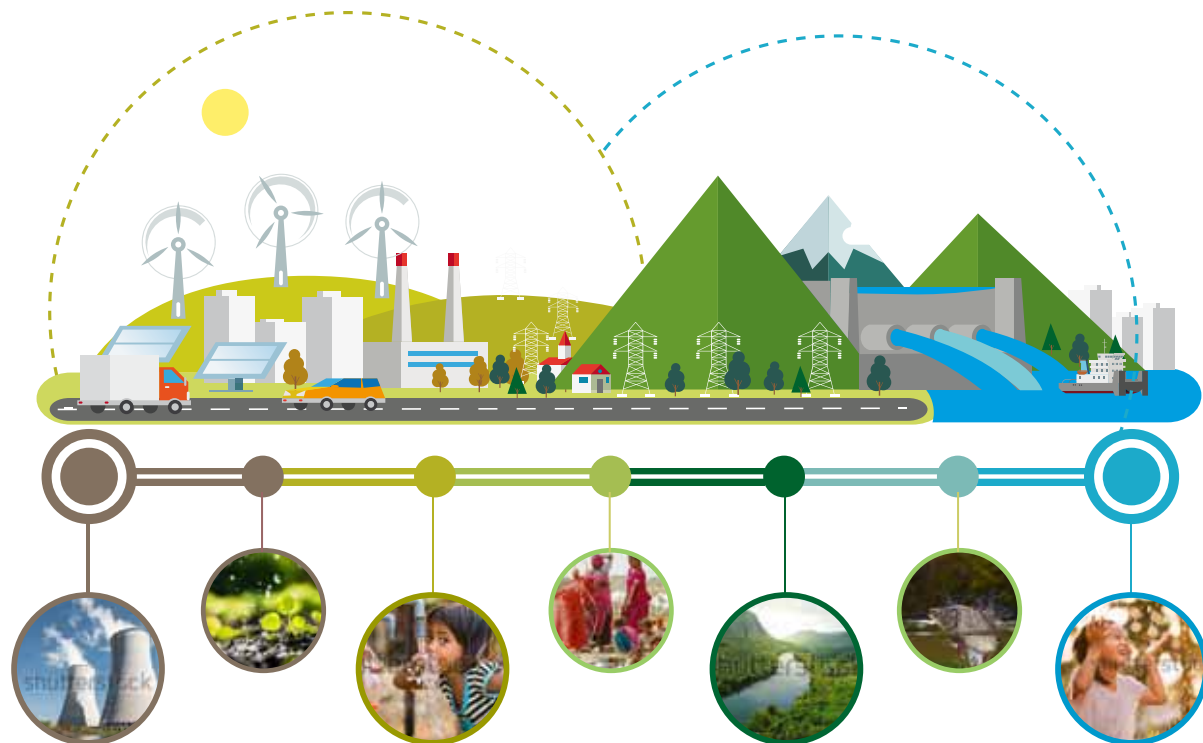


# WATER RESOURCES DIVISION : FACILITATING 'WATER FOR ALL'



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## FOREWORD

Water is considered as both the precursor and sustainer of life. All the great civilizations of this world originated around one or the other source of water, and are dependent on its continued availability for their existence. However, increasing population, increasing urbanization and increasing consumerism are leading to a precariously dangerous situation where demand for water are outgrowing its availability, and leading to deterioration in the quality of available water. Rivers of India, from North to South which have been the cradles of civilizations, ensuring food security to the local populations, have now exhausted their natural ability to sustain themselves.

The Water Resource Division in TERI was created with a vision to develop solutions for providing equitable access to clean water, while ensuring social, environmental, and economic sustainability in water resource allocation. In almost 15 years of its establishment, the Division has contributed in almost all the aspects related to water including freshwater availability, groundwater availability, climate change impacts on water resources, water quality problems and management of river basins etc. The Division has been among pioneers in initiating some of the key research in water sector such as promoting water neutral electricity production in the country, water audits and water use efficiency studies of industrial establishments and research on impacts of climate change on Himalayan glaciers etc.

The Division is working with different stakeholders such as central and state government agencies, academia, NGOs, corporate bodies, schools and universities, community level organisations etc., and has established close working relationships with a number of national and international organisations/ institutes/ scientists. It lays stress in transferring the research knowledge generated through different projects to the new generation of students through capacity building of doctorate and postgraduate students. The work has always found a place in international peer reviewed journals, books, periodicals etc. The policy briefs and discussion papers produced by the Division have always found place in decision making process.

TERI and its Water Resources Division will continue to provide innovative technological, regulatory and policy solutions to society. I look forward to our increased interaction with the broad array of stakeholders in this key area, and to strengthened partnerships which can enable change to a sustainable future.

A handwritten signature in black ink, appearing to read 'Ajay Mathur'. The signature is fluid and cursive, with a long horizontal stroke at the end.

**Ajay Mathur**  
Director General, TERI





## FOREWORD

For a country like India, where Water acts as the backbone of livelihood to more than 70% of Indian population engaged in agriculture, and for another 10-15% population engaged in industries based on water like textile, leather, food processing etc., it has multitude of linkages with the prosperity of the country. Furthermore, through its role in food security, energy security as well as health, water ensures the right to life for every common man. Climate change considered to be a reality now, presents additional vulnerabilities to the water security of the country. Increasing temperatures, erratic rainfall, extreme event like heavy floods and severe droughts, are the new challenges, which require careful considerations in the policy framework of the country to address water security issues.

With an aim to develop & implement integrated solutions for sustainable water management, the water resources division provides services in core areas, such as, applied research, training, and implementation. The Division has core competencies in quantitative and qualitative assessment of water resources, water audit and water foot-printing, watershed management, urban water demand management, glacier research, hydrological assessments, rural water supply and sanitation sector, water quality & pollution studies, and policy analysis.

The booklet titled, “Water Resources Division- Facilitating Water for All” is a compilation of key projects executed by the division in different sub-sectors related to water. A key focus of division’s activities is to provide inputs to the policy making in the country and generate discussions around the major issues related to water. The booklet also highlights the key publications produced as part of the division’s research activities.

I expect that the division will continue to work towards facilitating the achievement of water security for the country, and wish the team successful future endeavours.

A handwritten signature in blue ink, appearing to read 'S K Sarkar', with a horizontal line underneath it.

S K Sarkar  
Senior Director, TERI



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## Water Resources Division

Water resources in India are under severe pressure due to escalating demands, over-exploitation, inefficient use and pollution amongst others. With an aim to develop & implement integrated solutions for sustainable water management, the Water Resources Division (WRD) provides services in core areas, such as, applied research, training, and implementation. The Division has a vision to develop solutions for providing equitable access to clean and safe water, while ensuring social, environmental, and economic sustainability in water resource allocation.

The Division has taken up micro and macro level research in sustainable water resource management, focusing on two pertinent areas of research: Water Resources Policy & Management and Himalayan Ecology. The Division has core competencies in quantitative and qualitative assessment of water resources, water audit and water foot-printing, water use efficiency, rural drinking water and sanitation, urban water supply and demand management, water quality and pollution studies, water conservation: planning & implementation, water and climate change, water – energy-food-climate nexus, water foot-printing, policy, institutional and regulatory reform, agricultural water resource management, hydro-meteorological monitoring and modelling, mountain water resource management.

Over the years, the Division has built expertise in carrying out water audits and water foot-printing studies and has helped various industries and clients in enhancing water use efficiency. A number of water audits have been conducted by TERI for various entities such as Indian Railways (Various Railway Stations & Rail Coach Factory), Thermal Power Plants, Textile Industry, Tobacco

industry (ITC) etc., across the nation and strategic recommendations such as recycle/ reuse of wastewater, reduction in process water consumption, leakage/losses control, integrated automation of the water supply network, rainwater harvesting etc., were developed and recommended to enhance their water use efficiency and reduce their Specific Water Consumption (SWC).

The important emerging issue of water-energy-food and climate nexus have also been a focus of the Division in which the intricate nexus is assessed at various spatial scales. The Division has been actively involved in carrying out various research activities in the high altitude regions including studies on glaciers and glacier fed catchments and their impact on downstream community.

TERI in association with Jain Irrigation Systems Limited has set up a “Resource Centre on Water Use Efficiency” as an effort to address the current and future challenges on water and food security through improvement in consumptive water use efficiency and sustainable agricultural water use practices. The Division has been endorsed as the Regional Knowledge Hub for Water and Climate Change Adaptation by the Asia Pacific Water Forum. It has also been recognized as the National Key Resource Centre for rural drinking water and sanitation by the Ministry of Rural Development. In this capacity, TERI has been engaged in capacity building activities for technical and non-technical government personnel and representatives from Panchayati Raj Institutions (PRIs).

With multi-disciplinary team of experts, the division has been instrumental in providing research based innovative solutions for sustainable water management as well as policy inputs to assist the various goals of the Government.

### Water Availability

The WRD uses GIS, surface and groundwater modeling assessment tools, perform socio-economic assessment, demand assessment, vulnerability assessment, and institutional analysis to formulate implementation strategies for improving water availability through better management of the resource.

### Water Use Efficiency

The WRD performs comprehensive water audits and water foot-printing exercise for a range of industries, municipal corporations, etc. and helps establish the water use and water balance, water quality profiling, identification of losses/leakages and opportunities for water savings. The division is also conducting research on agricultural water use efficiency, urban and rural water use efficiency.

### WASH

The WRD is engaged in an array of research as well as implementation activities in the rural and urban drinking water and sanitation sector, including provision of drinking water and developing sanitation model/options along with capacity building trainings.

### Capacity Building

With an aim to address critical issues in water resources and associated issues TERI regularly conducts sensitizing and capacity building of various stakeholders on water resources management, sanitation, demand management and also trains master trainers.

## Water Conservation

With the objective of improving the water security of the country, WRD undertakes water conservation planning and implementation activities like rainwater harvesting, groundwater recharge, watershed development, etc.

## Agriculture and Water Management

The WRD also looks towards the improvement in consumptive water use efficiency and disseminate sustainable agricultural water use practices for intensive crop yield in the agriculture sector in India.

## Water Quality

The WRD's ISO 9001: 2002 certified laboratory undertakes water quality monitoring to assess the groundwater contamination and the surface water pollution by analysing water quality for drinking purposes, recreational use, industrial effluents released into water bodies, etc.

## Drought Mitigation

TERI has undertaken comprehensive impact assessment studies of drought mitigation packages which further led to the development of drought adaptive and mitigation activity plan.

## Water Energy Climate Nexus

TERI is working on the intricate nexus of water-energy-climate change with an aim to identify the opportunities and challenges for Integrated Governance of Water and Energy in a changing climate.

## TERI's Glacier Research Programme

Programme was started to bridge the knowledge gap for Himalayan cryosphere. 'Glacier Monitoring Observatories' in three benchmark glaciers with different climatic and geographical settings have been set up in the Eastern Himalaya, the Western Himalaya and Central Himalaya.

## Groundwater management

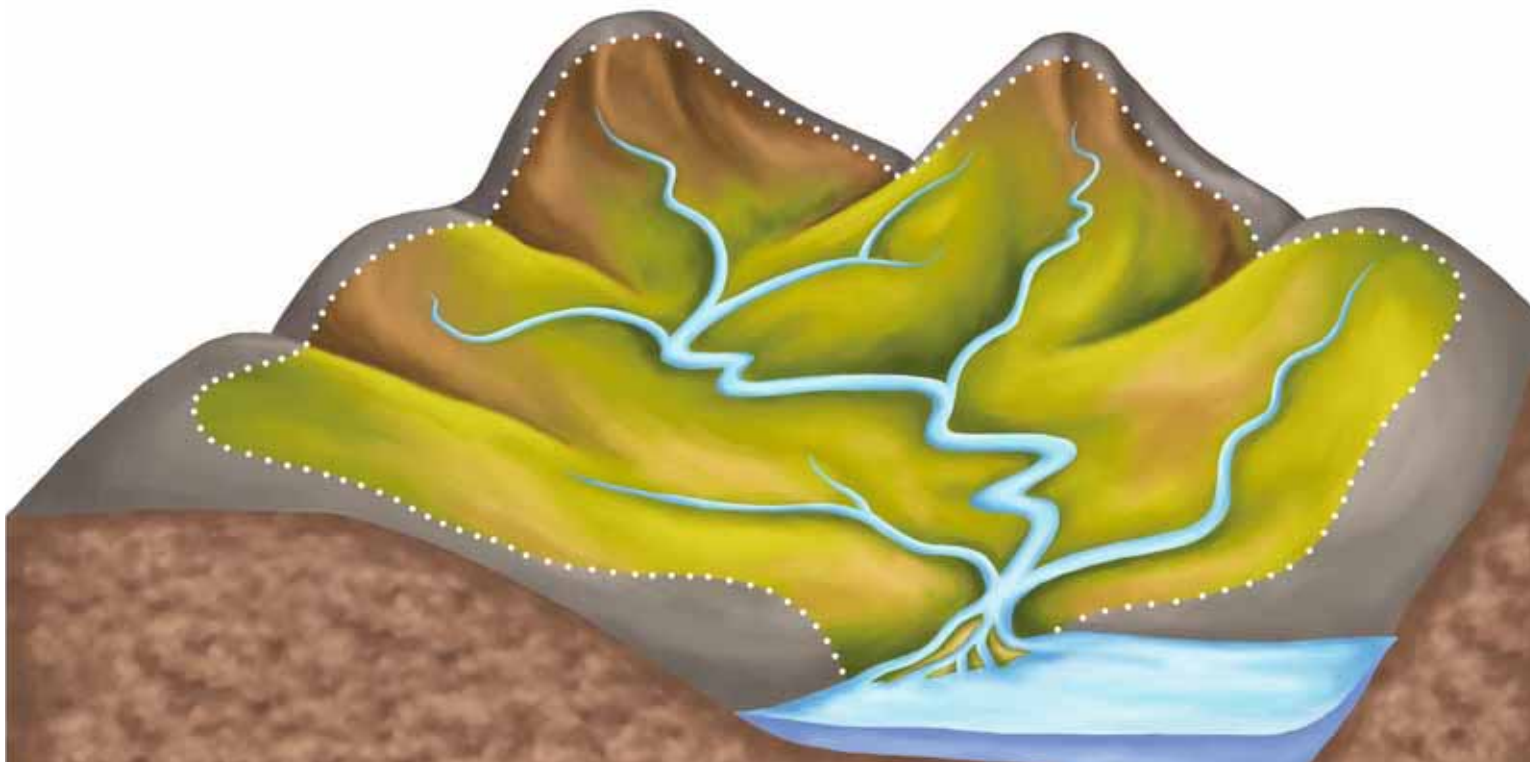
This entails assessment of groundwater through evaluating the availability, demand, extraction, and uses in different sectors which is followed by providing recommendations for improved groundwater management, governance and use.





**Water Availability**





## Conducting a GIS based diagnostic study for assessing availability and quality of water resources to address watershed wide concerns using watershed approach.

Sponsor: Coca-Cola Company

Study Area/ Location: 5 locations - Pune, Jaipur, Bangalore, Hyderabad and Goa

### Aim and Objectives:

- To undertake source vulnerability assessment of the 5 Coca-Cola plants

### Key Activities:

- Conducted hydrological and hydro-geological investigation for evaluating water resource availability and quality in selected watersheds
- Applied modelling techniques to investigate water availability and quality issues

- Identified the risk associated with various aspects of SVA and assessed the magnitude of the impact of risk
- Developed mitigation plan for the plants for sustainable water management

### **Project Impact:**

TERI used the source vulnerability assessment (SVA) tool to identify the risks, magnitude of the risks to the source of water to each of the plant and provided possible management or rectifying strategies specific for each of the plant. This tool helped the plants to understand the vulnerability to source of water from broader perspective including quantity, quality, community and legal. This is a replicable tool that could be used for various water based industries to assess the vulnerability to their source of water.

### **Stakeholders/ Beneficiaries:**

Coca Cola Company, local community within the vicinity of the plant



## Managing Impact of Water Use in GSK's Value Chain for Horlicks

**Sponsor:** Glaxo Smith Kline Consumer Healthcare Limited (GSK)

**Study Area/ Location:** Punjab, Haryana and Rajasthan

### **Aim and Objectives:**

To undertake a study on managing impact of Water Use in GSK's Value Chain for Horlicks to assess water use impact in GSK's supply chain and develop a water impact reduction plan with subsequent implementation of identified interventions

### **Key Activities:**

- Investigated supply chain for milk, malt and wheat based raw materials in order to confirm the locations and functions of GSK's suppliers
- Undertook a baseline assessment of current water use practices in GSK's supply chain for milk, malt and wheat based raw materials for Horlicks, in the states of Haryana, Punjab, and Rajasthan. Identified **gaps in the current practices of water use in comparison with the best practices.**



- Identified the data gap on the necessary raw data for water footprint of milk, malt and wheat based raw materials and propose a plan of action to collect them.
- Assessed the impact of water use in supply chain associated with milk, malt and wheat based raw materials in the four key risks areas viz. water stress, water quality, social and reputational/regulatory aspects. Identified state/local level initiatives, its efficacy and risks to GSK's water use w.r.t these key four areas.
- Identified specific action/projects interventions to reduce the overall water impact and enhance water use efficiency in GSK supply chain
- Developed water impact reduction plan and metrics to evaluate the efficacy of proposed actions in reducing the water impact along with targets that contribute to GSK's overall aim of water impact reduction by 20% for the GSK supply chain associated with milk, malt and wheat based raw materials

### Project Impact:

TERI assessed the water footprint of complete supply chain, beginning from the crops used for raw material to the processed product at the factory level. The supply chain assessment is an important approach to consider in water footprint reduction. The assessment provided important strategies for reducing the impact of water footprint at all tiers of production. The project recommendations if implemented would help the farmers who provide raw material by ensuring more water for agriculture and domestic purpose.

### Stakeholders/ Beneficiaries:

GSK Company, local community around the plant



## Water demand management strategy and implementation action plan for Bhopal, Jabalpur and Gwalior

Sponsor: United Nations Centre for Human Settlements

Study Area/ Location: Bhopal, Jabalpur and Gwalior

### Aim and Objectives:

To develop a water demand management strategy and implementation action plan for cities in Madhya Pradesh

### Key Activities:

- Undertake a rapid assessment of water supply services in Bhopal, Jabalpur and Gwalior
- Development of demand management strategy for the three cities covering technical, financial and legal issues.



- Development of GIS database of water supply infrastructure
- Undertake capacity building exercises for key functionaries

### Project Impact:

Through water audits, TERI identified the avenues for saving water at city level, and developed demand management strategies suitable for the cities under various aspects. The project also involved capacity building of key stakeholders including Urban Local Body (ULB) staff and officials. The project helped various stakeholders associated with ULB to understand the water supply, demand, water wastage and ways of using water efficiently. This could be undertaken by any city to manage its water efficiently.

### Stakeholders/ Beneficiaries:

ULBs, water consumers, other relevant stakeholders





**Water Use Efficiency**





## Comprehensive Water Audit Study for Vindhyachal Thermal Power Complex

**Sponsor:** National Thermal Power Corporation

**Study Area/ Location:** Vindhya Nagar, District. Sidhi, Madhya Pradesh

### **Aim and Objectives:**

To conduct a comprehensive water audit of thermal power complex (NTPC) to evaluate water use, identify avenues for water conservation and enhance water use efficiency.

### **Key Activities:**

- Secondary data collection: This entailed collection of secondary data and information covering aspects related to layout of the plant



and different unit processes, source(s) of water, the supply schematics and available instrumentation along with technical details related to supply (such as capacity of pumps); water supply network diagrams and operational capacities, etc. Based on the secondary data and discussions with the plant officials, locations for flow monitoring and water quality monitoring were identified and the entire water audit was conducted.

- Flow measurement & establishment of water balance: This exercise was undertaken to understand the quantum of water being drawn and consumed in the plant processes and account for leakages and losses as well as wastewater being discharged.
- Water and wastewater quality characterisation: The assessment of the water quality was done to characterise and understand the quality of water being used at different process & stages of power generation as well as the quality of wastewater being discharged and also to assess performance and efficacy of various system including the cycle of concentration (COC). Also drinking water from supply water was assessed for its potability.
- Data analysis and recommendations for water & wastewater management: Based on the secondary data, field observations & measurements, flows from various sources were compiled and analyzed in line and further aspects on water conservation and treatment were recommended in line with the objectives of the study. This included
  - Establishment of water balance of the water supply & distribution system and estimation of leakages and UFW (Unaccounted for water) in the plant.
  - Recommendations on improvement in water use efficiency, water conservation, recycle and reuse, COC, etc.

### Project Impact:

In the previous water audit conducted for the plant (in 2010-11), it was found that a considerable amount of wastewater was discharged unused into the drains. Along with this a significant amount of water was also lost in the ash handling process. It is worth mentioning that the plant has been able to bring down the specific water consumption from about 4.85 m<sup>3</sup>/MW to about 3.21 m<sup>3</sup>/MW (in 2014), mainly due to interventions in the improvement on ash water recirculation from ash dyke, reduction in blow down wastage, boiler auxiliary cooling wastage and reduction in wastewater through reuse.

### Stakeholders/ Beneficiaries:

NTPC, other water users in the vicinity of the plant



## Conducting Water Audit at Selected Railway Stations of Northern Railway, New Delhi

**Sponsor:** Northern Railway, Indian Railways

**Study Area/ Location:** Hazrat Nizamuddin, Old Delhi and New Delhi Railway Stations

### Aim and Objectives:

To conduct a comprehensive water audit of selected three railway station of the Northern Railways New Delhi to evaluate water use, water quality and identify opportunities for enhancing water use efficiency.

### Key Activities:

- **Secondary data collection:** This entailed collection of secondary data and information covering aspects related to layout of the stations and different water usage areas, source(s) of water, the supply schematics and available instrumentation along with technical details related to supply (such as capacity of pumps); water supply network diagrams and operational capacities, etc. Based on the



secondary data and discussions with the station officials, locations for flow monitoring and water quality monitoring were identified and the entire water audit was conducted.

- **Flow measurement & establishment of water balance:** This exercise was undertaken to understand the quantum of water being drawn and consumed in the station and account for leakages and losses as well as wastewater being discharged.
- **Water and wastewater quality characterisation:** The assessment of the water quality was done to characterise and understand the quality of water being used in different activities (such as drinking water, washing and other sundry uses) as well as the quality of wastewater being discharged. Chlorine demand was assessed in order to evaluate the chlorine dosing requirement. Besides this, the efficacy of sand filters used for drinking water treatment was also assessed.
- **Data analysis and recommendations for water & wastewater management:** Based on the secondary data, field observations & measurements, data from various sources was analysed and further aspects on water conservation and treatment were identified and recommended in line with the objectives of the study.

This included:

- Establishment of freshwater balance of all the railway stations and also estimation of the quantity of water currently used in different activities like coach washing, coach filling, apron and platform washing, etc.
- Assessment of physiochemical characteristics of potable water available for end use
- Assessment of efficacy of the current chlorination practices
- Assessment of freshwater and wastewater flow and quality at the platforms and the washing lines

### Project Impact:

The water audit at the railway stations assisted in identifying the water saving interventions that can be undertaken at the railway stations like wastewater recycling system, automation system, auto coach washing system and rain water harvesting system. These interventions together have a potential to save the freshwater withdrawals in the range of 27% to 44% in the railway stations.

### Stakeholders/ Beneficiaries:

Hazrat Nizamuddin, Old Delhi and New Delhi Railway Stations, Northern Railways



## Benchmarking industrial water use to assist policy for enhancing water use efficiency in India

Sponsor: DFID

Study Area/ Location: Thermal power plants and pulp & paper industries in India

### Aim and Objectives:

To undertake evaluation of water use and management practices of selected water intensive industries in India and identify avenues for improved water use efficiencies with potential benchmarks and relevant policy recommendations.

### Key Activities:

- Scoping and preliminary surveys: A comprehensive literature review was done in order to identify various water intensive industries and their water use. Based on the data two most water intensive industrial sectors were chosen for the study i.e. the thermal power plants and pulp and paper industry. After the selection, further secondary data collection was undertaken mainly through



questionnaire based information & survey of selected industries and visiting several organizations to procure data about water usage and the wastewater generated by different industries.

- Comprehensive technical water audit of selected industries: Selected industries viz. Thermal Power Plants and Pulp & Paper industry were then shortlisted for comprehensive assessment and water audit based both on the secondary data and primary water audit. Water audit consisted of evaluation of available secondary data and conducting primary field water audit. This included measurement of water quantity and quality at selected important processes of the identified industries and evaluating the water balance, water use, leakages/losses, wastewater discharge etc. Based on this the opportunities for reducing water consumption and enhancing water use efficiency was identified.
- Secondary data collection: This entailed collection of secondary data information from the plant authorities covering aspects related to plant water supply network and different unit processes, source(s) of water, water supply/use/flow schematics, wastewater management, water quality at different processes, operational capacities, etc.
  - Flow measurement & establishment of water balance: This included onsite water flow measurement at identified locations of the plant processes including flow monitoring at all the major water sources and usage areas at all important industrial processes. The flow measurement exercise involved use of flow meters at selected locations of distribution pipelines, channels and usage areas. Based on the flow measurement, water balance of the plant was established.
  - Water and wastewater quality characterization: The assessment of water quality was done to characterise and understand the quality of water being used at different processes as well as the quality of wastewater being discharged. Based on this

performance and efficacy of various system (e.g. cycle of concentration in case of thermal power plants) were assessed.

- Data analysis and recommendations for water & wastewater management: Based on the secondary data, field observations & measurements, data from various sources were compiled and analyzed for identifying the opportunity for water consumption reduction.
- Benchmarking and policy recommendations: The data thus collected was further evaluated and analyzed for water use, as well as identification of interventions and potential benchmarks. Short and long term strategies for integrated water management including technical, financial and policy aspects were identified. The specific water consumption in both the industrial sectors were calculated and based on the analyses, potential benchmarks were identified. The improvement options were also suggested after looking at the available information on best practices in the respective industries. Further, recommendations were also made to assist reforms/guidelines in policy for industrial water use.
- Outreach & dissemination: The project outcomes have been shared with relevant stakeholders through paper presentation and publications at national and international forum during the course of the study. Stakeholder workshop and several interactions were done with relevant stakeholders under the project. The project outcome based publication and information shall be continued to be disseminated further in future workshop/events organized by TERI. The study is expected to be helpful to the Government's focus on enhancing water use efficiency as one of the key goals under the National Water Mission.

### **Project Impact:**

The identified interventions, wherever applicable, can be suitably adopted by the thermal power plants and the pulp & paper industries to reduce their specific water consumption in the range comparable to the identified indicative potential benchmarks. This may be the first step towards an attempt to improve water use efficiency while simultaneous research & feasibility studies can supplement and/or improve these benchmarks as a continuous process.

### **Stakeholders/ Beneficiaries:**

Indian industries- thermal power plants and pulp & paper industries



**WASH**





## Sanitation activity under Coal India's CSR project

Sponsor: Coal India Limited

Study Area/ Location: West Bengal

### Aim and Objectives:

To address the larger challenges of development of the community, Coal India Limited, the largest Maharatna Company of India has supported a CSR project for developing 40 villages covering 11500 households in district Purulia of West Bengal under their CSR initiative.

- To construct individual household toilet instead of construction of common toilets.
- To motivate, sensitize and create awareness among the beneficiaries for water provision and usage of toilets.



### Key Activities:

The key activities were the construction of individual household toilet and capacity building of the community. Awareness generation was given due importance to ensure that the sanitation of the area is sustained beyond the project time period.

### Project Impact:

Reduce open defecation and improve the health and sanitation in the region.

### Stakeholders/ Beneficiaries:

Around 40 villages covering 11500 households in district Purulia of West Bengal are benefitted



## Strengthening Water and Sanitation in Urban Settings - State of Water Report (including WASH) (Activity 3.6)

**Sponsor:** United States Agency for International Development

**Partners:** TERI School of Advance Studies; Coca Cola India

**Study Area/ Location:** Kolkata and Chennai

### Aim and Objectives

- Conduct a comprehensive WASH related risk analysis and human health impacts in a cluster of slums in Kolkata and in Chennai
- Develop and implement participatory intervention strategies in the selected urban areas that engage all potential stakeholders and incorporate a variety of disciplines.
- Build and catalyse requisite capacities in faculty, students, and decision makers to help address the challenges related to sanitation and health and their engagement in action research with the intent of finding replicable solutions to the sanitation problem.

### Key Activities

- A comprehensive cross-sectional WASH related health risk analysis including the living, social, gender-related variables and occupational conditions



- A baseline evaluation of the WASH profile which is part of communities' life surrounding a slum of the urban areas
- Developed a model curriculum of sanitation related subjects that is integrated it into the curricula of relevant programs of TERI School of Advanced Studies. Disseminated the curricula for adoption by other Universities for both an immediate and a long term impact on the sector
- Sensitized mid-career professionals engaged in WASH sector to more systemic approaches to dealing with the challenges of delivering effective sanitation services
- Informed policy influencing community on the potential solutions and alternative business models for providing sanitation services.

### Project Impact:

The project led to a report entitled: 'State of Urban Water and Sanitation in India'. The report includes a collection of assessments highlighting the policies, progress and possible solutions in Water and Sanitation in urban India. The project helped in creating enabling conditions to achieve the sanitation targets for India and contributes to the Government of India's Swachh Bharat Mission (Urban).

### Stakeholders/ Beneficiaries:

Urban slum communities, students, WASH professionals, researchers, policy makers



## Economics of Sanitation Initiative: Sanitation Options Study (India)

Sponsor: The World Bank

Partners: GFK MODE Pvt. Ltd.

Study Area/ Location: National Level

### Aim and Objectives:

- To undertake cost-benefit and cost-effectiveness analyses of different sanitation technological options in selected urban and rural areas in India;
- To undertake water quality analysis of drinking water sources in the study locations (urban and rural);
- To assess the economic impacts of sanitation on domestic and international tourism in Kovalam, Kerala.



### Key Activities:

- Prepared and provided advocacy material for increased spending on sanitation, and to prompt greater attention of sector stakeholders to efficient implementation and scaling up of improved sanitation
- Enabled the inclusion of efficiency criteria in the selection of sanitation options in government and donor strategic planning documents, and in specific sanitation projects and programs

- Brought greater focus on appropriate technology through increased understanding of the marginal costs and benefits of moving up the 'sanitation ladder' in different contexts
- Provided the empirical basis for improved estimates of the total costs and benefits of meeting sanitation targets (e.g. MDG target), and contribute to national strategic plans for meeting and surpassing the MDG targets
- Contributed to the design of feasible financing options through identification of the beneficiaries as well as cost incidence of sanitation programs.

### **Project Impact:**

The purpose of the Economics of Sanitation Initiative (ESI) was to promote evidence-based decision making using improved methodologies and data sets, thus increasing the effectiveness and sustainability of public and private sanitation spending. Better decision making techniques and economic evidence themselves have stimulated additional spending on sanitation to meet and surpass national coverage targets.

### **Stakeholders/ Beneficiaries:**

Government and private agencies who fund sanitation initiatives, citizens, researchers, WASH professionals, policy makers



**Capacity Building**





## Environment Conflict and Cooperation Exhibition-II

**Sponsor:** Adelphi Research gGmbH

**Partners:** Adelphi Research gGmbH

**Study Area/ Location:** National Level

The ECC exhibition was conceived and realized by adelphi in 2005 as a touring exhibition at the initiative of the German Federal Foreign Ministry. The Environment, Conflict and Cooperation exhibition (ECC) visualizes the dramatic and growing impact of global environmental change.

### **Aim and Objectives:**

The exhibition aimed to showcase how an increase in environmental pressures will affect peace and security, as well as the threat to lives and livelihoods under a changing climate. The exhibition also looked



towards providing options on how resilience to environmental change can be established.

### Key Activities:

The Energy and Resources Institute (TERI), New Delhi and Adelphi, Germany, organised an exhibition from during DSDS 2012, to understand the dynamic status of environment and the repercussions. The exhibition had generated greater awareness and policy advocacy on the environmental issues leading to conflicts in and among South Asian countries. The informative texts, photos, and graphic elements give concrete examples that help explore complex interactions.

### Project Impact:

TERI had prepared India specific special exhibition modules in collaboration with Adelphi. The exhibition since its inception has toured about 50 cities in 20 countries and has informed visitors about the environmental challenges that the world and the respective region face.

### Stakeholders/ Beneficiaries:

Visitors of the travelling exhibition, policy makers, researchers, students



## Building capacities in community led total sanitation (CLTS) in Karnataka

Sponsor: The World Bank

Study Area/ Location: Karnataka

### Aim and Objectives:

The main aim was to achieve sanitary behaviour change in the entire community by using Community Led Total Sanitation (CLTS) approach which is aided by ways to ignite change, along with recognition for communities securing the desired outcome of an open defecation free environment. Thus, the main objective of the CLTS is to end open defecation by the entire community thereby contributing to an overall improvement in the environment as well.



### Key Activities:

- Training of Trainer on CLTS for master trainers at 6 districts of Karnataka (5 day sessions)
- Awareness generation through CLTS to help change behaviour and ensure sustainable sanitation in the region

### Project Impact:

The rural sanitation sector in the country is undergoing shifts in its approach to achieve better outcomes. The project resulted in a change where the entire community had stopped open defecation, thereby contributing to an overall improvement in the environment as well. The project helped generate more awareness that led to a change in behaviour which ensured sustainability of sanitation interventions in the region.

### Stakeholders/ Beneficiaries:

Trainees, villagers, researchers, policy makers



## Dialogue for Sustainable Management of Trans-boundary Water Regimes in South Asia: A Bangladesh-India Initiative

**Sponsor:** International Union for Conservation of Nature (IUCN)

**Study Area/ Location:** National Level

### **Aim and Objectives:**

To facilitate multi-stakeholder mechanisms that will promote a better understanding food, livelihood, and climate change concerns related to the water regimes of India and Bangladesh.

### **Key Activities:**

To initiate a dialogue on trans-boundary water management that could lead to the development of a dynamic hub for scientific information and knowledge pertaining to water and peoples of the riparian areas of the region.



The following themes were deliberated during under the project:

1. Food security, water productivity, and poverty;
2. Biodiversity conservation;
3. Environmental security;
4. Impacts of climate change;
5. Trans-boundary inland navigation.

### **Project Impact:**

The project brought together experts working in the Ganga and Brahmaputra basin of the two countries to share knowledge. The project led to the development of a situation analysis study on key issues on impacts of climate change in India in relation to trans-boundary water regimes.

### **Stakeholders/ Beneficiaries:**

Scientist, policy makers, researchers



## Workshop on urban water demand management

**Sponsor:** Asian Development Bank

**Study Area/ Location:** Delhi

### **Aim and Objectives:**

The workshop aimed to enhance the knowledge and augment capacity of personnel involved in water supply management/water managers in urban local bodies, municipal corporations through discussion, interaction and dissemination of information

### **Key Activities:**

TERI had conducted a workshop on urban water demand management for the Urban Local Bodies (ULBs) in the state of Odisha.

### **Project Impact:**

The workshop on urban water demand management helped the participants from the Urban Local Bodies in the state of Odisha to have a better understanding on how to manage demand. The hands on approach helped the participants get a better understanding on how to manage resources efficiently. This pilot workshop has been very successful in terms of the exposure that participants from various organizations received on the vital theme of 'water demand management'. There is a need to expand the coverage of this workshop to wider audience across the country in order to build the capacity of water managers engaged in various utilities.

### **Stakeholders/ Beneficiaries:**

Participants, Urban Local Bodies



## National Key Resource Centre in Rural Drinking Water and Sanitation (WATSAN) Sector

**Sponsor:** Ministry of Drinking Water & Sanitation

**Study Area/ Location:** Several states in India

### **Aim and Objectives:**

Department of Drinking Water & Sanitation, Ministry of Rural Development, Government of India identified TERI as National Key Resource Centre in Water & Sanitation. The objective of this exercise was motivation, awareness generation, capacity building of Technical and non-technical personnel working in the PHED and Jal Boards and Technical personnel working in Municipalities & Corporation, representatives from Panchayat Raj Institutions (PRIs), representatives from NGOs on sanitation, health and hygiene, operation & maintenance and sustainability issues.





### Key Activities:

The key activities are as follows:

- Training module development
- Case studies for rural water management and sanitation
- Conducting KRC- WATSAN training

### Project Impact:

TERI had built a pool of trainers at state level to develop community managed environmental plan for the village. These trained state level officers now act as master trainers for officials at district level in each state. The special emphasis given to participatory methodologies and techniques, community facilitation and gender based approach ensures that the activities in the sector are acceptable by the communities and hence becomes easier to sustain the impact of the activities taken in the WATSAN sector.

### Stakeholders/ Beneficiaries:

Technical and non-technical personnel working in the PHED and Jal Boards and Technical personnel working in Municipalities & Corporation, representatives from Panchayat Raj Institutions (PRIs), representatives from NGOs on sanitation, health and hygiene, operation & maintenance and sustainability issues.



## Training of water quality monitoring personnel in water and sewage treatment plants of Delhi Jal Board

Sponsor: Delhi Jal Board

Study Area/ Location: Delhi NCR and Bangalore

### Aim and Objectives:

The objective was to enhance capacity of the quality control staff in DJB plants through exposure to state-of-the-art in the field of water / wastewater treatment including advances in analytical techniques

### Key Activities:

TERI conducted training on emerging pollutants, water and wastewater treatment techniques, operation, maintenance and trouble shooting, analytical techniques, sludge management, quality control, etc.



Field exposure through visits was also done to ensure that the participants are able to correlate classroom learning with real world experiences.

### Project Impact:

The trainees have expressed that they found the training very informative and useful for their work. The trainees have used some concepts to help them manage the water and wastewater treatment plants.

### Stakeholders/ Beneficiaries:

Participants from Delhi Jal Board



**Water Conservation**





## Design and monitor rainwater harvesting implementation at BSES grid station in Common Wealth Village

Sponsor: BSES Limited

Study Area/ Location: Delhi

### Aim and Objectives:

The objectives of the project were to lower operating costs, reduce dependence on tankers and municipal water supply and to reduce impacts of the building.



### Key Activities:

1. This project involved the design of a rainwater harvesting system for a newly constructed electric grid station for BSES Yamuna Power Station
2. A detailed study of the site, collection of rainfall data, building maps, water requirements, designing of rainwater harvesting system, and suggesting monitoring and operating guidelines. All design work was supplemented with field visits, discussions with client and supervision during the implementation.
3. Create greater ownership and control over its water supply.
4. Decrease the environmental impact of new BSES Yamuna Power Station on water supply.
5. Provide customized guidelines for water conservation at site.

### Project Impact:

Rainwater harvesting is one of the major initiatives taken by BSES Yamuna Power Ltd., for water conservation while also helping in reducing the stress on public water supply. A rooftop rainwater harvesting system was adopted for the control room building, where the water collected from the roof top is stored in underground sumps and can be utilised for toilet flushing and cleaning purposes. A surface runoff harvesting technique was adopted for the electric grid portion, where the water is stored in underground sump and is used for the fountain and horticultural purposes. This lowered the operating costs by reducing dependence on tankers and municipal water supply, to provide ownership and to reduce the impacts of this new building on water supply. Further, this project also helped to create a showcase pilot project for “Green” environmental-friendly building practices, which can create awareness about water conservation.

### Stakeholders/ Beneficiaries:

BSES officials, researchers, visitors to the site



## Assess the impact of developmental activities on the lakes of Hyderabad

**Sponsor:** Government of Telangana

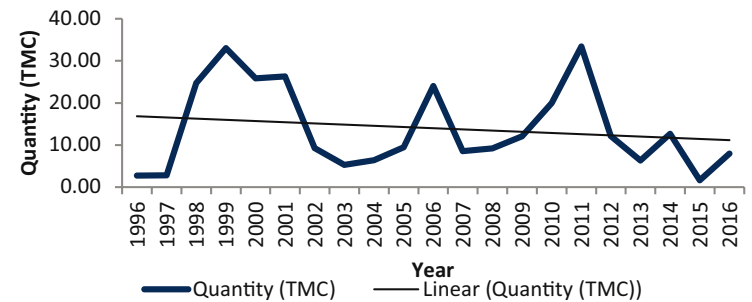
**Study Area/ Location:** Hyderabad

### **Aim and Objectives:**

- To assess the impact of developmental activities and changes in urban/ peri-urban land use on water resources of the two lakes: Osmansagar and Himayathsagar respectively.



Osmansagar Levels  
Post G.O.111 (1996-2016)



### Key Activities:

1. Understanding the role and share of Osmansagar and Himayathasagar lakes in drinking water supply to Hyderabad urban and peri-urban areas and the alternate uses where these two lakes can be put to use.
2. Study of the developments which have taken place in the catchment of lakes including changes in land use from agriculture, forest and tree cover to built uses and polluting industries.
3. Review of the existing policy, regulatory and institutional mechanisms for the protection of Himayathasagar and Osman Sagar and to identify the gaps, if any.

### Project Impact:

This study provided a scientific approach based zoning for the protection of two lakes keeping in mind the socio-economic growth of the region which is important for the development of the population residing in the 10 km area. The suggested zoning is based on the existing best practices in India and around the world.

### Stakeholders/ Beneficiaries:

Urban Local Bodies, Industrial sector, Local Community, Agricultural Labourers, Hyderabad Urban Development Authority





## Development, Rehabilitation & Outreach Project (DROP) on Integrated Watershed Management

**Sponsor:** PepsiCo Foundation

**Study Area/ Location:** Nelamangala district, Bangalore

### **Aim and Objectives:**

The project was aimed at improvement in the quality of life of the community by undertaking interventions in areas of water supply, sanitation, hygiene, health, and education. The project looked to ensure long-term availability of groundwater resources in the studied



watershed through eco-restoration water conservation measures such as pond construction, artificial groundwater recharge, drip irrigation, rainwater harvesting and demand management measures.

### **Key Activities:**

Socio - economic development of T. Begur Watershed using a watershed management approach with special emphasis on water resource management and ground water recharging. Improvement in the quality of life of the community by undertaking interventions in areas of water supply, sanitation, hygiene, health and education.

### **Project Impact:**

This project introduced water-conservation technologies like rainwater harvesting, groundwater recharge and drip irrigation that served to decrease the groundwater exploitation in the area. Total water saving potential created through DROP interventions was about 122 million litres/year. Number of water conservation measures undertaken under the project helped conserve or feed significant amount of groundwater from/ to aquifer. It provided sanitation education and health/hygiene awareness during the course of the project. TERI also implemented toilet construction and conducted health camps. Livelihood trainings such as driving, tailoring, and computer skills training were also conducted. This helped provide non-agriculture livelihood options for community members and established the Village Development Committee (VDC), a new community institution, and strengthened existing institutions, like SHGs and YGs, through training and education programs.

### **Stakeholders/ Beneficiaries:**

Women Self Help Groups, Village Development Committees, Marginal Farmers.



## Water Conservation through Rejuvenation of Pond with Participatory Community Engagement (Ongoing)

**Sponsor:** United Breweries Limited

**Study Area/ Location:** Ludhiana, Patiala and Alwar district

### **Aim and Objectives:**

To facilitate water conservation in villages of Ludhiana, Patiala and Alwar district through rejuvenation of Ponds with participatory community engagement

### **Key Activities:**

- Awareness generation, motivation & mobilisation of the local community



- Participatory implementation of Pond Rejuvenation for identified eight ponds in the districts of Ludhiana & Patiala (Punjab) & Alwar (Rajasthan), in consultation with the local community.
- Capacity building of relevant stakeholders for operation and maintenance of water conservation structures

### Potential Project Impact:

Project aims to restore and rejuvenate the ponds in the selected villages to ensure groundwater recharge. The rejuvenation of ponds would conserve the rainwater and recharge the declining groundwater of the area, along with enhancing the aesthetic value of the village surroundings. The local community would benefit from the project because of improved groundwater levels and clean surroundings of the ponds which currently is in poor state.

### Stakeholders/ Beneficiaries:

Local community around the pond, United Breweries Limited, Central Ground Water Authority, State Ground Water Board





# **Agriculture and Water Management**



## Impacts of Climate Change and Watershed Development on Whole-of-Basin Agricultural Water Security in the Krishna and Murray-Darling Basins

**Sponsor:** Australian Centre for International Agricultural Research

**Partners:** University of Melbourne, Indian Institute of Tropical Meteorology, International Water Management Institute

**Area/ Location:** Krishna Basin, Andhra Pradesh & Telangana

### **Aim and Objectives:**

To assess the impacts of watershed development and climate change on the long term water security for agriculture in the Krishna river basin.

### **Key Activities:**

1. Institutional mapping and review of water resources policies and programmes being promoted in the basin
2. Undertook stakeholder consultations to identify and characterise key water management issues that will be affected by climate change (sub-basin and basin scales)



3. Studied the socio-economic aspects and water utilisation patterns at sub-basin and basin levels
4. Developed a framework for identifying adaptation scenarios based on institutional and field based surveys.

### Project Impact:

An iterative multi-tier stakeholder consultation process carried out over a period of three years yielded a set stakeholder prioritised adaptation options, which includes changing cropping patterns, increasing watershed development and improving irrigation efficiency. The most enduring legacy of this project is the generic-adaptive framework that was developed, tested and applied in the Musi catchment, which can be applied to any catchment in an adaptive manner. The framework developed in this project had form the basis for up scaling the framework to the Krishna basin level.

### Stakeholders/ Beneficiaries:

Ministry of Water Resources, Panchayati Raj Institutions, policy makers, Farmers, Self Help Groups, Village communities, Researchers, Academia, Water Professionals.





A glass dropper is shown at an angle, with a single, clear drop of water suspended at its tip. Below the dropper, the rim of a glass is visible, ready to catch the drop. The background is a solid, light blue color. A yellow banner is positioned across the lower part of the image, containing the text "Water Quality".

**Water Quality**



## Water and wastewater management at Sri Mata Vaishno Devi

**Sponsor:** Sri Mata Vaishno Devi Shrine Board

**Study Area/ Location:** Sri Mata Vaishno Devi  
Jammu

### **Aim and Objectives:**

Broad objectives of the project were

- Improving the water use efficiency by conducting water audit
- Design and install rainwater harvesting structures at appropriate locations in Adkuwari and Bhawan
- Optimize performance of conventional sewage treatment plant at Bhawan
- Wastewater treatment for sewage generated from toilets en-route
- Explore wastewater reuse options in the area
- Explore sustainable business models for wastewater treatment plant operation



### **Key Activities:**

Water balance study, Design and install rainwater harvesting structures.

### **Project Impact:**

The water supply and distribution system for the region was assessed and the findings led to the development of a water balance for the study area. Wastewater assessment was also conducted for the sewage treatment plant (STP) and the results showed that there could be an improvement for the STP. A similar exercise was done for the treatment system of the toilets in the area. Rainwater harvesting potential was also developed for the area. The project brought about a better understanding of the water resources in the study area.

### **Stakeholders/ Beneficiaries:**

Sri Mata Vaishno Devi Shrine Board, pilgrims and downstream users



## Evaluation of water quality status of river Ganga

**Study Area/ Location:** Uttarakhand, Uttar Pradesh, Bihar, West Bengal

**Partner:** NDTV

**Sponsor:** TERI

### **Aim and Objectives:**

The project objective was to undertake monitoring (sampling) and testing of water quality at different stretches of river Ganga and assess causes of pollution related issues associated, and recommend remedial action points.

### **Key Activities:**

- Undertook monitoring (sampling) and testing of water quality at different stretches of river Ganga as well as few drains and groundwater
- Assessed the causes of key pollution related issues associated with river Ganga and identified the key problem areas/gaps



- Recommended key remedial action points

### Project Impact:

It created greater awareness of the need for more Effluent Treatment Plants (ETP), Centralized Effluent Treatment Plant (CETPs) and Sewage Treatment Plants (STPs) to treat the untreated waste water municipal sewage, industrial effluents etc. before they are released to the river .

### Stakeholders/ Beneficiaries:

Researchers, Policy makers, general public etc.



## Sampling and testing of lake water at Nainital and Bhimtal

**Sponsor:** Matsue Doken Co.Ltd. Japan

**Study Area/ Location:** Bhimtal and Nainital Lake, Uttarakhand

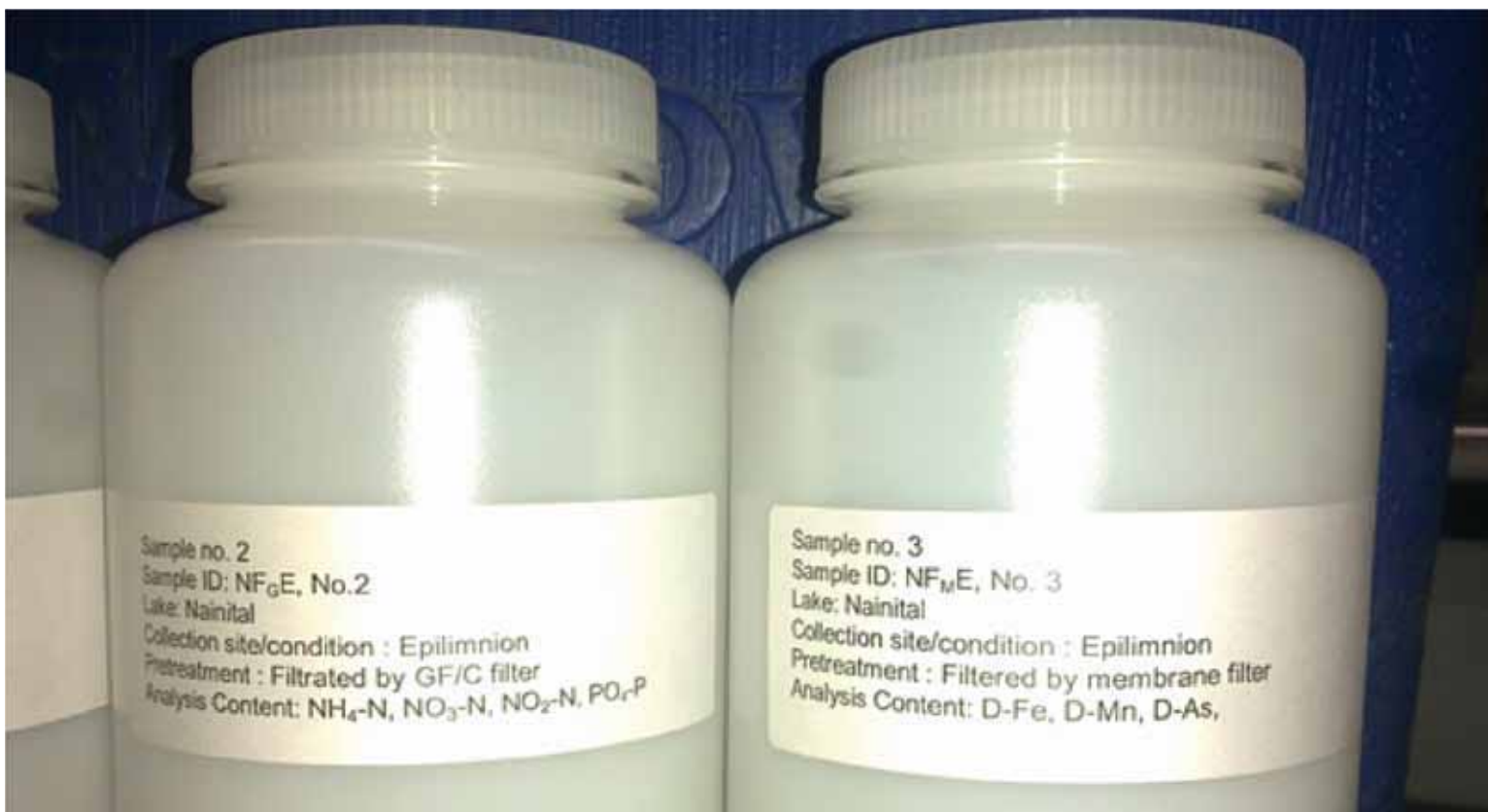
### **Aim and Objectives:**

The objective of the study was to conduct a water quality monitoring exercise to assess the water quality of Nainital & Bhimtal Lake at different depths.

### **Key Activities:**

Water Sample collection and analysis of Nainital and Bhimtal Lake, Uttarakhand

This study was conducted by TERI at Nainital & Bhimtal Lake in



association with Matsue Doken Co., Ltd. (MDCL), Japan. The study was carried out in two seasons (pre monsoon & post monsoon) for selected parameters such as Total Nitrogen, Ammonia, Nitrate, Nitrite, Total Phosphorus, Phosphate, Total Iron, Dissolved Iron, Total manganese, Dissolved Manganese, Chemical oxygen demand (COD) and Biochemical oxygen demand (BOD).

Subsequently, the impact of aeration (varying from 12 hrs to 30 days) was also assessed in the TERI water laboratory for the samples collected to suggest appropriate treatment technology.

Based on above assessments, recommendations for water quality management at both the lakes were made.

### **Project Impact:**

Through TERI's analysis, it was found that nearly 50% reduction was observed in BOD & COD values after 30 days of aeration. The other tested parameters also showed a decreasing pattern from their initial values.

### **Stakeholders/ Beneficiaries:**

Tourist, residents at the vicinity of the lake, researchers, Matsue Doken Co. Ltd.







**Drought Mitigation**



## Study of Impact of Special Package for Drought Mitigation Implemented by NITI Aayog in Bundelkhand Region

**Sponsor:** NITI Aayog, Government of India, New Delhi

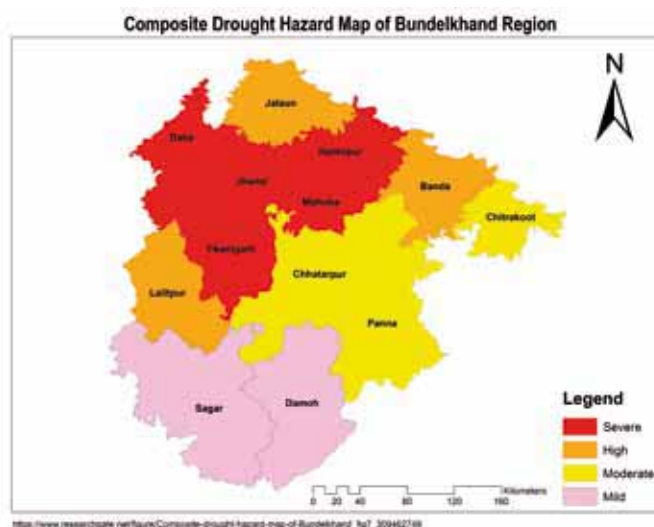
**Study Area/ Location :** Bundelkhand Region in Madhya Pradesh & Uttar Pradesh

Government of India implemented the Bundelkhand Special Package for drought mitigation (BKD Package), starting 2009-10 in the Bundelkhand region. The package involved multi-sectoral approach giving primary focus on water positive activities and projects, marketing and warehousing infrastructure and livelihood support interventions. The total outlay of the program was Rs 7,266 crore initially and then after another Rs 200 crore was provided. Government of India approved the continuation of the Bundelkhand special package during the 12th plan period (2012-2017) under the Backward Regions Grant Fund (BRGF) with the financial outlay of RS 4,400 crore.

## Aim and Objectives:

To carry out comprehensive assessment of impacts of Drought Mitigation package in Bundelkhand region and develop a drought adaptive and mitigative activity plan for NITI Aayog. Specific Objectives of the project were:

- To analyse the existing governance models related to groundwater management and augmentation of Uttar Pradesh and Madhya Pradesh and suggest improvements
- To assess the outcome of special package in terms of its impact on production, income employment, net value addition and net permanent asset creation in the districts of the Bundelkhand region
- To study the procedures for project formulations and conceptualisation and role of various agencies, approval procedures to identify problems in the implementation of the programme and to suggest remedial measures
- To study the effectiveness of scale of various interventions of special package and its effectiveness on the beneficiaries in different sectors
- To study the effect of package incentives and extension activities on agriculture/improvement technology to increase crop productivity, diversification in cropping pattern, cropping intensity, net area irrigation, employment, marketing, price realization and consequently raising the income of the farmers
- To study the favourable/adverse effect of the package on the neighbouring districts of Uttar Pradesh and Madhya Pradesh



## Key Activities:

Impact assessment of drought mitigation projects; develop a drought adaptive and mitigative activity plan for NITI Aayog. The study was based on the primary as well as secondary data on various relevant parameters. The primary data were obtained through sample survey across all the 13 districts of Bundelkhand Region covering beneficiaries of different set of interventions under the Bundelkhand package. In addition to sample survey, Focused Group Discussions were held with the beneficiaries of drinking water schemes, Secretary of Dairy Cooperative Societies, nodal officers of all line departments implementing the projects and Chief Development Officers/Collectors/ Commissions of districts/ division to understand their experience on implementation



of different activities under the package. A stakeholder workshop was also organized in Jhansi, Uttar Pradesh with different officials of the line departments in Bundelkhand districts of the state.

The secondary information was collected from the State Planning Commissions of Uttar Pradesh and Madhya Pradesh. Also, the data was collected from all district level line departments of 13 districts and official websites of each district as per the availability. The secondary information mostly encapsulated financial allocations, sanction, release and expenditure, activities, targets, achievement status and monitoring mechanism.

Evaluation of survey results was done against a set of socio-economic Impact Indicators and sector-wise achievements were ranked for each parametres.

### Project Results:

Interventions related to livelihood support were found to be highly impactful and have been helpful in generating additional income for the farmers. It is highly recommended that these activities should be further intensified. It was found that BKD package

has resulted in significant increase in both cultivated area as well as production of wheat in Bundelkhand district. Also, expenditure incurred under the Bundelkhand Package has been useful in creating employment opportunities in the region. Infrastructure created under the package has been able to generate both direct as well as indirect employment opportunities. Simultaneously, it was also found that package was able to generate self-employment as well as contractual employment opportunities as well.

### **Project Impact:**

The Impact Evaluation Study of Special Package for Drought Mitigation in Bundelkhand region provided comprehensive assessment of schemes implemented under the package and its impact on local beneficiaries. Study also evaluated the operational roles of various stakeholders/implementing agencies, identifying constraints and suggesting areas for improvement. The project resulted into development of a policy brief jointly with NITI Aayog, Government of India which provides a way forward for the policies and programmes facilitating the 'drought proofing' in India.

### **Stakeholders/ Beneficiaries:**

- Ministry of Water Resources, River Development & Ganga Rejuvenation, NITI Aayog, State Planning Commission, Agriculture Departments, Forest Department, Policy Makers





# Water Energy Climate Nexus





## Water-electricity nexus in India around supply side options

**Sponsor:** Shakti Sustainable Energy Foundation

**Study Area/ Location:** National Level

### **Aim and Objectives:**

The main goal of the project was to develop a framework for optimizing water use, enhancing water use efficiency in Power Generating Plants and for sustainable water management in PGP watersheds. Objectives of the project were;

- To develop a decision supporting tool in the form of a GIS map for PGPs vis a vis water availability in the country.
- Assessment of water energy nexus for selected categories of PGPs
- To establish inter-linkage between power generation, available water resources, and sectoral water demands in order to assess water related stress in the watershed
- Evaluating and proposing techno-economically feasible solutions for optimizing water use efficiency and for sustainable management of water resources

## Key Activities:

Key activities under the project involved the water consumption assessment for the power producing utilities, assessing the water stress at the river basin scale due to existing power plants in the basin, and exploring the options for reducing water footprints of electricity production in the country.



- Identification and mapping of PGPs according to source of power generation, type and capacity



- Water-energy nexus footprinting in PGPs
- Assessment and projection of water consumption into future energy production
- Watershed based assessment of stress due to a selected PGP utility



- Exploring solutions for reducing water stress
- Cost benefit analysis

## Project Impact:

1. The study resulted in the assessment of water stress existing in major river basins of the country and the contribution of power plants to this.
2. The study also focused on water consumption for the electricity generation and provided an overall assessment of water consumption for the electricity generation in the country, as well as for future time period.
3. Study also provided the possible solutions which included water use optimization through feasible techno-process modifications in the electricity production. The study also provided preliminary understanding about the possibility of water-neutral electricity production in the country.



The study resulted into the development of a policy brief titled, “Water Neutral Electricity Production in India: Avoiding the Unmanageable” and “Compendium of Best Practices to Reduce Water Footprints of Thermal Power Plants”. The policy brief and compendium provides the policy recommendations for the relevant stakeholders on various cost effective options available to reduce the water footprints of electricity production in the country.

### **Stakeholders/ Beneficiaries:**

Power Generation Utilities, Ministry of Power, Ministry of Water Resources, River Development & Ganga Rejuvenation, Policy Makers, Researcher/students



## Study of Assessment of Water Foot Prints of India's Long Term Energy Scenarios

Sponsor: NITI Aayog

Study Area/ Location: National Level

### Aim and Objectives:

- To assess the water footprint of India's long term energy scenarios in energy demand and supply sectors as follows:
  - Demand sectors: i) Agriculture, ii) Industries, iii) Domestic
  - Supply sectors: i) Fossil based power generation, ii) coal washeries, iii) Nuclear power stations, iv) Renewable based bio-energy, v) Oil & gas extraction
- To investigate the potential for improving water efficiency in the sector and suggest methods of efficient utilization of water in above industries
- To evaluate the regional water requirement

## Key Activities:

Work under the project involved a number of activities as follows:

- Integrating different water related datasets on the GIS platform and assessing the water availability at the state level
- Assessing the water demand for different sectors and resulting water stress within major states of India
- Assessing the water demand for various sectors related to energy and their contribution to the regional water stress in the country
- Projecting the water stress into future under both the business-as-usual and climate change scenarios

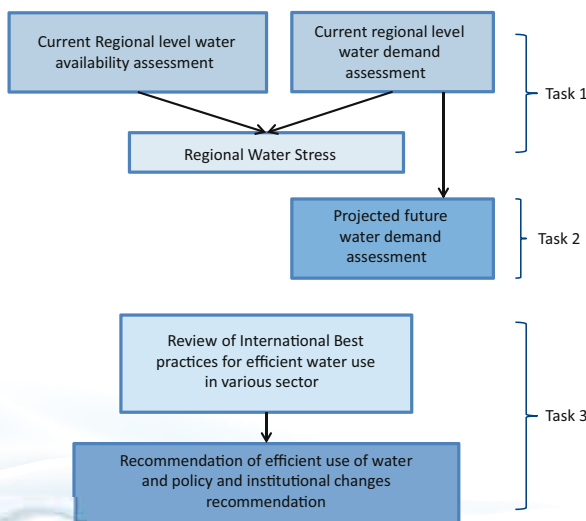
## Project Impact:

The project resulted in a set of recommendations for efficient use of water, and the required policy and institutional framework for the achievement of the same. Study provides an assessment of water consumption for the present and future energy requirements in the country and also assessed the water scarcity due to heavy water demand for electricity generation.

## Stakeholders/ Beneficiaries:

Power Generation Utilities, Ministry of Power, Ministry of Water Resources, River Development & Ganga Rejuvenation, Policy makers, NITI Aayog, Researcher/Students

*Sample of primary data was collected which was mainly corroborated with available secondary data for demand. Availability was based on primary data and calculations to arrive at regional figures*



*Projection was done based on available growth rate for various sectors a under BAU Scenarios other scenarios based on 'what-if' basis were defined*

*Literature review was carried out to identify existing best practices as well techniques available to efficiently use water in each of the sectors. A brief policy and program review was also undertaken to provide recommendations*





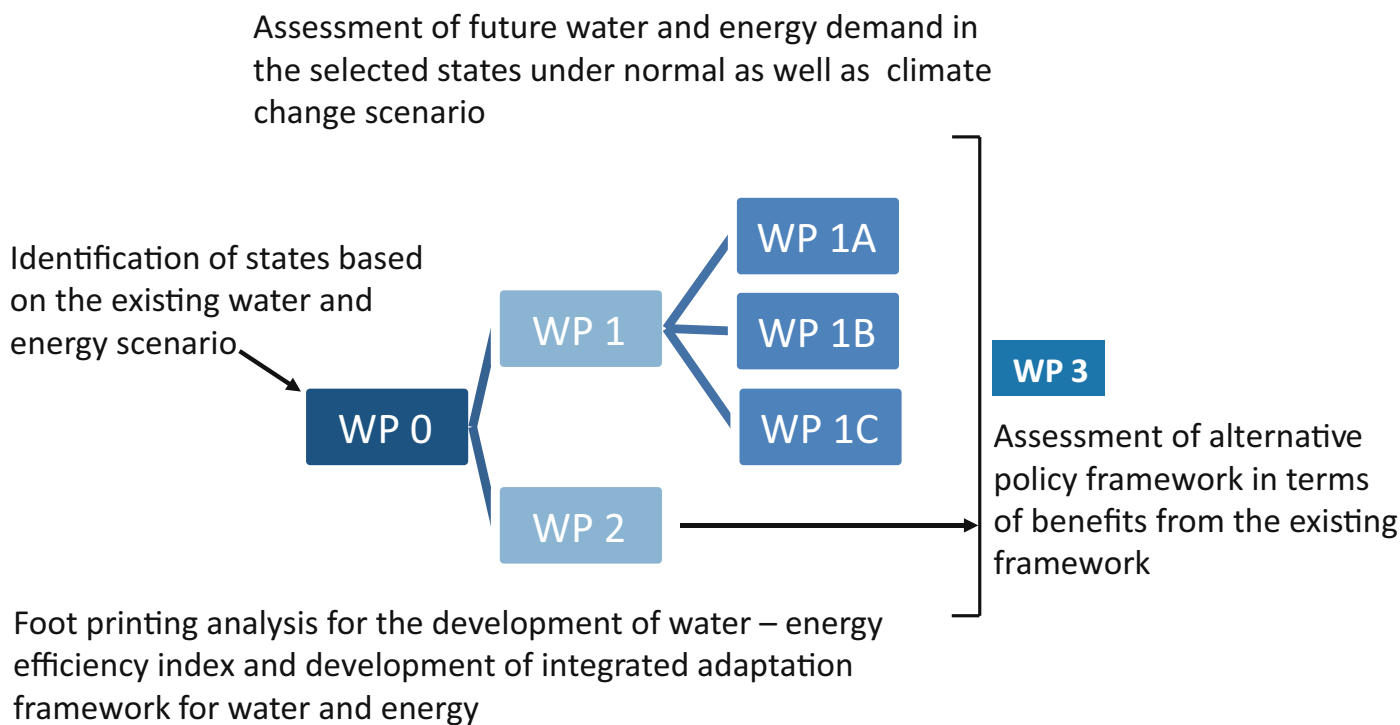
## Water, Energy, and Climate Interactions: Identifying Issues and Assessing Response Capacity at the State level

Sponsor: The Norwegian Ministry of Foreign Affairs

Study Area/ Location: National Level

### Aim and Objectives:

- To assess existing and future water-energy demand, climate change impacts on water-energy demand, availability patterns, and institutional adaptive capacity in agriculture, industrial, domestic water supply, and energy production in four states in India.
- To estimate water and energy footprints in agriculture, industry, domestic water supply, and energy production and to develop adaptive management guidelines for improving water and energy use efficiency.
- To analyze the costs and benefits of alternative policies that local/state/national government could initiate for improving the resilience and adaptive capacity in selected **sectors**.



## Methodological Framework for the activities under the project

### Key Activities:

- Development of 'Water-Energy nexus' indicators and ranking of Indian states based on the intensity of water-energy nexus in these states. Based on the ranking of states, 4 states were selected for further assessment.
- Assessment of current water and energy demand for sectors like Agriculture, Domestic and Industrial within the selected states.
- Projection of intensity of water-energy nexus into future under both normal as well as climate change scenarios within the selected states.
- Footprinting analysis for the development of water-energy efficiency index and development of integrated adaptation framework for water and energy
- Evaluation of existing policies, programmes, interventions, initiatives, and governance challenges related to Climate Change, Water and Energy in selected states as well as national level
- Review and analysis of international practices related to Climate Change, Water and Energy governance and regulation
- Development of adaptation framework to harmonize the stress among the different component of the nexus



### Stakeholders/ Beneficiaries:

Power Generation Utilities, Ministry of Power, Ministry of Water Resources, River Development & Ganga Rejuvenation, State Government, ULBs, NITI Aayog

### Project Impacts:

Research conducted under the project led to number of publications

- Wate Energy Nexus: Synthesis of Understanding
- Manjunath M. and Tayal S. (2014). Energy Implications of Water Use and Pollution Control in Textile Industries: A case study of Tirupur. Technical Paper
- Shresth Tayal and Ritu Mathur (2012). Dynamics of Water, Energy and Climate Interactions: Integrated Solutions for Sustainable Resources Development. Technical Paper
- Shresth Tayal and Sonia Grover (2012). An assessment of vulnerability to water-energy nexus for Indian states. Technical Paper
- Shresth Tayal and Sonia Grover (2014): Climate Change-Water-Energy Nexus: Exploring opportunities across boundaries



## Capacity Building under the project:

The project led to the creation of capacity on the concept of nexus assessment among doctorate and post-graduate students.

- Water Use estimation for power generation in India - A focus on coal based power generation - Ms. Garima Vats, Ph.D. student, TERI University
- Issues and concerns in the urban domestic water demand, supply vis-a-vis consumption in the Indian metropolitan cities- Ms. Priyanka Khanna
- An assessment of future water demand under developmental scenarios for the Sabarmati River basin of Gujarat - Mr. Jitender Taneja, M.Sc. 4th Sem., TERI University
- An assessment of energy consumption for different wastewater treatment processes and techniques- Ms. Gunjan Singh, M.Sc. 4th Sem, TERI University
- Water Footprint Assessment of the Textile Industries in Tirupur – Mr. Maneesh Manjunath, Master of Arts in Sustainable Development Practice, TERI University
- Assessment of Energy in Domestic Water Supply Scheme in Bhuj City of Gujarat State – Mr. Poojan Gor

A dramatic landscape of jagged, blue-tinted icebergs under a dark, stormy sky. The icebergs are scattered across the foreground and middle ground, with a dark, rocky mountain peak visible on the left. The sky is filled with heavy, dark clouds, creating a moody and atmospheric scene.

# Glacier Research Programme

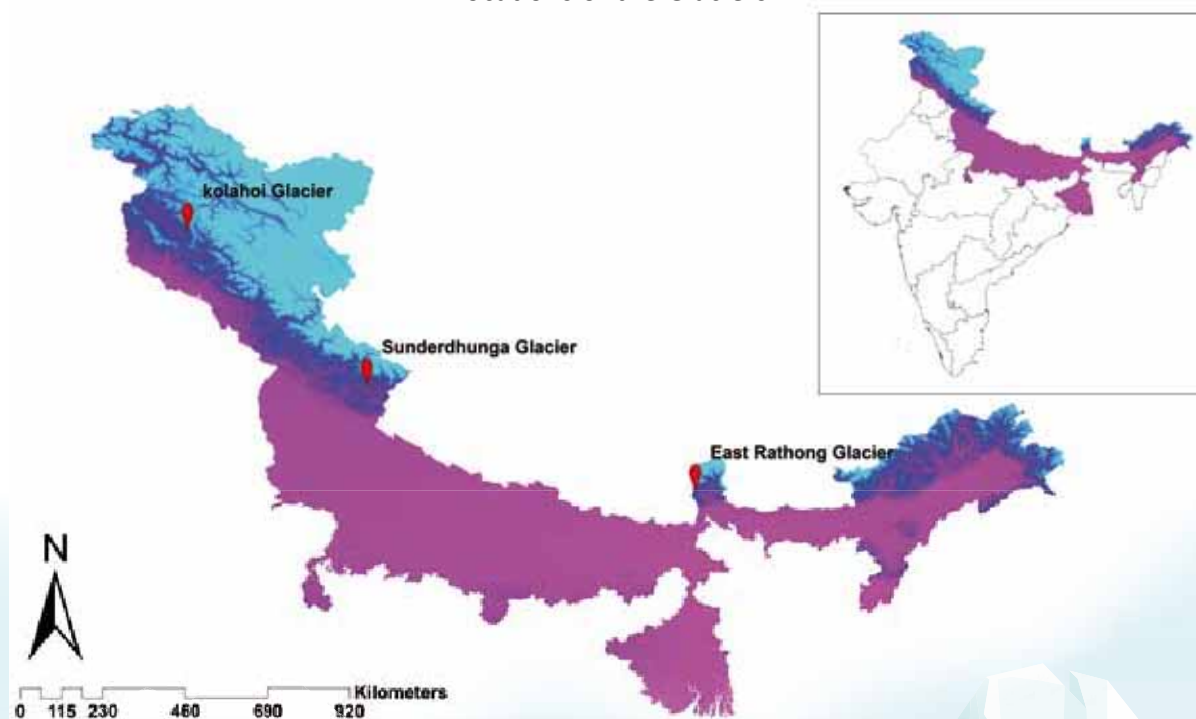
The Energy and Resources Institute, New Delhi started Glacier Research Programme in 2008 and two key benchmark glaciers with different climatic and geographical settings were selected. These benchmark glaciers are from Liddar valley in Kashmir and East Rathong valley in Sikkim, which are ideal for long-term measurements. The two glaciers were chosen after careful consideration keeping in view scientific relevance and logistics. The selected glaciers from different micro-climatic settings have been developed as Glacier Monitoring Observatories. TERI's scientists have undertaken several research expeditions to these glaciers, and preliminary understanding indicates present status of these glaciers have been developed.

With an integrated approach, simultaneous measurement of various parameters affecting the energy balance, glacier mass balance, as well as hydrological balance of these two glaciers is being undertaken. These glaciers have been equipped with Automatic Weather Stations (AWS) with sensors for air temperature, relative humidity, wind speed and direction, net radiation, precipitation and snow depth; stream-level recorder and flow velocity metres; along with the ablation stakes and accumulation pits, for measurement of glacier mass balance.

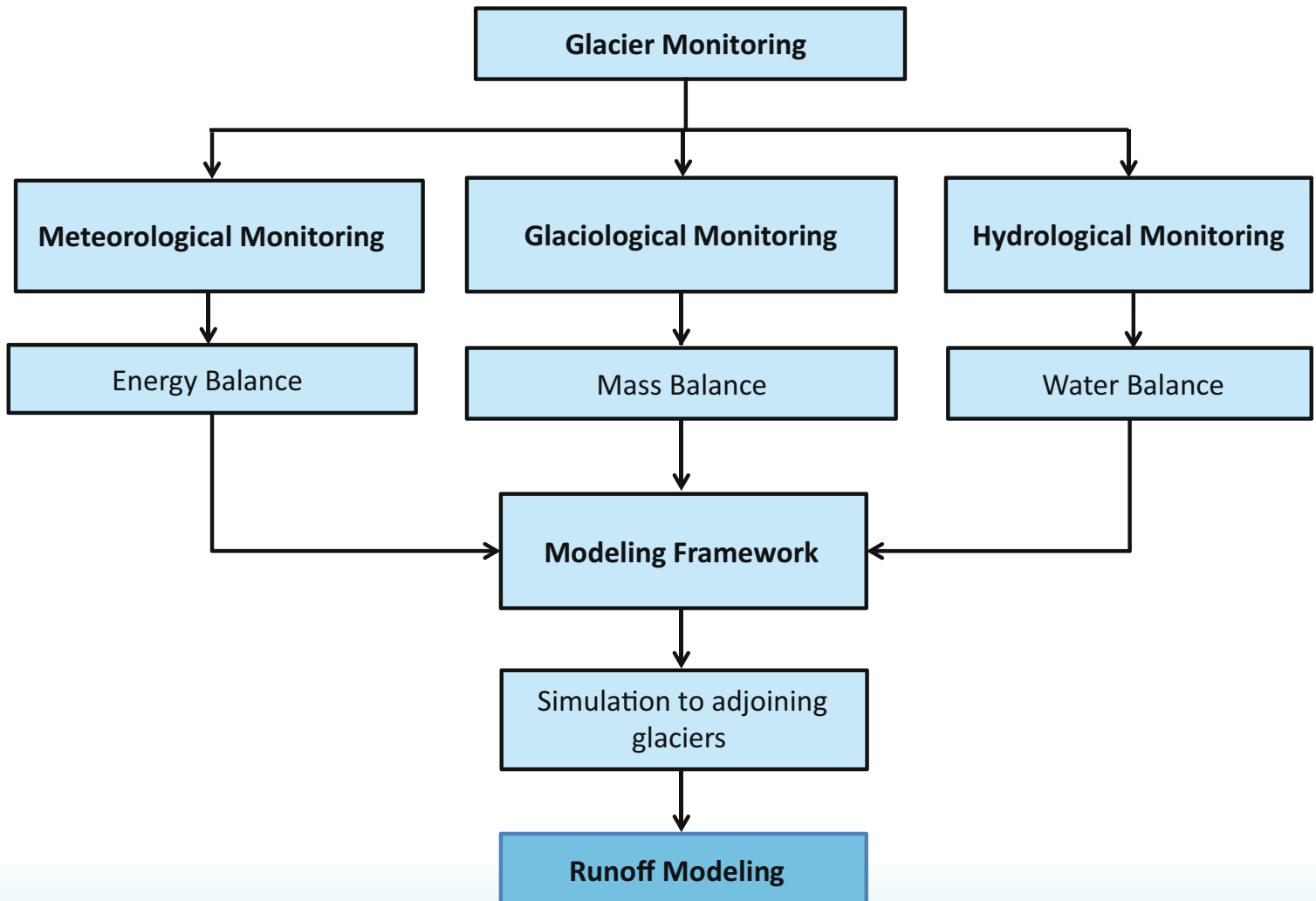
Presently in its second phase, the analysis of satellite data and field experimentation for calculation of modelling constants is being taken up. Subsequently, the programme aims to simulate the data from these observatories to adjoining glaciers, which will feed into the development of an integrated runoff model for high-altitude catchments of Himalayan rivers.

Recently, in 2015 another glacier located in the central Himalaya has been selected. The Durga Kot Glacier, is located in the Sunderdhunga valley in Uttarakhand. This glacier which represents a different micro climate is being developed as another 'Glacier Monitoring Observatory'.

### Locations of the Glaciers



## TERI's Integrated Approach to Glacier Research





## The response of the Hydrological System in India to Climate Change (INDICE)

**Sponsor:** Research Council of Norway

**Partners:** Norwegian Water Resources and Energy Directorate, Norway;  
Norwegian Meteorological Institute, Norway;  
Jawaharlal Nehru University, New Delhi;  
Bidhan Chandra Krishi Vishwavidyalaya, West Bengal

**Study Area/ Location:** Kolahoi Glacier and Lidar river basin, Jammu & Kashmir

### **Aim and Objectives:**

To understand the impact of climate change on the cryospheric contribution to rivers in western Himalaya and the consequential impact on water resource availability and socio-economic status of the local community.

- To assess the melt contribution of Kolahoi glacier to the downstream river
- To develop an understanding of the nature and degree of livelihood dependence (quantitative and qualitative) of the downstream communities on melt water; and their perception about the changes in natural factors regulating the livelihoods;

- To identify the degree of vulnerability due to variations in the melt water and changes in precipitation, on the livelihoods of the downstream population;
- To develop an adaptation framework for the identified stakeholders to reduce the intensity of climate change impacts.

### Key Activities:

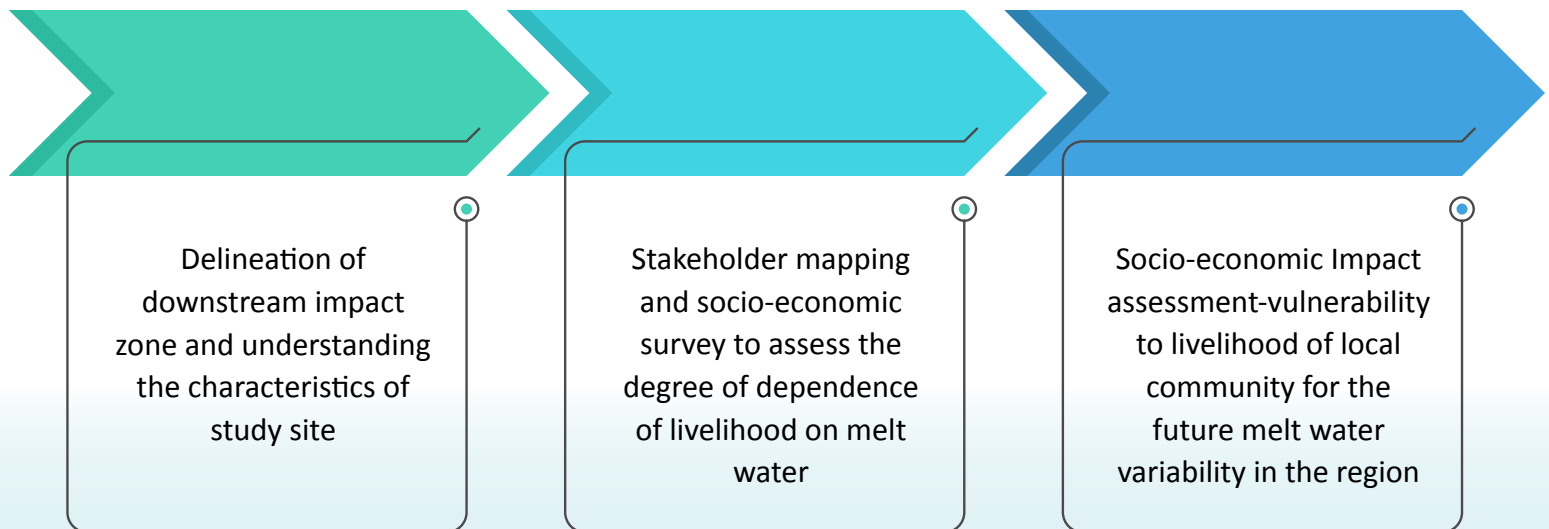
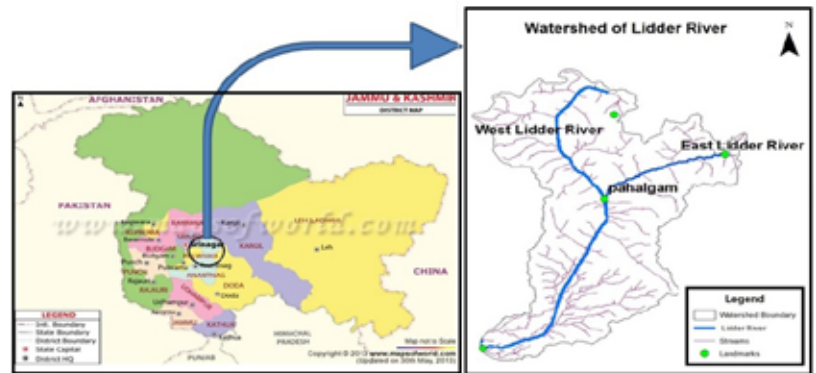
The project involved two specific activities: Glacier melt measurements and runoff modelling; and Socio-economic impact assessment

#### A. Glacier Measurements and modelling

This activity involved the glacier mass balance estimation, Climate Change impacts on Glaciated area and water availability in the study region, Monitoring of Climatic Parameters, and Snow Melt Runoff Estimation

#### B. Socio-economic Impact Assessment

This activity involved the assessment of degree of dependence of local community on the meltwater and projection of vulnerability due to future variability in melt water





## Project Results:

Mass balance measurements and the analysis conducted using satellite data for the regions indicated a high rate of melting as well as glacier dynamic processes leading to deglaciation of the Lidar valley.

An extensive survey conducted in the Anantnag district of Jammu and Kashmir resulted in an improved understanding about the role of meltwater on the livelihood of local communities.

## Stakeholders/ Beneficiaries:

Ministry of Environment, Forest and Climate Change, Ministry of Water Resources, River Development & Ganga Rejuvenation, State Government, Disaster Management officials, Researchers, Local Community



## Climate change and its impacts hydro-meteorological parameters in Pindar sub-basin, Uttarakhand

Sponsor: International Centre for Integrated Mountain Development

Study Area/ Location: Pindari Sub Basin

### Aim and Objectives:

- To establish the hydro-meteorological stations in Pindar sub-basin in Uttarakhand by installing and maintaining high-altitude scientific equipments
- To collect and analyse hydro-meteorological data from the glacier stations



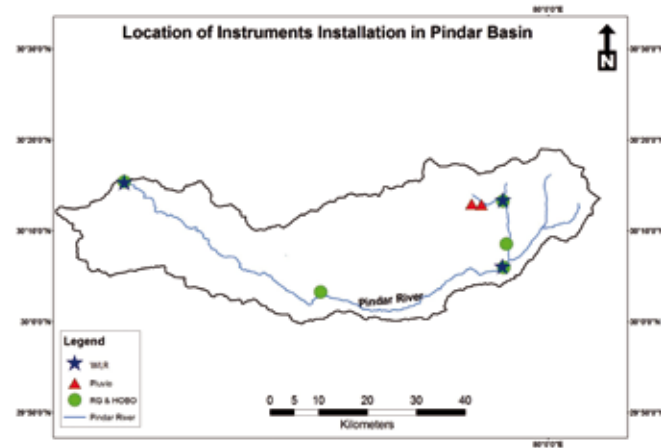
- To develop vertical profile for the study area through Digital Elevation Model, establish the flow direction, flow accumulation, stream network as well as flow velocity.
- Understanding snow cover variation in the region
- Establishing degree day factor for the snow catchments of the region: TERI has conducted few experiments for the purpose, and plan to elaborate it further.

### Key Activities:

- Installation and calibration of hydro-meteorological instruments along the vertical transect of the Sunderdonga glacier valley in the Pindar sub-basin
- In-situ measurements of the parametres influencing the runoff pattern of the stream
- GPS profiling of the catchment
- Analysis and modelling of the hydro-meteorological parametres influencing the runoff pattern
- Analysis of satellite data to understand the snow cover variation and snow melt runoff modelling

### Stakeholders/ Beneficiaries:

Ministry of Environment, Forest and Climate Change, Ministry of Water Resources, River Development & Ganga Rejuvenation, State Government, Disaster Management officials, Researchers, Local Community







## Climate change and its impacts on hydro-meteorological parameters in Teesta sub-basin, Sikkim

**Sponsor :** International Centre for Integrated Mountain Development

**Study Area/ Location:** Teesta River Basin

### **Aim and Objectives:**

- To strengthen the hydro-meteorological stations in East Rathong sub-basin in Sikkim by installing and maintaining high-altitude scientific equipment
- To collect and analyse hydro-meteorological data from the glacier stations
- To develop vertical profile for the study area through Digital Elevation Model, establish the flow direction, flow accumulation, stream network as well as flow velocity.

- Understanding snow cover variation in the region
- Establishing degree day factor for the snow catchments of the region: TERI has conducted few experiments for the purpose, and plan to elaborate it further.

### Key Activities:

Monitoring of Climatic Parameters in the sub basin area, Climate change scenario in the region, Hydrological Modelling, Vulnerability Assessment

- Installation and calibration of hydro-meteorological instruments along the vertical transect of the East Rathong glacier valley in the Teesta basin
- in-situ measurements of the parametres influencing the runoff pattern of the stream
- GPS profiling of the catchment
- Analysis and modelling of the hydro-meteorological parametres influencing the runoff pattern
- Analysis of satellite data to understand the snow cover variation and snow melt runoff modelling

### Stakeholders/ Beneficiaries:

Ministry of Environment, Forest and Climate Change, Ministry of Water Resources, River Development & Ganga Rejuvenation, State Government, Disaster Management officials, Researchers, Local Community





## Climate Induced Mobilization of Persistent Organic Pollutants (POPs) in Rivers in India

**Sponsor:** The Research Council of Norway

**Partner:** Norwegian Institute for Water Research, Norway

**Study Area/ Location:** Ganga river basin

### **Aim and Objectives :**

The overall goal of the project was to assess the climatic controls on the environmental exposure of diffuse chemical micro-pollutants in a large hydrological system.

### **Key Activities:**

- The project focussed on monitoring (seasonal) exposure and fluxes of Persistent Organic Pollutants (POPs) in the Ganges River waters and its Himalayan headwaters.

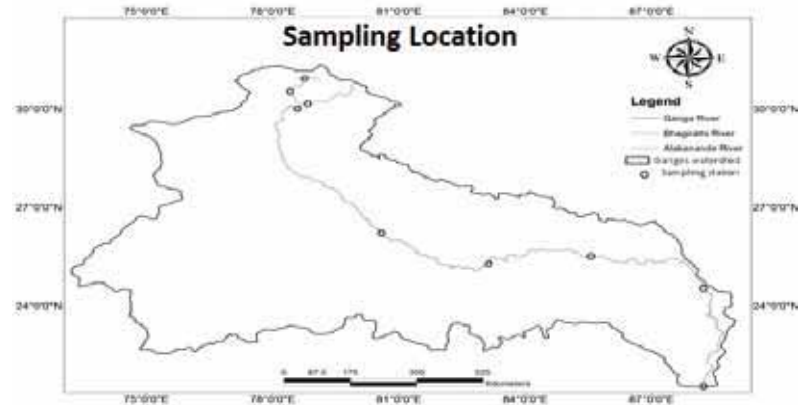
- Project also assessed the possible influence of climatic and hydrologic drivers (in particular glacier melting and precipitation) expected to have an impact on releases, exposure and fate of environmental contaminants for the water ecosystem.
- Links between climate and water borne contaminants were characterized to explore the possible implications for human exposure through water use (drinking water, irrigation, fisheries and fish farming).

### Project Results:

Chemical analysis of river water samples at different locations across river Ganga established profile for POP concentration in the river water. Also, a higher concentration at the headwater locations of river Ganga indicated that glaciers could be the potential contributor of POP flux in the river.

### Stakeholders/ Beneficiaries:

Central Pollution Control Board, Ministry of Water Resources, River Development & Ganga Rejuvenation, State governments etc.







# Groundwater Management





## Special Studies for Sustainable Groundwater Management in Urban Area of Lucknow Groundwater Department, Uttar Pradesh

**Sponsor:** Uttar Pradesh Ground Water Department

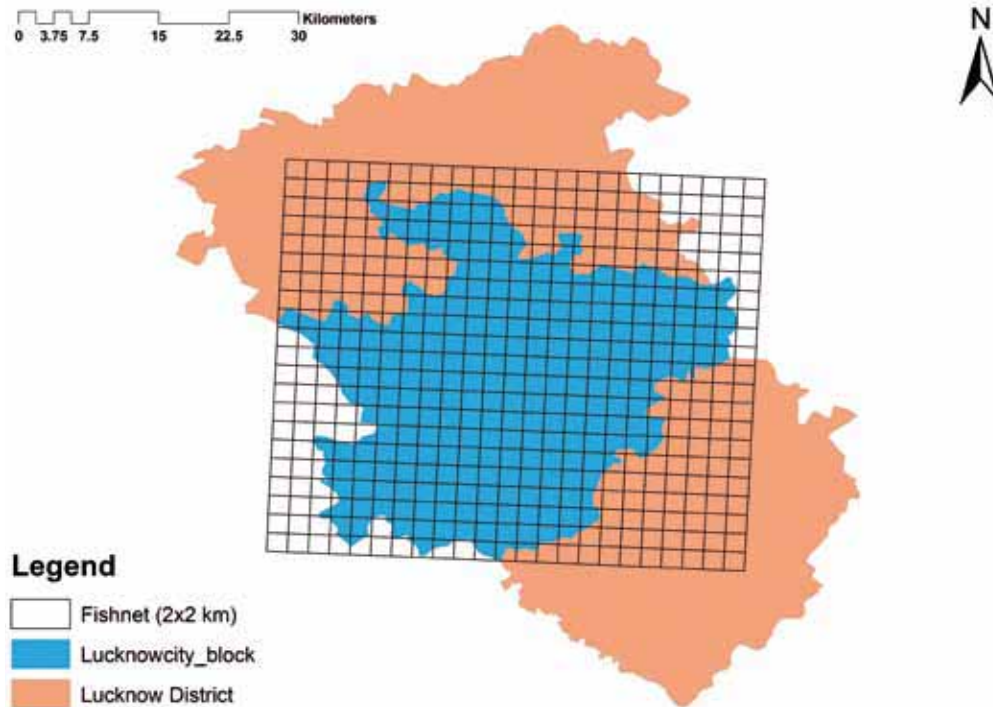
**Partner:** Department of Geology, Delhi University

**Study Area:** Lucknow city

### **Aim and Objectives:**

- To assess groundwater resources within urban limits of Lucknow City through assessment of availability, demand, extraction, and uses in different sectors.
- To estimate the overall contribution of groundwater to Lucknow's economy

- To assess groundwater contribution in meeting the drinking water demand in the different areas
- To project the Groundwater quality dynamics and its impact on health and environment.
- To project different groundwater development scenarios using computer model for next 10 years.
- To provide recommendation for improved groundwater management and governance involving all the different stakeholders



### Key Activities:

Tasks under the project have been distributed into 6 workpackages:

- Workpackage 1: Geo-spatial Investigations
- Workpackage 2: Hydrogeological Investigations
- Workpackage 3: Socio-economic Investigations
  - WP 3A: Groundwater Utilization Survey
  - WP 3B: Economics of groundwater
- Workpackage 4: Groundwater Quality Assessment
- Workpackage 5: Policy and Regulatory Assessment
- Workpackage 6: Consultation and workshops

### Expected Outcomes:

- Development of Sustainable groundwater management plan for the city of Lucknow





# Infrastructure and Resources



TERI is an organization of high repute that works to move human society towards a sustainable future. With staff strength of around 850, drawn from multidisciplinary and highly specialized fields, offices, and regional centres equipped with state-of-the-art facilities, and a diverse range of activities, TERI specializes in providing research based solutions that ensure sustainability of natural resources like water. Besides providing suitable technological solutions, TERI, through its strong outreach network, expertise and field experience undertakes implementation projects and ensures sustainability through stake-holders participation. Such stakeholders include people from various sections of society including Government bodies, water supply managers, manufacturers, engineers, planners and policy makers, corporates, urban and rural communities, NGOs, students & youth groups, etc.

## State-of-the-art Laboratories

TERI has state of the art ISO 9001:2002 certified and EPA recognised Water & Environment laboratory to carry out independent research and analytical support for projects undertaken. The laboratories are well equipped with highly sophisticated state-of-the-art instruments like Gas Chromatograph (GC), GCMS, High Pressure Liquid Chromatograph (HPLC), Atomic Absorption Spectrophotometer (AAS), Ultraviolet Spectrophotometer, Metal Analyser, Total Organic Carbon (TOC) Analyser, High Volume Samplers, Ultrasonic flow meters, Current meters etc. These laboratories are well placed to undertake the monitoring of flows and water quality analysis for water, soil, solid waste and air, as required by national and international protocols.



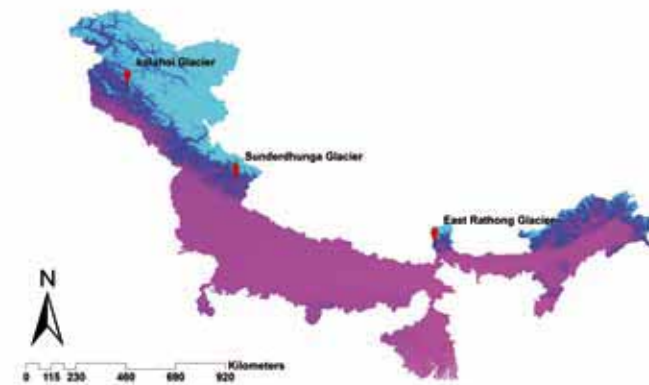


## Glacier Observatories in Himalayan Region

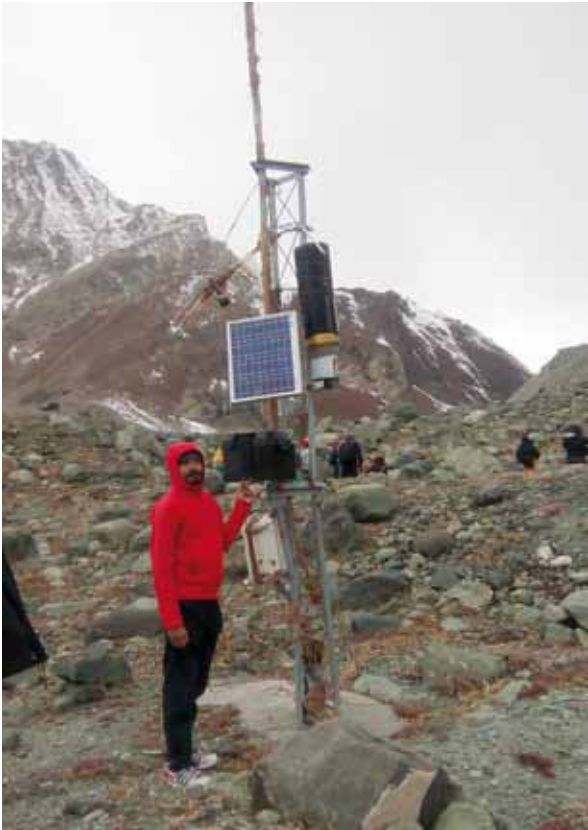
The Himalayan cryosphere ensures the continuous supply of water in the Himalayan river channel especially during the dry months; they also serve as a sensitive indicator to climate change. However, this source of water is not permanent as the Himalayan cryosphere is threatened by a changing climate. The extent of the impact of these changes in the cryosphere resources is still not well known. Therefore, it is important to monitor and assess the state of cryosphere and to assess the sustainability of glaciers in view of changing global scenarios of climate and water security of the nation. Field based information pertaining to Himalayan glaciers is limited as the harsh weather and rough terrains limits researchers to regularly conduct experiments and collect data. The lack of field based information had motivated TERI to establish 'Glacier Observatories' at 3 different locations in the Himalaya (covering the Western, Central and Eastern Himalaya) at altitude of > 4000 m from mean sea level and have developed expertise in measuring glacier dynamics.

### Glacier Observatory Locations

- Kolahoi Glacier, Liddar river basin, Jammu & Kashmir,
- East Rathong Glacier, Teesta Basin, Sikkim
- Sunderdhunga Glacier, Sunderdhunga river basin, Uttarakhand



Glacier Observatory Locations in Himalaya



**Hydro-meteorological Stations**



List of Instruments		
Glacier Sites	Instruments	Work specification
Sunderdhunga Glacier, Uttarakhand	Pluvio	Snowfall measuring and other Climatic Parameters
	AWS	Measuring as Climatic Parameters
	Tipping Bucket	Rainfall Measuring
	TidbiT V2	Temperature Recorder
	Davis AWS	Climatic Parameters in low altitude region
East Rathong Glacier, Sikkim	Water Level Recorder (WLR)	Water level recorder for glacier originated river
	Pluvio	Snowfall measuring and other Climatic Parameters
	AWS	Measuring Climatic Parameters
	Tipping Bucket	Rainfall Measuring
	TidbiT V2	Temperature Recorder
Kolahoi Glacier, J&K	Davis AWS	Climatic Parameters in low altitude region
	Water Level Recorder (WLR)	Water level recorder for glacier originated river
	Pluvio	Snow Fall Measuring and Climatic Parameters
	Water Level Recorder (WLR)	Water level recorder for glacier originated river
	AWS	Measuring Climatic Parameters





November 2018

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Dr. Gajja K. Khuntia, Director, TERI, New Delhi  
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**India Water Forum**

## India Water Forum: An International Water Convention

The Energy and Resources Institute (TERI), in association with the Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India, organizes the India Water Forum (IWF), an international water convention to attract diverse perspectives on issues related to ensuring water security for billions of people in India and South Asia.

### 1st India Water Forum

The 1st India Water Forum was organized in April 2011 on the theme: 'Water Security and Climate Change: Challenges and Opportunities'. It focussed on various issues related to dynamics of water in the purview of climate change impacts in the region. The theme of IWF 2011 has great significance even in today's world as climate change, being a global phenomenon, calls for collective action and knowledge sharing across countries. The aim of IWF 2011 was to explore vast opportunities in developing technically viable and economically feasible solutions for sustainable governance and management of water resources. The convention received the enthusiastic response from policy makers, industrial experts, researchers and water practitioners who presented their ideas on the challenges of climate change for water security and opportunities. Discussions, debates and dissemination of information by various water sector stakeholders presented new eco-friendly and sustainable strategies and technologies in this sector.

The key speakers during IWF 2011 were Dr Colin Chartres-Director General – International Water Management Institute (IWMI); Mr Ganesh Pangare-Coordinator, IUCN, Asia; Dr Mats Eriksson Project Manager Stockholm International Water Institute, Stockholm; Dr Eddy Moors, Team Leader, ALTERRA Wageningen University and Research Centre, The Netherlands; Dr Dipak Gyawali, Nepal Water Conservation Foundation and Former Minister Water Resources; Prof. Damia Barcelo, Head, Environmental Chemistry Department, University of Portsmouth, Barcelona, Spain etc.

### 2nd India Water Forum

The 2nd India Water Forum was organized in October 2013 on the theme of 'Water Use Efficiency' which was identified as the most promising approach for ensuring water security. The improvement of water efficiency requires structural changes in the policy and governance structure through innovative tools of promotion, and incentives for efficient water utilization, while



simultaneously, dealing with inefficient water consumption through taxes, disincentives, and tariffs. The aim of IWF 2013 was to develop a blue print for an effective mechanism necessary to achieve the objectives of water efficiency. IWF 2013 attracted rich deliberations on aspects related to water use efficiency, to develop a consensual understanding on the water use management through a series of interactive sessions with policy makers, industrial experts, environmentalists, researchers, academicians, students, and the general public.

The key speakers in IWF 2013 were Dr William Young, Lead Water Resource Management Specialist, The World Bank; Dr Robert Carr, Deputy CEO of eWater, Australia; Shri R D Singh, Director, National Institute of Hydrology, Roorkee; Professor Dr Hector M Malano, Department of Infrastructure Engineering, University of Melbourne, Australia; Mr Surinder Makhija, Jain Irrigation, New Delhi; Dr Arjen Hoekstra, Professor, Water Management, University Of Twente, The Netherlands, etc.

### 3rd India Water Forum

In April 2016, TERI organized its 3rd India Water Forum with the theme of 'Water for Sustainability: Towards Development and Prosperity'. The forum focused on the inter-linkages between water security and economic prosperity of the country. The forum worked to identify challenges related to ensuring the adequate quantities of acceptable quality water, which could be acting as bottlenecks for rapid and sustainable socioeconomic development of the country. The forum also explored solutions and implementation pathways that could transform water availability scenarios from a stressor to a catalyst in rapid growth of country's economy. As some conventional approaches to water management often fall short of the goals, there is a need to alter the compartmentalized approach to water management. The forum envisaged to give momentum to new holistic approaches that can improve the integration of water into socio-economic development.

The key speakers in IWF 2016 were Prof. Vinod Tare, Indian Institute of Technology, Kanpur; Dr Kees Bonns, Deltares, TL Strategic Basin Planning for the Ganga Basin in India Project; Dr Arvind Kumar, President, India Water Foundation; Shri A B Pandya, Former Chairman, Central Water Commission; Mr. Justin, Director – Habitat for Humanity India; Mr. Harbs Bains, Senior Manager, Clean Technology, Government of British Columbia, etc.



## 4th India Water Forum

4th India Water Forum is being organised in March 2019, with a broad aim of sharing knowledge on water resources management, facilitating water availability for all in a safe and sustainable way. IWF will provide the stage to highlight current and future water related issues and recognize good water governance practices and solutions through discussions among water experts from various fields such as academics, research, policy, industry and civic society.



**Partnerships and Networks**

# Partnerships and Networks

<b>Governments</b>		
<b>Partner</b>	<b>Focus Area</b>	<b>Type of Association</b>
Central Pollution Control Board	Wastewater	Funding
Delhi Jal Board (DJB)	Wastewater	Funding
Department of Drinking Water, Government of Uttaranchal	Water and sanitation, capacity building	Funding
Embassy of Israel	Water Use Efficiency	Funding
Finnish Meteorological Institute	Meteorology	Funding
Global Innovation & Technology Alliance	Water use efficiency	Funding
Ministry of Rural Drinking Water and Sanitation	Water and sanitation, capacity building	Key resource centre
Ministry of Water Resources, RD & GR	Water use efficiency	Funding
National Mission for Clean Ganga, Ministry of Water Resources, RD & GR	River basin management	Funding
National Thermal Power Corporation Ltd.	Water Audit, Water Use Efficiency	Funding
National Water Mission, Ministry of Water Resources, RD & GR	Water use efficiency	Funding
NITI Aayog	Water energy	Funding
Northern Railways	Water audit	Funding
The Norwegian Ministry of Foreign Affairs	Climate change, water, energy	Funding
Himalayan Mountaineering Institute, Darjeeling	Logistics Arrangement	Logistics Partner
Jawahar Institute of Mountaineering and Winter Sports (JIM&WS)	Logistics Arrangement	Logistics Partner
District Disaster Management Authority, Almora	Environmental Research	Collaborative Research

<b>Research and Academic Institutions</b>		
<b>Partner</b>	<b>Focus Area</b>	<b>Type of Association</b>
Australian Center for International Agricultural Research	Agriculture research and water management	Funding
Indian Institute of Tropical Meteorology (IITM)	Climatological studies	Collaborative research
International Water Management Institute (IWMI)	Research on water issues	Collaborative research
Monash University, Australia	Hydrology	Collaborative Research
Mountain Research Initiative, Switzerland	Mountain Ecology	Collaborative Research
Norwegian Institute of Water Research Niva, Norway	Water research, sectoral studies	Collaborative research
Norwegian Water Resources and Energy Directorate, Norway	Cryospheric hydro-metrological modeling	Collaborative research
Research Council of Norway	Climate change, environment and Persistent Organic Pollution (POPs)	Funding
Third Pole Environment, China	Mountain Ecology	Collaborative Research
University of Melbourne, Australia	Hydrological and basin assessments	Collaborative research
Icelandic Meteorological Office, Iceland	Envrionmental Research, Glacier Research, Climate Change	Collaborative research
International Centre for Integrated Mountain Development (ICIMOD)	Envrionmental Research, Glacier Research, Climate Change	Collaborative research
Norwegian Meteorological Institute, Norway	Envrionmental Research, Glacier Research, Climate Change	Collaborative research
Iceland University of Iceland	Envrionmental Research, Glacier Research, Climate Change	Collaborative research
Jawaharlal Nehru University (JNU)	Envrionmental Research, Glacier Research, Climate Change	Collaborative research
Finnish Meteorological Institute, Finland	Envrionmental Research, Glacier Research, Climate Change	Collaborative research



<b>Research and Academic Institutions</b>		
University of Helsinki, Finland	Environmental Research, Glacier Research, Climate Change	Collaborative research
Sikkim University	Environmental Research, Glacier Research, Climate Change	Collaborative research
University of Kashmir	Environmental Research, Glacier Research, Climate Change	Collaborative research
G.B. Pant National Institute of Himalayan Environment & Sustainable Development	Environmental Research, Glacier Research, Climate Change	Collaborative research
University of Delhi	Environmental Research, Glacier Research, Climate Change	Collaborative research
British Antarctic Survey, UK	Environmental Research, Glacier Research, Climate Change	Collaborative research

<b>Banks and financial institutions</b>		
Partner	Focus Area	Type of Association
Asian Development Bank (ADB)	Water Demand Management	Collaborative research
The World Bank	Water and sanitation	Funding

<b>Domestic and multinational corporates</b>		
Partner	Focus Area	Type of Association
BASF	Water Audit	Funding
United Breweries Limited	Water conservation	Funding
Coal India Limited	Sanitation	Funding

<b>Domestic and multinational corporates</b>		
GlaxoSmithKline Pharmaceuticals Ltd.	Water Foot printing	Funding
International Tobacco Co. Limited	Water auditing	Funding
Jain Irrigation Systems Ltd	Irrigation water use efficiency	Partner
L'Oreal	Water Audit	Funding
Matsue Doken Co.,Ltd., Japan	Water quality	Funding
WIPRO	Water Audit	Funding
Cenergist	Energy efficiency	Partner

<b>Bilateral and multilateral organization</b>		
<b>Partner</b>	<b>Focus Area</b>	<b>Type of Association</b>
Department for International Development	Industrial water use	Funding
UNDP	Environment	Funding
UN-HABITAT	Water demand management	
UNICEF	Climate Change, Water and Sanitation	Funding
USAID	Water and sanitation, gender equality, agriculture	Funding
Research Council of Norway (RCN)	Climate Change, Water, Environment	Funding
Department for International Development	Climate Change, Water, Environment	Funding
International Development Research Centre	Climate Change, Water, Environment	Funding

<b>NGOs/Foundations/PSUs</b>		
<b>Partner</b>	<b>Focus Area</b>	<b>Type of Association</b>
India Water Partnership (IWP)	Water resource management	Funding
INTACH	Water quality	Funding
NTPC Energy Technology Research Alliance (NETRA)	Water Use Optimization	Collaborative Research
SaciWaters	Water Research	Knowledge Partner
The Shakti Sustainable Energy Foundation	Climate policy, energy efficiency. power	Funding



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