It was found that a need for integrated planning and implementation is required.

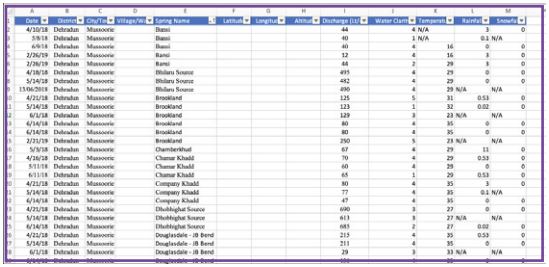
### REFERENCES

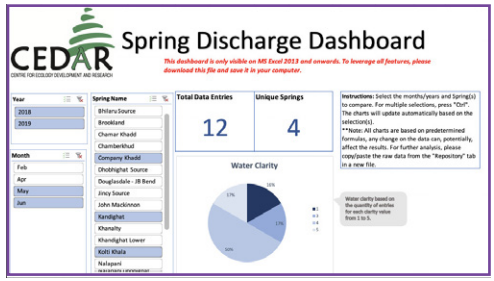
1. Aayog, NITI. 2018. Inventory and Revival of springs in Himalayas for Water Security. Government of India.
2. Aayog, NITI, 2018. Composite water management index: a tool for water management. Government of India.
3. Ministry of Water Resources, 2002. National Water Policy. Government of India.
4. Uttarakhand Gazette, 2013. Uttarakhand Management and Regulatory Act. Government of Uttarakhand.
5. UNDP, 2014. Uttarakhand Action Plan on Climate Change. Government of Uttarakhand.

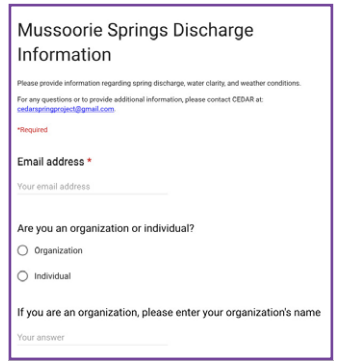
## Publications

1. Analysing Demographic and Water Sensitivities Arising due to Urban Water Insecurity in Haldwani, Uttarakhand (India): A GIS based Spatial Analysis
   ***Journal:*** *Journal of Geo-visualization and Spatial Analysis*
   ***Publisher:*** *Springer Nature, Switzerland*
2. Gender Contribution in Household Management of Water and its Impact on Residents of Dholak Basti in Haldwani City, Uttarakhand
   ***Journal:*** *wH2O (The Journal of Gender & Water)*
   ***Publisher:*** *University of Pennsylvania*
3. Institutional Mapping in Equitable and Integrated Urban Water Management in Haldwani City, Uttarakhand
   ***Journal:*** *New Angle Journal*
   ***Publisher:*** *New Policy Research Network (NPRN)*
4. Assessing Urban Water Systems in changing Climate Scenarios and Population Dynamics in Himalayan City of Mussoorie: Trends, Challenges and Way Forward
   ***Journal:*** *New Angle Journal*
   ***Publisher:*** *New Policy Research Network (NPRN)*
5. Spatial Analysis of Urban Water Sensitivity, Demographics and Institutional Responses in Hill Town of Mussoorie, Uttarakhand
   *(Working Paper)*

# Mobile Data Collector






Mobile data collector, Data repository and Dashboard for Mussoorie springs were developed under the project to collect long term spring data through community and institutional engagements.

# Capacity Building

# Public Private Partnership

**VSO-IBM:** CEDAR has collaborated with VSO-IBM which is the world's leading international development organization. Under this collaboration volunteers of IBM created an online platform for Spring monitoring and data collection. The online platform aims to help researchers, students, government, local people etc. to monitor the spring data of their area and create a database, which will act as a data repository.


*VSO -IBM Team at CEDAR Office*

# Institutional Engagement

**Woodstock School:** CEDAR has collaborated with Woodstock School which is an international coeducational residential school located in Landor, Mussoorie. The students helped in creating awareness in the city regarding the importance of water, strategies to save water, information regarding proper management of water etc.

**Pathfinder School:** CEDAR has collaborated with Pathfinder School which is a coeducational residential school located in Haldwani. The students helped in creating awareness in the city regarding the importance of water, strategies to save water, information regarding proper management of water etc.

*CEDAR Team at Woodstock school*

**Municipal Post Graduate College:** CEDAR has collaborated with Municipal Post Graduate College, Mussoorie to install Rain Water Harvesting Structure. Total capacity of the structure was 6000 liters'. The maintainance would be taken care by the school

**Nagar Nigam, Haldwani:** CEDAR has submitted a proposal of installing Rain Water Harvesting Structure for recycle and recharge at Girls Degree College, Kathgodam to Nagar Nigam, Haldwani and further necessary action is awaited.

# Community Engagement

**Media Communication (Radio Khushi 90.4 FM):** CEDAR has collaborated with Radio Khushi. Its highly interactive media has today built a great connectivity with the community around. Under this collaboration on every Thursday members of CEDAR host a show in which they discuss on various issues existing in the communities such as (Water Crisis, Migration, Decline in Biodiversity, Changing Climatic Patterns etc.

*CEDAR Team at Radio Khushi Studio*

**Community Participation:** CEDAR has collaborated with a community named Dholak Basti, a slum area in Haldwani. To supplement water quantity and improve quality bio-sand filters of 500 litres capacity each were installed at two locations in the area. The pilot was undertaken with active participation from the community. This helped in building the capacity of the community for long term operation and maintenance of the system. Thus, translating research findings to action based research with community participation.

# Organisational Engagement

| | |
|---|---|
| COP 24 Participation | Ms. Anvita Pandey participated in the COP 24 D&C days for the theme "Gender and Climate Change" |
| IIT Bhuvaneshwar Conference | Ms. Manya Singh presented paper on policy challenges at Tata Steel's Annual Tribal Conclave. |
| International Water Seminar | Ms. Yashi Gupta coordinated and participated in an International Water Conference held in Dehradun. |
| Write-shop in Dehradun | CEDAR staff organised as well as participated in the write-shop held at Dehradun ($11^{th}$-$14^{th}$ December, 2017) |
| Write-shop in Nepal | Ms. Manya Singh and Mr. Riyan Habeeb participated in the write-shop organised by SIAS-Nepal |
| Gender Training | A two day Training Programme by CEDAR under the theme "Gender and Climate Change" |

# Recommendations

- **Integrated Urban Water Management (IUWM):** Water sensitive urban development keeping storm water and waste water in consideration and their sharing amongst institutions such as Jal Sansthan and Irrigation Department.

- **Integrated Water Resources Management (IWRM):** Taking water as an economic good, fresh water as a finite source, regulatory and policy measure by Jal Nigam and Sansthan.

- Rejuvenation and protection of CUWRZ

- Data centre and Management Information System to monitor and record water sources and climate data.

- Land Use management and building regulation, codes, and norms to protect critical urban water zones by identifying them and restricting construction activities on such identified sites.

- Water metering & differential Pricing systems for domestic and commercial connections.

- Training and Capacity building as well as sensitization and awareness for citizen, institutions and related stakeholders.

- Development of mountain specific ground water policy

- Strengthen departmental and institutional linkages

- Incentivizing and penalizing mechanism for water usage

- Adopt nature based solutions

# Acknowledgements

This work was carried out by Centre for Ecology Development and Research (CEDAR) under Climate Adaptive Water Management Practices and Strategies (CAMPS) project with financial support from International Development Research Centre (IDRC), Canada.

Sincere thanks to all the collaborators, key informants and households who spared their valuable time to share experiences with the research team.

# Authors

- Dr. Vishal Singh, Executive Director
- Anvita Pandey, Senior Research Associate
- Riyan Habeeb, Programme Specialist
- Manya Singh, Research Associate
- Yashi Gupta, Junior Research Associate
- Himanshu Chinwan, Research Associate

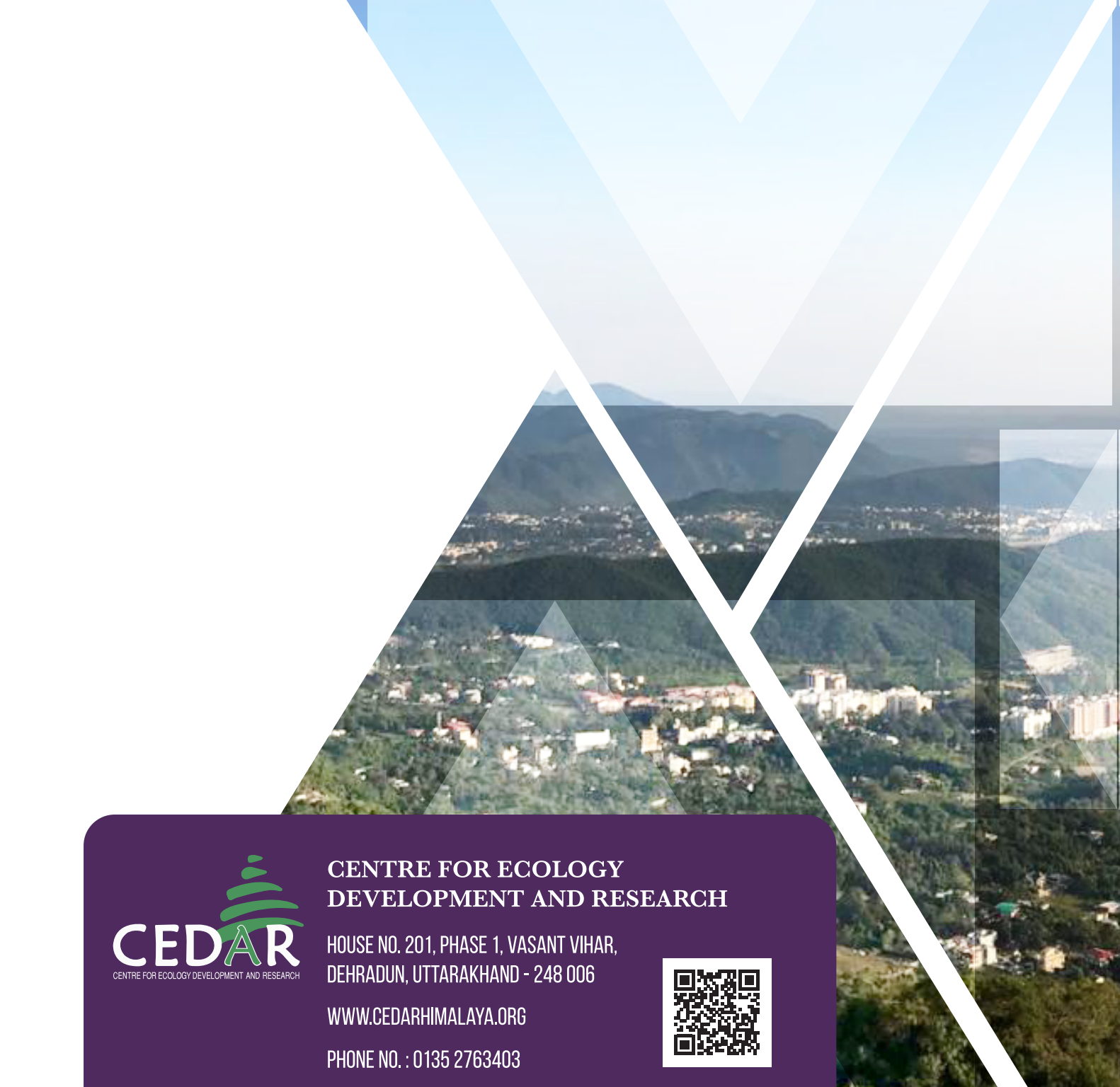
# Designed By

- Kshitiz Dobhal

# Photo Courtesy

CEDAR team

# Collaborators




CEDAR
CENTRE FOR ECOLOGY DEVELOPMENT AND RESEARCH

**CENTRE FOR ECOLOGY DEVELOPMENT AND RESEARCH**

HOUSE NO. 201, PHASE 1, VASANT VIHAR,
DEHRADUN, UTTARAKHAND - 248 006

WWW.CEDARHIMALAYA.ORG

PHONE NO. : 0135 2763403